

Quantifying surface water in the Yukon River Basin

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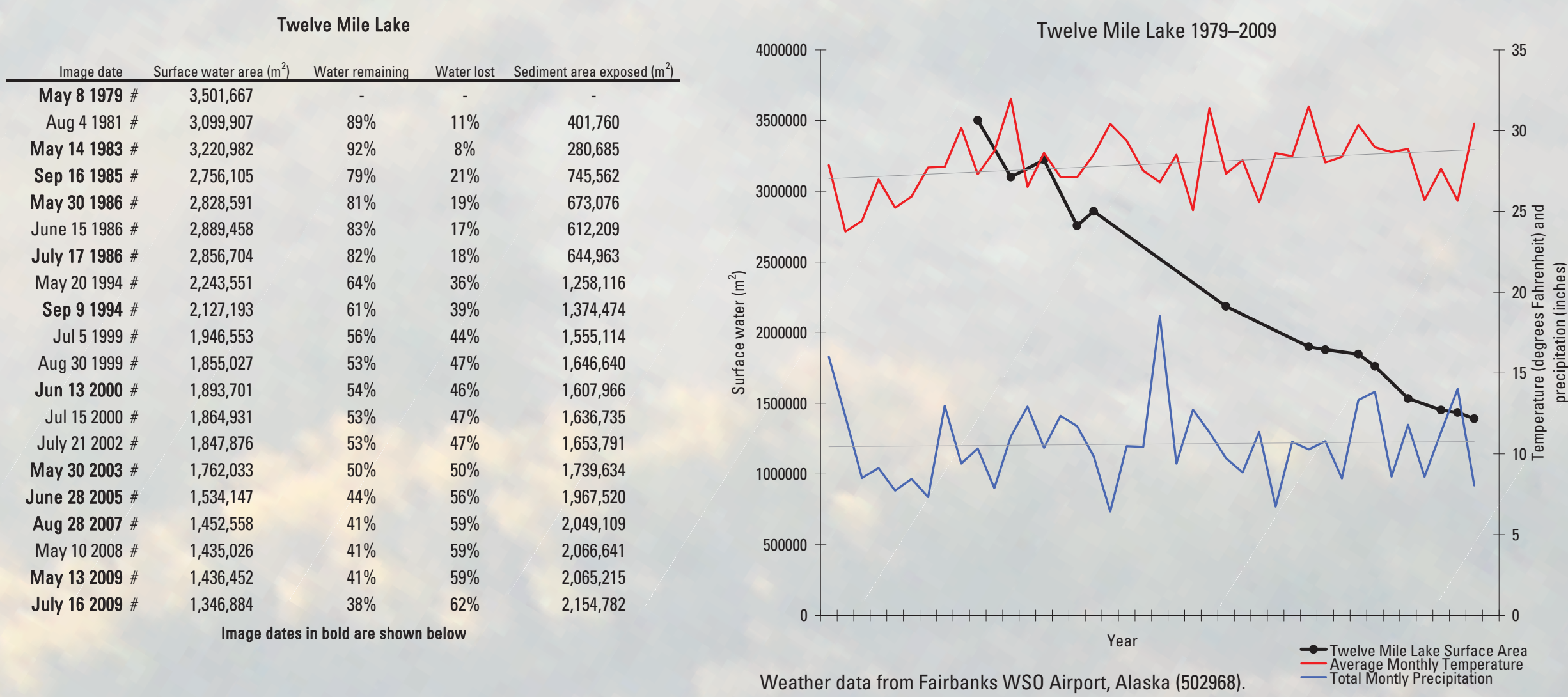
Abstract

The U.S. Geological Survey supports research on the spatial significance and specific drivers of surface water changes in the Yukon River Basin, a 330,000-mi² watershed covering portions of Alaska and northwestern Canada. The research varies in space and time. Using Landsat data (~ yr 2000), we developed a basin-wide surface water map for hydrologic model input and lake size frequency statistics. Local-scale research in the Yukon Flats quantify temporal surface water trends by using multipixel objects (water bodies) extracted from nearly 30 years of Landsat data. This dataset provides a chronological measure of exposed sediments in lakes that are decreasing in size. Similar trend analysis of a four-Landsat scene mosaic created from May 2008, May 2009, and July 2009 images provides measurements of surface water changes after flooding occurred in May 2009 along the Yukon River. The results provide a measure of spring runoff impacts on lake and stream surface water area and illustrate the functional gradient that area lakes serve, from temporary to permanent. This dataset also shows an increase in seasonal lake draining in areas burned by fires in 2004. Integrating data from water chemistry samples and fire maps may provide additional insight on why lakes and wetlands exhibit particular surface water dynamics. The final surface water classifications, based on temporal surface water trends and responses to climate, may indicate how lakes in this region will respond to future climate change.

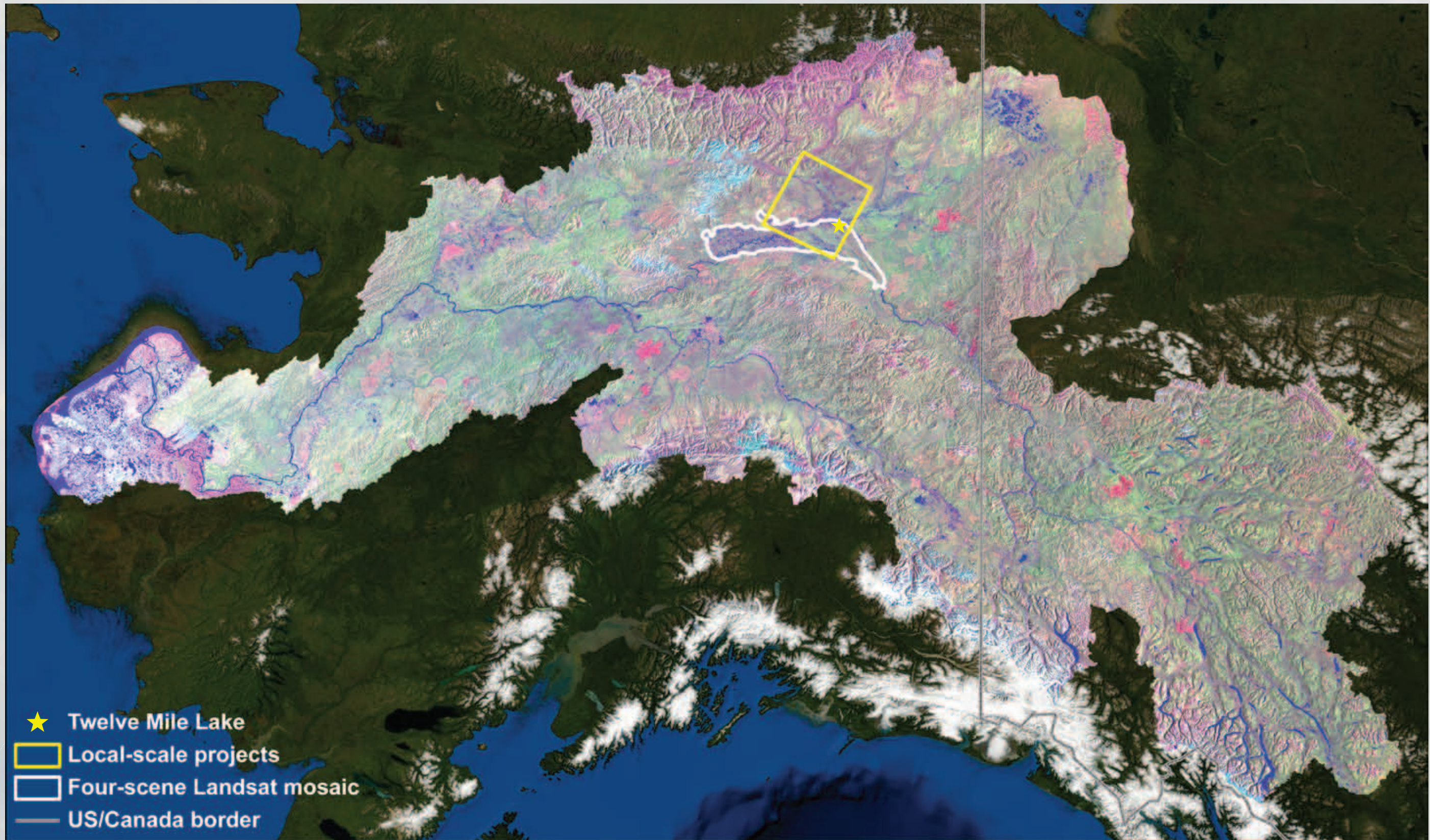
Local-scale project: Twelve Mile Lake 1979–2009

Twelve Mile Lake, located southwest of Fort Yukon in interior Alaska, illustrates considerable surface water change between 1979 and 2009. We estimate that the lake decreased 62 percent in size since 1979—from over 3,500,000 m² of visible surface water in 1979 to just fewer than 1,350,000 m² in 2009. As the lake dries, exposed carbon (C)-rich lake sediments decompose at faster rates, releasing the stored carbon to the atmosphere in the form of carbon dioxide (CO₂). The total carbon stock found in the above mineral soil extracted from sediment profiles at Twelve Mile Lake is nearly 60 kg C per m². In comparison, nearby forested soils contain about 5 kg C per m² in the organic horizon (Wickland et al., 2009).

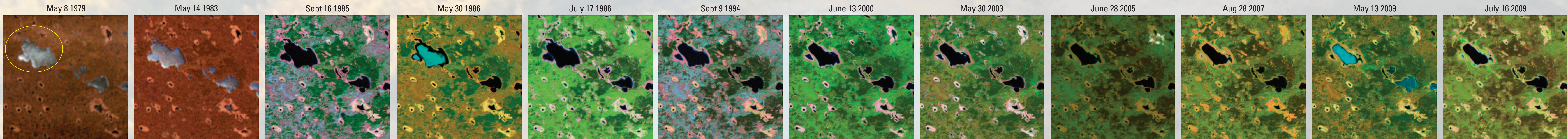
Using figures from the table at the right, we estimate that 2,154,782 m² of exposed lake sediments at Twelve Mile Lake contain approximately 129,286,920 kg C. The carbon stored in these drained sediments is equivalent to the amount stored by 25,857,384 m² (or over 25 km²) of the surrounding forest. Our current research will quantify the spatial and temporal extent of lake sediment exposure in this region. Future work will provide estimates of carbon stocks and potential CO₂ emissions for additional lakes experiencing declines in surface water area.



Basin-wide: Yukon River Basin surface water map



A map of Alaska and northwestern Canada overlaid with a Landsat mosaic (b7, b4, b2) showing the spatial extent of the Yukon River Basin (Bouchard et al., 2009). The locations and extents of projects are in yellow and white. The final overlay is a basin-wide surface water map.

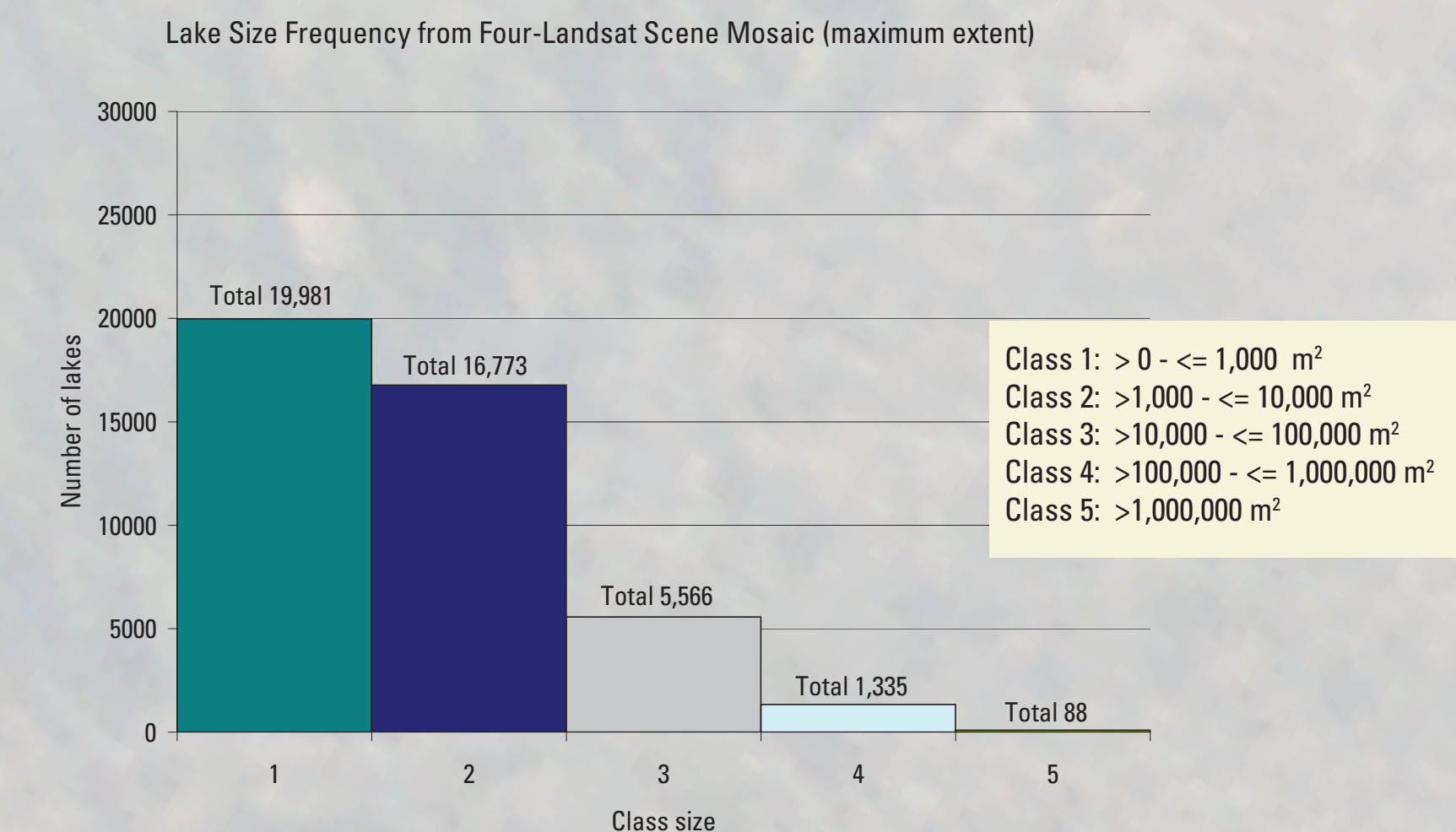


Twelve Mile Lake is circled in yellow. A time series of Landsat data captured the decrease in surface water (~62%) between 1979 and 2009.

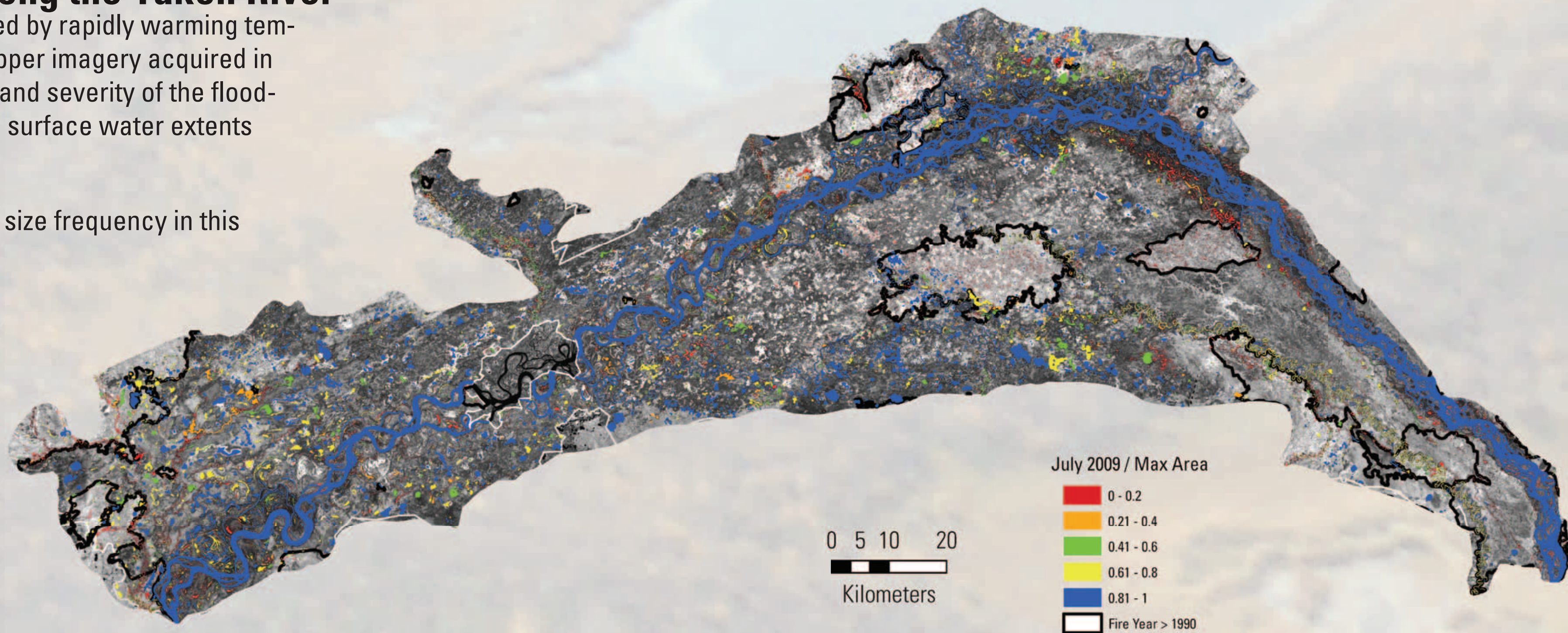
Local-scale project: Four-Landsat scene mosaic along the Yukon River

Heavy snow fell across most of Alaska during the 2009 winter season, followed by rapidly warming temperatures in late April, causing the Yukon River to flood. Landsat Thematic Mapper imagery acquired in May 2009 along the Yukon River provided a means for assessing the location and severity of the flooding. Surface water extents before the flood (May 10, 2008) were compared to surface water extents after the flood (May 13, 2009 and July 16, 2009).

Extracting the water bodies from the imagery allows us to determine the lake size frequency in this study area.

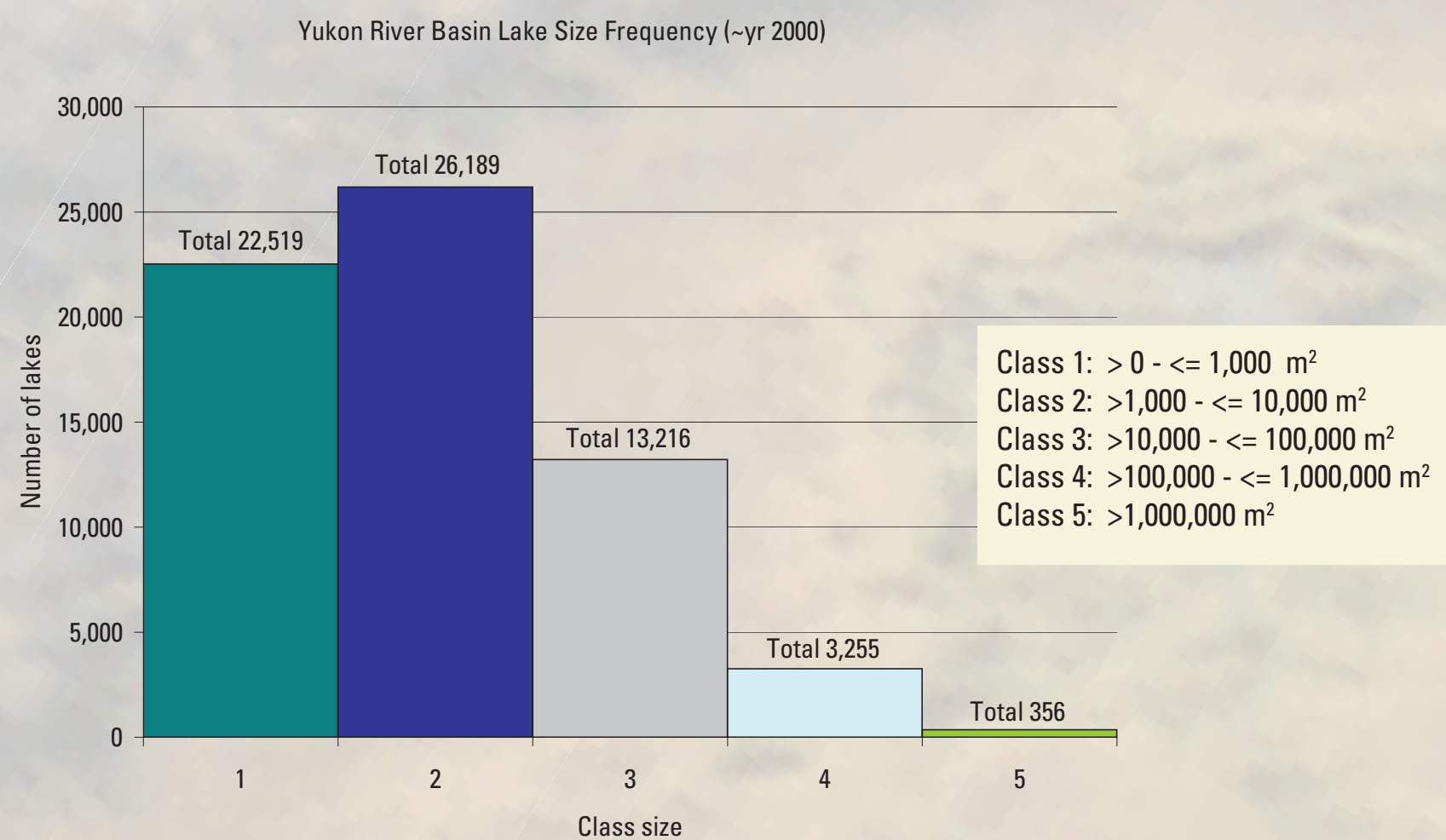


A histogram of lake size (>900 m²) frequency using the maximum water extents extracted from three separate Landsat acquisition dates (May 10, 2008, May 13, 2009, and July 16, 2009).



Surface water extents identified from Landsat data before the 2009 Yukon River flood were compared to surface water extents after the flood (May 13, 2009 and July 16, 2009). The colors represent water extents in July 2009 divided by the maximum water extents of the three dates. Water bodies in red have the most difference between July 2009 extents and their maximum extents. In contrast, water bodies shown in blue have stable water extents.

Basin-wide: Yukon River Basin lake size frequencies



Acknowledgements

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References

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