

# Kenai Mountains to Sea: Using Thermal Infrared Imagery to Implement Long-Term Salmon Conservation



Sue Mauger  
Cook Inletkeeper



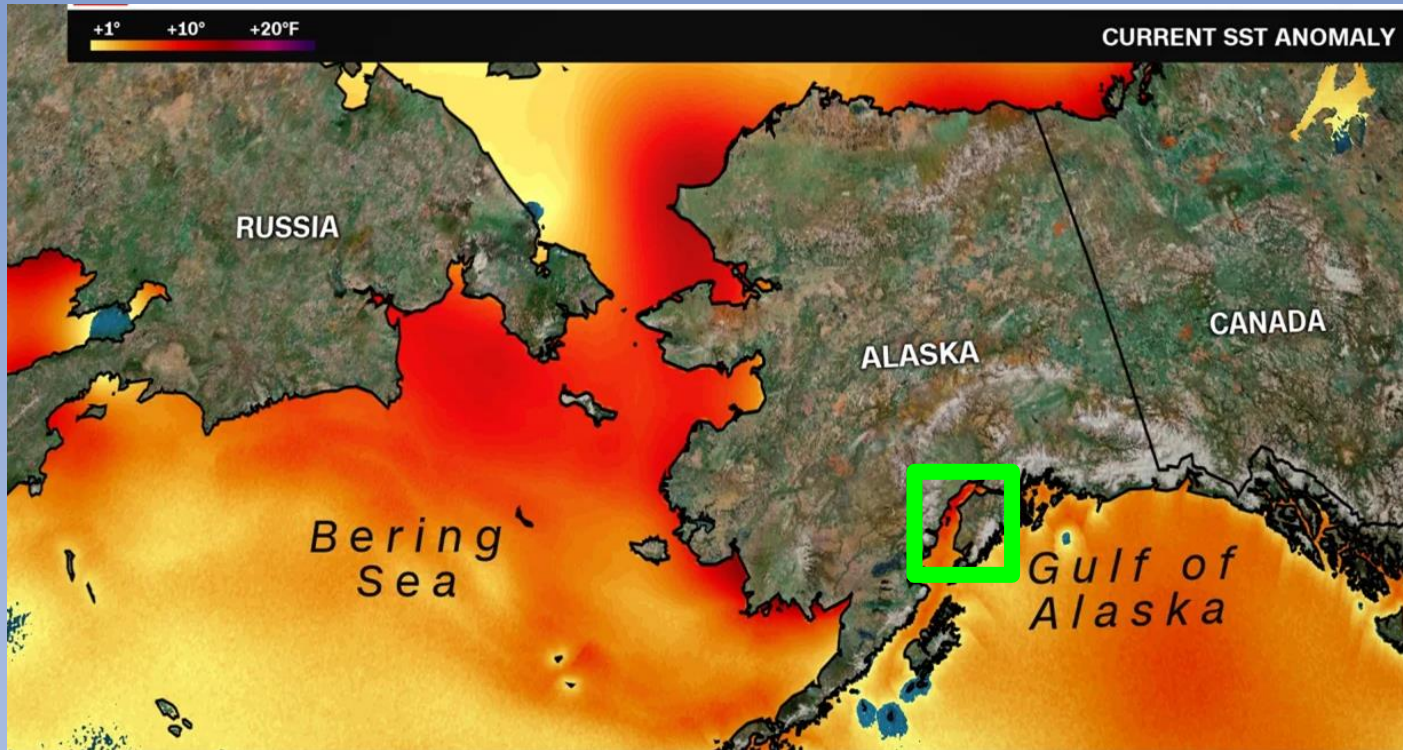
Marie McCarty and Lauren Rusin  
Kachemak Heritage Land Trust



Benjamin Meyer  
Kenai Watershed Forum

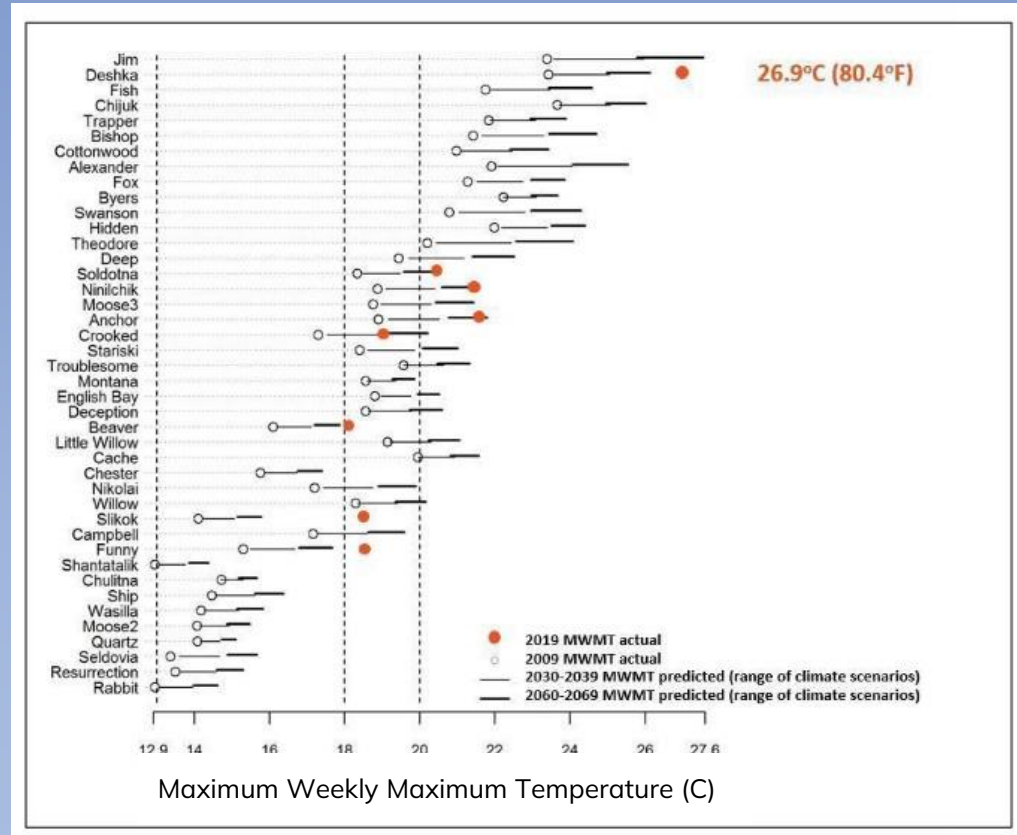
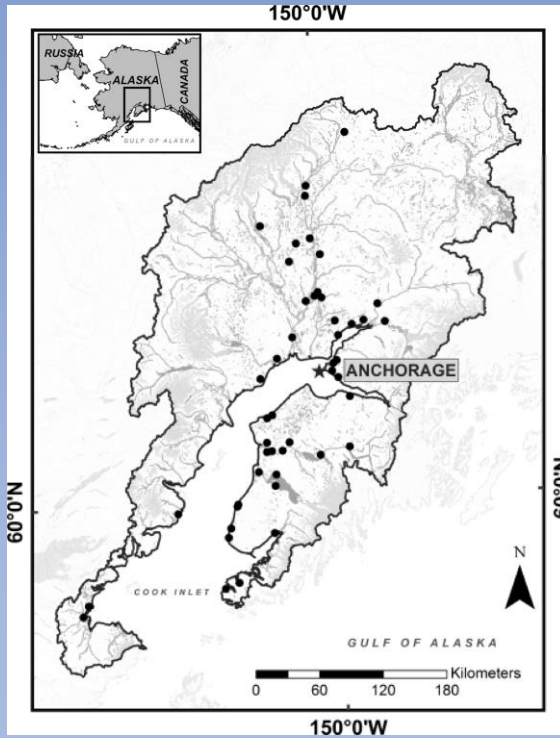
Kenai Peninsula Fish Habitat Partnership Science Symposium  
April 20th, 2023 | Kenai, Alaska

# Alaska's rising water temperatures



*June 28, 2019*

# Alaska's rising water temperatures



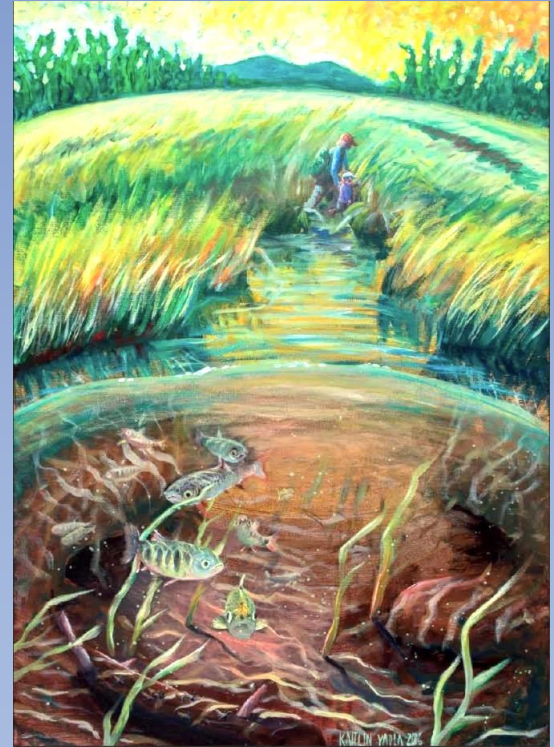
Adapted from Mauger et al 2017

# Local Conservation Strategies for Fish Habitat

Connectivity

Riparian Habitat Buffers

Cold-Water Inputs



*"Nursery Grounds" (Kaitlin Vadla)*

# KENAI MOUNTAINS TO SEA

A Land Conservation Strategy  
to Sustain Our Way of Life on the Kenai Peninsula



Kachemak Heritage Land Trust  
Audubon Alaska  
Cook Inletkeeper  
Kenai Watershed Forum  
Pacific Coast Joint Venture  
U.S. Fish and Wildlife Service

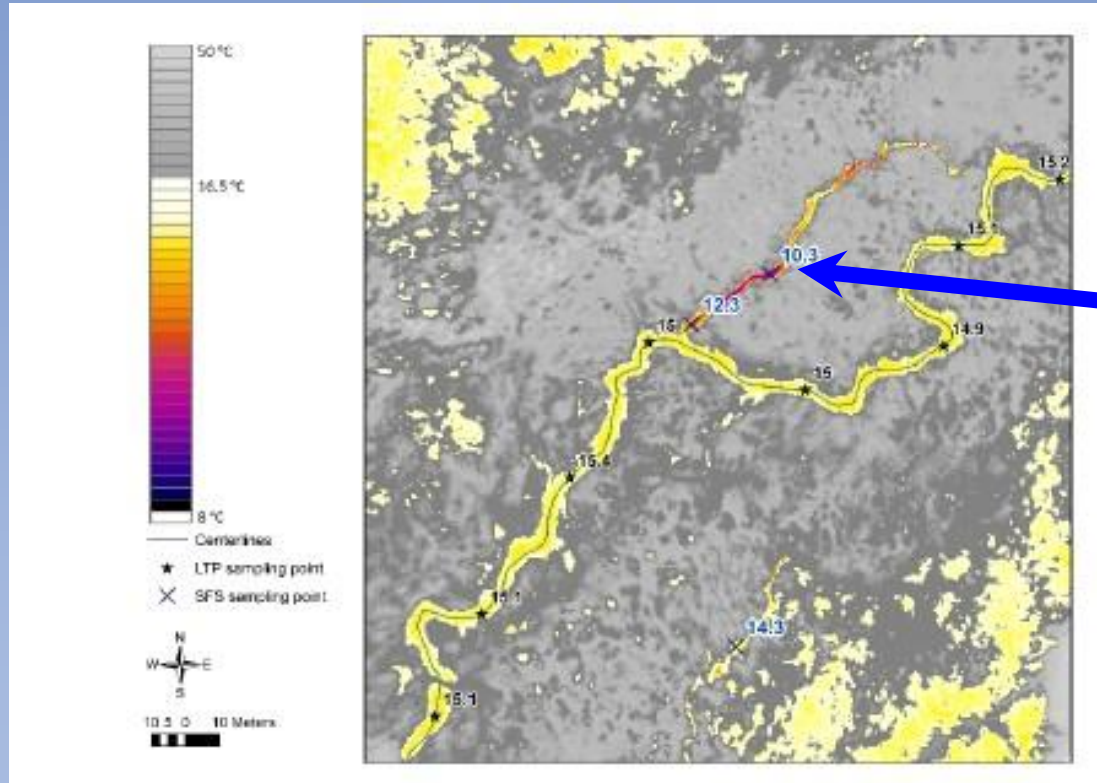
February 2015 (updated Nov 2016)

## Mountains to Sea Plan

Morton et al. 2015



# Thermal Refugia



**Cold  
Water  
Inputs  
From  
Slough**

# Aerial Thermal Infrared Imagery

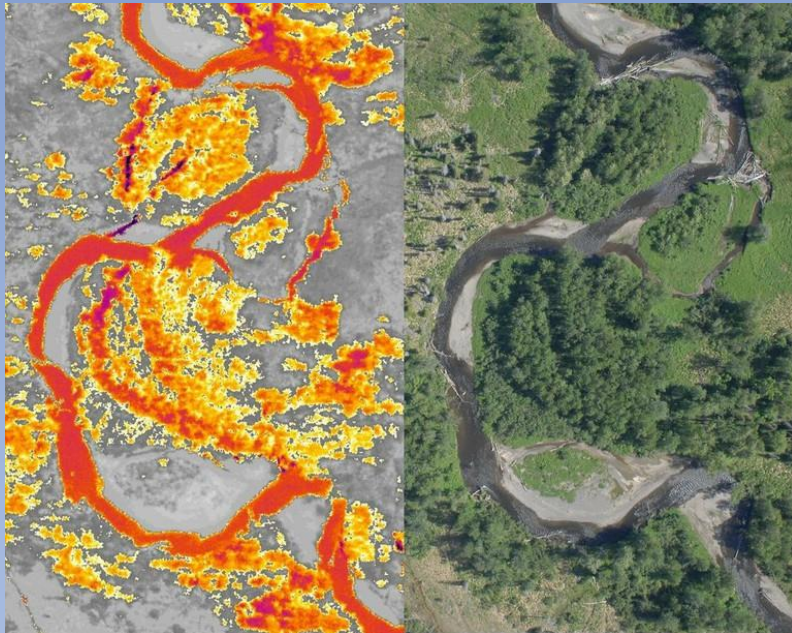
N|V|5

<https://www.nv5.com/geospatial/>



Figure 1: Sensor and aircraft setup (similar to the setup used for the project)

# Anchor River Thermal Refugia





# Central Peninsula Thermal Refugia



Central  
Peninsula  
Thermal  
Refugia  
Research  
Areas

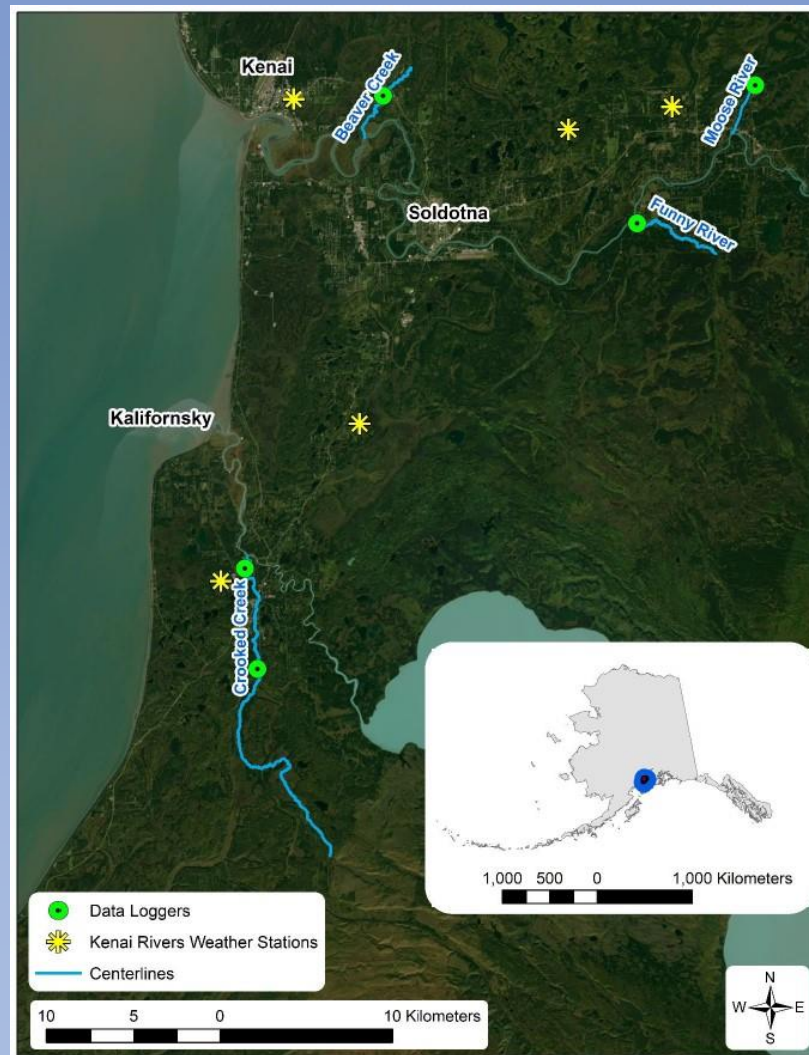
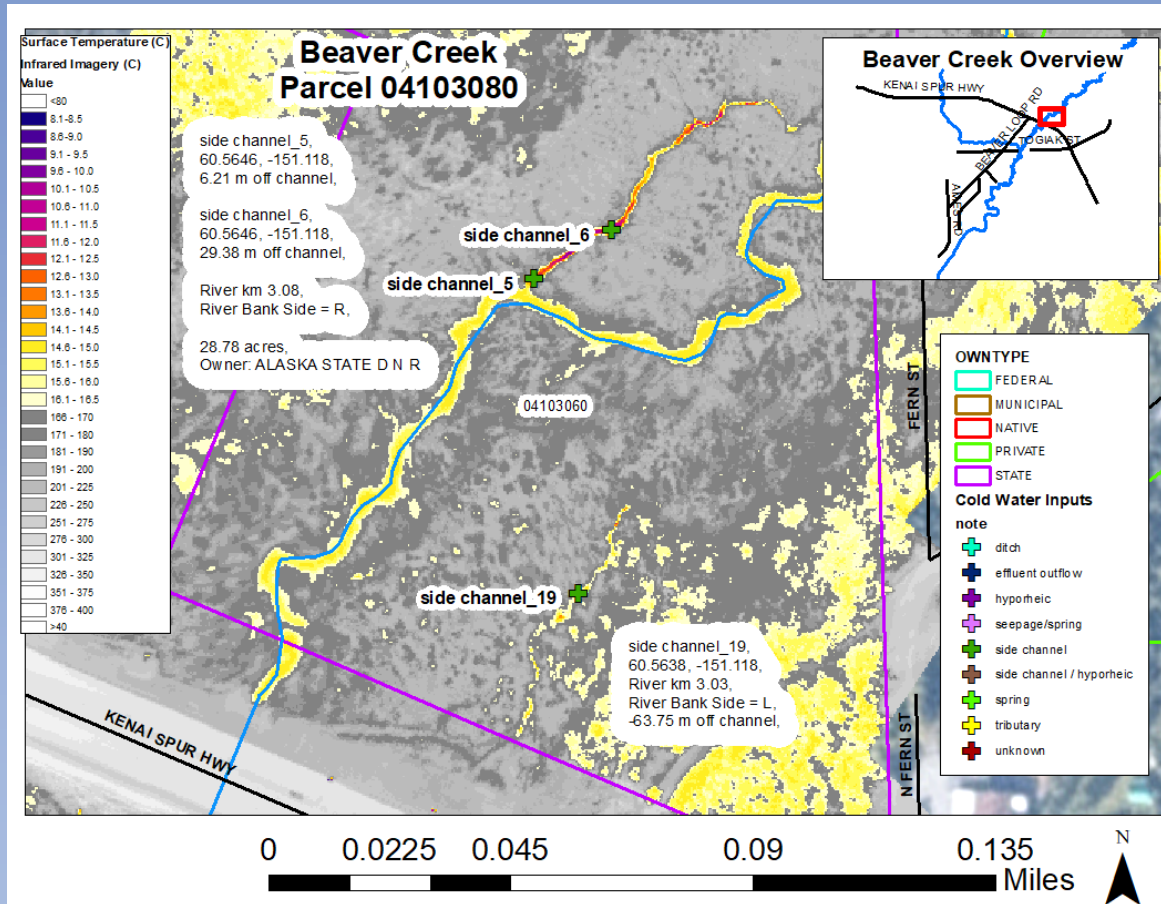
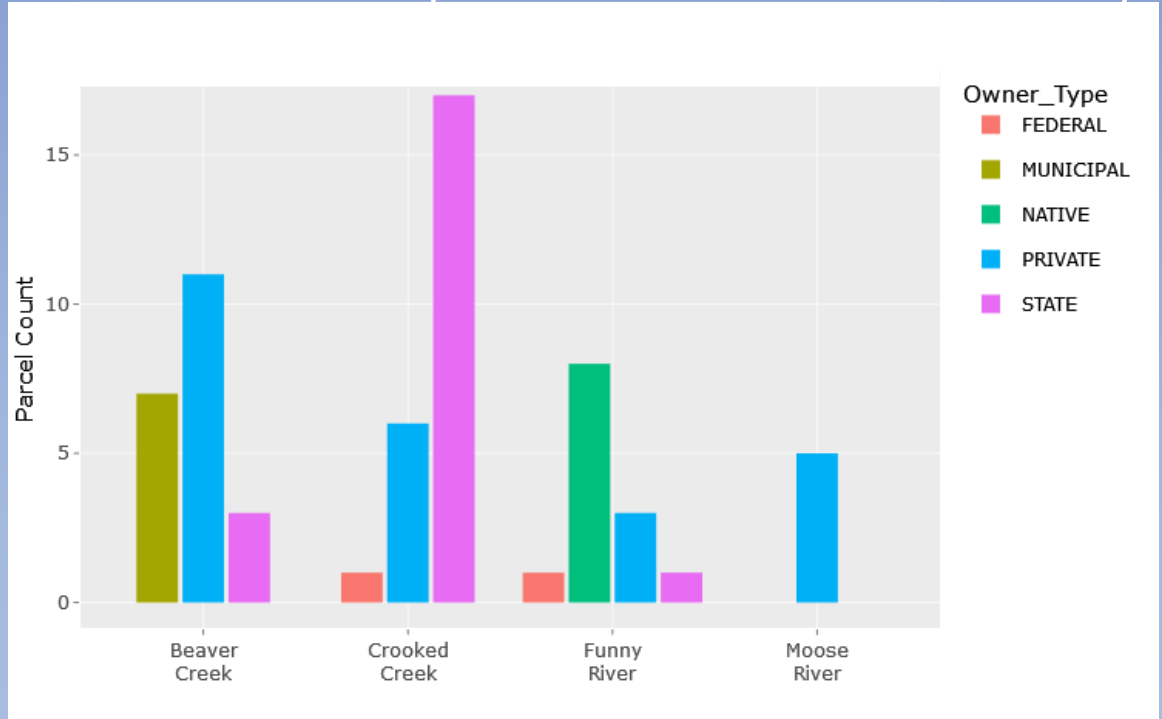


Figure from NV5 Geospatial 2021

# Land Ownership

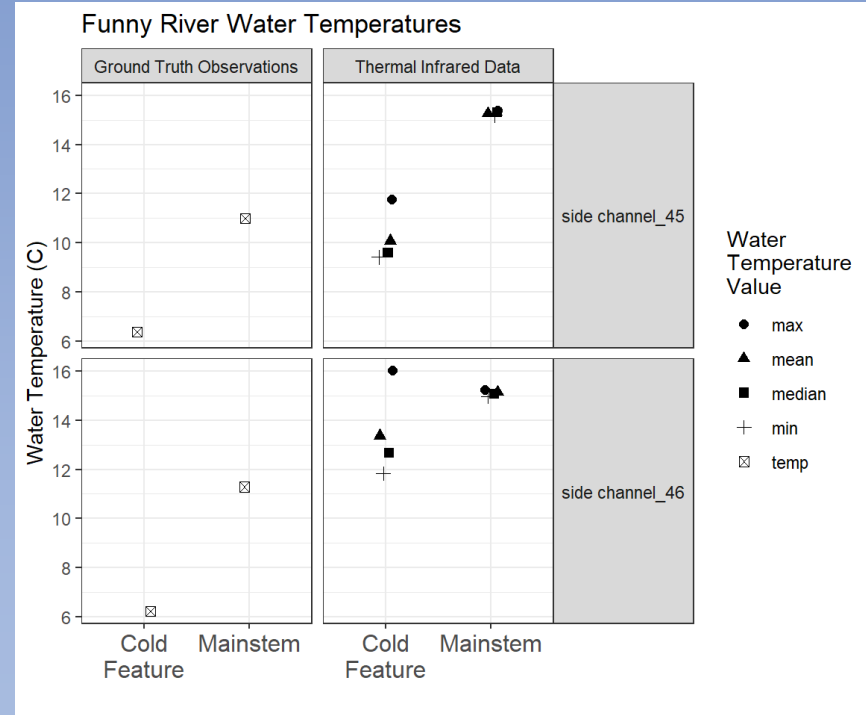


# Parcels with Cold Water Inputs to Streams, by Landowner Type

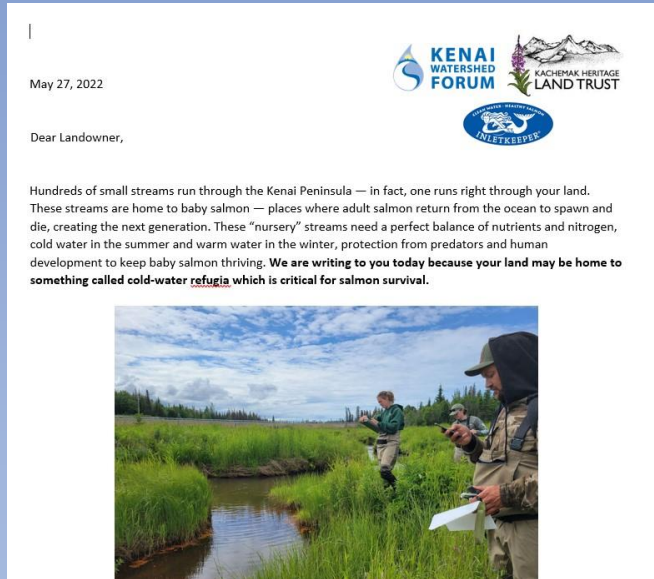




# Ground Truthing



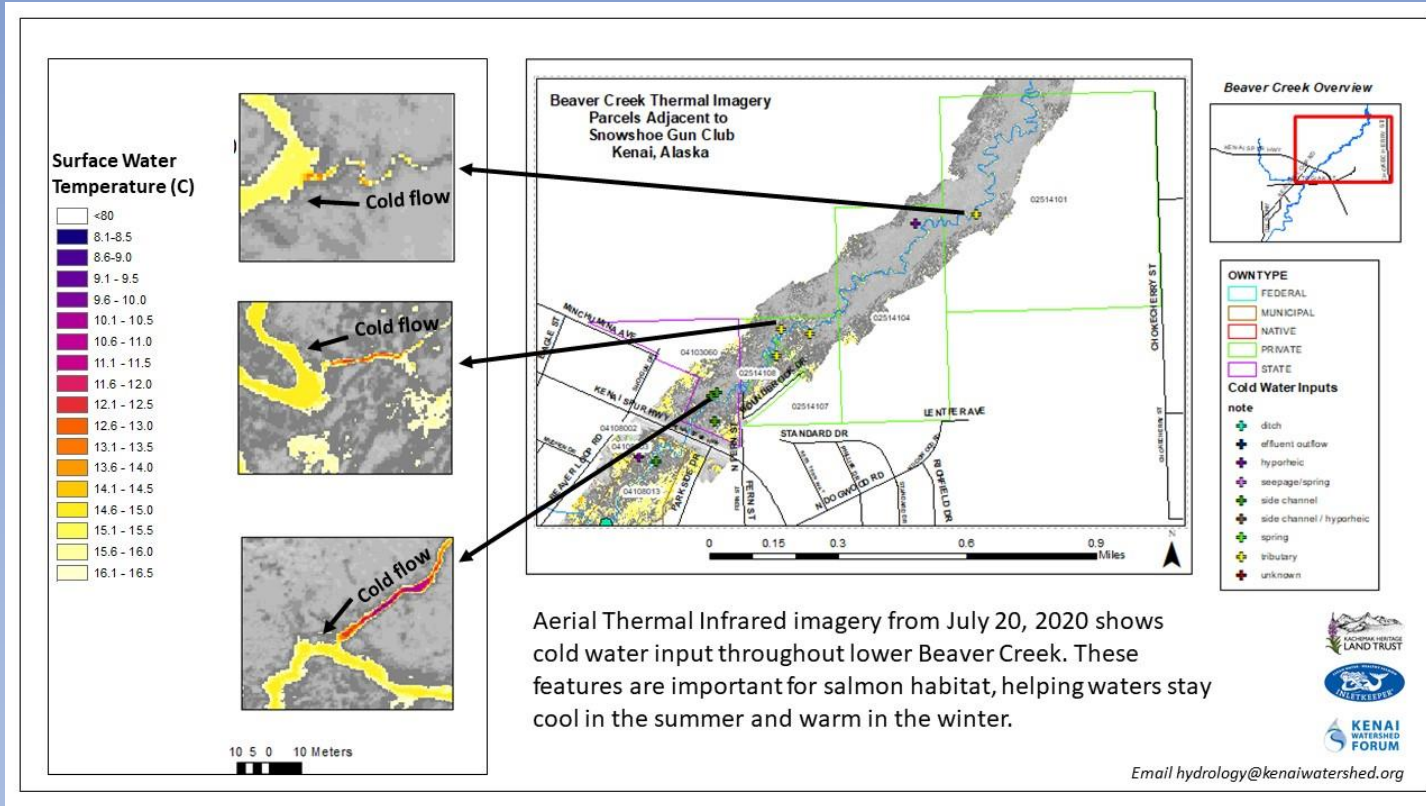
# Outreach



Letter  
Postcard



# Applications



# Applications

**KENAI**  
City of Kenai Draft Land Management Plan 2021  
Public Comment Submission Form

Public comments are an important part of developing the City of Kenai Land Management Plan and are encouraged. Please note that comments submitted are considered a public document.

**Submission Information**

First and Last Name (the name entered on this form will appear as part of the public record):  
NAME OPTIONAL Kenai Watershed Forum

Comment is related to the following map(s), page(s), or parcel number(s):  
IF KNOWN Parcel #: 4904031

Are you a resident of the City of Kenai?  Yes  No

**Comment**

The parcel contains two anadromous streams: Beaver Creek in the Northwest portion and a tributary of Beaver Creek crossing through the center. The parcel is occupied by wetlands classified as tidal in the riparian area along the center drainage, and is occupied by lakebed wetlands throughout most of the remainder. Future development should accommodate and preserve these features for fish and wildlife habitat.

This parcel also contains groundwater sources of cold water that flow into Beaver Creek. These seeps and springs are important for salmon habitat and were identified by local researchers using thermal infrared imagery collected in 2020. Mapping these cold-water sources which are needed for salmon to make their way up and down otherwise warming streams is the first step towards protecting critical salmon habitat in this time of rapid temperature change.

Thermal infrared imagery is effective for mapping small-scale temperature patterns in streams. The imagery provides a snapshot of stream temperatures at the time of the survey. And although temperature values change year-to-year, groundwater-fed cool water refugia remain persistent over time. In addition to providing a blast of cold water in the summer, these groundwater areas are relatively warm in the winter creating ice-free nooks for overwintering juvenile salmon.

Knowing the shape, size and location of these cold-water habitats allows for planners and managers to incorporate their conservation value into decision making.

This research is funded by the Alaska Sustainable Salmon Fund (State of Alaska and the Pacific Coastal Salmon Recovery Fund) and carried out by a partnership between Kenai Watershed Forum, Cook Inletkeeper, and Kachemak Heritage Land Trust.

For more information on thermal imagery research, visit <https://inletkeeper.org/our-work/healthy-habitat/cold-water-refugia>/<https://bit.ly/kenai-thermal-imagery-summary>. Detailed technical

“This parcel contains groundwater sources of cold water that flow into Beaver Creek. These seeps and springs are important for salmon habitat and were identified by local researchers using thermal infrared imagery collected in 2020...”



# Further Reading

[https://kenai-watershed-forum.github.io/kenai\\_thermal\\_imagery\\_v2/](https://kenai-watershed-forum.github.io/kenai_thermal_imagery_v2/)

The screenshot shows a web browser window with the URL [https://kenai-watershed-forum.github.io/kenai\\_thermal\\_imagery\\_v2/](https://kenai-watershed-forum.github.io/kenai_thermal_imagery_v2/). The browser's address bar and tabs are visible at the top. The main content area displays the title "Kenai Mountains to Sea: Using Thermal Infrared Imagery to Implement Long-Term Salmon Conservation" in a large, bold font. Below the title, the author information is listed: "AUTHOR Sue Mauger (Cook Inletkeeper), Marie McCarty and Lauren Rusin (Kachemak Heritage Land Trust), Benjamin Meyer (Kenai Watershed Forum)". The publication date is "PUBLISHED January 23, 2023". A search bar is located on the left side of the page. Below the title and author information, the section "Executive Summary" is visible. At the bottom of the page, there is a figure consisting of a vertical color scale legend on the left and a corresponding thermal imagery map on the right. The legend shows a temperature range from 1°C to 30°C, with colors ranging from purple (1°C) to yellow (30°C). The map shows a river system with various points marked, including "Centerline", "UPP sampling point", and "SIS sampling point".

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AUTHOR Sue Mauger (Cook Inletkeeper), Marie McCarty and Lauren Rusin (Kachemak Heritage Land Trust), Benjamin Meyer (Kenai Watershed Forum)

PUBLISHED January 23, 2023

Executive Summary

1°C 5°C 10°C 15°C 20°C 25°C 30°C

Centerline  
UPP sampling point  
SIS sampling point

# Thank You to Our Supporters

Alaska Sustainable Salmon Fund (project #53003)  
U.S. Fish & Wildlife Service Coastal Program



*Support for Cook Inletkeeper*  
William C. Bannerman Foundation  
Alaska Conservation Foundation



# References

Mauger, S., R. Shaftel, J. C. Leppi, and D. J. Rinella. 2017. Summer temperature regimes in southcentral Alaska streams: watershed drivers of variation and potential implications for Pacific salmon. *Canadian journal of fisheries and aquatic sciences*. *Journal canadien des sciences halieutiques et aquatiques* 74(5):702–715.

Morton, J M, D R Magness, M McCarty, D Wigglesworth, R Ruffner, M Bernard, N Walker, et al. 2015. “Kenai Mountains to Sea: A Land Conservation Strategy to Sustain Our Way of Life on the Kenai Peninsula.” [https://kenaiwatershed.org/wp-content/uploads/2019/03/Kenai-Mountains-to-Sea-Strategic-Plan\\_5nov2016\\_compressed.pdf](https://kenaiwatershed.org/wp-content/uploads/2019/03/Kenai-Mountains-to-Sea-Strategic-Plan_5nov2016_compressed.pdf).

NV5 Geospatial. 2021. Kenai Rivers - Thermal Infrared Airborne Imagery Technical Data Report. NV5 Geospatial. <https://paperpile.com/app/p/208c152b-ebdf-02cd-af3e-f42a415eddef>

Thank you!

[www.inletkeeper.org](http://www.inletkeeper.org)



[www.kachemaklandtrust.org](http://www.kachemaklandtrust.org)



[www.kenaiwatershed.org](http://www.kenaiwatershed.org)

