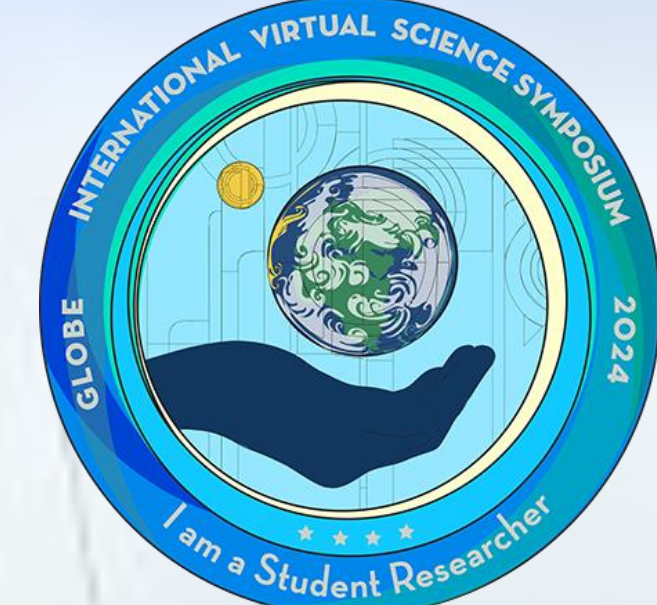
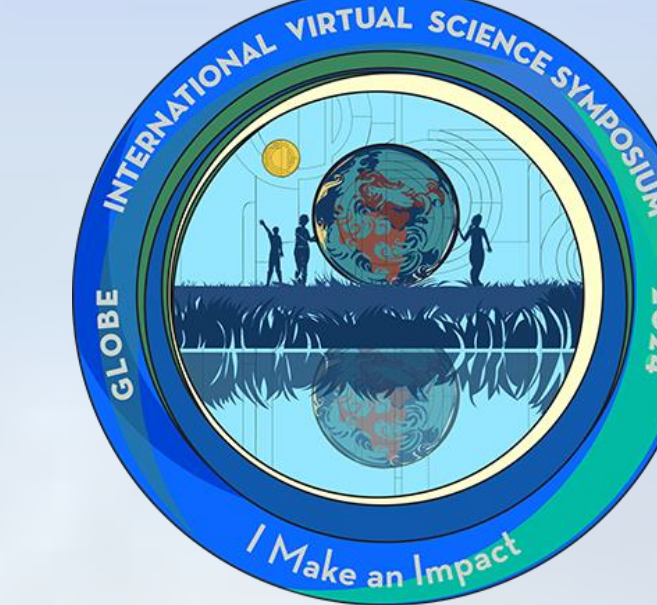


How does Urbanization Affect Water Temperature in the Chena River in Interior Alaska?



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Abstract

This study aimed to investigate whether there was a significant difference in water temperatures between a rural and urban location on the Chena River in Interior Alaska during the first two weeks of October 2023 (see Maps). Our research question was “**How does Urbanization Affect Water Temperature in the Chena River in Interior Alaska?**”. GLOBE data included water, air and surface temperatures as well as total snowpack depth. We analyzed each variable using a T-test with a significance level of $\alpha = 0.05$. It was found that there was no statistically significant difference in water temperatures between the urban location in downtown Fairbanks and the rural location near the Chena Lakes State Recreation Area east of North Pole. Differences in air temperature, surface temperature and snowpack were observed. The results suggest that further sampling during multiple seasons is needed to understand how urbanization affects water temperatures. Furthering this research can provide insight into how impervious surfaces in urbanized areas can create a "heat island effect" and thereby increase the temperature of water bodies.

Introduction

- Arctic grayling can be found in freshwater streams and rivers in Alaska, including the Chena River.
- These fish are experiencing unprecedented stress from rapid environmental changes across their range (Murdoch et al., 2020).
- Water temperature directly affects the amount of dissolved oxygen available for grayling, and other aquatic life to use.
- Dissolved oxygen concentrations that are lethal for 50% of test fish from one study are 0.75 mg/L for adults and 1.50–1.96 mg/L for juveniles at temperatures of 1–3°C (Davis et al., 2019).
- Many juvenile grayling seem to use impending freeze up as a cue to migrate to overwinter locations (Wipfli et al., 2015).
- Heat that is absorbed by impervious surfaces can cause an urban heat island effect that may impact water temperature, and thus timing of freeze up.
- Custom planning for restoring riparian zones and anticipating rapid change in temperature is essential to preserving these northern adapted species (Murdoch et al., 2020).

Research Methods

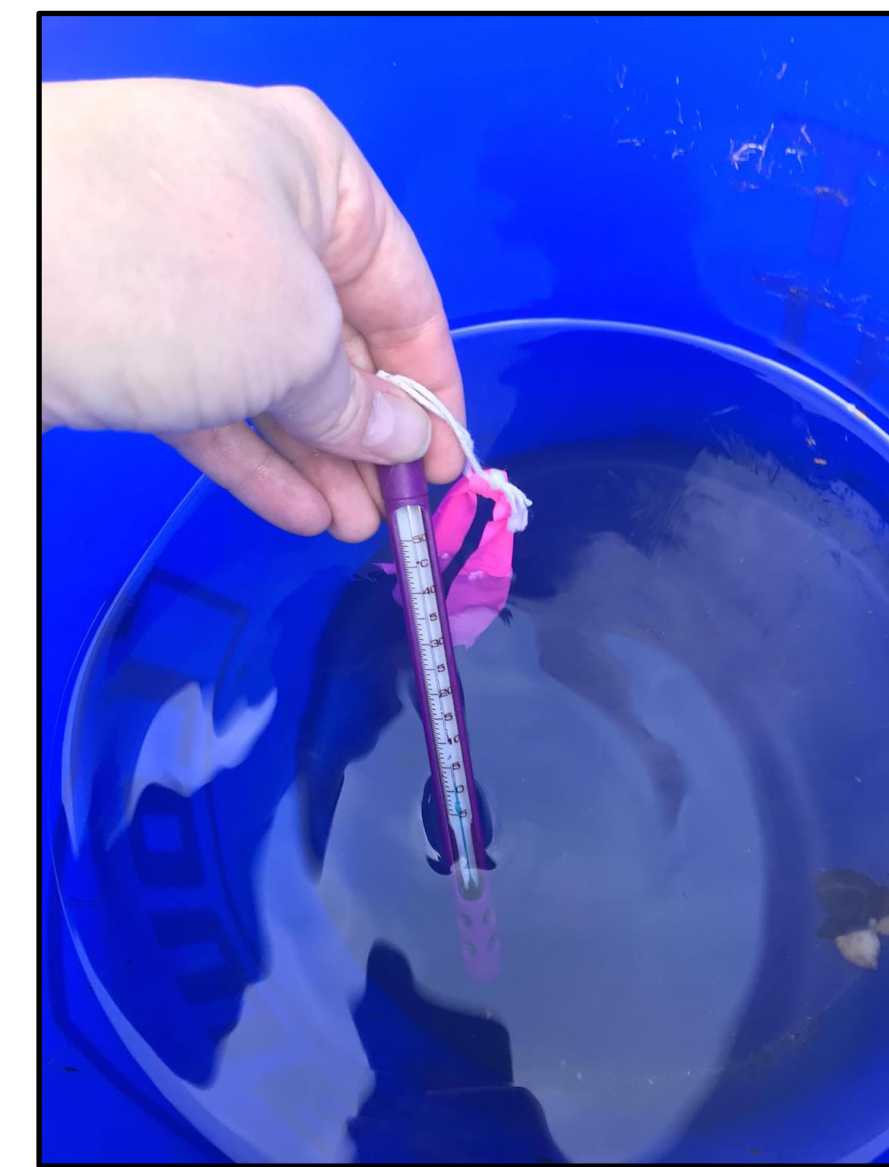
Data was collected according to the GLOBE atmosphere and hydrosphere protocols.

Air temperature



Thermometers were hung from trees and left undisturbed for five minutes to measure air temperature.

Water Temperature



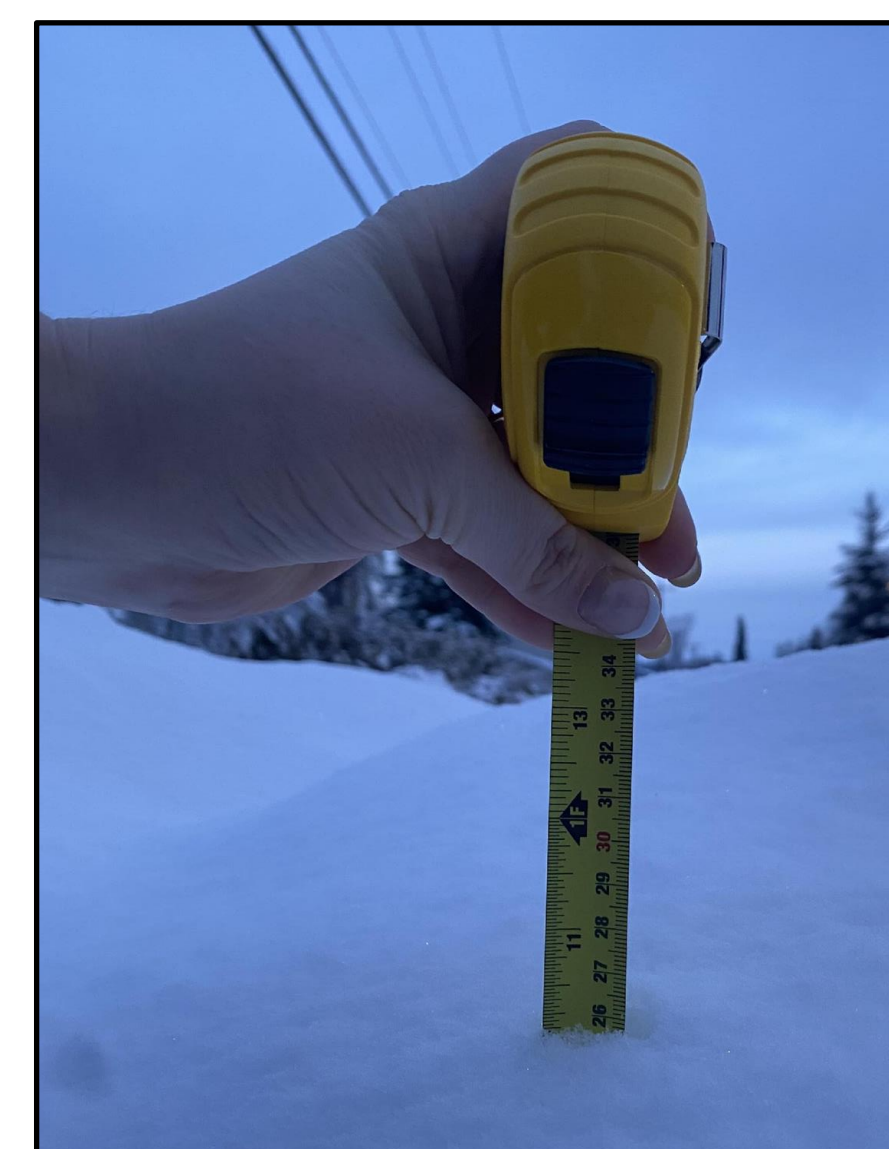
Bucket method was utilized. A thermometer was placed into the water and left undisturbed for three minutes. Process for collecting measurements was repeated three times during each sampling trip.

Surface Temperature



Hand-held infrared thermometer were used. Nine surface temperature measurements were taken per sampling visit. Measurements were taken five meters apart.

Snowpack Depth



Snow depth was measured at each spot where a surface temperature measurement was taken.

Results

Chena River Water Temperatures

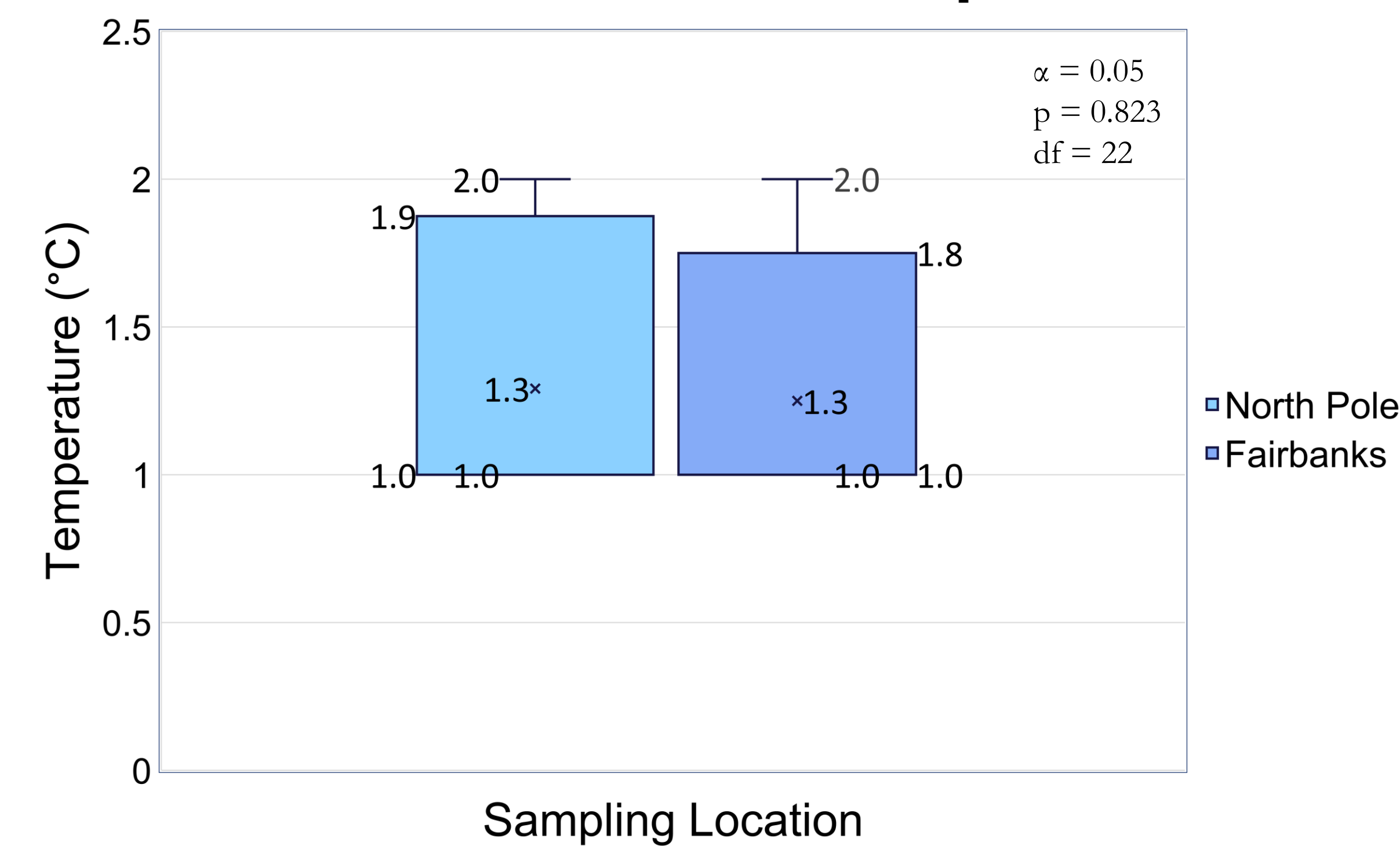


Figure 1. Comparison of Average Chena River Water Temperatures in North Pole and Fairbanks. n=24 (four dates x three samples per each location).

Chena Riparian Surface Temperatures

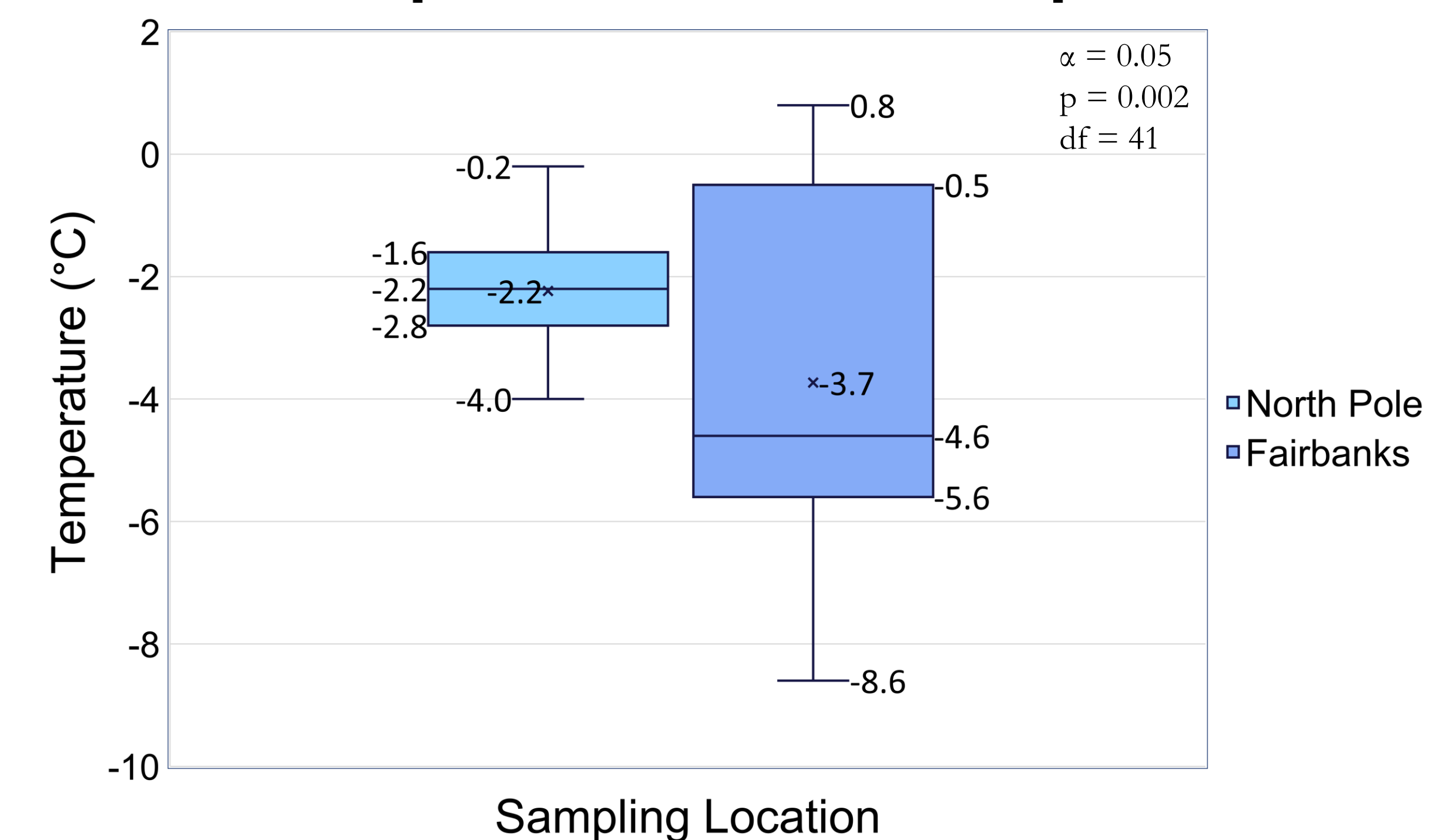


Figure 2. Comparison of Average Riparian Surface Temperatures for the Chena River Sampling Sites in North Pole and Fairbanks. n=72 (four dates x nine samples per each location)

Chena Riparian Air Temperatures

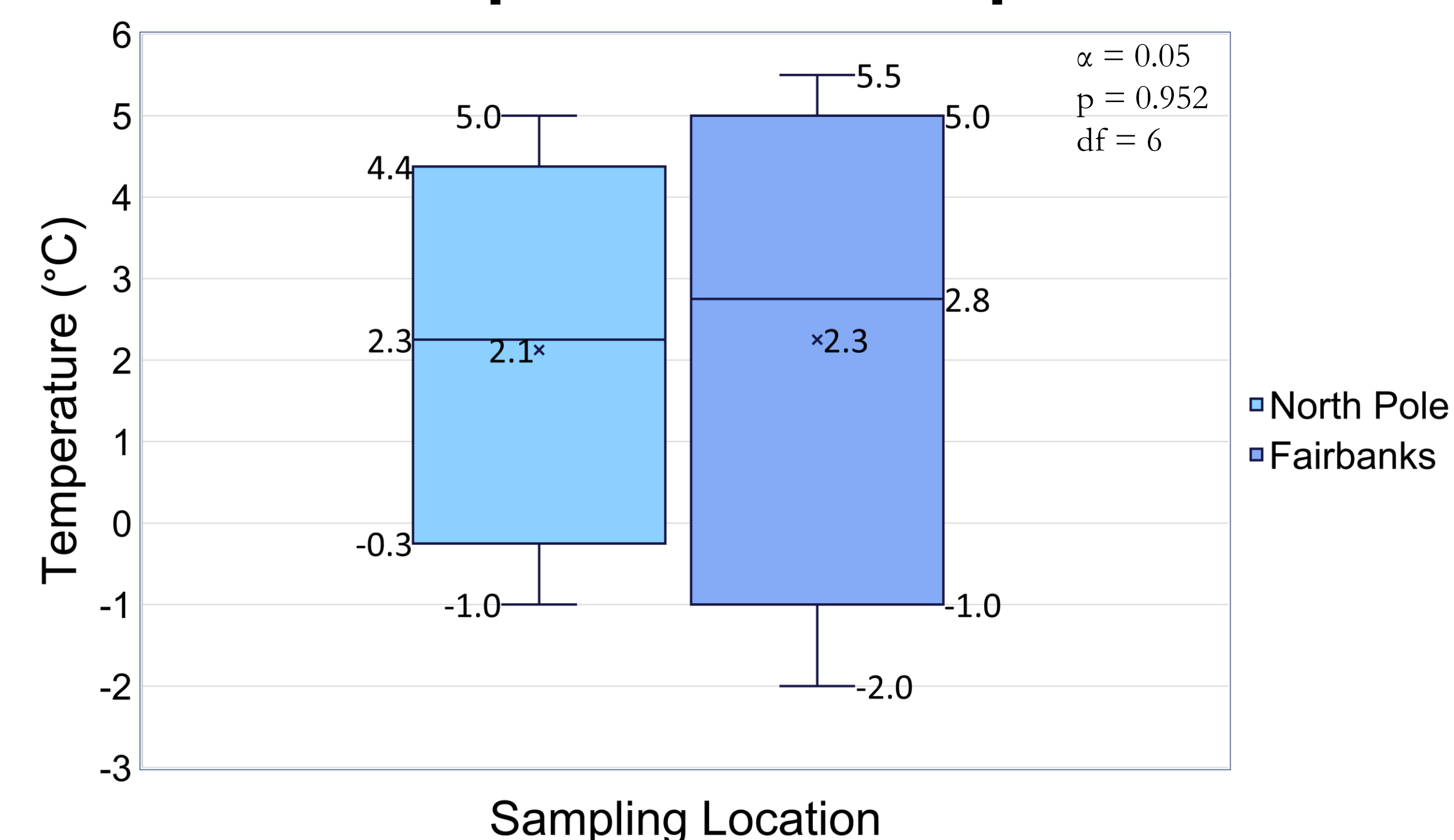


Figure 3. Comparison of Average Riparian Air Temperatures for the Chena River Sampling Sites in North Pole and Fairbanks. n=8 (four dates x 1 sample per each location).

Discussion

- The one statistically significant difference we observed was that of the surface temperature. The average surface temperature was -2.23°C for North Pole, while the average surface temperature for Fairbanks was -3.73°C.
- While this may not seem like a large temperature difference, when the T-test was applied with a significance level of $\alpha = 0.05$, the p value was 0.002, which means there's only a 0.2% chance that this difference that we observed is just by chance.
- We expected to see a similar difference in water temperature but did not. This is a good thing. A difference of just a few degrees can have a large impact on grayling.
- Recent efforts to revitalize the riparian zones of the Chena River may be working to stabilize and regulate the temperature of the water in the channel.
- The temperature of the water in the channel is staying relatively stable even when the ground surface temperature is changing along the stream corridor.**

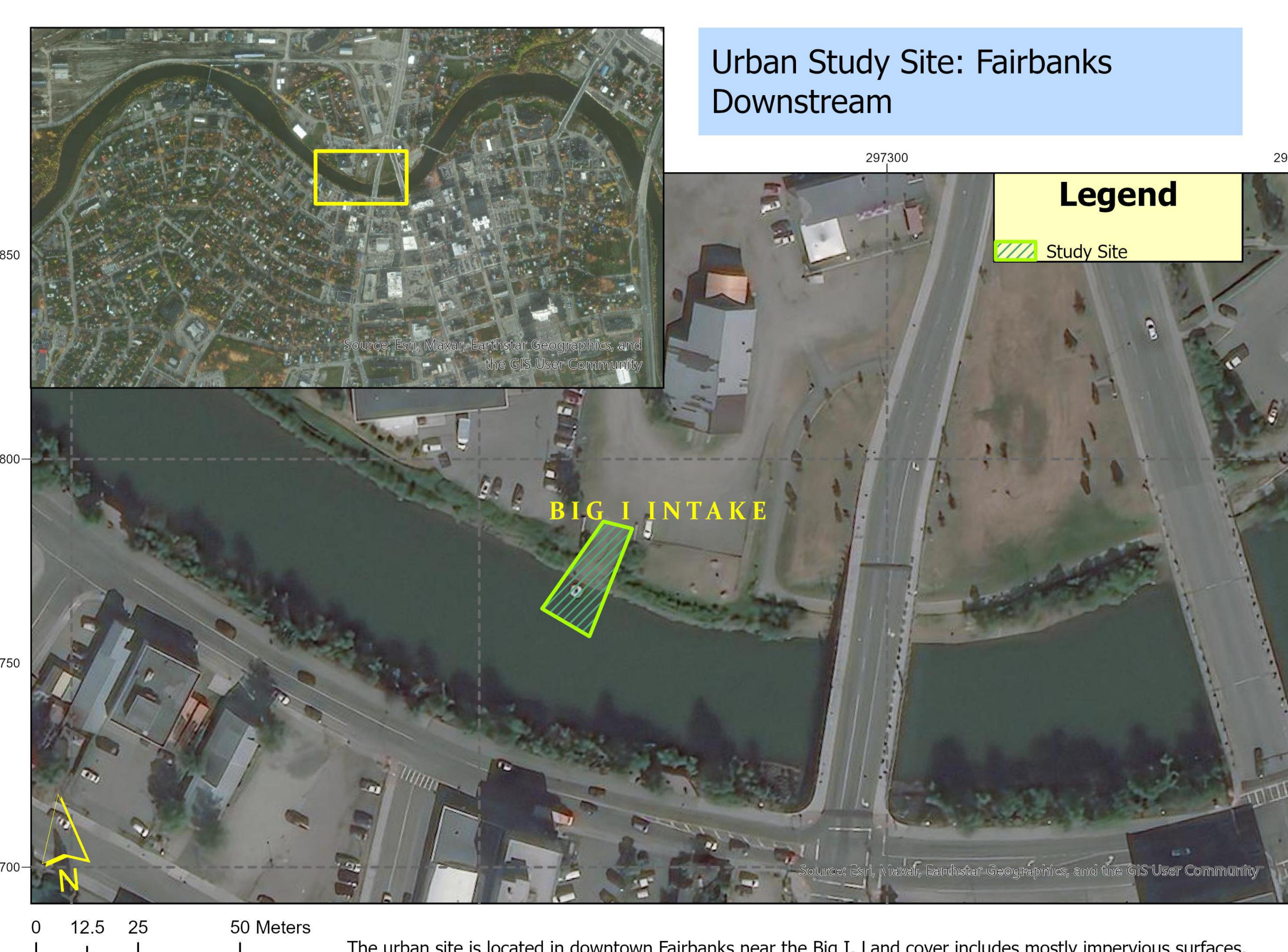
Conclusions

- Further seasonal sampling with longer duration and more urban and rural sample sites needed to draw conclusions on how urbanization affects water temperature on the Chena River.
- Design an investigation to assess the quality of riparian habitat between the rural and urban areas and the extent that riparian vegetation reduces the urban heat island effect
- To link the potential impacts of air and surface temperature increases due to urbanization and their corresponding water temperatures, more sampling and data analysis and mapping of urban catchments would be needed.

Acknowledgments and References



We acknowledge the Alaska Native nations upon whose lands our study sites are located. In Fairbanks and North Pole, our study sites are located on the ancestral lands of the Dena people of the lower Tanana River.



The rural site is located in North Pole near the Chena River Nature Trail. Land cover includes grass and a forest of deciduous trees. There is a dense riparian zone composed of willows, shrubs and tall grasses. North Pole is a subarctic environment that experiences mild summer temperatures, and severe winters.

The urban site is located in downtown Fairbanks near the Big I. Land cover includes mostly impervious surfaces. There is a small riparian zone along the river's edge composed of sparsely interspersed willow trees and shrubs. Fairbanks is a subarctic environment that experiences mild summer temperatures, and severe winters.