Mapping thermal refugia of Pacific salmon in southwest Alaskan parklands

Lauren Hintenlang[1], Dan Young[2], Tahzay Jones[3], Krista Bartz[4]

[1] Oceans and Coastal Research Program, NPS; [2] Lake Clark National Park and Preserve, NPS; [3] Science Applications and International Affairs, USFWS;
[4] Southwest Alaska Inventory and Monitoring Network, NPS

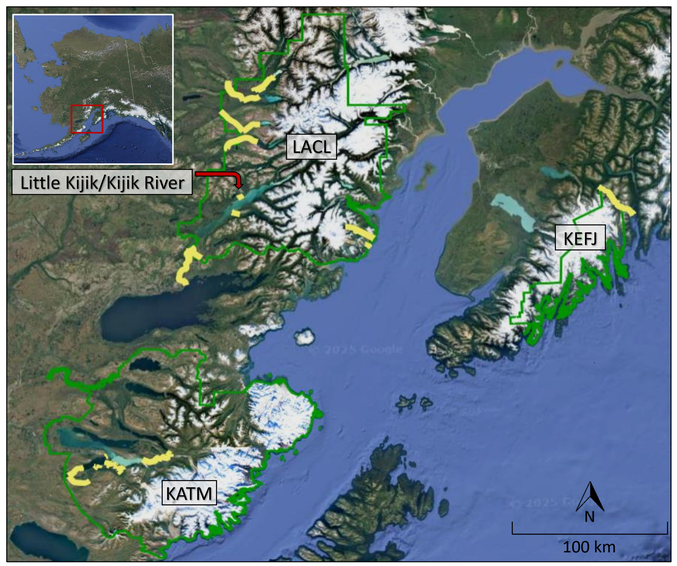
Introduction

- Pacific salmon are keystone species in Alaska, possessing substantial cultural, ecological, and economical importance.
- These salmon depend on cold water temperatures to survive their migration through freshwater habitats and spawn successfully[1,2].
- With the progression of climate change, the surface water temperatures of these habitats are warming[1,3,4], making cold water refugia increasingly important[5,6].
- Cold water refugia are discrete areas with temperatures at least 3°C colder than the surrounding water[7,8,9].
- Despite the growing relevance of thermal refugia for Pacific salmon, baseline information in Alaska is sparse.

Objectives

Year 1: Identify the locations of thermal refugia in high priority rivers of Katmai National Park and Preserve (KATM), Lake Clark National Park and Preserve (LACL), and Kenai Fjords National Park (KEFJ).

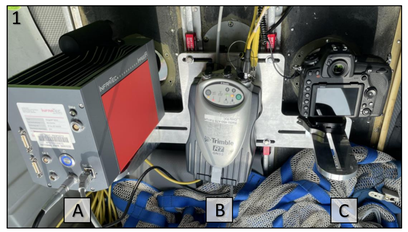
Study Sites

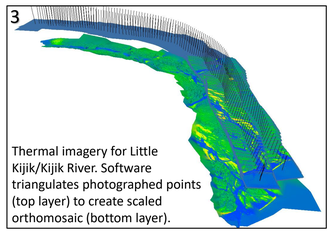


Yellow lines show the planned flight lines over the rivers flown. Green indicates park boundaries.

Methods

- Thermal infrared and color (red/green/blue [RGB]) images were acquired using two cameras mounted in a fixed-wing aircraft[10] in July, August, and October 2024.
- An InfraTec ImageIR8300 MWIR (Medium Wave Infrared) camera with a 25-millimeter lens acquired radiometric images at 1-second intervals (1A), while a NikonD850 camera with a 35-millimeter lens acquired RGB photos at 1-second intervals (1C). A Trimble R7 GNSS receiver was used to record camera positions (1B).





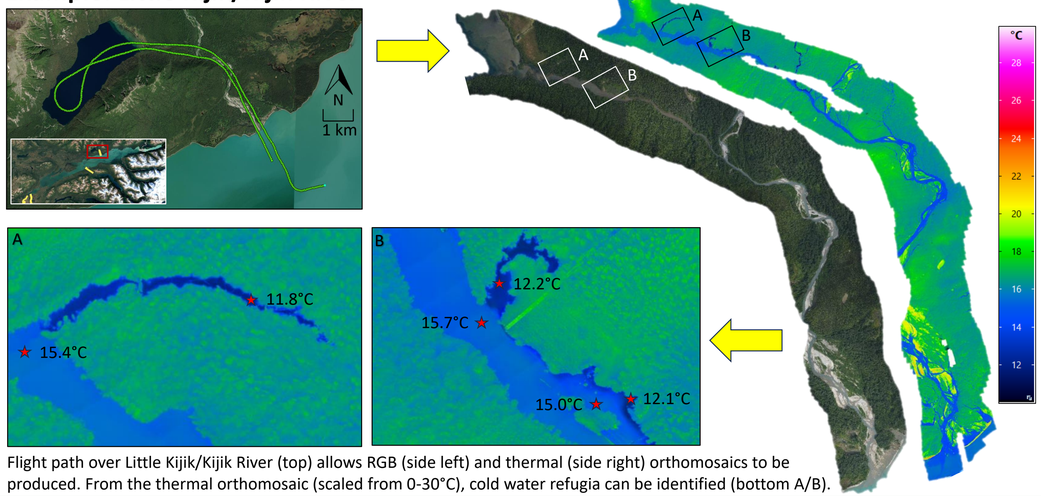
Thermal imagery for Little Kijik/Kijik River. Software triangulates photographed points (top layer) to create scaled orthomosaic (bottom layer).

- The aircraft, a Cessna 206 (2), flew at an average speed of about 100 knots and 2,000 feet above the ground. Transects were flown about 600 feet apart to provide the image overlap necessary to mosaic the images.
- Agisoft Metashape, a photogrammetry software, was used to create thermal and RGB orthomosaics from the images (3).
- Cold water refugia were visually identified through systematic observation of each orthomosaic.

Results

19 rivers flown - 265+ miles of river covered - 30.2 hours of flight time - 60,000 images

Example: Little Kijik/Kijik River



Flight path over Little Kijik/Kijik River (top) allows RGB (side left) and thermal (side right) orthomosaics to be produced. From the thermal orthomosaic (scaled from 0-30°C), cold water refugia can be identified (bottom A/B).

Discussion

Project Status

- Organization of collected data complete.
- Image processing and refugia identification in progress.
  - Completed for Little Kijik/Kijik River, Tanalian River, and Tazimina River. All located in LACL.

Future Objectives

Year 2: Quantify spatial and temporal variability of thermal refugia and then characterize refugia using location, distribution, frequency, connectivity, and persistence.

Summer 2025 Workplan

- Approximately 20 of the identified cold water refugia will be selected for intensive monitoring based on location, temperature differential, and historic importance to migratory salmon populations.
- Additional flights will be flown over these sites to better understand refugia extent and persistence over time.
- At each refuge, a series of 5 HOBO water temp data loggers will be deployed for a year along a longitudinal gradient and set to measure hourly water temperature.

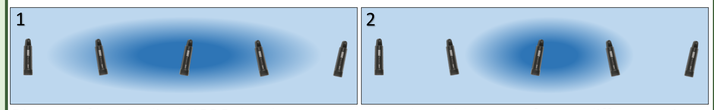


Diagram of longitudinal HOBO data logger array through a cold water refuge at different points of the year (1 vs 2). The refuge (blue oval) may shrink or grow so the loggers will be placed to record water temperatures both within and outside the refuge. Diagram not to scale.

Conclusions

This mapping and characterization of cold water refugia provides important baseline data that informs salmonid management in the context of a changing climate.

Acknowledgements

Project funded by the NPS Alaska Region Block Grant. Special thanks to Stephan Larmann at Infratec, NPS pilots Paul Anderson and Steven Bell, and the Scientists-in-Parks Program.

Scan QR code for abstract, citations, and a copy of the poster.