DEALING WITH TEMPERATURE LISTINGS ON THE 303(D) LIST: IS THERE A BETTER WAY?

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ABSTRACT

Pacific Northwest states (Washington, Oregon, and Idaho) have temperature criteria limits to protect for coldwater aquatic fish species, in particular salmon and trout. Temperature is a complex criteria that is naturally affected by many variables, including local climate, the hydrology of the waterbody, and elevation. Human actions can also adversely affect temperature by removing riparian buffers, disrupting natural instream flows, and altering the natural hydrology of the waterbody. State agencies responsible for environmental protection are faced with challenges in identifying waterbodies that are adversely impacted by temperature and what is needed to bring the waterbody back into compliance with the water quality standards, while also factoring in the natural variability of temperature.

This paper provides an overview of how temperature criteria has been established in the Pacific Northwest, the importance of temperature to salmon and trout habitat, and how human actions can adversely affect temperatures. It describes the challenges of determining when waters should be listed as "impaired" on the 303(d) list for temperature, and what we have learned to date about developing total maximum daily load (TMDL) studies for temperature impairments. Finally, it explores ideas and alternatives to improving temperature for salmon habitat in a manner that addresses concerns more expeditiously and, where possible, in a less resource-intensive manner. It provides food for thought to state environmental agencies and others interested in furthering the goal of achieving clean water important for the health and productivity of salmon and other aquatic species, in an effort to answer the question: When dealing with temperature listings, is there a better way?

KEYWORDS

Temperature, TMDL, salmon, trout, 303(d) list, shade, fish habitat, Category 4b, natural conditions, Pacific Northwest, assessment, water quality

INTRODUCTION

Pacific Northwest states (Washington, Oregon, and Idaho) have numeric temperature criteria limits in their water quality standards for rivers and streams that are designed to protect for cold water aquatic species, in particular salmon and trout. The importance of salmon as a vital cultural, spiritual, and economic representation of the Pacific Northwest is well known. Salmon are an integral part of the ecosystem in which we live. They are a "keystone species" of the Pacific Northwest. The abundance and health of salmon is important to those who make their livelihood from commercial salmon fishing, and those who recreate by sport fishing along the coastal waters and up-river. And, most importantly, to the indigenous native populations of the Pacific Northwest who rely on salmon not only as an important food source, but also as a cultural and spiritual symbol to their people.

Healthy salmon runs mean healthy water resources and healthy people. Stream temperatures are well recognized as a critical component of healthy aquatic habitat for salmon and trout. However, temperature is a complex criteria that is naturally affected by many variables, including local climate, the hydrology of the waterbody, and elevation. Human actions can also adversely impact temperature by removing riparian buffers, disrupting natural instream flows, and altering the natural hydrology of the waterbody.

Determining when temperature exceedances are natural and when human actions are significantly impacting water temperatures can be a challenge for state environmental agencies. With these challenges, identifying waterbodies that are impaired by temperature and what is needed to bring the waterbody back into compliance with the water quality standards can be difficult. These issues are discussed in further detail in this paper.

BACKGROUND

Impacts of Temperature on Cold Water Fish Habitat

Research has shown that water temperatures significantly affect the distribution, health, and survival of native salmon and trout, or salmonids, in the Pacific Northwest (WDOE 2002). Salmonids are cold-blooded, meaning that their survival is dependent on external water temperatures and that they can experience adverse health effects when exposed to temperatures outside their optimal range. Evidence suggests that prior to significant human impacts, salmonids have evolved and thrived under the water temperature patterns that historically existed in Pacific Northwest streams and rivers. Although it is noted that historical water temperatures exceeded optimal conditions for salmonids at times during the summer months on some rivers, the temperature diversity in these unaltered rivers provided enough cold water during the summer to allow salmonid populations as a whole to thrive (EPA 2003).

Pacific Northwest salmon populations are affected by many factors and have historically fluctuated dramatically, likely due to climatic conditions, ocean conditions, and other disturbances. In general, it can be deduced that the increased exposure to stressful water temperatures and the reduction of suitable habitat have contributed to the reduction in the abundance of salmon. Human-caused increases in water temperatures can supplement the

magnitude, duration, and extent of natural thermal conditions that make the water unsuitable for salmonids.

The freshwater life cycle of salmonids are closely tied to water temperatures. Naturally cooling rivers in the autumn trigger the instinct to migrate upstream. Fall spawning is initiated when water temperatures decrease to suitable temperatures. Eggs generally incubate over the winter or early spring when water temperatures are coolest. Rising springtime water temperatures may signal the start of downstream migration, and the cycle continues.

Human Activities That Can Contribute to Increased Temperatures of Rivers and Streams

Because of the significance of water temperature for salmonids in the Pacific Northwest, human-caused changes to natural temperature patterns have the potential to reduce or impact salmonid populations. Of particular concern are human activities that lead to excess warming of rivers and the loss of temperature diversity.

Rivers and streams in the Pacific Northwest naturally warm in the summer due to increased solar radiation and warm air temperature. Human activities that change the landscape or affect the hydrology of the river can increase the degree of warming. This, in turn, can adversely affect the health and abundance of salmonid habitat. Human activities can increase water temperatures by adding heat load to the river, reducing the river's capacity to absorb heat, or reducing the amount of groundwater flow which can have a cooling effect on surface water temperatures.

Specific ways in which human development has caused excess warming of rivers are summarized in EPA Region 10's guidance (EPA, 2003):

1. Removal of streamside vegetation reduces the amount of shade that blocks solar radiation and increases solar heating of streams. Examples of human activities that reduce shade include forest harvesting, agricultural land clearing, livestock grazing, and urban development.

2. Removal of streamside vegetation also reduces bank stability, thereby causing bank erosion and increased sediment loading into the stream. Bank erosion and increased sedimentation results in wider and shallower streams, which increases the stream's heat load by increasing the surface area subject to solar radiation and heat exchange with the air.

3. Water withdrawals from rivers for purposes such as agricultural irrigation and urban/municipal and industrial use result in less river volume and generally remove cold water. The temperatures of rivers with smaller volumes equilibrates faster to surrounding air temperature, which leads to higher maximum water temperatures in the summer.

4. Water discharges from industrial facilities, wastewater treatment facilities and irrigation return flows can add heat to rivers.

5. Channeling, straightening, or diking rivers for flood control and urban and agricultural land development reduces or eliminates cool groundwater flow into a river that moderates summertime river temperatures. These human actions can reduce two forms of groundwater flow. One form is groundwater that is created during over-bank flooding and is slowly returned to the main river channel to cool the water in the summer. A second form is water that is exchanged between the river and the riverbed (i.e. hyporheic flow). Hyporheic flow is plentiful in fully functioning alluvial rivers systems.

6. Removal of upland vegetation and the creation of impervious surfaces associated with urban development increases storm runoff and reduces the amount of groundwater that is stored in the watershed and slowly filters back to the stream in the summer to cool water temperatures.

7. Dams and their reservoirs can affect thermal patterns in a number of ways. They can increase maximum temperatures by holding waters in reservoirs to warm, especially in shallow areas near shore. Reservoirs, due to their increased volume of water, are more resistant to temperature change which results in reduced diurnal temperature variation and prolonged periods of warm water. For example, dams can delay the natural cooling that takes place in the late summer-early fall, thereby harming late summer-fall migration runs. Reservoirs also inundate alluvial river segments, thereby diminishing the groundwater exchange between the river and the riverbed (i.e., hyporheic flow) that cools the river and provides cold water refugia during the summer. Further, dams can significantly reduce the river flow rate, thereby causing juvenile migrants to be exposed to high temperatures for a much longer time than they would under a natural flow regime.

SETTING TEMPERATURE CRITERIA TO PROTECT AQUATIC LIFE

Considerations of Stream Temperatures and Aquatic Organism Needs

In determining how to set statewide temperature standards that can be effectively regulated, several factors have been considered by both EPA and the states. Temperatures standards should be set that:

- Maintain existing beneficial uses;
- Minimize the risk that the aquatic species will become threatened or endangered;
- Encourage the reduction of water temperatures that have been raised by human activities;
- Maintain existing temperature regimes or move towards historically healthy regimes where normal patterns have been altered;
- Control extreme temperatures;
- Include a margin of safety to provide for the difference between normal and critical weather patterns (such as an extremely hot, dry year); and
- Provide a minor allowance for human activity where waters naturally do not meet the numeric criteria set for the biological needs of salmon..

In addition, the relationship between stream temperatures and the temperature requirements of cold water aquatic species raises several factors that should be considered, such as:

- When and where the various life stages of salmonids occur;
- The sublethal effects that temperature can have on these life stages, both physiological and interactions with other organisms;
- The differences in temperature requirements for various fish and aquatic organisms; and
- The role that cold water refugia (ground water influence) plays in the health of salmonids.

Temperature Metrics

Another factor to be considered is what standard of measure is most appropriate for reflecting temperature. It is now generally accepted that a "7-Day Average of the Daily Maximum Temperature" or "7-DADMax" is an appropriate standard for measuring temperature. The 7-DADMax is the arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date. This standard reflects the following assumptions:

1) Sublethal chronic biologic reactions generally take more than a week's exposure to become meaningful; and

2) It is recognized that small daily maximum temperature fluctuations beyond a "healthy" target level will not cause adverse affects to aquatic organisms. Therefore, a single daily maximum metric alone would be overly stringent.

Factoring in Natural Conditions

Waterbodies come in a wide range of sizes and flow characteristics. Source waters may be cold and plentiful or they may be fed only by infrequent rains. They may be supplied by well-established surface water streams or dominated by shallow or deep ground water seeps and upwelling. The soil and biologic input material may be rich in biologically and chemically active materials or may be composed mostly of inert rock types. The air temperatures and altitudes may also vary considerably based on where the waterbody is located. All of these factors can strongly influence the ability of a waterbody to meet established water quality criteria for temperature even without any human activity involved. Aquatic systems are often naturally warmer than biologically optimal temperatures.

Therefore, it is understood that the needs of aquatic species will not always be fully met even under natural conditions. The closer we establish water quality standards to optimal biologic levels, the more waterbodies we will find which cannot meet the criteria due to their natural characteristics. To deal with this, water quality standards should contain a mechanism to account for when less-than-optimal conditions naturally occur on a waterbody.

It is realized that many streams, or portions of streams, cannot meet the recommended criteria due to natural conditions. The temperature criteria should be applied so that they will protect

portions of streams that can provide a fully supportive thermal environment. When a waterbody cannot meet numeric criteria due to natural conditions, then the waterbody's thermal potential plus a small allowance for further human warming should be used as an alternate compliance target. Thus the criteria should be viewed as being comprised of two equal parts:

1. Meeting the biologically-based numeric criteria values wherever attainable, and
2. Setting targets elsewhere that approximate the thermal potential of the waterbody.

TEMPERATURE CRTIERIA GUIDANCE

The Pacific Northwest has been at the leading edge in recent years in dealing with temperature criteria to protect cold water species, especially salmon and trout. These efforts began to escalate in the early to mid-1990's as salmon populations began to show significant declines, leading to federal Endangered Species Act (ESA) listings, fishing restrictions, and watershed planning and restoration work (Governor's Salmon Recovery Office, 2006). To add to the controversial nature of setting temperature standards, all three states were dealing with opinions that the temperature standards in place were overprotective, while others believed the standards were not protective enough.

EPA Temperature Guidance for Cold Water Fisheries

Under Clean Water Act section 304(a), EPA is responsible for issuing national criteria recommendations that guide States and Tribes in developing scientifically defensible water quality standards. EPA's current 304(a) criteria recommendations for temperature can be found in *Quality Criteria for Water 1986*, commonly known as the "gold book." The freshwater aquatic life criteria described in this 1986 document were first established in 1977, and were not changed in the 1986 document (EPA, 2003). In general, EPA's national temperature recommendations for salmonids and other fish involved calculating the protective temperatures for short-term exposure and a maximum weekly average exposure.

With the ESA listings of salmon in the Pacific Northwest in the early 1990's, the National Oceanic and Atmospheric Administration (NOAA) Fisheries and the United States Fish and Wildlife Service (USFWS) began to more closely scrutinize water quality standards revisions that could impact ESA-listed salmon, in particular temperature. Based on an extensive review of the most recent scientific studies, EPA Region 10 and the federal fish services concluded that that there was potentially a variety of chronic and sub-lethal effects that were likely to occur to Pacific Northwest salmonid species using calculations from the current 304(a) recommended formulas. These chronic and sub-lethal effects included reduced juvenile growth, increased incidence of disease, reduced viability of gametes in adults prior to spawning, increased susceptibility to predation and competition, and suppressed or reversed smoltification (EPA, 2003). Given the vulnerability of the endangered or threatened salmonid populations in the Pacific Northwest, the Services were concerned that these chronic and sub-lethal effects could reduce the overall health
and size of the population.

In 1999, EPA Region 10 took the lead in creating additional temperature guidance to assist Pacific Northwest States and Tribes in developing temperature criteria that would protect the coldwater salmonids in the Pacific Northwest. The final guidance is a product of a three year collaborative effort involving the Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, Washington Department of Ecology, NOAA Fisheries (formerly the National Marine Fisheries Service), U.S. Fish and Wildlife Service, Nez Perce Tribe, and the Columbia River Inter-Tribal Fish Commission. The EPA temperature guidance and associated information can be found at: www.epa.gov/r10earth/temperature.htm.

STATE REGULATORY EFFORTS TO ESTABLISH TEMPERATURE CRTIERIA

Simultaneously in the early to mid-1990's, the three affected Pacific Northwest states- Oregon, Washington, and Idaho- were conducting their own reviews and analyses to determine whether the temperature criteria established in their current water quality standards would be fully protective of salmon and trout, or were, as some public members felt, overprotective. All three states have put significant efforts into establishing temperature criteria that considers the many factors that affect salmonids, as well as setting standards that are reasonable.

Oregon

In the early 1990's, the Oregon Department of Environmental Quality (DEQ) conducted an extensive review of their temperature standards (Oregon DEQ, 1995) that led to adoption of revised temperature criteria in 1996. EPA approved in part and disapproved in part the Oregon temperature criteria in July 1999. Rather than promulgating new temperature criteria based on the disapproval, EPA instead focused its energy on completing the Regional Temperature Criteria Guidance. This led to a lawsuit filed by the Northwest Environmental Advocates (NWEA) in April 2001, alleging that EPA's approval of Oregon's temperature and dissolved oxygen standards was invalid because the standards were not protective of the designated uses of salmonid spawning and rearing. Further, EPA did not promulgate new criteria within 90 days, in accordance with the Clean Water Act. The Court Decision in April 2003 required that either EPA promulgate new criteria or Oregon adopt new standards that reflected the decision.

Rather than have EPA promulgate standards for Oregon, DEQ met the required timeframes and adopted new criteria in December 2003. EPA approved these new standards shortly thereafter. For additional information on Oregon's temperature standards, go to: http://www.deq.state.or.us/wq/standards/temperature.htm.

Washington

Washington Department of Ecology (Ecology) also began its triennial review in the early 1990's by convening a technical work group to evaluate the water quality criteria established to protect freshwater aquatic communities. One of the recommendations of the work group was for Ecology to re-evaluate the existing criteria for temperature. Ecology conducted an extensive review of the technical literature to establish temperature recommendations that would maintain healthy and productive populations of the state's aquatic species and not hinder efforts to recover populations of fish species that are threatened with extinction. Tracking the disapproval of

temperature standards in Oregon and Idaho in the late 1990's, Ecology believed it would be more advantageous to delay revisions to the temperature standards in order to participate and benefit from EPA Region 10's regional guidance effort. However, the EPA Region 10 guidance endeavor surpassed expected timelines to finalize the guidance. In January 2003, Ecology began formal revisions to the temperature criteria as part of a broader standards review, after determining that it was more important to seek revisions than continue to wait for the EPA regional guidance to be finalized.

In July 2003 Ecology adopted new standards that included significant revisions to temperature. These standards have since been under EPA review and ESA consultation. In March 2006, EPA partially disapproved Washington's standards, particularly for where and when salmonid spawning occurs and where "core" rearing occurs. In July 2006, Ecology began a regulatory process to revise application of its' temperature standards in accordance with EPA's disapproval, and adopted new standards December 2006. Ecology has not received approval of these new standards pending EPA review and ESA consultation, expected to occur by October 2007.

Information on temperature criteria and supporting documents for Washington can be found at: http://www.ecy.wa.gov/programs/wq/swqs/index.html.

Idaho

Idaho Department of Environmental Quality (DEQ) has perhaps had the most contention and frustration of the three states in adopting temperature standards. Idaho submitted its entire compilation of water quality standards to EPA in 1994. In 1996 EPA disapproved the temperature criteria as not being protective of bull trout and also disapproved criteria on a segment of the Kootenai River. In an effort to prevent federal rule promulgation, Idaho adopted a temporary rule that contained revised temperature criteria for bull trout and a segment of the Kootenai River. EPA determined there was insufficient scientific rationale for the temporary bull trout temperature criteria, disapproved that portion of the temporary rule, and proceeded with federal promulgation of bull trout temperature criteria.

In 1997 DEQ undertook an effort to examine the relationship between documented stream temperatures and salmonid populations in Idaho. This study found there were many instances where salmonid spawning has occurred coincidentally with measured temperature criteria exceedances. DEQ followed up this finding by proposing a seasonal cold aquatic life use category and associated criteria in 1999. The seasonal cold aquatic life use category and associated criteria were adopted into Idaho water quality standards in 2000. To date, EPA has not formally acted on this portion of Idaho's water quality standards.

In 2001, DEQ started a promulgation effort to allow for the stream temperature criteria to be exceeded during unusually hot climatic conditions, resulting in a rule adoption in 2003. To date, EPA has not acted on the rule.

In March 2006, DEQ hosted a Temperature Summit to discuss the history of water temperature issues in Idaho and the Pacific Northwest, the current temperature criteria in Idaho, EPA's

regional temperature guidance, and Idaho's temperature-related efforts to date. In addition, DEQ presented potential options for addressing temperature criteria and discussed information needs prior to the state's decision on this issue. Additional information on Idaho's temperature standards can be found at:
http://www.deq.idaho.gov/water/data_reports/surface_water/monitoring/temperature_index.cfm

Common Elements of State Temperature Criteria

All three states in the Pacific Northwest have made revisions to their temperature standards to reflect research and studies indicating that cooler temperatures are needed for salmonids, although each of the state's chosen criteria vary to some degree. The three states have numeric criteria to protect bull trout, an endangered species that needs colder water than salmon. The states also have specific temperature criteria for the significant life stages of salmon. The states also have criteria metrics based on weekly averaging of the daily maximums, or some variation of that.

Numeric temperature criteria is established to protect the biological needs of salmonids. In recognition of the fact that waterbodies can have naturally higher temperatures than the numeric criteria, all three states have narrative standards that allow the temperature standard to be set at the natural condition of the specific stream, and also allow a small increment of human warming for those waters with naturally high temperatures..

IDENTIFYING WATERS THAT ARE IMPAIRED FOR TEMPERATURE

All three Pacific Northwest states have numerous temperature listings on their state's 303(d) list. Determining an actual impairment of a waterbody based on temperature can be difficult, given the natural variations that can occur and the allowable human increment based on those natural conditions. Ideally, modeling should occur before one can truly differentiate the natural condition of the stream and the significance of human influence. However, decisions for placing a waterbody on the Section 303(d) list must typically be made with a minimal amount of data.

The Process of Listing Waters for Temperature on the 303(d) List

The rest of this paper discusses only how the Washington Department of Ecology deals with waters on their Section 303(d) list for temperature and development of resulting Total Maximum Daily Loads (TMDLs). It does not compare how Oregon and Idaho conduct their 303(d) listings or TMDL processes. Rather, it is offered for purposes of example. It is assumed that at least to some degree, all three states have grappled with similar issues for temperature.

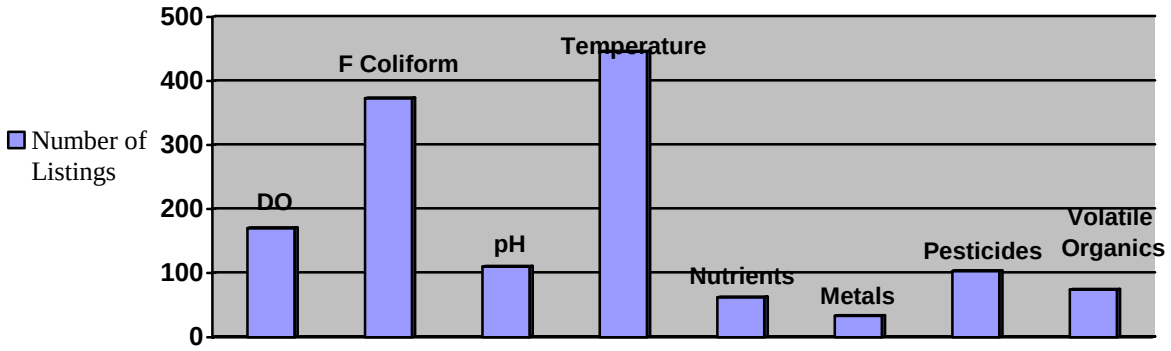
The Washington Department of Ecology places waterbodies on their 303(d) list for temperature when the numeric criteria are exceeded, but in most cases the human influence on temperature is not known for each listed site. This approach assumes that human influences have contributed to the exceedances and those exceedances are greater than the 0.3 mg/L allowance in the standards. The Ecology approach has resulted in dissatisfaction from some groups who assert that prior to 303(d) listing, the human influence must be included as part of the specific assessment in order

to determine if the temperature exceedance is actually a violation of the criteria. Using this approach would assume that human influences have not contributed to more than a 0.3 mg/L increase in temperature in a water body unless data are available to identify the human source and it's contribution to the exceedance.

For the 2004 303(d) listing process, Ecology attempted to address the issues of human influence by performing an exercise with regional field staff using land use maps to make a "first call" on whether we could rule out human actions as the cause of temperature exceedances. Only a handful of fresh water listings came off the 303(d) list as a result of this exercise, most of them in designated wilderness areas where human influences do not occur. In the majority of other areas in the state, human activities, especially from nonpoint sources such as agriculture, urban development, and forest practices, could not be ruled out as a potential significant contributor to temperature increases. Additionally, we did not have the information to specifically determine whether the potential human actions were raising water temperature more or less than the 0.3 degree allowance stipulated in the rule. Therefore, we erred on the conservative side of placing on the 303(d) list until further study could be done to determine the extent of human influence.

Dealing with a Large Number of Temperature Listings

There were a total of 2,372 waterbody segments on the 303(d) list in the 2004 Washington Water Quality Assessment, with 795 resulting from temperature exceedances. Approximately 1,371 can be attributed to nonpoint sources of pollution, and of those, 446 are listed as impaired due to elevated water temperature. Roughly 19% of all listings in Washington State are temperature related (WDOE 2005).



Relative Significance of Nonpoint Parameters, 2004

Increased temperature listings can primarily be attributed to the loss of vegetation along streams, and to lower flows of water remaining in streams after withdrawals (WDOE 2006).

Following the approval of the 2004 Water Quality Assessment and 303(d) list in the Fall of 2005, Ecology developed a short term advisory work group to discuss temperature. The purpose of the advisory group was to provide perspective and insights on the temperature standards as

they relate to 303(d) listing and placement in the WQ Assessment categories, as well as resulting work to bring the waterbodies back into compliance with the standards. The group consisted of a diverse set of stakeholders and included the Pulp and Paper industry, tribes, environmental interests, and EPA.

A wide variety of opinions and suggestions resulted from two days of meetings with this group. There was a high degree of frustration from the industry representatives that waters were being improperly placed on the 303(d) list without truly knowing that significant human actions were contributing to the higher temperatures. There was an equally high level of frustration from tribes and environmental groups that not enough was being done to implement controls for temperature and related protection of riparian habitat, resulting in continued declines of healthy salmon habitat. Everyone did acknowledge the complexities of temperature when trying to differentiate the natural variations from human influences. Frustration was also expressed by both sides of the issue that having a large number of temperature listings on the 303(d) list and not getting an adequate number of TMDLs done is a dilemma. Representatives of state Forest and Fish lands expressed specific concern that the state Forest and Fish Rules are in place to protect against temperature increases and should be recognized by placing those waterbodies into Category 4b.

The advisory group expressed interest in pursuing whether temperature TMDLs could become more efficient and less resource intensive as we discover what works and what doesn't to make improvements on the ground. There was also a general interest and willingness from the group to work together and with Ecology to brainstorm and evaluate alternatives for prioritizing TMDLs and perhaps finding ways to make implementation more automatic for parameters such as temperature.

A discussion on public perception was also held. Public perception of having waters on the 303(d) list can be negative, and if temperature listings occur with some uncertainties, that negative perception is unfairly directed at industries discharging to those waters. There is also a perception from some members of the public that once a water is on the 303(d) list, it can never get off. Ecology noted that part of this problem stems from the fact that a new 303(d) list had not been done since 1998, and that has fostered the notion that once on the 303(d) list, it can never get off. The department committed to have more timely, frequent updates to help with this perception.

RESTORING HEALTHY STREAM TEMPERATURES

Meeting temperature standards should be viewed as part of the larger fish recovery efforts to restore habitat. Wherever practicable, implementation actions to restore water temperatures should be integrated with implementation actions to improve habitat in general, and should be targeted first toward those reaches within a basin that will provide the biggest benefit to the fish. It should also be noted that the actions needed to improve water temperatures are, in many cases, the same as those needed to improve other fish habitat features. For example, restoring a stream’s riparian vegetation can reduce water temperature as well as reduce sediment erosion, provide over bank micro-habitat, and add fallen wood to the river that over time creates pools and a more diverse stream habitat preferred by salmonids (EPA 2003).

EPA Region 10 guidance provides the following examples of specific on-the-ground actions that could be done to meet temperature water quality standards, protect salmonid populations and also aid in the recovery of threatened and endangered salmonid species (EPA 2003):

- Replant native riparian vegetation.
- Install fencing to keep livestock away from streams.
- Establish protective buffer zones to protect and restore riparian vegetation.
- Reconnect portions of the river channel with its floodplain.
- Re-contour streams to follow their natural meandering pattern.
- Increase flow in the river derived from more efficient use of water withdrawals.
- Discharge cold water from stratified reservoirs behind dams.
- Lower reservoirs to reduce the amount of shallow water in "overbank" zones.
- Restore more natural flow regimes to allow alluvial river reaches to function.
- Restore more natural flow regimes so that river temperatures exhibit a more natural diurnal and seasonal temperature regime

DEALING WITH TEMPERATURE LISTINGS THROUGH TMDLS

TMDLs in Washington are conducted in the following steps:

1. Once a watershed has been selected, existing and new data about the waterbodies is gathered. The analysis and modeling of the data, along with conclusions and recommendations on how to reduce or eliminate the pollution from its sources, is included in a technical report.

2. From these recommendations and conclusions, an implementation strategy is developed which outlines what activities will be initiated to reduce the pollution. Once this strategy is put in place the success of the activities will be evaluated through effectiveness monitoring. Ecology staff work with local interests to develop the implementation strategy.

3. From the implementation strategy, Ecology and local interests then develop a Water Quality Implementation Plan (WQIP). This plan describes strategies for achieving the standards.

Temperature TMDLs can be resource intensive and time-consuming, with sometimes limited results. A typical watershed-scale temperature TMDL can take 2-3 years to complete the technical work, which involves study planning, one season of field sampling, data analysis, modeling, and report writing/review. Over that time period, multiple staff working on the project can add up to approximately 3 FTEs. A recent exercise in the costs of TMDLs found that temperature TMDLs are the most expensive TMDLs to perform, averaging $411,000 (Melissa Gildersleeve, personal communication). Some projects may be less costly because of a more limited geographic scope, local communities assisting with the monitoring, or perhaps the companion hydrogeologic survey is not needed because groundwater is determined to be a non-factor in the particular watershed.

Experience has shown that TMDL work must engage the whole community in order to achieve

success. Generally, we find that engaging communities requires a significant initial commitment of time and energy to ensure local involvement in the future.

When dealing primarily with TMDLs that nonpoint pollution, we have found that the same suite of best management practices (BMPs) is recommended over and over again, which is the case for temperature. This has led to the conclusion that we should spend less money on rigorous technical studies to prove the same thing over and over, and more money on implementing BMPs. This is an approach Ecology is considering for future TMDL work (WDOE, 2006). However, it should be noted that in some locations, rigorous technical studies need to be done to help persuade people to implement BMPs by identifying problems in their own backyard and by showing how much better the water could potentially be.

DEALING WITH TEMPERATURE LISTINGS-IS THERE A BETTER WAY?

The following suggestions resulted from the advisory work group meeting held with Washington Ecology in December 2005 and internal staff discussions at Ecology:

- Focus on going straight to implementation where temperature is a known concern or problem (note that this would require defining areas where it would work to go straight to implementation, and areas it would not).

- The state should develop processes for de-listing naturally warm waters.

- Recognize that the 0.3 degree human-caused allowance in the temperature standards is the key to evaluating compliance. The state could formalize a process to pre-screen listings to determine if a TMDL would be meaningful or not. This would be done outside of the TMDL process instead of as a part of the TMDL itself.

- Look at ways to increase instream flow from up-stream sources.
- The TMDL process uses models to assess temperature conditions. This approach treats sunlight as a “pollutant” and tries to use shade as a mitigating factor. The approach doesn’t make sense to the general public. Suggest looking at the problem from a landscape perspective: Where are temperatures impaired from natural conditions, and how can habitat improvements be made in these reaches to bring temperature closer to the natural state?

- Work to conserve Ecology resources and public resources by looking at ways to prioritize where Temperature work should focus:
    - Write a single TMDL for a common type of impairment (for example, a general TMDL that applies at multiple locations).
    - Consider the waterbody’s value (contribution) to fisheries or wildlife habitat, when making 303(d) listing decisions.
    - Conduct temperature studies by watershed or basin to delineate portions of watersheds that meet salmon, steelhead, and bull trout temperature requirements, and determine the system potential of that watershed.

- Focus on habitat improvements within areas, and bringing those areas up to suitable temperature for their habitat type, rather than on making an entire watershed conform to a single standard. TMDLs need to be focused on streams (and stream segments) where the citizens of the State gain the greatest return on their investment.
- Identify the value of the geographic area based on ESA species, important salmon habitat.
- Ecology should work with EPA and other states to develop processes to simplify TMDLs where most of the information is already known and it is more a matter of implementation.

- Pursue ideas for implementing temperature TMDLs or other alternatives for improving temperature.
    - Habitat Conservation Plans as a vehicle for improving temperature
    - Category 4B-Pollution Control Plans
    - Generic TMDL applied by local groups
    - Standard BPMs and Implementation that can occur regardless of location

- The state needs to explore how can we honor or credit the work going on with Washington's Forest & Fish rules. The 2004 303(d) list set a low priority for TMDLs to give a chance for Forest & Fish rules to take effect. Explore ways to highlight that.
- Stream-lining of the Use Attainability Analysis Process: Different assessment tiers are needed that apply different scales of data collection and assessment, depending on the characteristics of each waterbody being assessed.
- Developing a standard that recognizes Eastern Washington climate conditions, which are very different from those in Western Washington, would help reduce public confusion.

- *Washington's Water Quality Management Plan to Control Nonpoint Sources of Pollution, Volume 3, June 2005*, recognizes elevated temperature as a major problem with the state's rivers and streams. Because of that recognition, one major objective that was developed is to restore degraded systems. Suggest targeting critical areas and publishing those areas annually, increase grant and loan funding to improve riparian habitat activities and educate the public on the importance of riparian areas to salmon.

CONCLUSIONS

The importance of salmon as a vital cultural, spiritual, and economic symbol of the Pacific Northwest is well known. Healthy salmon runs mean healthy water resources and healthy people. Stream temperatures are well recognized as a critical component of healthy aquatic habitat for salmon and trout.

However, temperature is a complex criteria that is affected by many variables, both natural and human-caused. Determining what are the most appropriate temperature limits to protect salmonids, and factoring in when temperature exceedances are natural and when human actions are significantly impacting water temperatures can be a challenge for state environmental agencies. The large number of temperature listings on states' 303(d) lists places additional

challenges on how to prioritize them in comparison with other listings, and how to more efficiently work toward improved salmon and trout habitat.

Temperature TMDLs have proven to be expensive and time consuming, with limited results that typically identify the same BMPs to bring the waterbody back into compliance. It makes sense for state TMDL staff to work with their stakeholders and communities to do some "out-of-the-box" thinking on different approaches to improving temperature other than the traditional TMDL. This can involve on a variety of solutions depending on the area and willingness of the local community to proactively engage in improving stream riparian habitat and other practices to improve temperature. It is critical that we involve the regional EPA staff in these discussions so that resulting work will be recognized as a reasonable, or better, alternative to a TMDL.

Overall, the hope is that these improvements and efficiencies in conducting temperature improvement work will lead to healthy, sustained aquatic habitat for salmon and trout--a goal we all share in the Pacific Northwest..

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