Alaskan Salmon Responses to Changing River Conditions

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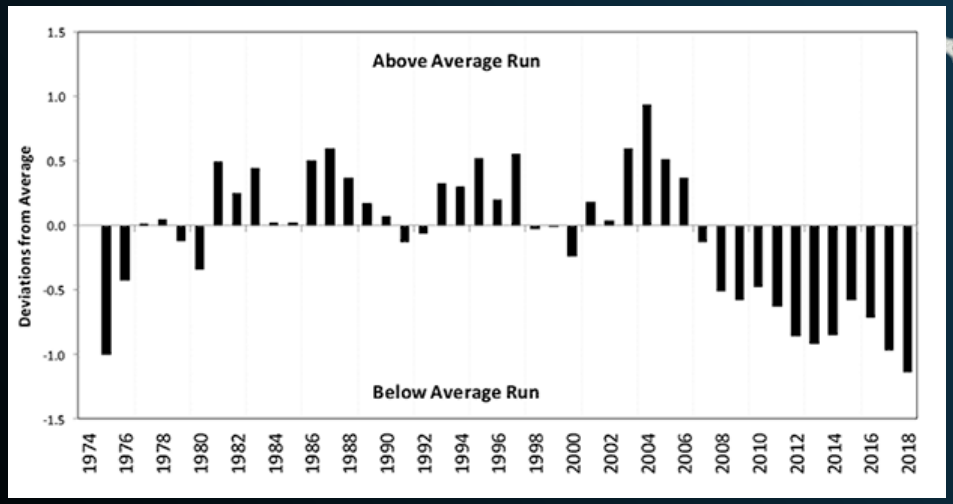
1. NSF NCAR, 2. Alaska Department of Fish & Game, 3. NOAA, 4. Advisory Panel

Rising Voices, Changing Coasts



Source: ADF&G Report, 2019

Image from Unsplash

Approach & Data

How are Chinook salmon adapting to their environment?

Genetic structure

Samples: >27,000 Chinook salmon collected at 180 spawning locations across Alaska

Genetic data: DNA analyzed at ~300 points across the genome*

+

Earth system model output

Precipitation: Regional Arctic System Model (RASM), a 4 km-resolution coupled WRF-CTSM simulation (Cheng et al. 2023)
River temperature and discharge: River basin model (RBM) with CTSM runoff routed using mizuRoute. (Blaskey et al. 2024)

Ocean conditions: CESM-LE2
Ocean food availability: CESM-MARBL
Ocean predators: CESM-FEISTY

*Genetic data is produced by the Alaska Department of Fish & Game- Gene Conservation Lab

Important variables and thresholds

Range of winter air temperature

Elevation

Range of summer air temperature

Range of winter headwater temperature

Average winter air temperature

Slope of summer air temperature over time

Maximum daily precipitation

Annual rain rate

Slope of winter stream temperature over time

Slope of summer stream temperature over time

Slope of summer headwater temperature over time

Annual snowmelt

Environmental boundaries to gene flow

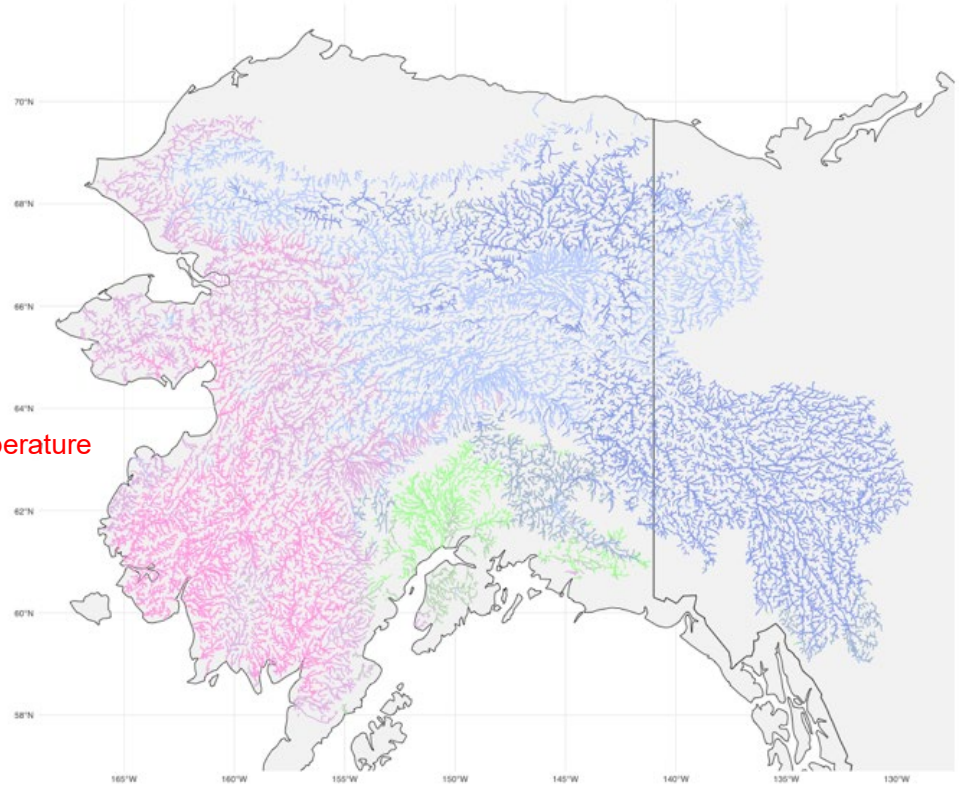
Range of winter air temperature

Range of summer air temperature

elevation

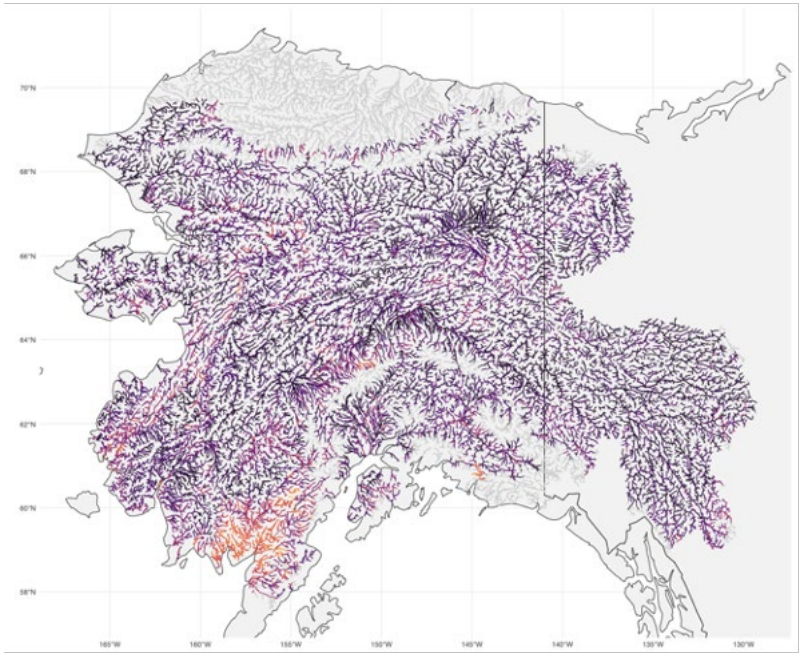
Range of winter headwater temperature

Slope of summer air temperature over time

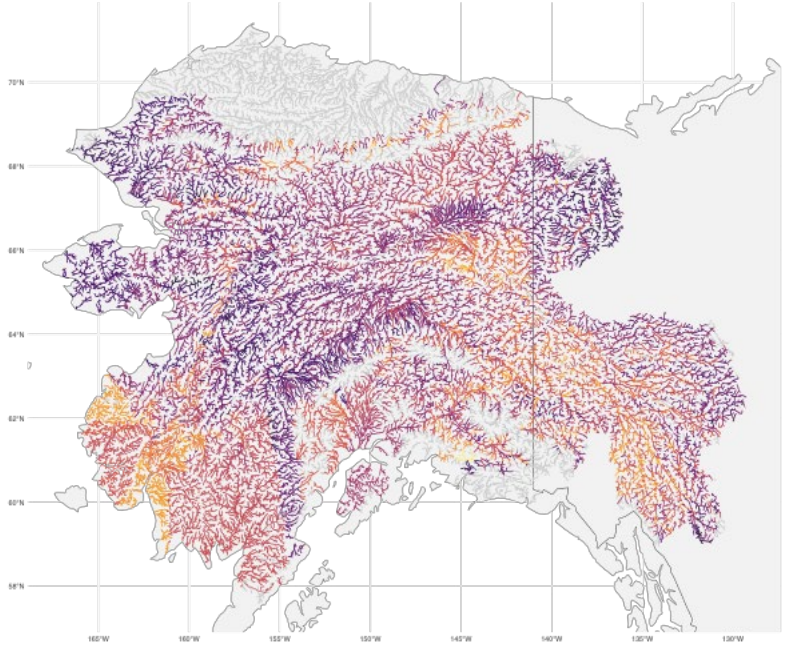


Future predictions

Using climate projections for the mid -21st century (2035–2064), we explored how Chinook salmon may need to adapt to changing river conditions. These maps indicate where salmon populations are predicted to be most vulnerable to future climate change.



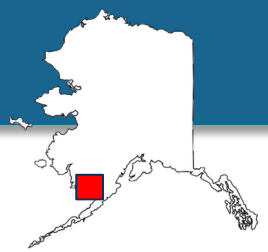
Moderate warming scenario



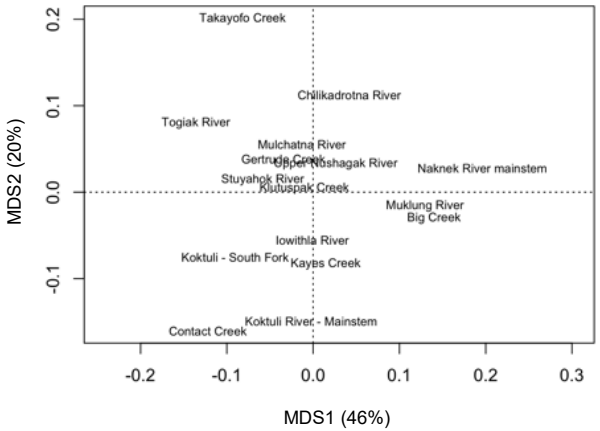
High warming scenario

High risk  Low risk

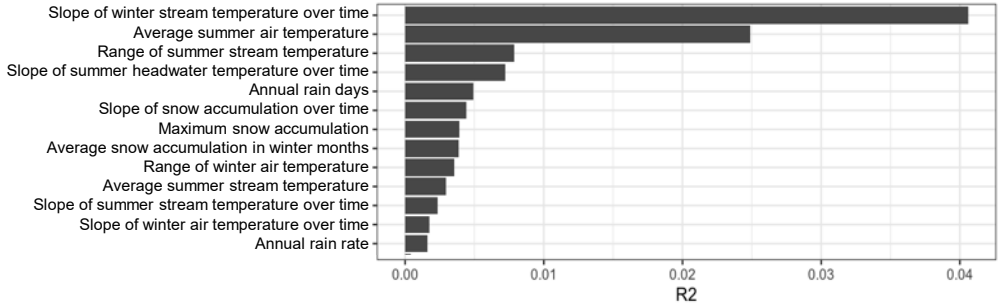
Regional context (Bristol Bay)



Genetic structure

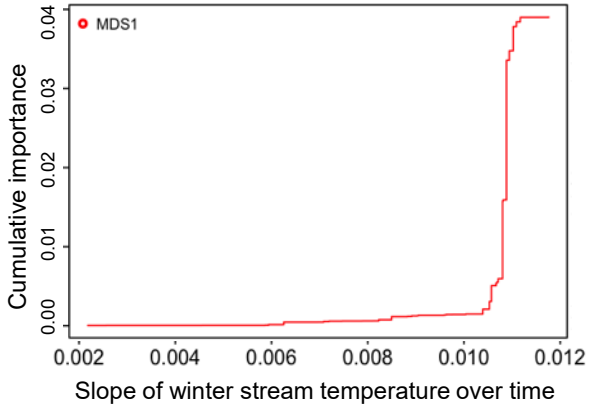


Important variables



Vulnerable areas

Ecological thresholds

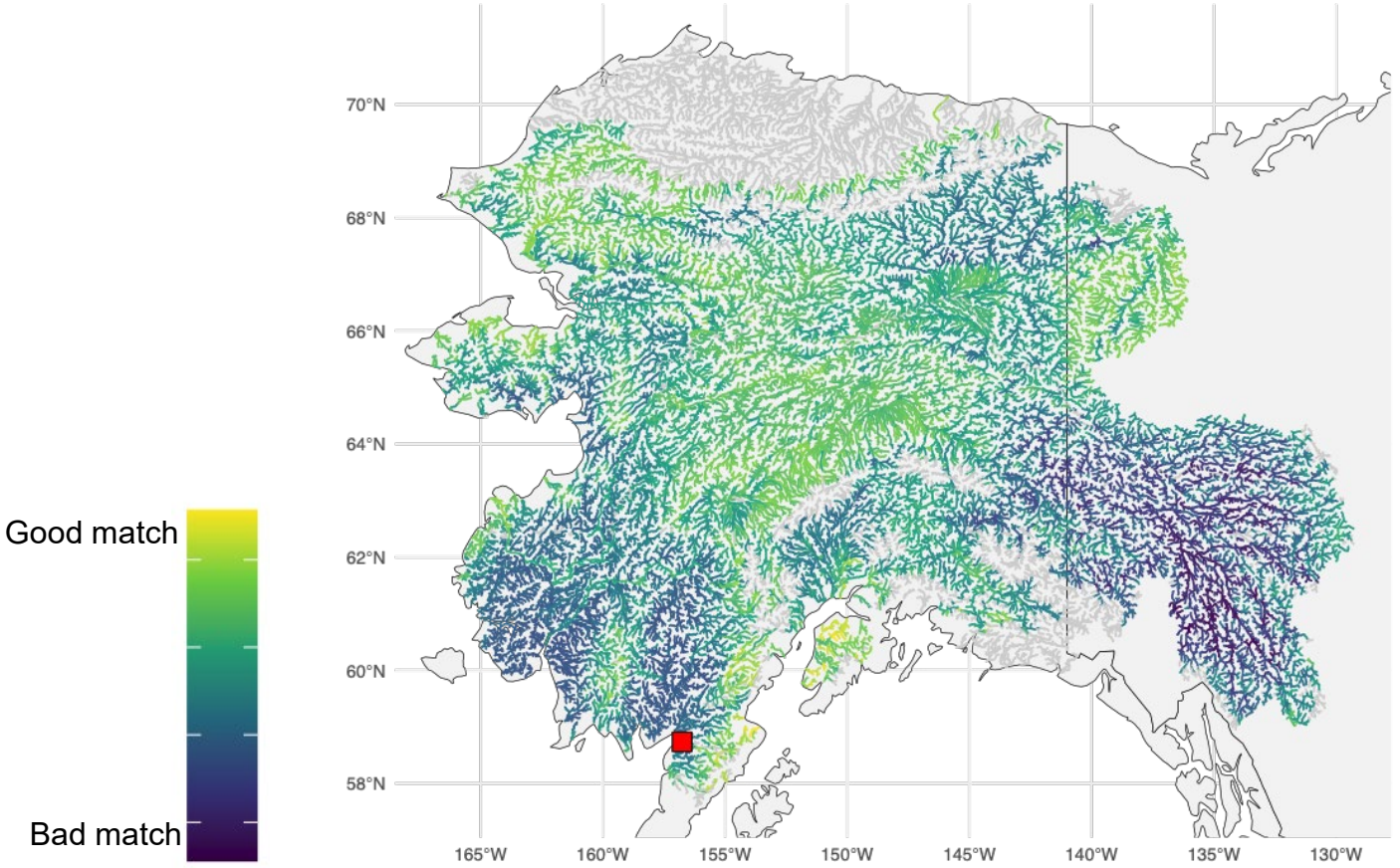


Slope of winter stream temp. over time

Bristol Bay

Future strategies

Where else could Bristol Bay salmon live in the future?

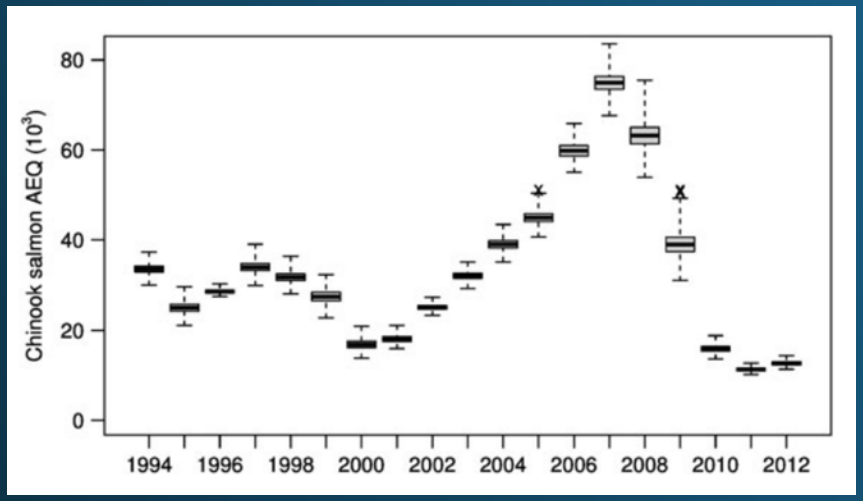


Caveats

- Genotype-environment associations (and future predictions) are *correlative* and require experimental validation
- Key environmental variables may be *missing* or incompletely represented
- Assume *polygenic* selection at associated loci
- *The ocean* plays a major role in salmon life history

Political Challenges

Source: NOAA, Public Domain



Source: Ianelli et al. 2015, *ICES J. Marine Science*

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KUSKOKWIM RIVER
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YUKON RIVER
INTER-TRIBAL FISH COMMISSION

Political Challenges

Fisheries and Oceans Canada | Pêches et Océans Canada

Agreement of April 1, 2024 regarding
Canadian-origin Yukon River Chinook Salmon for 2024 through 2030

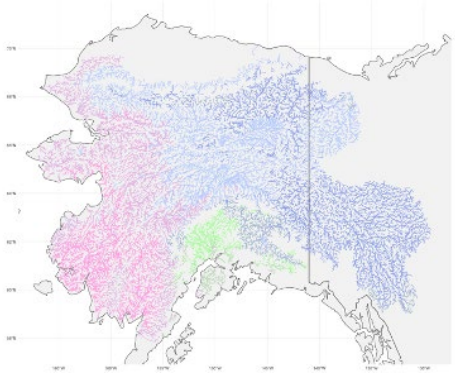
The following agreement between Fisheries and Oceans Canada and the Alaska Department of Fish and Game (hereafter referred to as "the Parties") concerning Canadian-origin Yukon River Chinook salmon shall apply to the period from April 2024 through 2030.

7-Year Moratorium on Chinook salmon in the Yukon

Source: Wilds et al. ArcGIS StoryMaps

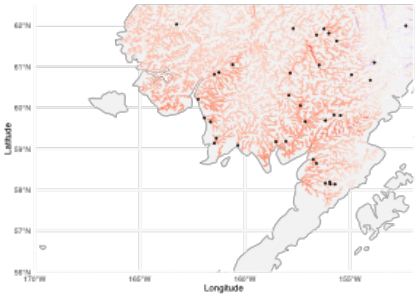
Takeaway points

- Genetic divergence in Chinook salmon is correlated with local river conditions across Alaska.

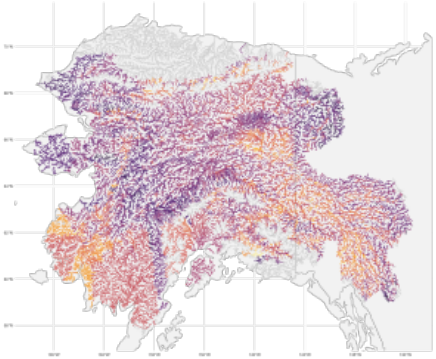


- Statewide genetic patterns are correlated with differences in winter air temperature at spawning sites.

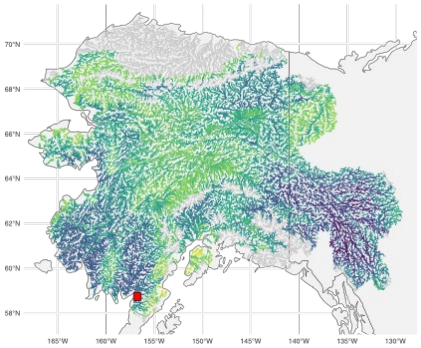
- Findings at the regional scale are consistent with Indigenous and local knowledge of environmental shifts.



- Some populations may be more poorly matched to future environments than others



- Vulnerable populations might access more favorable spawning habitats elsewhere



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- Alaska Department of Fish & Game- Andy Barclay, Elizabeth Lee, Kyle Shedd, Tyler Dann
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