

Water Quality

Lakes integrate water, energy, nutrients, sediments, and pollutants from the surrounding land and air. Therefore, lake water quality can be a useful indicator of broad scale stressors, such as climate change. High-latitude lakes are projected to become not only warmer as a result of climate change, but also more turbid, more enriched in nutrients and organic matter, and more productive (Wrona et al. 2005). These changes have the potential to impact the growth, survival, and reproduction of aquatic organisms, such as salmon, and also the terrestrial organisms that rely on them. The Southwest Alaska Network (SWAN) monitors several lake water quality parameters, including temperature, pH, conductivity, and dissolved oxygen. Of these parameters, temperature is particularly important because all the other parameters are directly related to it.

Findings

SWAN monitors water temperature hourly, year-round in four lakes: Naknek Lake and Lake Brooks in Katmai National Park and Preserve (NPP), and Lake Clark and Kijik Lake in Lake Clark NPP (Figure 1). This monitoring relies on the use of programmable data loggers attached at various depths, from 1 to 100 m, on moored vertical lines called “temperature arrays.” Recent results from the Lake Clark and Naknek Lake arrays are summarized in Figure 2. Variability is evident both between years in a given lake and between lakes in a given year. Average daily temperatures

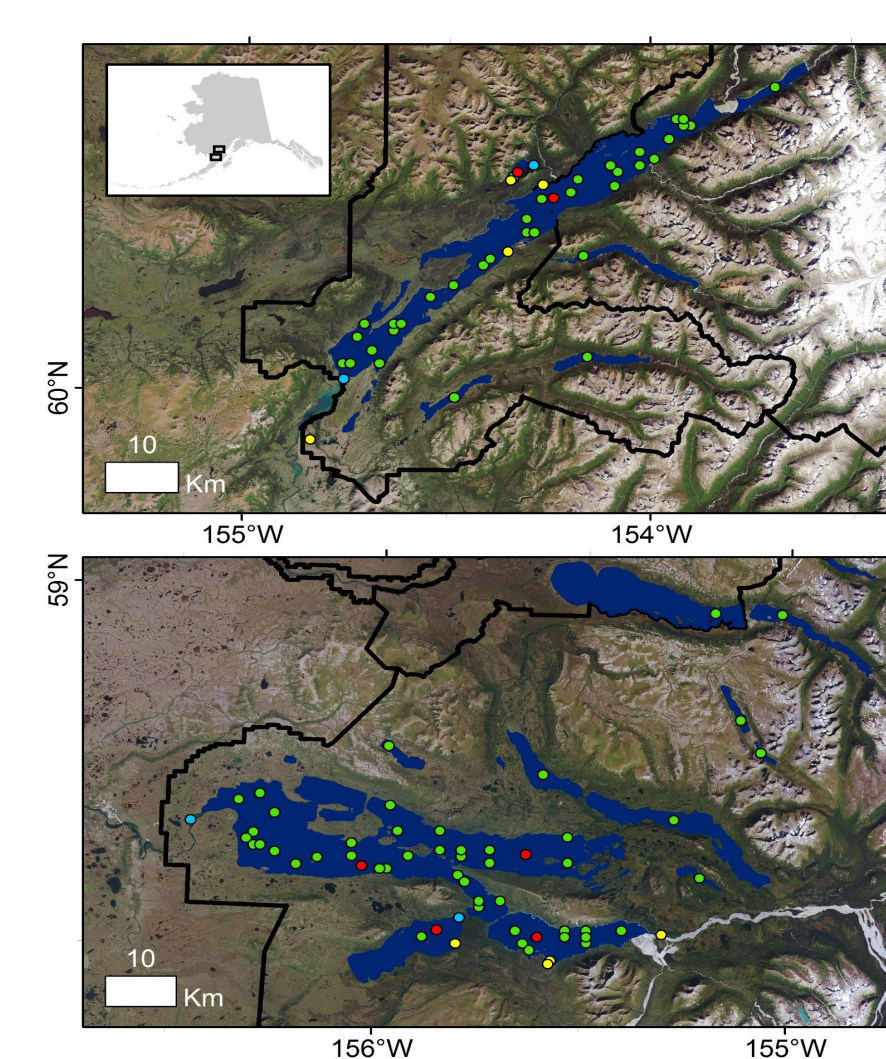


Figure 1. SWAN water temperature monitoring sites in Lake Clark NPP (upper) and Katmai NPP (lower). Red dots indicate mid-lake sites where temperature arrays are deployed continuously; green dots signify mid-lake sites where sondes are used annually; blue dots represent lake outlet sites where sondes and other types of temperature sensors are deployed seasonally or longer; and yellow dots indicate lake shore or tributary sites where various types of temperature sensors are deployed continuously. Park boundaries are depicted in black. (Some outlying sites in each park unit are not shown.)

depicted in Figure 2 rarely exceed the state’s water quality threshold of 15°C, for the migration routes and rearing areas of fish. However, the fact that this threshold is crossed at a

depth of 5 meters mid-lake warrants concern, given that temperatures at the surface and lake edges are likely warmer. Moreover, average surface temperatures during July are projected



Hydrological technician, Jeff Nelson, samples water quality with a multi-parameter sonde in Hallo Glacier Lake, Katmai NPP.

to increase 3 to 6°C by the year 2100 in six nearby lakes, including Naknek Lake and Lake Brooks (Jones and Arp 2014).

Methods

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. For example, temperature arrays are deployed at a six sites continuously; multi-parameter sondes are deployed at two sites seasonally and are used at an additional hundred or more sites annually (Figure 1).

References

- Jones, B. M. and C. D. Arp. 2014. Thermal response of western Alaska lakes to past, present, and future changes in climate. Western Alaska LCC Final Report. Anchorage, AK.
- Wrona, F. J., T. D. Prowse, and J. D. Reist. 2005. Freshwater ecosystems and fisheries. Pages 353-452 in Arctic Climate Impact Assessment. Cambridge University Press, New York, NY.

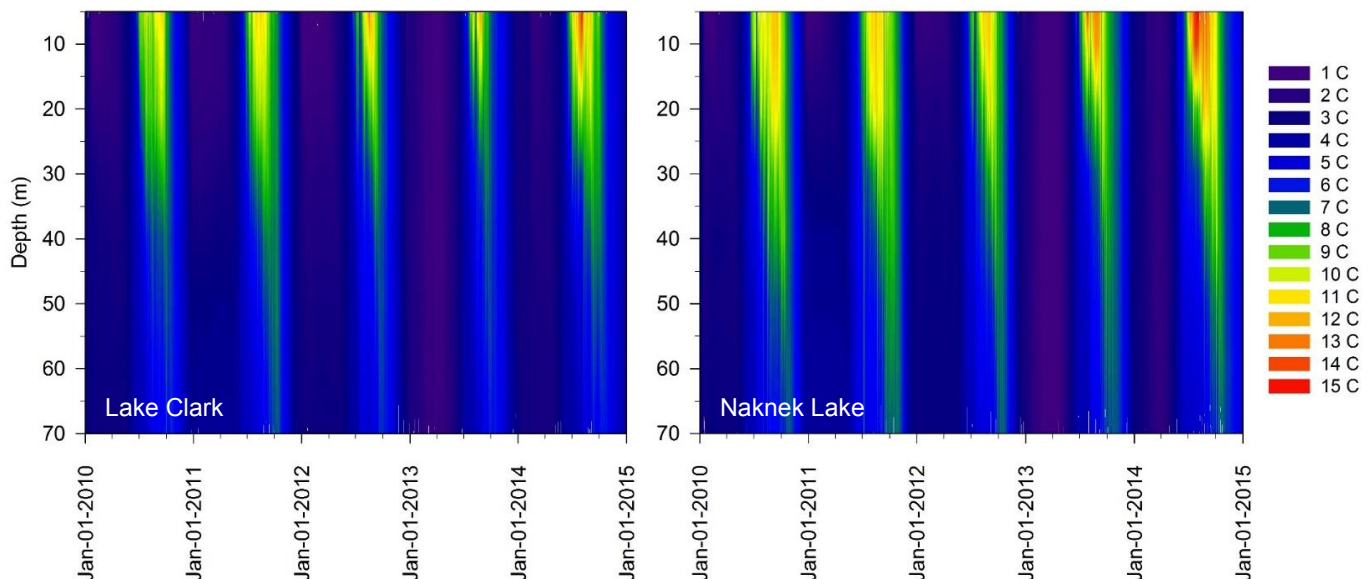


Figure 2. Average daily water temperatures (°C) from 5 to 70 m depth in Lake Clark and the North Arm of Naknek Lake, based on temperature array data from 2010 to 2015. According to the State of Alaska's water quality standards (<http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf>), the upper temperature limit for fish migration and rearing habitat is 15°C.