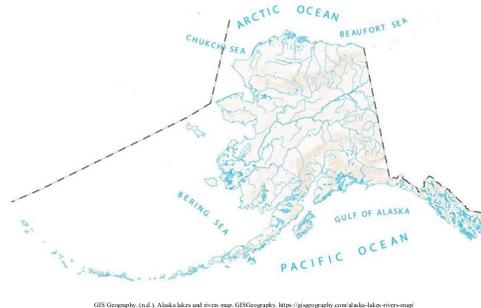


Warming Waters, Changing Fish: The Impact of Water Temperature on Arctic Fish Size

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CONTEXT AND PLACE

- Unprecedented regional warming across Alaska's oceans since 1982 has seen the Chukchi Sea rise by 3°F and the Kotzebue Sound by an astounding 12.1°F (Thoman & McFarland, 2024).
- Rising water temperatures in Arctic rivers now frequently exceed the tolerance levels of migrating fish, inducing physiological heat stress that hinders successful spawning runs (von Biela et al., 2020)
- Significant declines in body size among maturing Pacific salmon are linked to these warmer waters and increased competition for lower-quality food sources (Vanessa et al., 2020).
- Traditional subsistence cycles are being destabilized as smaller, less nutritious fish and unpredictable ice conditions threaten the food security of Indigenous communities like Akiak (River, 2021).



GIS Geography. (n.d.). Alaska lakes and rivers map. GISGeography. <https://gisgeography.com/alaska-lakes-rivers-map/>

LEARNING GOALS

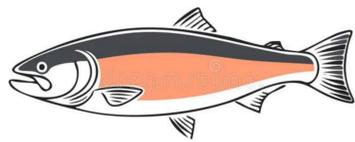
How does water temperature affect fish size in the Arctic?

KNOWLEDGE SOURCES & METHODS

Centering Community Voice (Project Jukebox)

Found points of connection and difference using data from NRC and UAF

Looked at both to create dialogue between language systems



Drumtime. (n.d.). Salmonidae fish [Illustration collection]. Drumtime. <https://www.drumtime.com/illustrations/salmonidae-fish.html>

INDIGENOUS WAYS OF KNOWING

James Robert [Athabascan], Tanana (Project Jukebox 2009):

- "Of we weren't getting as much yield on the firewood because of the climate changes, like it was colder springs and we had no big, major ice rushes and we didn't get scoured was kind of what I was talking to Bill about, and I was telling him that we couldn't depend on getting enough firewood like we used to, where it would run for days and days or -- or the water table changed and the water times changed, whereas in the June rush, sometimes it only came in May or sometimes it didn't come at all, it came in July."

Andy Bassich, Eagle (Project Jukebox 2005):

- "I -- it's the temperature, it's got to be. The temperatures aren't -- aren't the same. I mean, you can't count on it being falltime cold when you want it to be cold."

Andy Bassich, Eagle (Project Jukebox 2005):

- "We're always pretty much in the top five in the high temperatures in the summer, and we're always close to the top five of the lower temperatures in the winter."

Andy Bassich, Eagle (Project Jukebox 2005):

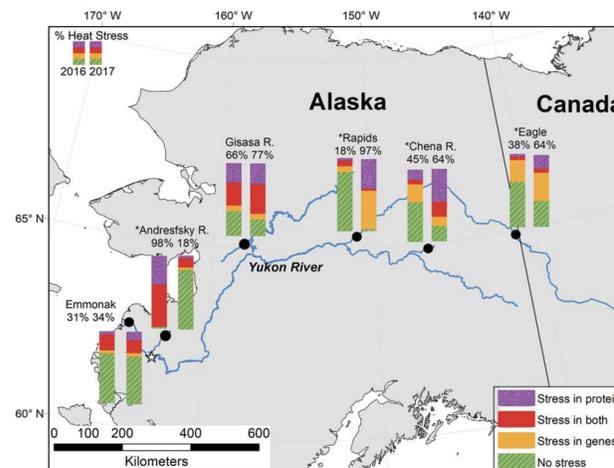
- "Across the state, all species of salmon are maturing at smaller body sizes. This is especially true for Chinook. Smaller spawners produce smaller and fewer eggs, exacerbating population declines and reducing value of each fish for both subsistence and commercial fisheries. This shift is linked to warmer ocean temperatures, coupled with more competition at sea, lower quality food, and possibly more marine predators selecting the largest fish."

Joe Mello Leavitt [Iñupiat], Utqiagvik (AAOKH 2023):

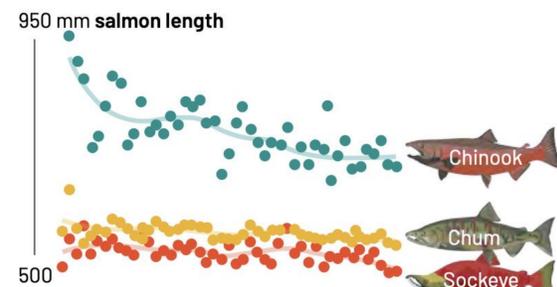
- "The sea ice and permafrost are melting too fast."

WESTERN SCIENTIFIC PERSPECTIVES

A map depicting the percentage of Chinook salmon in each capture location (black circles) and year with evidence of heat stress. Paired stacked bar charts reflect the heat stress classifications from gene transcript and HSP70 protein for fish captured in summer 2016 (left) and 2017 (right). Fill reflects the proportion of individuals in each of the four heat stress categories: hatched green = no evidence of heat stress in either gene transcription or HSP70 protein; gold = heat stress identified only in gene transcription; red = heat stress identified in gene transcription and elevated HSP70 protein; and dotted purple = heat stress identified only by elevated HSP70 protein. Numbers near each bar are the sum across the three categories that identified heat stress presence. The white star is the location of the temperature experiment near Pilot Station, Alaska, USA. An asterisk (*) prior to the capture location name denotes a significant difference ($P < 0.05$) in the heat stress proportion between capture years. Map created in ArcMap 10.7 (Esri, Redlands, California, USA) with selected rivers from the National Hydrography Dataset (US Geological Survey 2015) and shorelines from Wessel and Smith (1996).



von Biela, V. R., Bowen, L., McCormick, S. D., Carey, M. P., Dorety, D. S., Waters-Dynes, S. C., Regier, A. M., Leslie, S. M., Bowen, R. L., Larson, S., Zarey, S., & Zimmerman, C. E. (2020). Evidence of prevalent heat stress in Yukon River Chinook salmon. *Canadian Journal of Fisheries and Aquatic Sciences*, 77(11), 1876–1892. <https://doi.org/10.1139/cjfas-2020-0209>



St Thomas, R., & McFarland, D. R. (Eds.). (2024). Alaska's Changing Environment 2.0. Alaska Center for Climate Assessment and Policy. International Arctic Research Center, University of Alaska Fairbanks. <https://alaskaclimate.org/wp-content/uploads/2023/06/Alaska-Env-Changing-Environment-2024.pdf>

Alaska Center for Climate Assessment and Preparedness at the UAF International Arctic Research Center Report (2024):

"Across the state, all species of salmon are maturing at smaller body sizes. This is especially true for Chinook. Smaller spawners produce smaller and fewer eggs, exacerbating population declines and reducing value of each fish for both subsistence and commercial fisheries. This shift is linked to warmer ocean temperatures, coupled with more competition at sea, lower quality food, and possibly more marine predators selecting the largest fish."

INSIGHTS GAINED

6% decrease in body length and 15% egg count per female, so hunters' efforts have had to increase for lower nutritional value.



Shutterstock. (2022). Raw fish piece icon. Creative Commons Attribution (CC BY). <https://www.shutterstock.com/product-photo/raw-fish-piece-illustration>



Freepik. (n.d.). Salmon graphic [Image collection]. Freepik. <http://www.freepik.com/free-photo/salmon-graphics>

Subsistence and commercial fishing are both impacted by the decline in salmon size.

Thermal stress leads to a 26% loss in meals for rural families and 16% fewer eggs (Oke et al., 2020). This destabilizes traditional subsistence cycles and threatens the intergenerational transfer of knowledge.

INTERPRETATION & LIMITS

- Confounding environmental factors
- Species specific responses
- Migration timing variability

NEXT STEPS & CONTINUING RELATIONSHIPS

- Long-term monitoring programs
- Genetic and evolutionary studies
- Climate projection modeling

ACKNOWLEDGMENTS & REFERENCES

"We acknowledge that we are on the unceded lands of the Dena'ina Athabascan people and honor their enduring relationship with this land."



Androgonne Museum. (n.d.). The Dena'ina homeland with commentary [Web page]. Androgonne Museum. https://denaina.androgonnemuseum.org/landand_community_map.html

