

## **APPENDIX B**

### **Summary of Important Water Temperature Considerations**

Tables B-1 and B-2 provide summaries of the important water temperature considerations, which formed the scientific basis of USEPA's recommended temperature criteria. The tables are taken from the *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (April 2003). For more detail on the derivation of the numbers in the tables see the Temperature Guidance and the Technical Issue Papers.

**Table B-1. Summary of Temperature Considerations for Salmon and Trout Life Stages**

Life Stage	Temperature Consideration	Temperature & Unit	Reference
Spawning and Egg Incubation	Temperature range at which spawning is most frequently observed in the field	4 - 14 °C (daily avg.)	Issue Paper 1, <sup>1</sup> pp. 17-18 Issue Paper 5, <sup>2</sup> p. 81
	Egg Incubation Studies - results in good survival - Optimal range	4 - 12 °C (constant) 6 - 10 °C (constant)	
	Reduced viability of gametes in holding adults	13 °C (constant)	Issue Paper 5, p. 16
Juvenile Rearing	Lethal temperature (1-week exposure)	23 - 26 °C (constant)	Issue Paper 5, pp. 12, 14 (Table 4), 17, and 83-84
	Optimal growth - Unlimited food - Limited food	13 - 20 °C (constant) 10 - 16 °C (constant)	Issue Paper 5, pp. 3-6 (Table 1), and 38-56
	Rearing preference temperature in lab and field studies	10 - 17 °C (constant) <18 °C (7DADM)	Issue Paper 1, p. 4 (Table 2) USEPA 2003
	Impairment to smoltification	12 - 15 °C (constant)	Issue Paper 5, pp. 7 and 57-65
	Impairment to steelhead smoltification	>12 °C (constant)	Issue Paper 5, pp. 7 and 57-65
	Disease risk (lab studies) - High - Elevated - Minimized	>18 - 20 °C (constant) 14 - 17 °C (constant) 12 - 13 °C (constant)	Issue Paper 4, <sup>3</sup> pp. 12-23
Adult Migration	Lethal temperature (1-week exposure)	21 - 22 °C (constant)	Issue Paper 5, pp. 17, 83-87
	Migration blockage and migration delay	21 - 22 °C (average)	Issue Paper 5, pp. 9, 10, 72-74 Issue Paper 1, pp. 15-16
	Disease risk (lab studies) - High - Elevated - Minimized	>18 - 20 °C (constant) 14 - 17 °C (constant) 12 - 13 °C (constant)	Issue Paper 4, pp. 12 - 23
	Adult swimming performance - Reduced - Optimal	>20 °C (constant) 15 - 19°C (constant)	Issue Paper 5, pp. 8, 9, 13, 65 - 71
	Overall reduction in migration fitness due to cumulative stresses	>17 - 18 °C (prolonged exposure)	Issue Paper 5, p. 74

<sup>1</sup> Sauter, S.T., J. McMillan, and J. Dunham. 2001. *Issue paper 1: salmonid behavior and water temperature*. Prepared as part of USEPA Region 10 Temperature Water Quality Criteria Guidance Development Project.

<sup>2</sup> McCullough, D.A., S. Spalding, D. Sturdevant, and M. Hicks. 2001. *Issue paper 5: summary of technical literature examining the physiological effects of temperature on salmonids*. EPA-910-D-01-005. U.S. Environmental Protection Agency. 114 pp.

<sup>3</sup> Materna, E. 2001. *Issue paper 4: temperature interaction*. EPA-910-D-01-004. Prepared as part of the U.S. Environmental Protection Agency's Region 10 Temperature Water Quality Criteria Guidance Development Project, Seattle, WA. 33 pp.

**Table B-2. Summary of Temperature Considerations for Bull Trout Life Stages**

Life Stage	Temperature Consideration	Temperature & Unit	Reference
Spawning and Egg Incubation	Spawning initiation	<9 °C (constant)	Issue Paper 5, <sup>1</sup> pp. 88 - 91
	Temperature at which peak spawning occurs	<7 °C (constant)	Issue Paper 5, pp. 88 - 91
	Optimal temperature for egg incubation	2 - 6 °C (constant)	Issue Paper 5, pp. 88 - 91 Issue Paper 5, p. 16
	Substantially reduced egg survival and size	6 - 8 °C (constant)	Issue Paper 5, pp. 18, 88 - 91
Juvenile Rearing	Lethal temperature (1-week exposure)	22 - 23 °C (constant)	Issue Paper 5, p. 18
	Optimal growth - Unlimited food - Limited food	12 - 16 °C (constant) 8 - 12 °C (constant)	Issue Paper 5, p. 90; Selong et al. 2001; Bull trout peer review 2002, as cited in USEPA 2003
	Highest probability to occur in the field	12 - 13 °C (daily maximum)	Issue Paper 5, p. 90; Issue Paper 1, <sup>2</sup> p. 4 (Table 2); Dunham et al. 2001 and Bull trout peer review 2002, as cited in USEPA 2003
	Competition disadvantage	>12 °C	Issue Paper 1, pp. 21 - 23; Bull trout peer review 2002, as cited in USEPA 2003

<sup>1</sup> McCullough, D.A., S. Spalding, D. Sturdevant, and M. Hicks. 2001. *Issue paper 5: summary of technical literature examining the physiological effects of temperature on salmonids*. EPA-910-D-01-005. U.S. Environmental Protection Agency. 114 pp.

<sup>2</sup> Issue Paper 1: Sauter, S.T., J. McMillan, and J. Dunham. 2001. Salmonid behavior and water temperature. Prepared as part of USEPA Region 10 temperature water quality criteria guidance development project.