

ensure the presence of well-distributed cold water refugia. This 20°C/68°F criterion roughly translates to an equivalent constant temperature of about 19–20°C/66–68°F because the large mainstem rivers where this use is proposed have little diurnal variation. Well-distributed cold water refugia are portions of a river with cooler nighttime temperatures, or portions of a river that are cooler during the day, that allow salmon and steelhead to migrate through the river segment with minimal stress. Spatial cold water refugia are waters that are at least 2°C/4°F colder than the daily maximum temperature at the nearest location in the main river channel. Spatial cold water refugia results from cold tributaries and cooler groundwater flow entering into a warmer river. Temporal cold water refugia are waters in rivers at times of the day when water temperatures are at least 2°C/4°F colder than the daily maximum temperatures on that day in the main river channel (from diurnal temperature variation in a river), and are waters in rivers on days in the summer when maximum water temperatures are at least 2°C/4°F colder than the summer maximum temperature (from seasonal temperature variation).

EPA believes that a 20°C/68°F criterion accompanied by a narrative criterion to ensure the presence of well-distributed cold water refugia would protect migrating juveniles and adults from lethal temperatures and would prevent migration blockage conditions. However, information in the record indicates that many sublethal effects could occur without cooler nighttime temperatures or portions of the river that are cooler during the day, rendering the numeric criterion of 20°C/68°F alone unprotective of the designated use. See Temperature Guidance, pp. 28–30. In such a situation, even if the river meets a 20°C/68°F criterion for maximum temperatures, the duration of exposure to 20°C/68°F temperatures may cause adverse effects in the form of increased disease and decreased swimming performance in adults, and increased disease, impaired smoltification, reduced growth, and increased predation for late emigrating juveniles (e.g., fall chinook in the Columbia and Snake Rivers). Therefore, in order to protect this use, it is appropriate to accompany the numeric criterion of 20°C/68°F with a narrative provision that would require protection of well-distributed cold water refugia.

EPA believes the amount of cold water refugia would be sufficient to protect this use if a typical migrating salmon or steelhead could access waters that are 18°C/64°F or colder for at least

12 hours a day. Salmon and steelhead that are exposed to 18°C/64°F for half the day and up to 20°C/68°F for the remainder of the day are likely to be at less risk than if these fish were continuously exposed to 20°C/68°F because studies show the severity of adverse effects from elevated water temperatures increases significantly as temperatures reach 20–21°C/68–70°F.

As a practical matter, this provision is likely to be implemented during establishment of a Total Maximum Daily Load (TMDL), because all the waters where EPA is proposing for this use currently do not attain 20°C/68°F, thus a TMDL is required based on the numeric criteria. When applying this narrative criterion in the context of a TMDL, the State or EPA would identify the existing cold water refugia and determine whether or not they were sufficient to protect the use. Existing cold water refugia would be identified in the TMDL and the existing temperatures of the cold water refugia would be the applicable numeric criteria for those water segments. Thus, the TMDL would be the document where the narrative cold water refugia criteria is translated into numeric terms. If the existing cold water refugia were insufficient to protect the use, then additional cold water refugia sufficient to protect the use would also be identified and expressed in numeric terms in the TMDL. Depending on how the TMDL is structured, the expression of cold water refugia in numeric terms might also occur during the development of watershed plans to implement the TMDL rather than in the TMDL itself. In addition, the watershed plans may contain measures to protect and restore the cold water refugia.

In the future, as these waters come into attainment of the 20°C/68°F numeric criterion, attainment of the specific numeric cold water refugia criteria identified in the TMDL or watershed plan will also need to be assessed to determine the attainment status of these waters.

In the NPDES permitting context, existing cold water refugia are required to be protected. Where additional cold water refugia have not yet been identified, EPA believes it is impracticable to do so in the context of an individual NPDES permit because this assessment requires an evaluation of the adequacy of the existing cold water refugia on the water body as a whole and is likely to be data intensive. EPA believes this kind of comprehensive assessment is only practicable in the context of TMDL development. Once the TMDL is completed, however, any wasteload

allocations to protect either existing or new cold water refugia must be incorporated into NPDES permits during the next permit cycle.

EPA seeks comment on whether a 18°C/64°F 7DADM criterion (without well-distributed cold water refugia) would be a more appropriate criterion for protection of the salmon and steelhead migration use, since the record shows that it would be equally protective of the use and may be more straight forward to implement than the 20°C/68°F with a narrative criterion for well-distributed refugia. See EPA Temperature Guidance, pp15–25. EPA, however, believes 18°C/64°F *throughout* the waters would be extremely costly to attain as compared to the 20°C/68°F with a narrative criterion for well-distributed refugia.

*v. Temperature Criteria for Waters Designated for Salmon and Steelhead Spawning Through Fry Emergence.* EPA proposes a 13°C/55°F maximum 7DADM criterion (which roughly translates to an equivalent constant temperature of 11.5°C/53°F) for this use (during the time of year when it applies) to: (1) Protect gametes inside adults prior to spawning (less than 13°C/55°F constant), (2) provide temperatures at which spawning is most frequently observed in the field (4–14°C/39–57°F daily average), and (3) provide protective temperatures for egg incubation (4–12°C/39–54°F constant for good survival and 6–10°C/43–50°F constant for optimal range) that occurs over the winter (salmon) and spring (trout), assuming the typical annual thermal pattern. As discussed in section III.B.1, EPA believes that in many water bodies, attainment of the summer maximum criteria for all the other proposed designated uses will result in attainment of the 13°C/55°F maximum 7DADM criterion for protection of salmon and steelhead spawning through fry emergence.

#### 4. Alternative Criteria

*i. EPA's Basis for the Proposed Natural Conditions Criterion.* EPA is proposing an alternative criterion for natural conditions that would apply instead of the numeric criterion, where applicable. The criterion would require that where a water body or segment's water temperature under natural conditions exceeds the numeric criterion identified above, then the natural condition would be the applicable water quality criterion. Natural temperatures are those that would exist in the absence of human activities that alter stream temperatures. EPA views numeric criteria that reflect natural conditions to be protective of