



Water Quality

Katmai and Lake Clark national parks and preserves were created, in part, to protect high-quality habitat for salmon. Cold water is a key habitat requirement, but exactly how cold depends on the salmon species, population, and life stage. To address this complexity, the State of Alaska uses several freshwater temperature thresholds that align with the upper end of the range of temperatures tolerated by salmon at specific life stages. According to these thresholds, water that supports spawning or incubating salmon may not exceed 13°C, and water that supports migrating or rearing salmon may not exceed 15°C. Also, water may not exceed 20°C at any time, if it supports aquatic life. In 2019, water temperatures in Katmai and Lake Clark national parks and preserves exceeded all of these thresholds.



NPS/Paul Gabriel

A view of Telaquana Lake, in Lake Clark National Park and Preserve, where surface water temperatures reached 26°C on July 8, 2019, shortly after salmon began migrating into the lake to spawn, according to the park's fish count data.

Findings

Air temperatures in Alaska during 2019 topped previous records for the warmest year. Water temperatures also broke records in many locations. For example, 12 monitoring sites that support salmon migration and rearing had the highest number of days where water temperatures exceeded the State of Alaska's defined 15°C threshold (Figure 1). Daily mean water temperatures at these sites reached maximum values ranging from 16°C to 23°C, corresponding with

temperatures considered stressful (at best) and lethal (at worst) for adult salmon (Figure 2). Fortunately, salmon at these sites did not experience mass pre-spawn die-offs like those elsewhere in western Alaska, such as the Igushik River (which empties into Bristol Bay) and Fish River (which empties into Golovin Bay). Instead, they seem to have adjusted their use of habitat to avoid the high temperatures, either by delaying migration or seeking deeper, colder water.



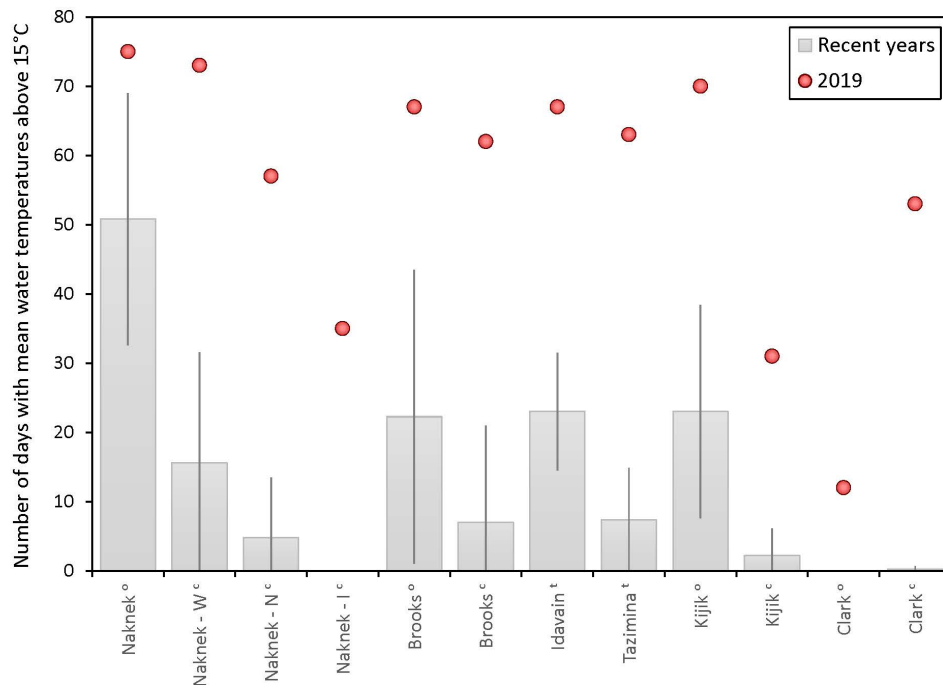


Figure 1. Number of summer days with average water temperatures above the State of Alaska's water quality threshold (15°C) at monitoring sites during 2019 (points), compared with recent years (bars and lines signify averages and standard deviations, respectively). Sites include lake outlets (^o), lake centers (^c), and lake tributaries (^t). For most sites, the bars include data from 2014 through 2018. For Idavain, Tazimina, and Brooks outlet, the bars include fewer years during the same time span. For all sites, summer encompasses June 1 through October 1.

Methods

The Southwest Alaska Network (SWAN) uses several approaches to monitor water temperature, ranging from year-round measurements at targeted locations to once-a-year measurements at randomly selected sites. These measurements rely on various types of equipment located in different types of habitat. For example, moored arrays are deployed at seven lake center sites, where they record temperatures experienced by juvenile salmon while rearing. Likewise, multi-parameter sondes and pressure transducers are deployed, respectively, at two and four lake outlet sites. There, they record temperatures experienced by migrating smolts and spawners. In all, SWAN monitors temperature at more than 180 sites distributed throughout three parks.

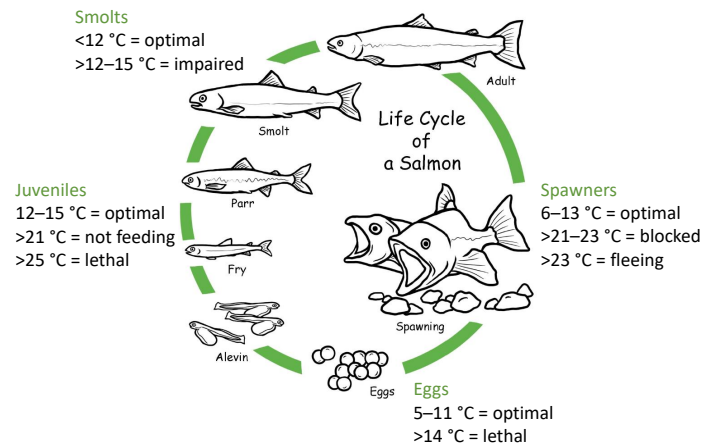


Figure 2. Optimal and lethal temperatures for salmon are difficult to generalize because they vary by life stage and species. They also vary at the sub-species level, because individual populations are adapted to localized habitat conditions. For detailed reviews, see Sauter et al. 2001 and Richter and Kolmes 2005.

References

- Sauter, S. T., J. McMillan, and J. Dunham. 2001. Issue Paper 1: Salmonid behavior and water temperature. Prepared as part of US EPA Region 10 Temperature Water Quality Criteria Guidance Development Project. EPA-910-D-01-001.
- Richter, A. and S. A. Kolmes. 2005. Maximum temperature limits for chinook, coho, and chum salmon, and steelhead trout in the Pacific Northwest. *Reviews in Fisheries Science* 13:23–49.

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