Sound Watershed Consulting
Creating Functional Water Environments

DRAFT TECHNICAL MEMORANDUM

TO: BOARD OF FORESTRY

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SUBJECT: T&I LITERATURE REVIEW PRIMER

DATE: 4/30/08

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This document describes several aspects of our preliminary review of the primers and key questions associated with the Scientific Literature Review Project. In the sections below we:

1. Document the results of our review of the primer for each Riparian Exchange Function,
2. Justify a revised structure to the Key Questions that will support our synthesis process, while establishing a context for clarifying and simplifying the Key Question responses,
3. Outline some additional literature that we might consider for the primers and/or literature reviews, and
4. Describe our approach to revising the Literature Review Documentation Form (Appendix G) *[draft version to be delivered separately]*

TASK 1.1 PRIMER REVIEW

The Primers vary considerably in structure, thoroughness, and apparent intent. Some of the primers have enough information with the associated initial list of literature to answer many of the Key Questions and some do not. In this section, we offer general comments that clarify, refute, or add relevant information contained in the Primer.

It is clear that the goals for riparian buffers are not consistent among the primers even though the Introduction states "The initial focus of riparian Forest Practice Regulations is to limit or avoid significant impacts to existing riparian function and habitat regardless of specific salmon species needs". For example, the goal of the biotic primer is to identify buffer characteristics that will achieve "desired conditions" to produce invertebrate prey for juvenile salmonids which is an in-

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stream biological target. Whereas, the goal for sediment primer is to identify buffer characteristics that will "ameliorate sediment production" which is a riparian target.

Some primers have in-stream (heat) and riparian (wood) targets. Some goals are described as avoiding impacts and some are described as supporting some desirable condition. The goal for the water primer is not clear, as hydrologic effects typically extend well beyond the riparian zone to road and harvest issues, and riparian effects alone are typically beyond the ability to measure. We recommend that the goal and intent of riparian management be clearly stated and consistent among all primers.

The role of disturbance is a key riparian ecosystem function that is not sufficiently considered in the existing primers, yet has a significant influence in the function of all five riparian exchange functions described by the primers. Forest management activities not only assert direct influences (e.g. harvest, roading, etc), but also has indirect effects on the patterns of natural disturbances like fire, blowdown, infestation and disease. Since these disturbance process are a primary factor in how each riparian exchange function evolves over time, we suspect that they should be considered during the rule-making process.

WATER

The Primer on Water is a good summary of what we know (or think we know) about forests and the runoff hydrograph. It highlights that the biggest gap in our understanding is found in the headwater channel areas that are strongly influenced by the variable source area concept. As the concept name implies, these processes are variable in both space and time, suggesting that Key Question 2 can never really be resolved (answer: it varies).

The term "forest management activities" is used in several of the questions, and can include a multitude of activities, which vary by region. The simple answer to Key Question 1 is "Yes, depending on…". The trick is to make the leap from site-specific studies to regional generalizations that take account of vegetation, hydrology, etc. For example, large clearcuts may be hydrologically important in the rain/snow transition zone, but not so important in the rainfall zone.

While the literature review may yield some insight, many of these regional variations have not been well studied, and literature resources are often unavailable. In other cases, the information to support the question can be found within literature used in the primer, but not assigned to the SWC Team. For example, key question 1.b) concerns effects of canopy on evaporation and interception. The Reid and Lewis (in press) paper addresses this issue and is included in the Primer, but is not included in our list (perhaps because it doesn't focus on riparian effects, but upslope effects). A recent unpublished study in the Tahoe basin (by the US Forest Service Lake Tahoe Basin Management Unit) shows how tree harvest in riparian zone can decrease hydraulic conductivity.

While the hydrologic functions are important ecological processes, it's not clear that the literature will support basing any riparian zone designs on hydrologic issues alone. For example, Key Question 2 relates to the buffer zone width issue, but can only be answered as it relates to other riparian functions. As such, we suspect the primary value to the literature review of the Water Riparian Exchange Function will be to support synthesis questions that integrate water with issues of channel stability (sediment), nutrient cycling, and aquatic communities in headwater channels.

SEDIMENT

The sediment primer is a very broad discussion of sediment in a general context. It covers all types

of sediment-related issues including mass wasting, sediment sizes, suspended sediment, turbidity, bedload, effects on aquatic life, types of erosion, roads, etc. Much of this Primer is ancillary to the key questions about the production, transport and storage of sediment associated with riparian forests. Nevertheless, some of the overview information is helpful.

The sediment effects summary provides an adequate assessment of the potential impacts on salmonids for different life stages. The summary has minimal information on impacts to macroinvertebrates and no information on other aquatic life (e.g., primary production or amphibians). One could argue that protection of salmonids at all life stages is probably adequate to protect other aquatic life, but this assumption would need to be qualified. Many amphibians are found in non-fish baring headwaters. Therefore, the potential differential effects of fine sediment in headwaters versus downstream may need to be addressed. We recognize that this has been an area of extensive scientific debate in recent years.

The section entitled "What we do not know or do not yet agree on" contains questions that may best be answered with a systematic monitoring and adaptive management program. We suspect that the literature may provide some insight into these questions, but we question if the literature can be conclusive.

An important sediment issue that is not addressed is the question of; how much sediment is too much for aquatic life? The suspended sediment standards, natural levels, and aquatic responses (e.g., fish feeding and growth; see White and Harvey 2007) should be addressed as well as population scale impacts (e.g., Allen and MacNeill 2004). More research is needed in these areas to provide a biological context for planning and developing meaningful performance targets.

WOOD

Overall, the Wood primer states a number of generally recognized principles about wood recruitment, storage and stream effects based on a couple of recent review papers. However the points made are somewhat disorganized. The primer may rely a bit too much on two review papers and as such, it misses some key points. For example, the primer fails to describe the role of "chronic mortality" (i.e. competition and senescence) and other natural disturbances (e.g. fire, infestation, disease) as a primary source of woody debris in certain locations. The wood primer inadequately relates the information to various California landscapes and forest management.

We would find this Primer more helpful if it followed a structure similar to the Heat primer, where a set of bullets are used to outline the key aspects of wood recruitment and storage that have ramifications for regulatory purposes. We might suggest organizing the primer by topic, using a wood budget approach as a central organizing framework for the input, storage and output of wood to streams (e.g. Benda & Sias 1998). Describing how these topics/characteristics vary spatially across the landscape (region) and within watersheds (headwaters to mouth) would be an especially important consideration in support of rule-making. As it stands now, this will need to be done during the literature review process that attempts to answer the key questions.

The wood primer makes a few claims that we would disagree with. For example, the primer states "wood plays a disproportionate role in small (headwater) streams" yet we might argue that wood in headwater channels prone to debris flows may be more important compared to headwater streams that are not prone to debris flows. Or wood may be important in headwater streams in terms of sediment storage (although small wood may act similarly to large wood in larger streams).

The primer only implicitly recognizes the importance of spatial variability as a core

principle. For example, the overview of landslides or snow avalanches processes as sources highlights just one area of spatial variability in recruitment process.

There are also a number of oversimplified and potentially misleading conclusions in the Primer, for example "..second growth forests must grow at least 50 years before trees contribute LWD in sizes and amounts similar to old growth forests" (pg. 28). Similarly, the statement that "in moderate to high gradient streams, logs play an important role in bedload storage…" ignores the often low amounts of wood in high energy channels and the risk of dam-break floods that often occur in high-gradient streams.

The discussion on the affects of riparian management on wood recruitment (quantity, size, species) on a spatial (source distance, network location) and temporal (short and long-term) basis needs significant revision and additions. Nearly all of referenced material is older than 2000. Since then there has been a number papers addressing wood processes and management effects (e.g., see Gregory et.al 2003) and several from CA (e.g. PALCO Watershed Analyses).

HEAT

The format of the Heat primer is appealing – simple objective statements may be more easily understood by non-technical readers. It is generally well-organized and comprehensive. There are some minor statements that have lost some important distinctions, primarily as result of simplifying the statement. For example, on page 58 the statement that "forest canopies affect the microclimate…because canopies intercept the transmission of radiation" is partly correct. With regard to microclimate, the canopy's greater role is in regulating advective exchange of air. Similarly, the statement that "much of the change in microclimate takes place within about 1 tree height of the edge" generally applies to the edge effect created by clearcuts, and may not apply to other management methods.

Buffers can effectively mitigate the impact of stream heating. On page 71, statement 5 [regarding clearcut effects on stream temperature] might be interpreted to imply that clearcuts increase stream temperatures even with riparian buffers. This statement should be clarified.

There are two sections with similar titles (page 116 "Temperature Patterns and Salmonid Species Distribution Within Watersheds" and page 119 "Fish Species Distribution Within Watersheds") where the discussion confuses and mixes the differences between landscape scale (regional patterns) and watershed scale (within watershed) patterns of temperature, species, and fish use. We recommend that the titles and corresponding text be revised to differentiate these spatial scales. More discussion is needed on spatial patterns of fish use relative to temperature within watersheds. Fish movement patterns and timing of habitat use within watersheds is closely related to temperature and food availability. Therefore management effects on temperature and potential fish use will depend on location (see Welsh et. al 2001, Ebersole et. al 2006).

Some discussion that addresses (links) physical and biological temperature sensitivity for evaluating or planning management impacts on temperature would also be useful (e.g., Neiltz et. al. 2007).

BIOTIC & NUTRIENTS

The structure of this Primer is somewhat different than the others because the introductory statement basically outlines a hypothesis that biotic and nutrient riparian influences are a good predictor of stream ecosystem health and the condition of salmonid populations, and therefore

that riparian management has the potential to sustain and/or enhance these salmonid populations. Our comments address the underlying rationale for this hypothesis.

There are at least three areas of important linkages to the other Exchange Functions. First, the hyporheic zone, especially in alluvial stream systems, plays an important part in water quality control. It is sometimes a zone of denitrification, and thus may reduce nitrate concentrations in surface stream water. It may also be a source of soluble phosphorus. These functions are mentioned briefly in the Water section, but need to be integrated with the Nutrient section.

Second, the mix of species in a riparian zone influences the quality of litter and FPOM ("fast" or "slow") and thus is an important factor in food supply for juvenile salmonids. But the mix of species and age classes also influences the future supply of LWD and stream temperature, issues which are addressed in other sections.

Third, Question 7 concerns the width of buffer strips needed to assure a good supply of terrestrial insects and FPOM to the stream. Buffer strip width and management intensity within the buffer zone also have a strong influence on stream shade (and thus water temperature), and on available supply of LWD. Our synthesis efforts will seek to cross-reference these issues between Exchange Functions.

The statement that "management actions that shift the periphyton to domination by filamentous forms" may be true for agriculture and urban areas, but we question if this impact has been documented for forest management in nutrient limited mountain streams? A reference to qualify this statement would be helpful. As presented, this might overstate the probable impact.

The statement "Increase of nutrients and light, especially if combined with the deposition of fine sediments, can favor the development of rooted vascular aquatic plants" needs context for interpretation. This potential hazard needs to be qualified with respect to the geomorphic channel type (i.e., low-gradient palustrine channels with silt bottoms) where this condition could occur. What is the relative occurrence of these channel types on forest lands. Generally, this condition is more likely for areas downstream of forest lands where agriculture and urbanization have greater influence on nutrients, light, sediment. As presented, this tends to overstate the probable impact.

The statement that "Terrestrial invertebrates also constitute transfers from the riparian area into the stream ecosystem" is supported by the cited literature. However, the implied assumption that riparian vegetation composition influences terrestrial invertebrate abundance and composition should be qualified.

The relative importance of different invertebrate types and sources to fish consumption by season needs elaboration. For example, these statements" Aquatic invertebrates are more abundant in the winter and terrestrial forms are more abundant in the summer in juvenile salmonid diets" and "These two invertebrate groups (filtering and gathering collector invertebrates) contain the most important prey items for juvenile salmonids (Wilzbach et al. 2006)" tend to over simplify the invertebrate supply and fish feeding relationships. Food consumption is driven by food availability and temperature which changes by season and stream flow. Recent research shows annelids may be very important during winter high flows (White and Harvey 2007) and terrestrials become important during summer low flows (e.g., Romero et. al 2005). Also, the effect of season depends on location in CA (e.g., Hayes et. al 2008).

The statement that "These cumulative effects from small headwater streams to larger tributaries constitute an important delivery system to juvenile salmonid populations down stream (e.g. Wipfli and Gregovich 2002, Wipfli and Musselwhite 2004) and constitute a basis for their protection

(Cummins and Wilzbach 2005)" needs qualification and context. The implied assumption that organic export and food supplies from headwaters are a significant component of downstream fish food has not been validated. The often cited study by Wipfli (2005) only estimates the potential export. Research by Danehy (unpublished) suggests that travel distance of invertebrate drift in headwater streams is relatively short and may not contribute greatly to downstream fish food supply. We are not aware of any research that validates utilization of headwaters invertebrate export by downstream fish populations.

CONSIDERING OUR APPROACH TO THE KEY QUESTIONS

Our review of the primers raises several issues about the role of the literature review project toward informing the overall rule-making process. The primers will offer useful background information to policy-makers. However, the nature and structure of the Key Questions varies among primers and consequently affects the level of inquiry. Some questions direct us toward teasing out the details associated with variation within each Riparian Exchange Function, some are overly broad, and some do not reflect the knowledge contained within the primers. We're concerned about finding the right level of detail that will inform the rule-making process and not yield too much complexity or compromise the utility of this project. We believe that a balanced inquiry may be obtained by restructuring the key question within a common format and by describing a synthesized scientific framework that is supported by the existing literature.

We have developed a set of refinements to the Key Questions to help focus our efforts during the literature review and synthesis process in ways that we believe will improve the rule-making results. We've attempted to outline some of the more specific refinements for each section below. We also suggest that more effort toward structuring our synthesis process, including appropriate synthesis literature, might help bring these issues together.

To set the context for the changes to the Key Questions, we first describe our thoughts about how we'd like to structure the synthesis.

STRUCTURING THE SYNTHESIS

The SWC Team would like to engage the TAC in a discussion about how we might approach synthesis, and specifically, how we might balance our workload between the Key Questions and Synthesis tasks. Our original proposal assumed a very modest effort toward synthesis, largely because the level of effort to address the Key Questions is quite large. However, after review of the primers and more detailed assessment of the Key Questions, it has occurred to us that the Board may be better served by more focus toward synthesis, even if it reduces the level of detail associated with each individual Exchange Function.

We feel that this is driven in part by the highly analytical nature of the Key Questions, which tend to isolate extensive detail for each Exchange Function. Each set of questions seeks to break down each riparian exchange function into a complex series of component factors. Each level of increasing detail will undoubtedly uncover more complex interactions, variations, and exceptions. As presented to the SWC Team, the TAC has proposed 48 broad questions (or subquestions) to be answered by our review. Within each question are 5 additional inherent questions regarding regional variation, stream size, management impacts, salmonid responses, etc. Despite the comprehensive effort necessary to review these articles, we can't help but wonder if a focus on each varied components of the Key Questions will uncover more new uncertainties than can be resolved. In other

words, we suspect that answers to Key Questions might increase the level of complexity associated with rule-making.

We see the synthesis process as bringing these issues back toward an integrated and more manageable set of issues. One of the roles of synthesis is to highlight the spatial variable components associated with riparian processes. Answers to the key questions are going to be sensitive to variability at the CA regional scale, and also at the watershed scale involving stream order, stream class, topography, hydrologic regime, and climate etc.

As such, we would like to create a framework for synthesis that considers the literature in the context of the latest concepts that stress the occurrence and ecological importance of spatial variability and dynamics. And, as a practical matter, the answers for many of the key questions will presumably depend on where one is located both geographically and within individual watersheds: in-stream wood is more important here and less important there; a large buffer for temperature sensitivity is needed for this stream but not for another etc. This approach will take us down the path to a process-based riparian protection system that depends on various watershed-specific factors. It is also an approach that aligns itself with emerging scientific views of CWE (e.g., spatially explicit stochastic modeling [Dunne 1999]) and other regulatory mechanisms (TMDLs, PFCs).

In our experience, one of the dominant trends in recent literature is the importance of spatial heterogeneity and dynamics that are replacing older concepts characterized by spatial homogeneity and de facto steady state. In part, uniform one-size fits all riparian buffers reflect what some might consider dated concepts: spatial homogeneity and steady state. For example, past fire suppression tactics reflected this concept (disturbance is bad, uniform forest cover is good etc.).

The TAC and the BOF are interested in considering the role of regional variability in each of the Riparian Exchange Functions. In terms of this project, we anticipate that it may be very difficult to address the "it depends on where you are" issue for each of the key questions without exponentially increasing the variations associated with each question. We suggest that the place to address such variability is in a synthesis process, where scale and interdependence of Exchange Functions will be considered.

It would seem, however, that variability could be potentially as strong (if not stronger) at the scale of individual watersheds. Thus the spatial variability argument is valid at any scale. Regarding the conceptual and/or analytical basis for considering spatial variability in watershed processes, regional versus small-scale controls imply a similar scale of variability. That is, if one constructed a conceptual model for say wood recruitment to streams (or any of the other exchange functions), all levels of scale variability would be encompassed. These might include regional to watershed scale controls on ambient air temperature, vegetation type, and reach-scale controls on topographic shading and stand densities etc.

For example, recent evidence about the role of uniform riparian buffers creating opportunities and pathways for fire leads us in the direction of dynamics. Management actions within or near riparian areas are just one of many forms of disturbance that affect the evolution of the riparian stand. As management increases risks for some ecosystem processes, it also reduces risks in others, and it is the sum of effects that controls the outcome.

We understand that the TAC would like us to evaluate the effectiveness of managing for a desired condition (e.g., enhance salmon production). Such a shift in thinking from a "protection" mindset to an "ecosystem processes" mindset is consistent with several general themes in the literature in recent years. So, for example, instead of considering the width of a riparian zone that is necessary to protect existing functions and processes, we would explore landscape-scale forms of variability that

can more effectively support salmonid requirements. We suspect that this might lead to science-based criteria for effective riparian management that can better inform the policy deliberation.

REVISED KEY QUESTION STRUCTURE

To support this line of thinking, the SWC Team has developed a revised framework for the Key Questions and Synthesis activities that we describe in more detail in the section below. Using this approach would provide a consistent format for how we formulate answers that crosses all Exchange Functions, and would provide a context for rule-making that we believe would be significantly simpler for both policy-makers and professional foresters.

We attempted to retain most of the intent behind the Key Questions that were proposed by the TAC. Our revised framework provides a common structure by reorganizing and/or restructuring the Key Questions. For example, we divided compound questions into separate parts, and in some cases combined similar questions into a single theme. The revised structure for each of the Key Questions includes:

- **Overarching Question** - addresses the broad influence of forest management activities on each riparian exchange function.
- **Scale Questions** – these questions frame the variability that occurs for each exchange function in a spatial context
    - Site Scale Questions
    - Watershed Scale and Processes Questions
    - Geographic and Landscape Scale Questions
- **Ecosystem Process Questions**
    - **Disturbance** –addresses those natural disturbance processes that are affected by management actions in or near the riparian communities. We note that we may want to address disturbance within answers to the watershed scale and eco-region questions.
    - **Management** – addresses the direct role of management on riparian functions
- **Synthesis Questions** – addresses those dynamic interactions that occur among and between specific exchange functions. The SWC Team may develop additional Synthesis Questions as the literature review proceeds.

WATER KEY QUESTIONS

OVERARCHING

- Can management in riparian zones sufficiently affect hydrologic conditions in the watershed?

SITE SCALE QUESTIONS

- How do forest management activities or disturbances in or near riparian zones/floodplains and adjacent to small headwater first and second order channels affect flow pathways and streamflow generation?

WATERSHED SCALE & PROCESS QUESTIONS

- Have forest management activities in riparian zones for higher order channels with floodplains and adjacent to small headwater first and second order channels[1] been shown to alter water transfer to stream channels, affecting near-stream and flood prone area functions (e.g., source area contributions to stormflow, bank instability, lateral and vertical channel migration, flow obstruction or diversion of flow)?

- Have forest management activities in riparian zones for higher order channels with floodplains and adjacent to small headwater first and second order channels been shown to result in changes in tree canopy/volume that significantly affects evapotranspiration and/or interception, with resultant changes in water yield, peak flows, low flows, etc.?

GEOGRAPHIC & LANDSCAPE-SCALE QUESTIONS

- What (if any) are the regional differences in the effects of forest management or disturbances in or near the riparian area/zone on the water transfer riparian function?

DISTURBANCE QUESTIONS

- How are natural disturbances different from forest management activities with regard to hydrologic response?

MANAGEMENT QUESTIONS

- Can forest management activities in riparian areas alter water yield, peak flows, or low flows sufficiently to affect channel morphology or the aquatic ecology of headwater streams?

- Can forest management activities alter water quantity in riparian zones for higher order channels with floodplains sufficiently to affect overflow/side channels that serve as refugia for fish during floods?

- Do forest management activities in riparian zones for higher order channels with floodplains and adjacent to small headwater first and second order channels significantly affect hyporheic exchange flows?

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[1] I just realized that the phrase "riparian zones for higher order channels with floodplains and adjacent to small headwater first and second order" is ambiguous. It could refer to a very specific geomorphic situation, where a small first or second order stream cuts across the flood-plain of a large river. Or, it could mean: "…1) riparian zones for higher order channels with floodplains, and 2) riparian zones adjacent to small headwater first and second-order channels…" We need to clarify the meaning of this question. If the second interpretation is correct, is might more simply say "riparian zones".

SYNTHESIS QUESTIONS

- What bearing do the findings of the reviewed articles have on riparian zone buffer strip delineation (area influencing water transfer/exchange function) or characteristics (cover, plant species and structure, etc.)?

SEDIMENT KEY QUESTIONS

OVERARCHING

- How do forest management activities or related disturbances in or near the riparian zone affect erosion and delivery of sediment to streams?

SITE SCALE QUESTIONS

- How effective are riparian buffer practices in mitigating sediment impacts to local and downstream reaches?

WATERSHED SCALE & PROCESS QUESTIONS

- By what mechanisms is sediment: produced, delivered and stored from riparian areas?
- How do these processes vary at the watershed scale?

GEOGRAPHIC & LANDSCAPE-SCALE QUESTIONS

- What regional or geographic variations are there in sediment production, delivery and storage?

DISTURBANCE QUESTIONS

- To what extent are forest management activities a significant source of sediment in unmanaged riparian areas?
- How can forest management activities in riparian areas influence natural disturbance processes?

MANAGEMENT QUESTIONS

- To what extent are forest management activities a significant source of sediment in riparian buffers?

SYNTHESIS QUESTIONS

- What riparian zone characteristics can establish criteria to ameliorate sediment production and delivery from managed forests?
    - Is there a recognized delineation threshold (e.g. width)?

- Are there patterns of variations that have been reported?
- What ecosystem processes & functions can be mitigated by buffers
- What ecosystem processes & functions cannot be mitigated by buffers
- Does vegetative structure or composition have any effect?

WOOD KEY QUESTIONS

OVERARCHING

- How do forest management activities or related disturbances in or near the riparian zone affect the recruitment of wood to streams?

SITE SCALE QUESTIONS

- What is the effect of stand level forest conditions (tree ht, diameter, density, species) on wood recruitment to streams? *Add - to maintain salmonid habitats?*
- Does plant succession and forest composition have an effect on wood recruitment in these areas?

WATERSHED SCALE & PROCESS QUESTIONS

- To what extent and by what mechanisms do low-order channels deliver wood to fish bearing streams?
- How do wood recruitment processes and rates vary by watershed attributes (e.g. size, location, vegetation type, geomorphology, etc)?

GEOGRAPHIC & LANDSCAPE-SCALE QUESTIONS

- How do wood recruitment processes and rates vary by geographic and biological conditions?
- How do management effects vary by geographical region, geology, topography, size of watershed, vegetation, stream type?

DISTURBANCE QUESTIONS

- What are the effects of natural disturbances on wood recruitment in streams of all sizes and types?

MANAGEMENT QUESTIONS

- How does forest management affect the recruitment of wood to streams? (inferred difference between managed versus unmanaged systems)
- How can forest management encourage vegetation conditions to maintain recruitment of

wood to streams?

- To what extent and in what ways is recruitment of in-stream wood from stream banks and flood prone areas (by bank erosion) affected by current forest management practices?

- What minimum buffer width and characteristics are necessary to maintain wood recruitment to streams (and variation due to geographical region, geology, topography, size of watershed, vegetation, stream type)?

SYNTHESIS QUESTIONS

- How should forest management goals (with respect to wood recruitment) differ by stream order, vegetation, topography, climate etc. ?

HEAT KEY QUESTIONS

OVERARCHING

- How do forest management activities or disturbances within the riparian area affect the temperature of forest streams?

SITE SCALE QUESTIONS

- What conditions of canopy structure, density, and width, influence water temperature?

WATERSHED SCALE & PROCESS QUESTIONS

- How might riparian controls on temperature vary with California forest types and stream size?

- Are riparian area microclimates affected by forest management within and/or adjacent to fish-bearing streams sufficient to influence water temperature?

- How and to what extent do temperatures in low order streams influence temperatures in downstream fish-bearing streams?

GEOGRAPHIC & LANDSCAPE-SCALE QUESTIONS

- How and where are the potential temperature effects from forest management likely to impact salmonid species of concern?

- Is there information from California eco-regions indicating the effects of observed temperature on salmonids?

DISTURBANCE QUESTIONS

MANAGEMENT QUESTIONS

- Are there conditions that adequately ameliorate the occurrence of adverse temperatures?

SYNTHESIS QUESTIONS

- What bearing do the findings of this literature review have on riparian zone delineation or characteristics of riparian zones for protecting water temperature?

BIOTIC & NUTRIENTS KEY QUESTIONS

OVERARCHING

- How do forest management activities in or near the riparian zone affect riparian litter, nutrient, and terrestrial invertebrate inputs to streams?

SITE SCALE QUESTIONS

- How does riparian plant composition (species mix, stand age structure, stem density) affect riparian biotic inputs to streams?

WATERSHED SCALE & PROCESS QUESTIONS

- How does riparian plant composition and biotic inputs vary by stream size, valley/channel morphology and other physical watershed attributes (e.g., geology, topography, size of watershed, stream type)?

- How does stream size, valley/channel morphology and other physical watershed attributes affect the transport, storage, and utilization of biotic inputs?

- What watershed location, stream size, geomorphic characteristics, or other physical factors constrain or facilitate riparian plant management actions that are designed to enhance aquatic production?

GEOGRAPHIC & LANDSCAPE-SCALE QUESTIONS

- Are there regional differences in the effects of natural disturbance or forest management activities on the biotic or nutrient riparian area functions?

- What eco-regions or forest types are better or less suitable for managing riparian plant composition and riparian biotic inputs to favor or enhance aquatic production?

DISTURBANCE QUESTIONS

- What is the relative influence of disturbance processes on riparian plant composition and

biotic inputs to streams?

- How do large and small scale disturbances affect the species mix, stand age structure, and stem density and hence the delivery and quality of litter?

- How does this vary by watershed location and region?

MANAGEMENT QUESTIONS

- How does riparian management influence riparian plant composition and riparian biotic inputs to streams?

- How can management (manipulation) of the riparian area alter riparian plant composition and riparian biotic inputs to favor or enhance aquatic production?

- What is the duration and effectiveness of riparian plant management actions that are designed to enhance aquatic production?

SYNTHESIS QUESTIONS

- How does riparian plant management actions that are designed to enhance aquatic production influence other riparian exchange functions.

- How feasible are riparian plant management actions that are designed to enhance aquatic production given the initial focus of CA riparian forest practice regulations, which is to limit or avoid significant impacts to existing riparian function and habitat regardless of specific salmon species needs?

TASK 1.2 INITIAL ASSESSMENT OF PRELIMINARY LITERATURE LIST

Upon acceptance of the Key Questions, the SWC Team will provide an initial review of the existing literature to evaluate its utility in addressing each key question.

We have noticed that some of the papers listed for a single exchange function may also apply to one or more other exchange functions. We assume that these papers can be reviewed in every context necessary to respond to the Key Questions and/or synthesis.

The papers listed for review are all from the peer-reviewed literature. It is likely, however, that some relevant studies related directly to management questions (such as buffer strip width) will be found in the "gray literature". For example, a recent report by the Lake Tahoe Basin Management Unit (Norman, Loupe & Keely, 2008) may be appropriate for addressing the effectiveness of water functions. We may need to refer to some of these studies, as we find them. Professional judgment will have to substitute for the peer-review process in weighting the relative importance of gray literature papers.

We will likely identify additional papers that fill gaps or otherwise help to inform key issues as we engage the literature. We'd like to reserve the ability to add additional papers as needed to address key questions without seeking TAC approval. We can use Appendix F: Literature Screening Criteria,

for selecting articles and document the basis for our inclusion in the literature review form. We feel that this will expedite our review.

We also assume that in our report on the Key Questions and synthesis, that the SWC Team will be allowed to cite literature beyond those articles we might directly be responsible for reviewing. In other words, we might cite papers that were not assigned without requiring a literature review documentation form.

Some of the literature we are currently considering are listed below. This is a preliminary list that will be subject to further screening by the SWC Team and the TAC.

WATER

Norman, S., T. Loupe, and J Keely. 2008. Heavenly Creek SEZ Demonstration Project 2007 Soil Monitoring Report. USDA Forest Service Lake Tahoe Basin Management Unit. 58pp

SEDIMENT

Allen, R. and W. MacNeill. 2004. Population-level responses to sediment during early life in brook trout J. N. Am. Benthol. Soc. 23(1):140–150.

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WOOD

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DISTURBANCE

In addition to those listed, we would like to review additional literature that focuses on various disturbances that the response in riparian areas. These might include some of the following:

Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone by Leah A. Beche, Scott L. Stephens, and Vincent H. Resh

Continuity in fire disturbance between riparian and adjacent sideslope Douglas-fir forests by Richard Everett, Richard Schellhaas, Pete Ohlson, Don Spurbeck, and David Keenum

Fire and riparian ecosystems in landscapes of the western USA. By Kathleen A. Dwire, and J. Boone Kauffman

The role of terrain in a fire mosaic of a temperate coniferous forest by John D. Kushla, and William J. Ripple

Should riparian buffers be part of forest management based on emulation of natural disturbance? By Ellen Macdonald, Carl J. Burgess, Garry J. Scrimgeour, Stan Boutin, Sharon Reedyk, and Brian Kotak

Time, space, and episodicity of physical disturbance in streams by Daniel Miller, Charlie Luce, and Lee Benda

Fire and amphibians in North America by David S. Pilliod, R. Bruce Bury, Erin J. Hyde, Christopher A. Pearl, and Paul Stephen Corn

Changes in a Reach of a Northern California Stream Following Wildfire by Kenneth B. Roby, and David L. Azuma

The relative importance of fire and watercourse proximity in determining stand composition in mixed conifer riparian forests by William H. Russell, and Joe R. McBride

Movement and characteristics of stream-borne coarse woody debris in adjacent burned and undisturbed watersheds in Wyoming by Michael K. Young

Fire behavior, fuel consumption, and forest-floor changes following prescribed understory fires in Sierra Nevada mixed conifer forests by J. Boone Kauffman, and R.E. Martin

Wildfire burn patterns and riparian vegetation response along two northern Sierra Nevada streams by Leda N. Kobziar, and Joe R. McBride

The Effects of Fire Exclusion on Ponderosa Pine Communities in Glacier National Park, Montana by James S. Lunan, and James R. Habeck

Broadening the scope of prescribed fires: Opportunities to rehabilitate degrades riparian zones by Clayton B. Marlow, Ronald Tucker, Brad Sauer, and Vinita Shea

Wildfires and Yellowstone's Stream Ecosystems by G. Wayne Minshall, James T. Brock, and John D. Varley

Status of native fishes in the western United States and issues for fire and fuels management by Bruce Rieman, Danny Lee, Dave Burns, Robert Gresswell, Michael Young, Rick Stowell, John Rinne, and Philip Howell

The relative importance of fire and watercourse proximity in determining stand composition in mixed conifer riparian forests by William H. Russell, and Joe R. McBride