



Lake Ice in Lake Clark

Lake ice cover is a key component of Alaska ecosystems because it influences the physical processes, chemical processes, and biological productivity of the region's lakes and the wellbeing of communities that depend on them. Global climate models indicate the climate is warming more rapidly at higher latitudes than it is closer to the equator. Historic records of Northern Hemisphere lake ice trends indicate duration is decreasing as a result of warming. The magnitude and impact of these changes in timing and duration (phenology) of lake ice is poorly understood in southwestern Alaska.



NOAA Fisheries/Dave Withrow

The genetically distinct Eastern Pacific Harbor Seals that live in Lake Iliamna, south of Lake Clark National Park and Preserve, are one of many species that are adapted to living with lake ice.

Observing Lake Ice using Remote Sensing

Southwest Alaska Network scientists are studying lake ice using remote sensing, climate data from long-term observations in the region and statistical modeling of the observed patterns. The ice phenology was estimated for important lakes in Lake Clark National Park and Preserve using images from satellites that pass over Alaska daily beginning in 2002 (Figure 1).

Timing of Freeze-up

Freeze-up, the date when ice cover first exceeds 90%, varies depending on lake size and elevation. Between 2002 and 2016, mean freeze-up dates for large lakes in

Lake Clark National Park and Preserve ranged from December 3 (64th day of the water year) at Twin Lakes, to January 13 (105th day of the water year) at Lake Iliamna. Mean freeze-up dates for Lake Clark (January 12; 104th day of the water year) and Telaquana (December 6; 67th day of the water year) fell within a similar range. The larger lakes, Clark and Iliamna, were highly variable and did not freeze in years following warm summers and mild autumns. The two smaller, high-elevation lakes, Twin and Telaquana, were synchronous in terms of the timing of freeze-up, such that freeze-up occurred later following warm summers and earlier during cold autumns (Figure 2).



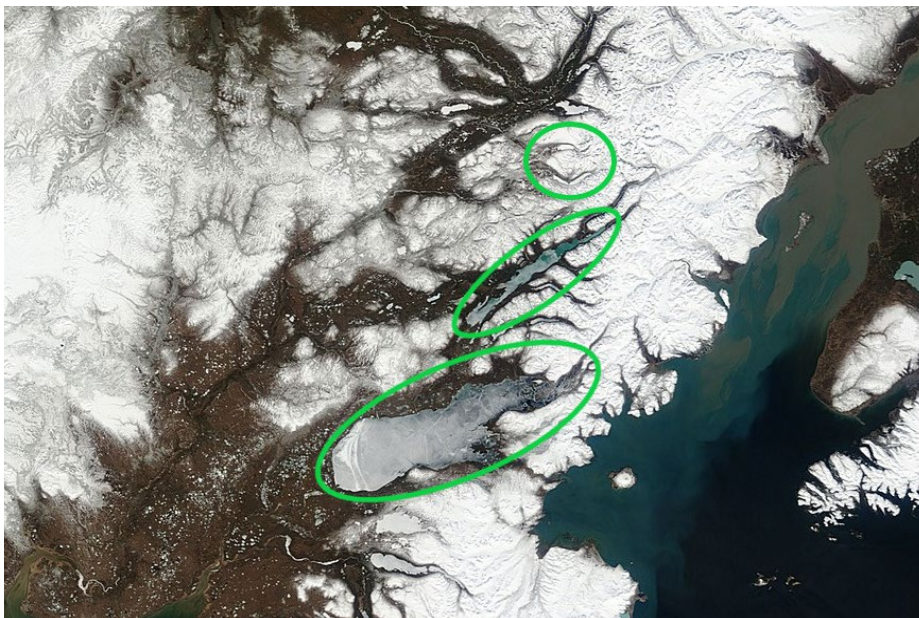


Figure 1. Image from NASA's Aqua satellite used for estimating lake ice cover in southwest Alaska. Lakes featured from Lake Clark National Park and Preserve are circled.

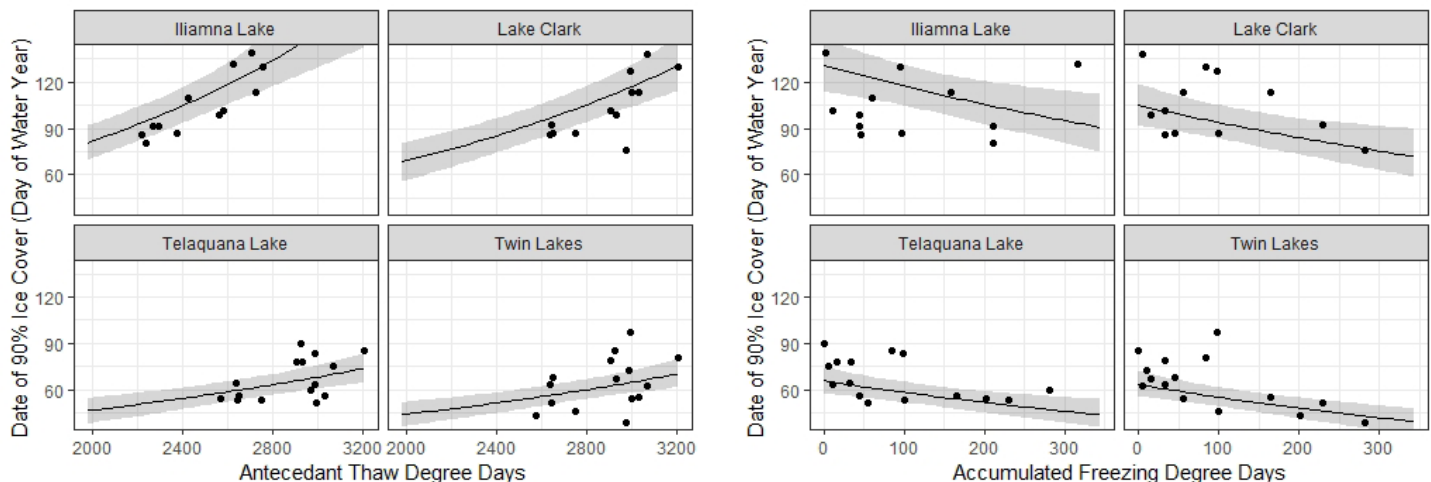


Figure 2. Freeze-up date versus antecedent thaw-degree days for each year and model-predicted freeze-up date $\pm$ 95% credible intervals across the range of thaw-degree days, at the average value of freeze-degree days (on left). Freeze-up date versus freeze-degree days for each year in study and model-predicted freeze-up date $\pm$ 95% credible intervals across the range of freeze-degree days, at the average value of antecedent thaw-degree days (on right).

Modeling Lake Ice Using Air Temperature

We used a statistical model to measure the relationship between freeze-up dates and warm summer temperatures and cold autumn temperatures. We summarized the addition of heat to the lakes using cumulative *thaw-degree days*, which equate to the daily mean above freezing, between June 1 and September 30. We summarized the subtraction of heat using cumulative *freeze-degree days*, or the daily mean below freezing, between October 1 and December 15.

Predicting the Future

While there will always be some uncertainty in the weather and climate, with these data and model it's possible to make reasonable estimates of the coming winter's freeze-up date using the cumulative thaw-degree days of last summer and the present year's accumulating freeze-degree days.

Contact

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