

# InSight Consultants

PO Box 10  
Yoncalla, Oregon  
97499

Phone: (541) 849-2724  
Fax: (541) 849-3378  
E-mail: [insight@yoncalla.net](mailto:insight@yoncalla.net)

10/3/03

Emily Smith  
Oregon DEQ  
Water Quality Division  
811 SW Sixth Ave.  
Portland OR 97204-1390.

Dear Emily,

Please accept the attached document as my comments for the ongoing stream temperature standard rulemaking process. While I am an active member of the Umpqua Basin Watershed Council, I want to emphasize that these comments represent only my personal opinions.

Thank you for the opportunity to respond to this process.

Respectfully submitted,

Kent Smith  
Hydrologist  
InSight Consultants  
10/3/03

# Comments to DEQ proposed changes to water quality standards

## Comment Item 1:

Page 2 of 87

### *340-041-0002 Definitions*

*(2) "Ambient Stream Temperature" means the actual stream temperature measured at a specific time and place. The selected location for measuring stream temperature must be representative of the stream's thermal condition in the vicinity of the point being measured.*

I suggest that this definition, combined with "Ecologically Significant Cold-Water Refuge" is not sufficient to fully describe fish thermal habitat. Generally stream waters are well mixed and the temperature of the bulk of the water in a cross section is quite homogeneous. However, subsurface groundwater seepage and hyporheic flow can produce a small interface zone with a volume that may be very small with respect to the entire reach but may be vital to a migrating fish during the heat of the day. These areas are very difficult to identify because they are small and sparsely distributed and since they are below the surface, they may not be detectable by remote methods that measure only the surface temperature of the water. Consequently, these areas are often ignored because they are difficult to detect and managed. However, their role in the Umpqua Basin, which has warm summer temperatures and exceptionally long migration routes, may be very important.

Toward that end, I suggest that the word "actual" be deleted from the above definition and the word "bulk" be added to describe the thermal condition being considered.

### *Proposed revision:*

**(2) "Ambient Stream Temperature" means the ~~actual~~ stream temperature measured at a specific time and place. The selected location for measuring stream temperature must be representative of the stream's bulk thermal condition in the vicinity of the point being measured.**

Also, I propose that an additional definition be established to account for the micro refugia areas.

Proposed definition:

**(X) "Micro-Thermal Refugia" refers to small cool water zones associated with subsurface seeps and hyporheic flow that may provide short-term refuge to a small number of stenotypic cold-water species (flora or fauna) in streams with warm ambient temperatures.**

This definition differs from the existing definition (19) below in that the areas are small and difficult to detect. Individually the micro refugia areas may not be "significant" but collectively they are significant in systems like the Umpqua with warm migration routes. The context of definition (19) suggests areas that are large and easily detected.

***(19) "Ecologically Significant Cold-Water Refuge" means all or a portion of a waterbody that supports stenotypic cold-water species (flora or fauna) not otherwise widely supported within the subbasin, and either:***

***(a) Maintains cold-water temperatures throughout the year relative to other segments in the subbasin, providing summertime cold-water holding or rearing habitat that is limited in supply, or;***

***(b) Supplies cold water to a receiving stream or downstream reach that supports coldwater biota.***

It is further suggested that appropriate language be inserted into the new rule to assure appropriate consideration and maintenance of the above-mentioned micro-thermal refugia.

## **Comment Item 2**

Page 5 of 87

***(38) "Natural Conditions" means conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the State which are uninfluenced by anthropogenic activities. Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation, diseased vegetation are considered natural conditions.***

***In the case of temperature criteria, the natural condition of a subbasin or stream reach is the anticipated thermal potential of the subbasin or stream reach.***

Stream temperature data from over 300 sites in the central Umpqua Basin indicate that many areas are functioning at "natural condition." Further, the data provides a means to establish the expected "natural condition" value for the entire central basin.

The cited data was collected by the Umpqua Basin Watershed Council (UBWC) and other agencies over a period from 1998 – 2002 and is available at the Eugene DEQ office or through the UBWC. Several documents containing analysis and summaries of this data can be obtained at the web site for InSight Consultants at [www.yoncalla.net](http://www.yoncalla.net). In particular, the document "Stream Temperature in the Umpqua Basin – Characteristics and Management Implications" (Smith 2003) provides a detailed discussion of the information presented here.

### ***Anthropogenic influence:***

The EPA technical Synthesis (Poole, Dunham et al. 2001) identifies many human-related factors that can influence stream temperature and does acknowledge that some stream

dissipate added heat effectively and may return to pre-disturbance conditions. The data for the Umpqua Basin indicates that this situation is the general rule rather than the exception. The rising and falling nature of the longitudinal temperature profile curve indicates a strong local effect that tends to override other cumulative effects. The constancy of the timing of the diurnal pattern at all of the sites also indicates a strong local influence. This result isn't surprising to anyone familiar with summer flow conditions on the Umpqua.



**Figure 1 Main Umpqua River at Elkton.**

During the summer, flows recede drastically and the channel pattern converts to a series of connected shallow reservoirs (See Figure 1). Water molecules moving through these reaches are subject to dispersion, eddy circulation, hyporheic exchange, and evaporation. The net result is a long dwell time with ample opportunity to equilibrate with the local environment. The result if this condition is that the effect of upstream influences is limited to a few upstream pool areas.

Water withdrawals and flood management can also influence the heating process. The subject of flow depth does not seem to be fully understood. While less flow means more heat per unit area of the water column, it may also mean a larger proportion of local groundwater inflow. If the water is reaching local equilibrium temperature, the depth of water isn't a critical issue since the mean daily temperature can not exceed the daily equilibrium value. Stream temperature data from a 1937 study ((Roth 1937) indicates that streams in the Tiller area of the South Umpqua that were less than ten miles from the watershed divide were exceeding the 64°F temperature value. Forest Service records indicate that the area was not roaded and conditions could be considered "non-anthropogenic."

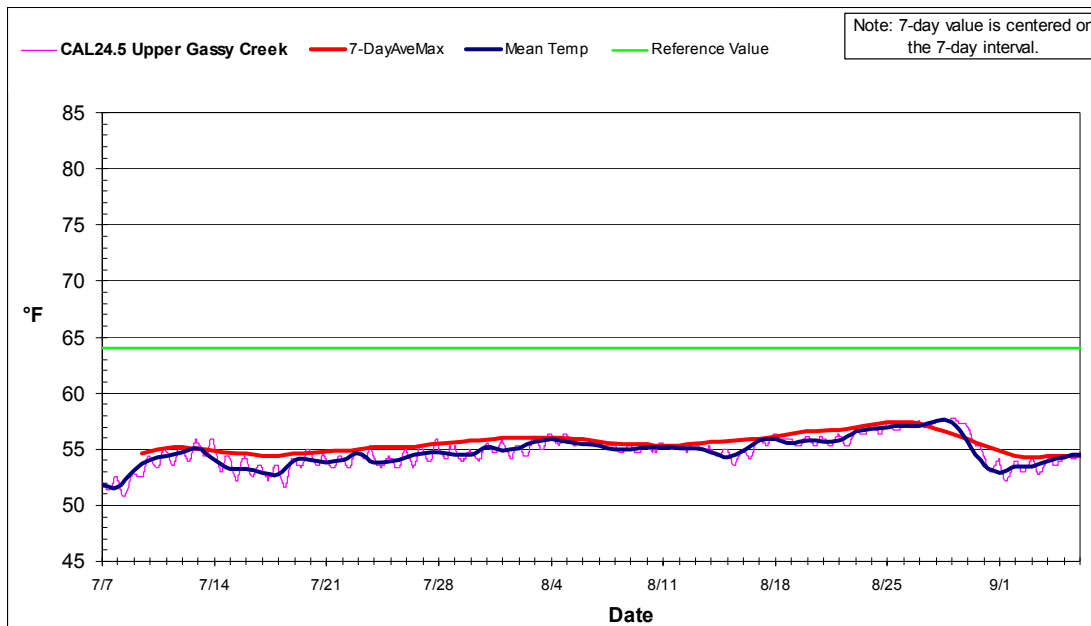
Flood management can reduce the amount of stored water available for summer release ((Coutant 1999) and this can certainly can effect the functionality of the micro-habitat mentioned in Comment Item 1. However, this change and other "cumulative effects" would probably have no measurable effect on the equilibrium ambient stream temperature.

In conclusion, the data indicates that it is possible for sections of Umpqua Basin streams to achieve ambient stream temperatures equivalent to "Natural Conditions."

### ***Expected Temperature Value***

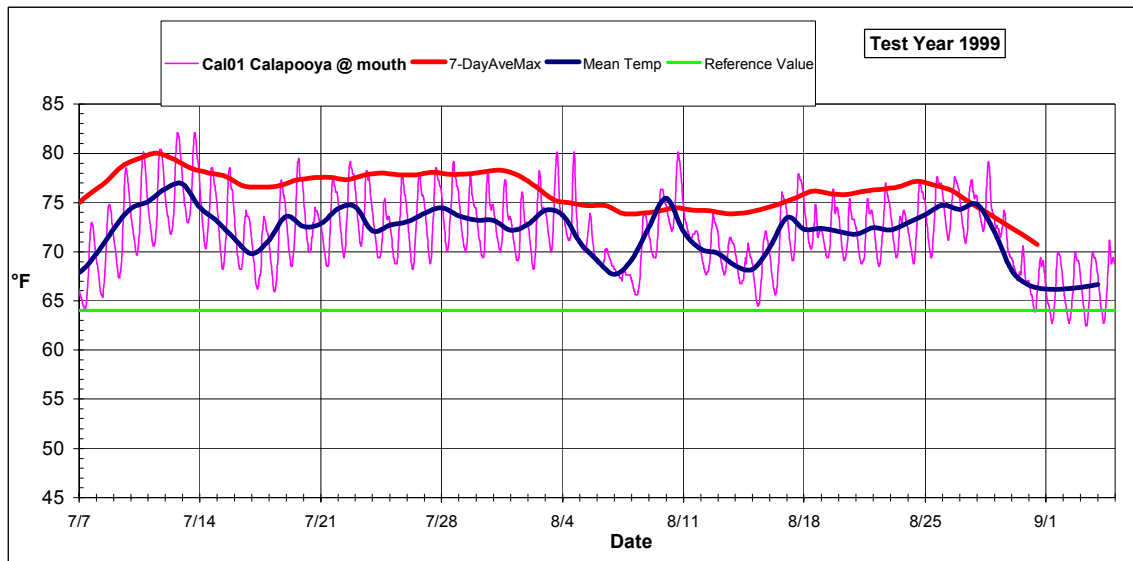
The heating patterns of stream systems has been well documented (Sullivan and Adams 1990; Mohseni and Stefan 1999). Basically, during the summer cold ground water emerges at the headwaters and, as it accumulates downstream, eventually equilibrates with the local environmental temperature. Consequently the range of achievable temperatures is determined by the emergent groundwater temperature and the ambient environmental temperature.

The stream temperature data indicates that the summer source-area emergent temperatures in the central portion of the Umpqua Basin are consistently about 52°F. It is interesting to note that the mean annual air temperature in the basin is in the range of 52-54°F. These temperatures are warmer than other parts of the state due, in part, to the warm winter patterns of western Oregon. Note that the streams in the Umpqua have warmer summer temperatures because of the warmer winter temperatures. Figure 2 shows typical data from a headwater area that is located 2.9 miles from the watershed divide.



**Figure 2 Upper Gassy Creek Temperature 1999**

Figure 3 shows typical results at the mouth of Calapooya Creek located 43 miles from the watershed divide.



**Figure 3 Calapooya Creek at the mouth 1999**

This pattern is typical for the central Umpqua Basin and represents the equilibrium conditions at the downstream end. The final mean stream temperature is generally in the low seventies which correspond to a mean August ambient temperature of 69°F in the central basin area. The 7-day maximum is usually within five degrees Fahrenheit of the maximum daily mean value.

The data from the intermediate temperature sites provides some insight of the longitudinal temperature profile of the 7-day max temperature as shown in Figure 4. The lower edge of the data cluster typically follows a logarithmic curve and it is assumed that these temperature values are representative of "natural conditions" at discrete points along the stream (the table in Figure 4 lists temperature based on the logarithmic curve). A detailed analysis of all of the data is contained in the UBWC document (Smith 2003).

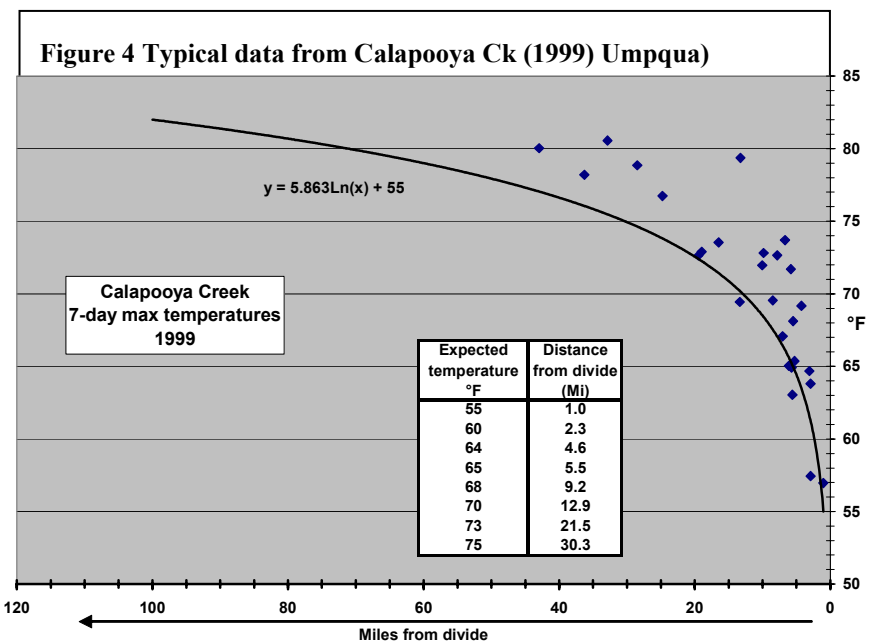
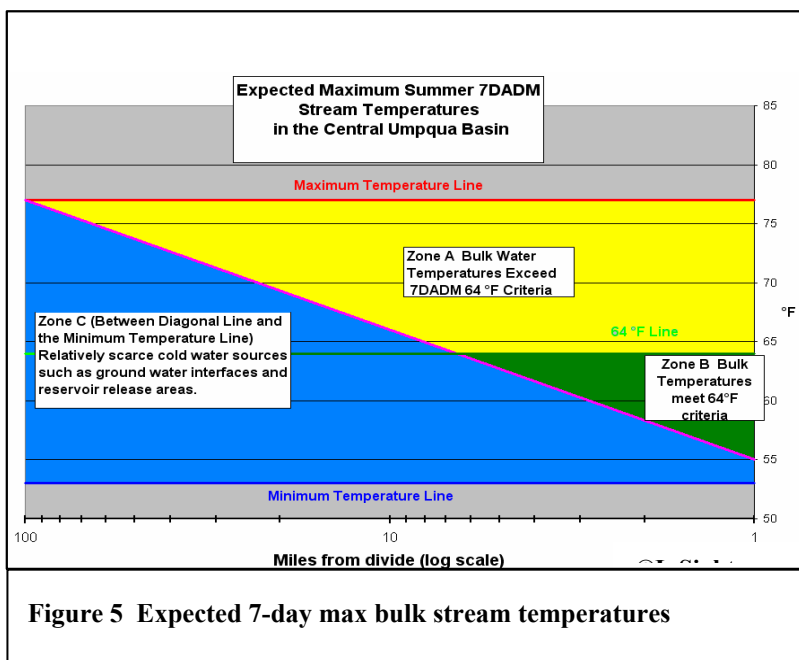


Figure 5 shows the summary result from the Lower North Umpqua, Main Umpqua, South Umpqua, Cow Creek, Calapooya Creek, Elk Creek and Hinkle Creek watersheds. The sections above the diagonal line indicate the bulk stream temperature as discussed in the first section of this document. It is important to remember that temperatures below the line can occur at all points along the stream albeit at scarce locations.

The data analysis indicates that the 64°F cutoff point occurs at about 6 miles from the watershed divide for the Calapooya and Elk Creek watersheds. For the remaining watersheds, the 64 °F cutoff point is at 7 miles. Figure 4 shows that the 68°F cutoff point occurs at 9.2 miles from the watershed divide.



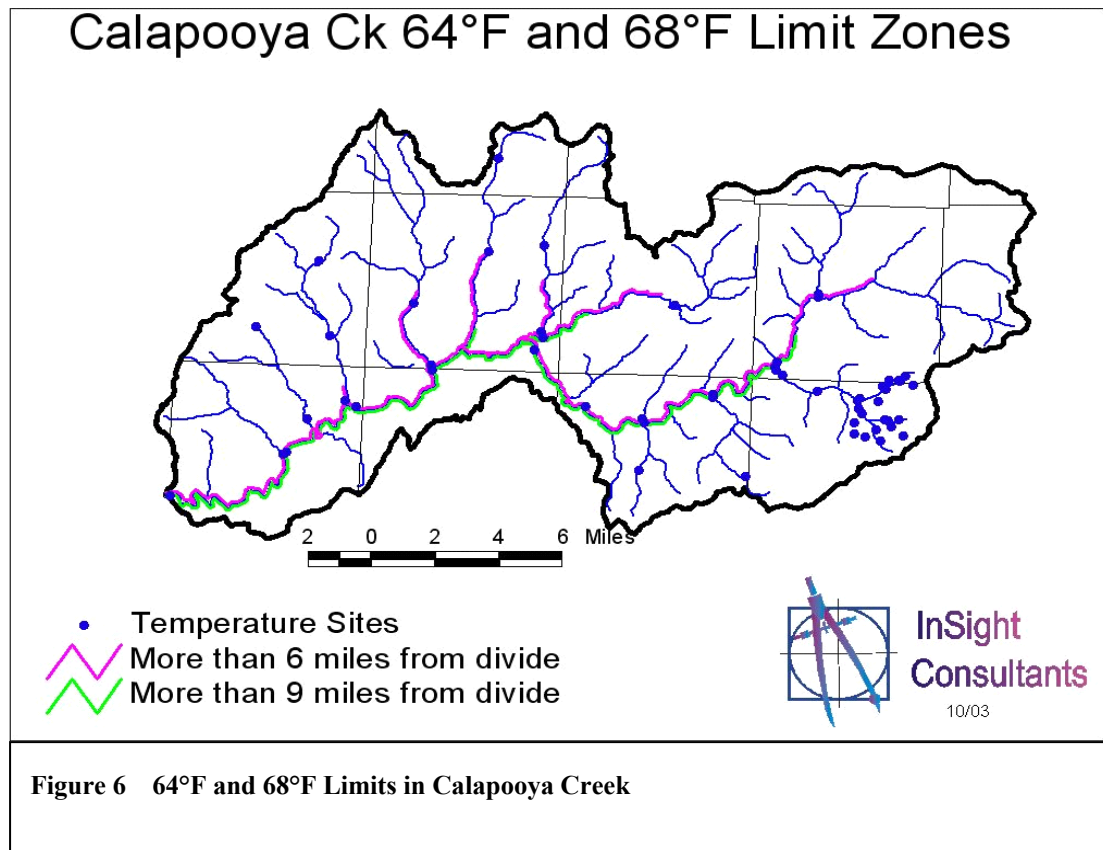
As shown in Figure 4, many sites have temperatures that are significantly above the curve. There may be management opportunities to reduce these values until they approach the line. However, the analysis indicates that the ambient (bulk) stream temperature should not be expected to be below the line.

Figure 6 shows the implications of this analysis on a representative Umpqua Basin watershed. In this case, the streams greater than six miles from the divide would not be expected to achieve bulk stream temperatures below 64°F and streams greater than 9.2 miles would not achieve 68°F. It is apparent that the entire main stem and the lower portions of the larger tributaries of the streams in the central Umpqua Basin are incapable of meeting these criteria.

***Proposed action***

Problems with fixed numeric criteria were identified by the EPA Criteria Work Group (Poole, Dunham et al. 2001). Specifically, a fixed value criterion will under protect colder areas and put an onerous regulatory burden on areas incapable of meeting the value.

The preferred action would be to adopt a temperature standard based on the natural thermal regime of the stream. The data available from the Umpqua is a good start toward accomplishing that task. However, if it is deemed necessary to retain the fixed numeric criteria than the process to establish the "natural condition" of a stream needs to be developed and implemented in a timely manner so that realistic management plans can be developed. This process should include the use of empirical methods such as those described in this letter.



The rule as written defines the natural condition of a subbasin or stream reach as the anticipated thermal potential of the subbasin or stream reach. The question then becomes how the "thermal potential" value is determined. The empirical analysis of over one million temperature readings suggests that these values can be determined as shown in Figure 5. It is recommended that empirical methods similar to the methodology used here be considered acceptable for determination of the thermal potential value.

### Cited References

- Coutant, C. C. (1999). Perspectives on temperature in the pacific northwest's fresh waters. Oak Ridge, Oak Ridge National Laboratory: 108.
- Mohseni, O. and H. G. Stefan (1999). "Stream temperature/air temperature relationship: a physical interpretation." *Journal of Hydrology* **218**: 128-141.
- Poole, G., J. Dunham, et al. (2001). Technical synthesis - Scientific issues relating to temperature criteria for salmon, trout, and char native to the Pacific Northwest, EPA: 21.
- Roth, A. R. (1937). A survey of the waters of the South Umpqua Ranger District, Umpqua National Forest. Portland, Oregon, USDA Forest Service: 41.
- Smith, K. (2003). Stream Temperature in the Umpqua Basin - Characteristics and management Implications. Roseburg, Umpqua Basin Watershed Council: 80.
- Sullivan, K. and T. N. Adams (1990). The physics of stream heating: 2) an analysis of temperature patterns in stream environments based on physical principles and field data, Weyerhaeuser: 79.