



Focus

Effects of Elevated Water Temperatures on Salmonids

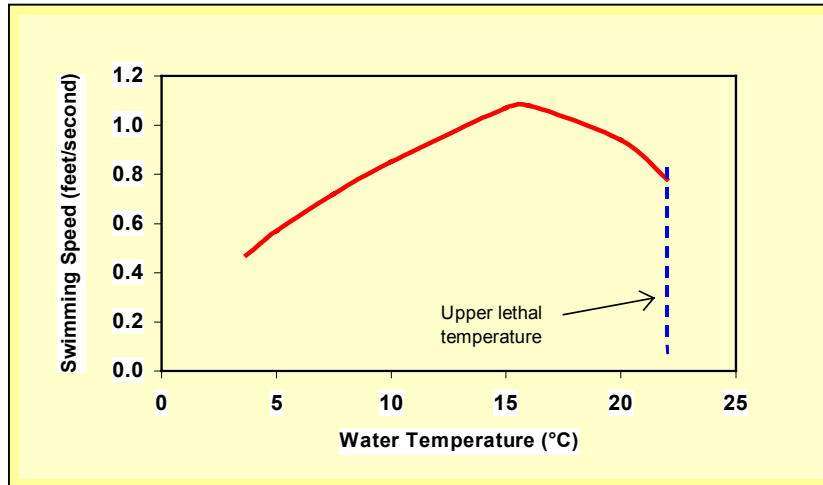
Issue

Salmonids (salmon, trout and char – including bull trout) require cool, well-oxygenated water to survive. The maximum temperature that salmonids can tolerate varies with species, life-stage (e.g., fry, fingerling or adult), prior acclimation, oxygen availability, duration of warmer temperature, and the presence of pollutants. Given the opportunity, juvenile and adult salmon will occupy water that is 13-18° C (55-64° F), with the warmer water selected only if excess food is available. Water temperatures of approximately 23-25° C (73-77° F) are lethal to salmon and steelhead, and genetic abnormalities or mortality of salmonid eggs can occur above 11° C (52° F).

Many laboratory studies have shown that elevated water temperatures can have a number of negative effects on salmonids. While laboratories cannot duplicate the complex situations that salmonids encounter in nature, they do offer a picture of some of the harmful effects of warm water on salmonids, including the following:

1. **Decreased supply of oxygen.** Higher water temperatures lower the availability of dissolved oxygen by reducing its solubility. Higher temperatures also increase the rate of organic decomposition, further decreasing available oxygen levels. When dissolved oxygen levels are low, fry emerge late, are smaller and less healthy, and have reduced survival rates due to predation, disease and starvation.
2. **Disrupted metabolism.** Elevated temperatures accelerate the metabolism, respiration, and oxygen demands of fish and other aquatic life. Respiration rates nearly double with a 10° C rise in water temperature, thereby increasing food and oxygen needs. The increased need for food forces salmonid fry to spend more time feeding and thus they are exposed to predators for longer periods. Also, since warmer water holds less oxygen, a salmonid's increased oxygen needs may not be met.
3. **Increased susceptibility to toxins.** The toxicity of many substances to salmonids intensifies as water temperature rises. One example is the rapid increase in the toxicity of nickel and chlorine to juvenile salmonids exposed to increased temperatures.
4. **Increased vulnerability to disease.** Many fish diseases spread more rapidly at higher temperatures. A substantial amount of research demonstrates that many fish diseases become considerably more virulent at water temperatures over 16° C (61° F). Additionally, salmonids are weakened by higher temperatures and are more susceptible to disease. Even if infected fish do not die from the disease, they are more susceptible to predation and less able to compete for food, and they often transmit the disease to other fish.

5. **Reduced ability to avoid predators.** At elevated water temperatures, juvenile salmonids are not able to swim as fast as at lower water temperatures. The average optimum temperature for swimming speed of most salmonid fry is about 15° C (59° F) (see figure below). Warmer water also accelerates the metabolism of predator fish, increasing their ability to prey upon juvenile salmonids.



The effect of temperature on swimming speed of salmonids. Slower swimming speed at warmer temperatures reduces ability of juvenile salmonids to avoid predators.

6. **Reduced food supply.** Many of the aquatic insects that salmonids prefer for food cannot live at elevated water temperatures. In warmer waters, desirable salmonid food sources such as mayfly, stonefly and caddisfly nymphs die off and are replaced by other insects (e.g., midges and mosquito larvae) that are much less desirable as food for salmonids.

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