Summary of Scientific Peer Review Discussion Concerning US EPA Region 10 Guidance For Stream Temperature Water Quality Standards

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Panelists:

Sherri L. Johnson, Research Ecologist, US Forest Service, Pacific Northwest Research Station, Corvallis, OR

John Bartholow, Ecologist, Biological Resource Division, US Geological Survey, Fort Collins, CO

Robert L. Beschta, Emeritus Professor, Department of Forest Engineering, Oregon State University

John P. Bolte, Professor, Bioengineering Department, Oregon State University

Stanley V. Gregory, Professor, Department of Fisheries and Wildlife, Oregon State University

Gordon Reeves, Research Fisheries Biologist, US Forest Service, Pacific Northwest Research Laboratory, Corvallis, OR

Introduction

EPA and the Working Groups dramatically revised the first draft of the regional Stream Temperature Guidance and asked for an additional Scientific Peer Review of the second draft, dated October 10, 2002. The statements below are a summary of the discussion, December 3, 2002, during which strengths and weaknesses of the current draft were discussed. John Palmer, EPA Coordinator, presented an introduction to the revised draft (by speaker phone from Seattle, Washington) and briefly answered questions at the beginning of the meeting. John Bartholow also participated by speaker phone.

The Panelists have reviewed the written summary below, and concur that the statements reflect consensus opinion, unless specifically noted.

To summarize, all panelists agreed that this second draft is a greatly simplified but improved Guidance. EPA has more clearly detailed a stream temperature Criteria, the logic behind the Criteria, and how states can respond (including alternative responses). Much more background information and discussion of the influences of stream temperature on salmonids have been included in this draft. The required modeling of thermal potential has been replaced with numeric criteria, based on life stage and use. Technologically, it is a 'step back' from the previously proposed criteria, about which a number of the panelist voiced concerns regarding establishing modeling as a major driver in the criteria-setting process. This second draft is a more traditional standard setting approach, which has a different set of strengths and weaknesses. General comments are provided below and in answer to the questions provided by EPA. Specific comments have been inserted into the Draft Guidance.

General comments

This Guidance builds on a growing scientific foundation regarding salmonids and temperature, much of which has been summarized in the Technical Reviews. However, much more remains to be learned about individual, species and community responses to elevated stream temperature. Scientists will continue to explore the complex issues regarding responses and interactions of salmonids to their environment, a major factor of which is water temperature. Temperature is not the only factor influencing salmonid recovery, but it can be a restrictive or stressful factor. Because salmonids are some of the most sensitive of the beneficial uses, they have been the foci of this Guidance. But temperature is also very important due to its influences on stream food webs and aquatic communities. Maintenance of ecological processes is required to maintain fish. Ideally, stream temperature criteria should approximate as closely as possible the natural thermal regime of a stream or river ecosystem to provide for all the beneficial uses which are influenced by temperature.

The panelists suggest that EPA expand the introductory section of this Guidance to help the public understand the temperature criteria in a temporal and spatial context. The standards are important, not only as targets of temperature to be attained, but also because exceedance of the standards should initiate a basin-wide planning process, which is what will ultimately make a difference towards improvement of conditions in streams and rivers and for designated beneficial uses. Spatially, temperature remediation activities as a result of basin planning efforts will generally have much greater effect than individual or single landowner efforts. Rather than focusing on absolute numbers, these basin evaluations and the potential remediation activities which follow will lead to improvement of stream conditions, through identification of problem

areas and encouragement of implementation of Best Management Practices. Temporally, improving non-point water quality conditions will be a slow process with which the public may grow impatient; therefore, if the standards were promoted as triggers to initiate watershed planning efforts and evaluation of landscape conditions, efforts can begin and some early progress will be visible long before stream temperatures decline.
An example presentation, using data and maps, might help the public, States, and Tribes better understand the criteria and the time frames under which the various activities would occur.

Human caused elevated temperature as a factor (IV.3): Panelists noted that although every state and many agencies have issued numerous reports about elevated stream temperature and its role in limiting salmonid habitat, only reports from some areas are summarized. Ideally, to show the generality of the problem, assessments or reports from each state and region within a state would be listed. For example, the ODEQ review (1995) is not included in this section. Oregon State of Environment Report (2001) could be cited. OFIC has issued salmon and steelhead reports for Oregon and Washington (compiled by John Palmisano and Vic Kazcynski). A report by Bryan Spence, for Mantech, on Salmon and their Habitats might be an additional citation in this section.

Issues regarding timing of criteria (V.1)**: 7 day max, increased frequency of high temperatures, seasonal shifts, 90% percentile:** The criteria are focused on 7 day average of daily maximum (7DADM) stream temperature, which is a useful indicator of the magnitude of the highest summer temperatures. The panel agreed with the EPA's consistent use of this 7DADM standard. It was suggested that mention could be made of other metrics that were considered and are used by some of the states and why EPA chose to use 7DADM. There is an implicit assumption that by reducing these maxima in impacted streams, temperatures throughout the summer will also be reduced. However, because the assumption is implicit, rather than explicit, there is the possibility that in highly modified situations, such as where effluent or dam releases occur, that the maxima could be reduced but that the frequency of high temperatures could increase. The situation could occur where the high maximum temperatures expand from the "normal range" to a prolonged period of week after week of the high temperatures. A good example of this would be for dams fitted with multiple-level outlets to provide thermal control. Such a dam could have operational criteria specified to keep the water temperatures at the just below criteria level for long periods of time. Seasonal shifts in the temperature regime, even if not above the criteria, can have physiological and behavioral impacts on salmonids, as noted in Carnation Creek studies of the effects of forest harvest on stream temperature and fish (Holtby 1988). Given that modifications of habitat occur both in space and time, several panelists questioned whether the potential of increasing the frequency/duration of higher temperatures is what EPA wishes to allow to occur. If it is, then the policy should so state (the top of page 21 might be a good place). If it is not, then supplementation of the guidance will be necessary and could include language suggesting that States or Tribes show that seasonal temperature regimes coincide with those in 'undisturbed systems' or from historical records.

The exemption of criteria during 'unusually' warm periods was discussed among panel members. Several questioned whether exempting temperatures when they exceeded the 90th percentile was appropriate, but agreed that for salmonid species, potential loss or damage to one

year's recruitment would probably not endanger a healthy population. However, two warm years in a row could be problematic. Two panelists noted that when this 90th percentile rule is challenged, it could be hard to defend biologically (from observations of Instream Flow litigation). A strong point is that stream temperature monitoring will need to be considered in a longer temporal view than just one year of monitoring. Panelists noted that it was far sighted to consider the implication that the annual average maximum 7DADM value will need to be lower than the numeric criteria in order to meet the criteria in all but one year out of ten.

Several panelists objected to statements about air temperature as a driver, because stream temperatures are responsive to seasonal stream discharge regimes as well as unusual summer weather patterns. 'Unusually' warm summer air temperatures do not necessarily equate with 'unusually' warm stream temperatures. In addition, ambiguous terms like 'unusual' should be explicitly defined.

Optimal (V.1): The rational and basis for selection of the selection of optimal temperatures as the focus are well described in this draft. Selecting a single number as a threshold is difficult; there is considerable scientific uncertainty about effects of temperature, due to the combination of factors influencing fish responses to temperature (behavior, food supply, habitat availability, stress or prior condition of fish). Unfortunately, the standards will be challenged and there will be potential battles over very fine scale details, which may not be able to be resolved based on the existing scientific information. Because multiple lines of evidence were used to set optimal temperatures, and many considerations have gone into them, the criteria recommended in this guidance should be adequate.

Current vs potential use and determination of "core" juvenile rearing habitats (V.1): There was concern by all panelists regarding the definition of core areas and how the core areas will be determined. In addition, the distinction between degraded and non-degraded habitats will be difficult to determine; degree of degradation is better expressed along a gradient, with undisturbed or non-degraded habitats on one end and highly degraded habitats on the opposite. Because present distributions of salmonids are marginal, decisions based on current distributions will result in underestimation of core areas. The present use of an area by salmonids may not be an indication of restoration potential or an indication of historical use. If an area is degraded and has low fish numbers presently, then it would be categorized as rearing habitat, when it may have historically contained high densities. If goal is to recover salmonids, the setting of standards needs to focus on potential as well as existing core areas.

Many questions remain about how to determine core areas. We suggest that the guidance be made as clear and specific as possible to prevent battles later. Historical maps of the distribution of species (through NMFS or NOAA Fisheries) will be useful tools for describing potential distributions of specific species. Within basins, local professional judgment could be used to note areas of high or low potential salmonid productivity (Burnett, KB. 2001. Relationships among juvenile anadromous salmonids, their freshwater habitat and landscape characteristics over multiple years and spatial scales in the Elk River, Oregon. PhD Dissertation, Oregon State University). The timing of the survey to determine the core areas could be a critical factor - when do the determinations of fish use of an area occur? Fish move seasonally and existing temperatures may play a role in encouraging use or abandonment of a habitat. Could a specified percentage of the population (10%, 50%, 80%) using an area used to help define core? How

frequently are these determinations revisited? Every year or 5 or 10 years? Panelists also discussed the implications of mis-identifying core vs rearing habitats, and depending on the salmonid species, this distinction could have consequences for population distributions and recovery.

Protection of existing high quality habitats (V.2;VI.2)**- non-degradation and cold water refugia:** The thermal heterogeneity provided by cold water refugia is an important contribution to salmonid survival and panelists believed that it should have more emphasis within the Guidance. Spatial and temporal temperature diversity has been lost in most streams and the criteria in this Guidance do not protect existing thermal diversity. The panel suggested that the non-degradation clause (V.2) be strengthened and highlighted to protect existing high quality thermal habitats (i.e. colder than the criteria). In addition to cold headwater streams, important thermal heterogeneity also exists within larger rivers and protection of these locations should be recommended. We recognize that the exact locations of heterogeneity are difficult to identify or regulate at the landscape scale because they are often points within larger stream networks. However, the processes and locations that contribute to the heterogeneity can be protected.

Tributary junctions, as well as hyporheic flows, contribute to thermal heterogeneity within a basin. The draft guidance mentions very broadly that states should pursue ways to capture the effects restoring alluvial rivers and associated hyporheic flows, but does not mention tributary junctions, which are very important sites contributing to thermal heterogeneity. Where small, cool tributaries join larger, warmer rivers there are numerous benefits for stream food webs and habitat diversity; specifically for temperature, tributaries can provide thermal refugia for migrating salmonids (Everest, FH 1977, Ecology and Management of summer steelhead in the Rogue River, Oregon. Fish Commission Report 7, Oregon Game Commission, Corvallis) The importance of these tributary junctions should be explicitly stated within the guidance, which will hopefully encourage the States and Tribes to focus on these features for protection of existing thermal refugia and restoration in water quality management plans.

Significant human impacts (VI.2): Panelists expressed concern that "significant" was being used in this context and were confused as to how significant would be defined or evaluated. Clearer definition of which and to what extent human impacts would be required to be removed is essential and could prevent protracted litigation over these issues in the future.

Natural background and attainability analyses (VI.3): All panelists were concerned about ambiguous terms and conditions in this section. The panelists agree that for some stream and rivers, historical thermal regimes and spatial variability in preferred habitats might have reduced use by salmonids. Several panelists felt there should be a distinction between low natural densities and "marginal use" and suggested that streams or rivers with temperatures at natural background levels be classified as "full use". "Marginal use" would be a designation for sites that had human impacts and for which an attainability analysis had shown that temperatures would not be able to be further reduced without "widespread economic and social impact" (very ambiguous terms that should be clarified!).

For rivers that have not had anthropogenic changes, it should be a straightforward process to show they are at natural background conditions or have a natural thermal regime and they should

be designated as “full use”. However, many rivers that might historically had higher 7DADM than present standards have also had multiple anthropogenic impacts, ranging from geomorphic changes, to water withdrawals to riparian removal. Steps for conducting or evaluating an attainability analysis are not clearly described. What are “all reversible” impacts? How will “widespread economic and social impacts” be defined? At what point is an impact widespread or reversible? Most conditions are reversible, given enough money and time for restoration. These are policy questions and tradeoffs that need to be clarified. And finally, how will these types of impacts be modeled? Temperature modeling for very large basins or for interactions among multiple types of impacts is not very accurate, so how will new criteria be established?

Alternatives (VI): This Draft Guidance is generally straightforward and lays out the steps the States or Tribes should go through to have their Water Quality Standards be approved for meeting ESA and CWA requirements. Flexibility is built into the process because different Standards can be adopted by State and Tribal Authorities, as long as it was shown that the alternate standard still meets ESA and CWA. However, this flexibility can also be a weak point because EPA will have to continually evaluate proposed rationale for alternate standards, especially where the existing stream temperature is above the criteria.

Questions for the Scientific Peer Review Panel
EPA's 2nd Draft Temperature Guidance
11/26/02

- Panelists comments are shown in bold italics below questions

1) Provide an overall assessment of the draft guidance from a scientific perspective identifying the strengths and the weaknesses, with particular emphasis on the degree to which the draft guidance (if implemented) protects cold water salmonids and aids in their recovery. As part of this assessment, EPA is interested in what features/recommendations the peer review panel thinks are well supported by scientific studies (i.e. studies referenced in the guidance and the technical issue papers, as well as others that EPA may not have cited but the peer review panel is aware of) and which features/recommendations are not.

- See preceding summary

2) The bull trout rearing criteria (12°C 7DADM) and the core salmon/trout rearing criteria (16°C 7DADM) are intended to reflect "upper optimal" temperatures. Where "optimal" is the temperature range where fish do best (i.e. where adverse effects are minimized) in the natural environment (i.e. includes both physiological and ecological considerations). As described in Section V (*Integrating the General Factors in Selecting Protective Criteria),* EPA felt it is appropriate to target "upper optimal" temperatures for criteria based on how the criteria would apply (see discussion on pages 14-21).

Some have argued that applying an "upper optimal" temperature criteria for the summer maximum condition, lowest downstream extent of use, and all but the warmest years in ten is unrealistic (with respect to natural physical potential) and/or unnecessarily protective in that fish populations will not be adversely affected if a portion of their habitat experiences temperatures a few degrees "above-optimal" (well below lethal) for a portion of the time in the summer. Others have argued that because these salmonids are threatened and endangered and that their habitat has significantly shrunken relative to historic distribution, that exposure time to "above-optimal" temperatures should be minimal (e.g. to minimize any reduction in juvenile growth) and criteria should be set to assure "optimal" temperatures throughout the summer months. And that this level of protection is needed to remove elevated temperature as an impediment to restoring sustainable wild population levels (especially in situations where exposure to "above optimal" temperatures may be extended).

EPA recognizes that selection of criteria (and where and when it applies) is ultimately a policy decision based on acceptable risk level. EPA, however, would like the peer review panel to critique EPA's logic in integrating the various factors listed in the draft guidance and the basis for each of the recommended summer maximum criteria (pages 14-27) from a scientific perspective. In doing so, EPA is interested in any scientific considerations that would aid in the debate described above. *(Note: the 18°C and 20°C criteria explicitly recognize "above-optimal" temperatures for parts of rivers during the summer maximum condition).*

-The logic appears sound to panelists.
One panelist expressed concern that salmonids were being lumped in the standards and that Chum and Pink Salmon might be more sensitive, especially for incubation and rearing temperatures.

3) The guidance indicates that human-caused elevated temperature is a factor in salmonid decline. An underlying premise of the guidance is that waters that cold water salmonids use today for migration, spawning, and rearing are thermally degraded in many places, which reduces individual fitness and reduces salmonid population levels. Thus, restoring temperatures will improve fish populations. Further, the guidance states that human-caused warming of rivers and streams has generally pushed cold water salmonid distribution upstream in order to have suitable spawning and rearing thermal habitat and that restoring (reducing) temperatures will thereby expand suitable spawning and rearing habitat downstream and increase fish populations (or at least remove elevated temperature as a limiting factor in fish populations). EPA believes that scientific studies support these general premises and is interested if the peer review panel concurs.

- The scientific studies do support that elevated water temperature negatively impacts salmonids at multiple scales (individual, population and community dynamics) and landscape studies show that the distribution of appropriate stream temperatures for salmonids is greatly reduced. Regarding the first sentence in this question- the decline of salmonid populations is a function of multiple factors and it would be very difficult to separate the role of only increased stream temperature in this decline. Therefore, we suggest that EPA's focus be on increased stream temperatures, that can harm, impact and limit the distribution and recovery of the existing populations, which should to be addressed as part of the impaired water quality in the regions' streams and rivers.
Significant temperature effects on salmonids can occur well below the lethal levels and these effects can have dramatic ecological consequences. (Holtby 1988, CJFAS 45:502-515;Reeves et al. 1987, CJFAS 44:1603-1612; T. Hillman, 1991, Ph.D. Dissertation, Idaho State University)
Behaviors of individuals are changed and competitive interactions within communities are modified. Increased temperatures interact with other stressors, such as decreased habitat conditions (also prominent in NW streams and rivers), which results in increased stress and reduced resistance to disease. Temperature also has influences on many portions of stream food webs, including decomposition processes, invertebrate growth and emergence, and metabolic rates.

4) In judging "optimal" temperature range for salmonid rearing in the natural environment, EPA concluded from scientific studies (see Issue Paper 5) that food is generally limited in natural rivers and streams. Thus, when considering laboratory growth studies as a line of evidence to determine "optimal" temperatures in the field, EPA used optimal growth temperatures at reduced rations (not full rations). Additionally, EPA also concluded from studies on fluctuating temperatures, that maximum and mean temperatures are important considerations for growth (and possibly other chronic effects, such as elevated disease). Thus, EPA equated constant lab temperatures to the mid-pt between the maximum and mean temperature in the field when using this line of evidence to determine appropriate 7DADM criteria (see discussion on page18).

Although EPA recognizes a fair degree of uncertainty regarding these issues, EPA believes the scientific evidence suggests the above approaches are appropriate and is interested if the peer review panel concurs.

- As the EPA notes, there is scientific uncertainty regarding the effects of fluctuating temperature, availability of food resources, and fish responses. The "optimal" ranges selected in this draft Guidance are appropriate, given this uncertainty. As the Technical Reviews state, most of the studies have examined fish responses to constant temperatures and maximum food resources. Exposure time (and acclimation) have been shown to be critical elements for lethal and presumably sub-lethal effects, but how exposure time from controlled experiments translates to exposure in fluctuating environments is uncertain, especially given other environmental influences.

5) In a basin that has minimal thermal impacts and naturally exhibits summer maximum temperatures that range from optimal to thermally stressful for rearing (e.g. maximum temperature ranging from 15°C to 22°C along the longitudinal profile of the river), what might we expect the rearing distribution to be. Specifically, how much use of "warmer than optimal" thermal habitat might occur? (*Note: the temperatures in this example are specific to salmon and steelhead rearing, but the same question could apply to bull trout, but with a lower temperature range).* Additionally, EPA is interested in any suggestions the peer review panel has to determine "core" use areas (see discussion on the application of the 16°C core salmon/trout juvenile rearing use on page 23).

- See comments on Core in preceding summary.
Use of warmer than optimal habitat does occur, but panelists were not aware of studies examining use of warmer than optimal habitats when optimal habitats were also available.

6) EPA is recommending separate spawning/incubation criteria for bull trout and salmon/trout. Some have suggested that this is inappropriate for several reasons: a) late summer-fall spawning is triggered by a decline in temperature and peak spawning time will vary somewhat year-to-year so "fixing" a certain time that a spawning criteria should be met is inappropriate, b) some percentage of the population will always initiate spawning prior to when there are "optimal" temperatures, so setting an "optimal" spawning criteria at the onset of spawning is inappropriate, c) if you control (particularly non-point sources) for the summer maximum temperature the annual thermal regime will shift and provide protective temperatures for spawning and egg incubation that occurs other times of the year, d) steelhead trout incubation time is dependent on temperature (higher temperature, faster development, earlier emergence), thus steelhead eggs will adjust if streams warm-up faster in the late spring and summer due to human alteration of the thermal regime.

EPA is interested in the peer review panel's critique of the above reasons why it may be inappropriate to have separate spawning/incubation criteria (or any other reasons the peer review panel may offer). In particular, EPA is interested if the peer review panel thinks that some of the reasons above (or others) are sufficiently valid as to make the spawning/incubation criteria recommendation in the guidance too inflexible for a life history that is inherently variable.

- Warm temperatures during normal times of spawning are a concern. As a result of maternal exposure to high temperatures, in vivo egg mortality and reduced survival of alevin and fry has been documented. Setting criteria for spawning is difficult, due to variation in the timing of spawning within a population in a given year, stemming from individual preferences or behavioral or genetic drivers. In addition, there is variation in time of spawning from year to year due to climatic and hydrologic conditions. Several panelists felt that protection for times of spawning and incubation should be explicitly part of the criteria, and suggested that by establishing a specified time frame for a spawning criteria, such as one based on average spawning behavior over several years, the range of variation would be protected. Two other panelists suggested that, given this range of variation, the focus on adequate temperatures during the summer maxima should also provide for appropriate temperatures during other times of the year, such as spawning times.

c) The reasons for temperature increases (i.e. point vs non-point factors) are an important consideration when considering criteria for other times of the year besides summer maxima. Increased temperatures throughout the year are generally related to the same factors which would lead to increased temperatures during the summer, such as increased incoming solar radiation associated with removal of riparian shading. Addressing or remediation of conditions which have led to increases in summer maximum will likely also affect increased temperatures during other times of the year – assuming that the increases at other times of the year have the same cause as increased summer maximum. There have been very few studies of the effects of restoration on summer maxima, and less data exists for other times of the year. The assumption of 'related-ness' would not hold for increases due to point sources.

d) Fish populations do 'adjust' their life cycle when exposed to warmer than normal conditions during incubation and growth. At Carnation Creek, BC, fish grew faster and migrated earlier when exposed to warmer water after forest harvest. Although these factors looked like benefits to individuals initially, these shifts resulted in negative repercussions to overall population recruitment, because of increased vulnerability to predation that occurred during migration by shifting of timing of migration (Holtby 1988). We do not know all the associated repercussions which can be influenced by a change to one part of a life cycle – therefore, stream temperature criteria should strive to approximate as closely as possible the natural thermal regime of a stream or river ecosystem.

Note: in answering the above questions, if would be helpful to EPA to distinguish between responses that are a group consensus, near consensus with a minority opinion, and where there are differing views. Further, EPA encourages the peer review group to cite studies, where appropriate, to support their responses.