



Wild Salmon in a Warming World

Do we have the tools we need to manage our fisheries during rapid climate change?

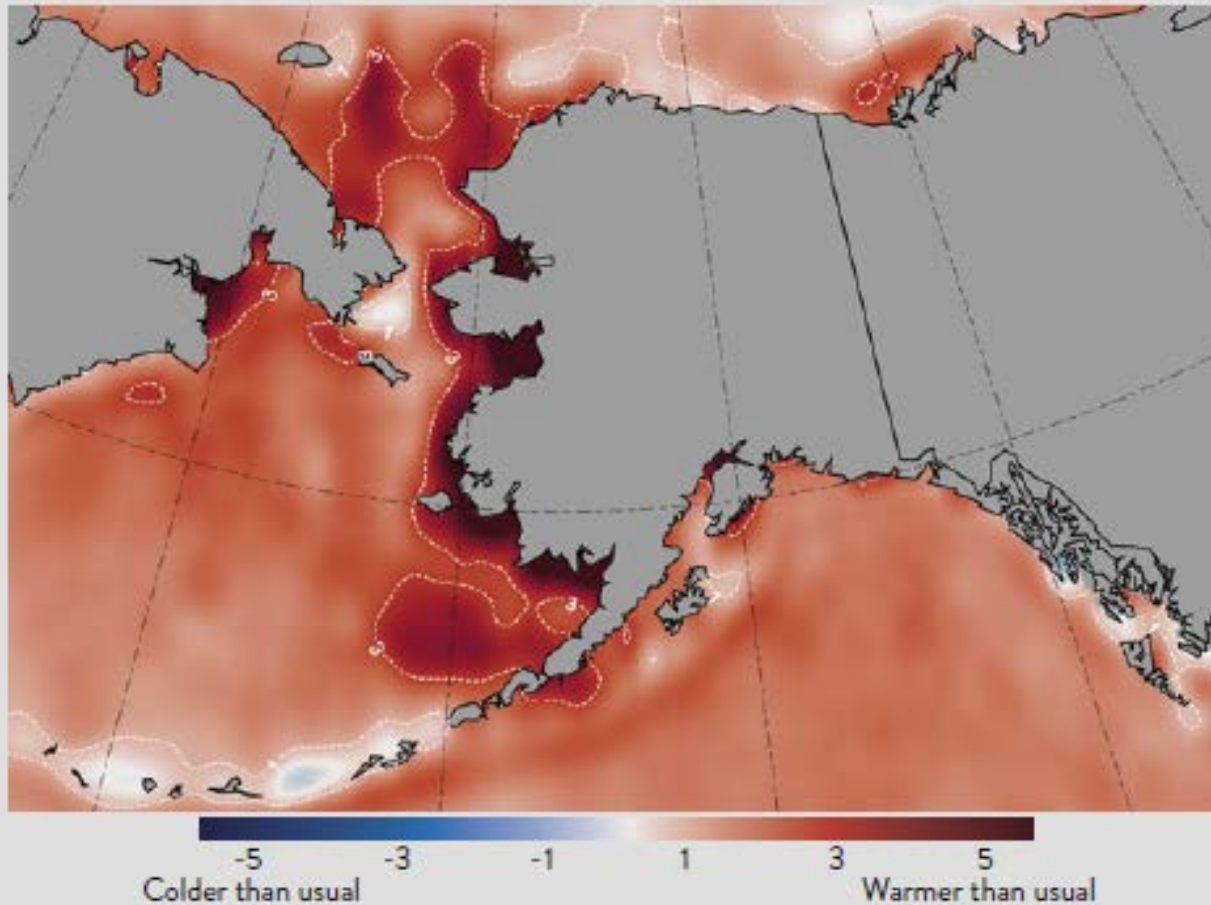
Sue Mauger
Science Director, Cook Inletkeeper
sue@inletkeeper.org



WARM SURFACE WATERS

Summer sea surface temperatures in Alaska waters have been much warmer (colored red below) than average (colored white) during 2014–2018, especially along the west coast, where the surface waters were 4–11°F warmer than average in the summer of 2019.

25



Data source:
NOAA/NCEI

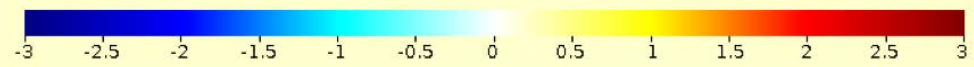
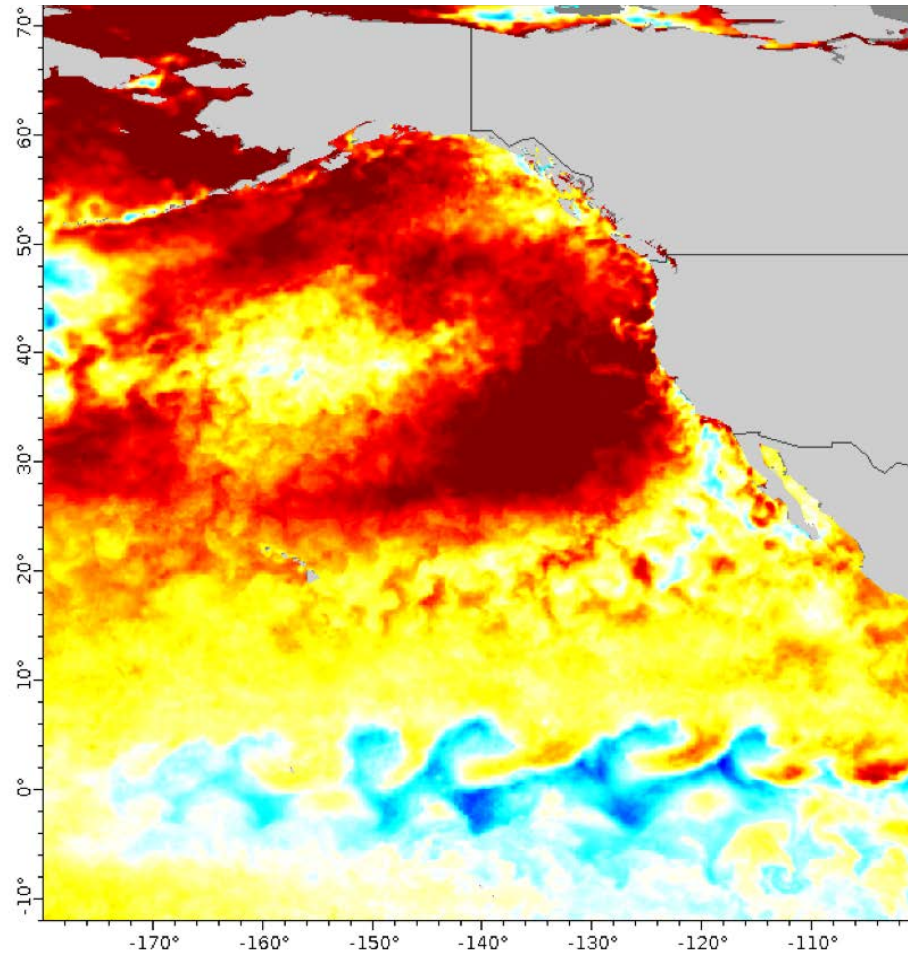
Thoman, R. & J. E. Walsh. (2019). Alaska's changing environment: documenting Alaska's physical and biological changes through observations. H. R. McFarland, Ed. International Arctic Research Center, University of Alaska Fairbanks.

ENVIRONMENT



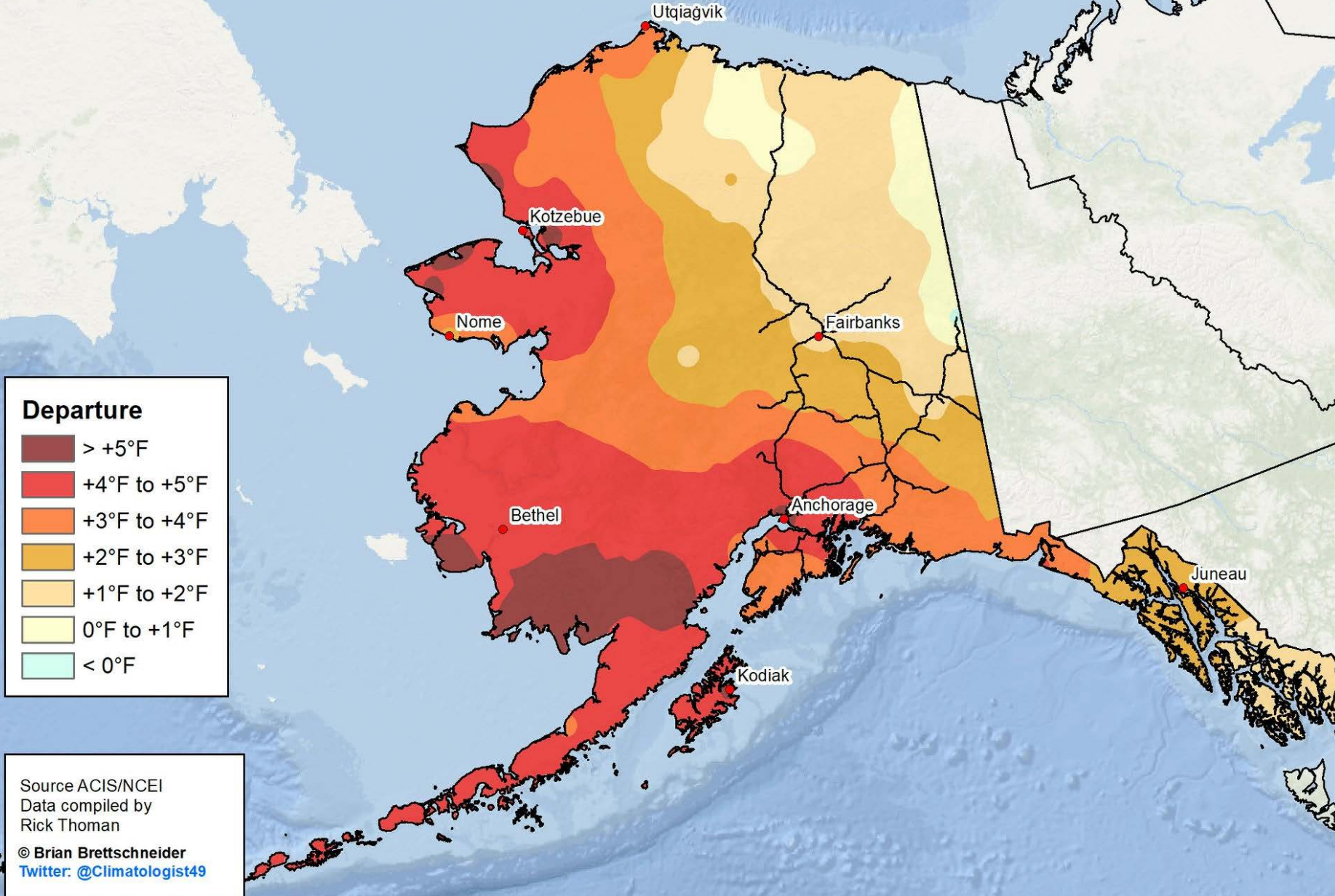
Is 'The Blob' Back? Latest Marine Heat Wave Could Pose New Risks To Sea Life

September 6, 2019 - 4:02 PM ET



sea surface temperature anomaly (Celsius)
NOAA Global Coral Bleaching Monitoring Products: Daily 5-km
(2019-09-02T12:00:00Z)
Data courtesy of NOAA Coral Reef Watch

Summer 2019 Temperature Departure from Normal



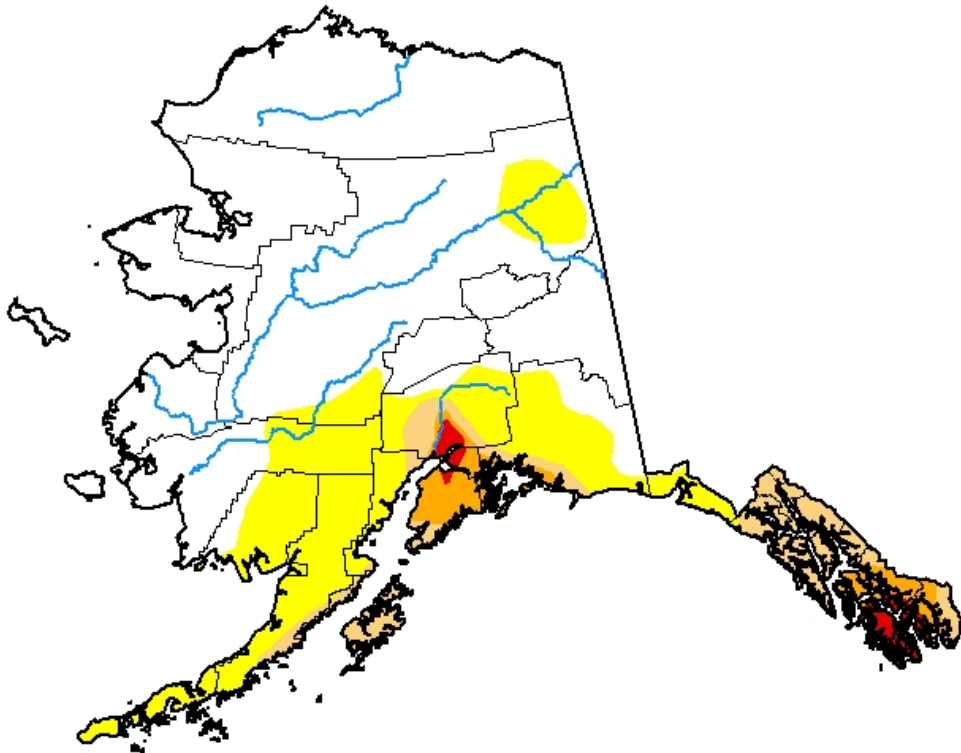
Departure

- > +5°F
- +4°F to +5°F
- +3°F to +4°F
- +2°F to +3°F
- +1°F to +2°F
- 0°F to +1°F
- < 0°F

Source ACIS/NCEI
Data compiled by
Rick Thoman
© Brian Brettschneider
Twitter: @Climatologist49

U.S. Drought Monitor Alaska

August 20, 2019
(Released Thursday, Aug. 22, 2019)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	66.67	33.33	11.19	4.58	1.32	0.00
Last Week 08-13-2019	69.37	30.63	9.63	3.77	0.88	0.00
3 Months Ago 05-21-2019	94.17	5.83	2.78	1.65	0.88	0.00
Start of Calendar Year 01-01-2019	94.17	5.83	2.35	1.02	0.00	0.00
Start of Water Year 09-25-2018	95.65	4.35	2.34	2.06	0.00	0.00
One Year Ago 08-21-2018	95.65	4.35	2.34	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

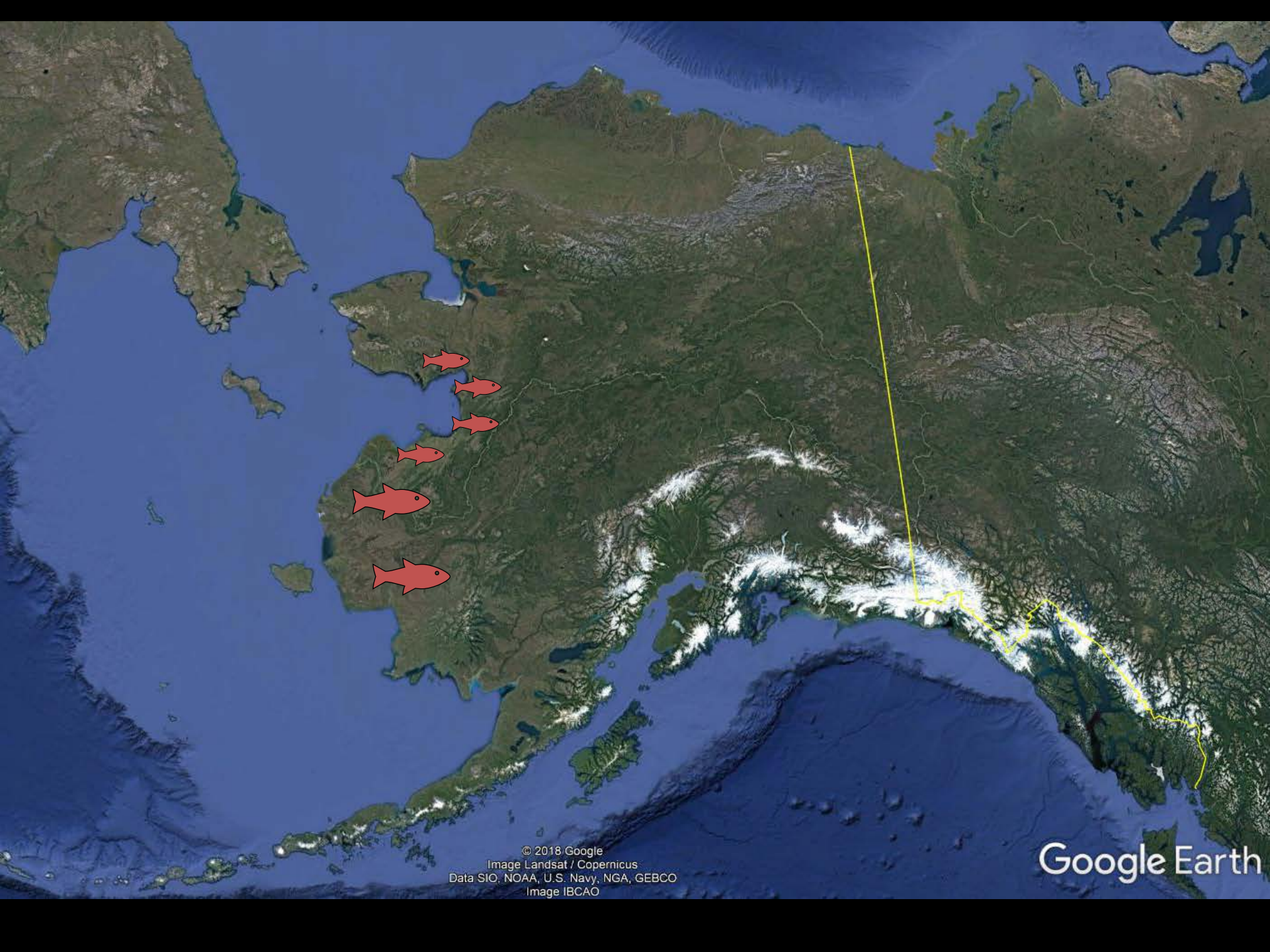
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:

Jessica Blunden
NCEI/NOAA



droughtmonitor.unl.edu



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Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

Google Earth



Photo credit: Stephanie Quinn-Davidson



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Photo credit: Stephanie Quinn-Davidson



DESHKA RIVER

CURRENT CONDITIONS:

07/08/2019
5:00 pm AK TIME
Water Temp = 27.1 °C (80.8 °F)
Air Temp = 31.0 °C (87.8 °F)

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Deshka River 2019

— Chinook count — average daily water temperature

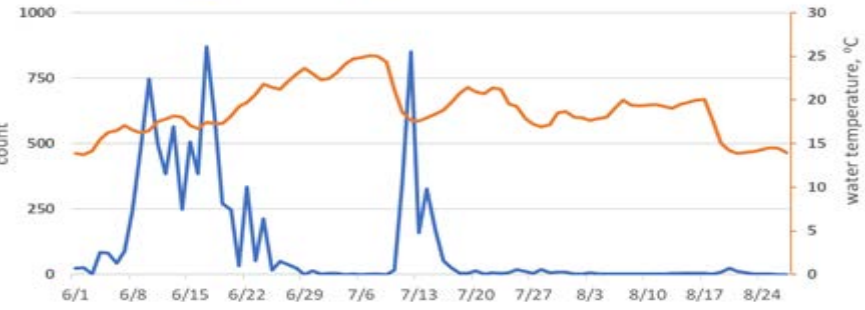
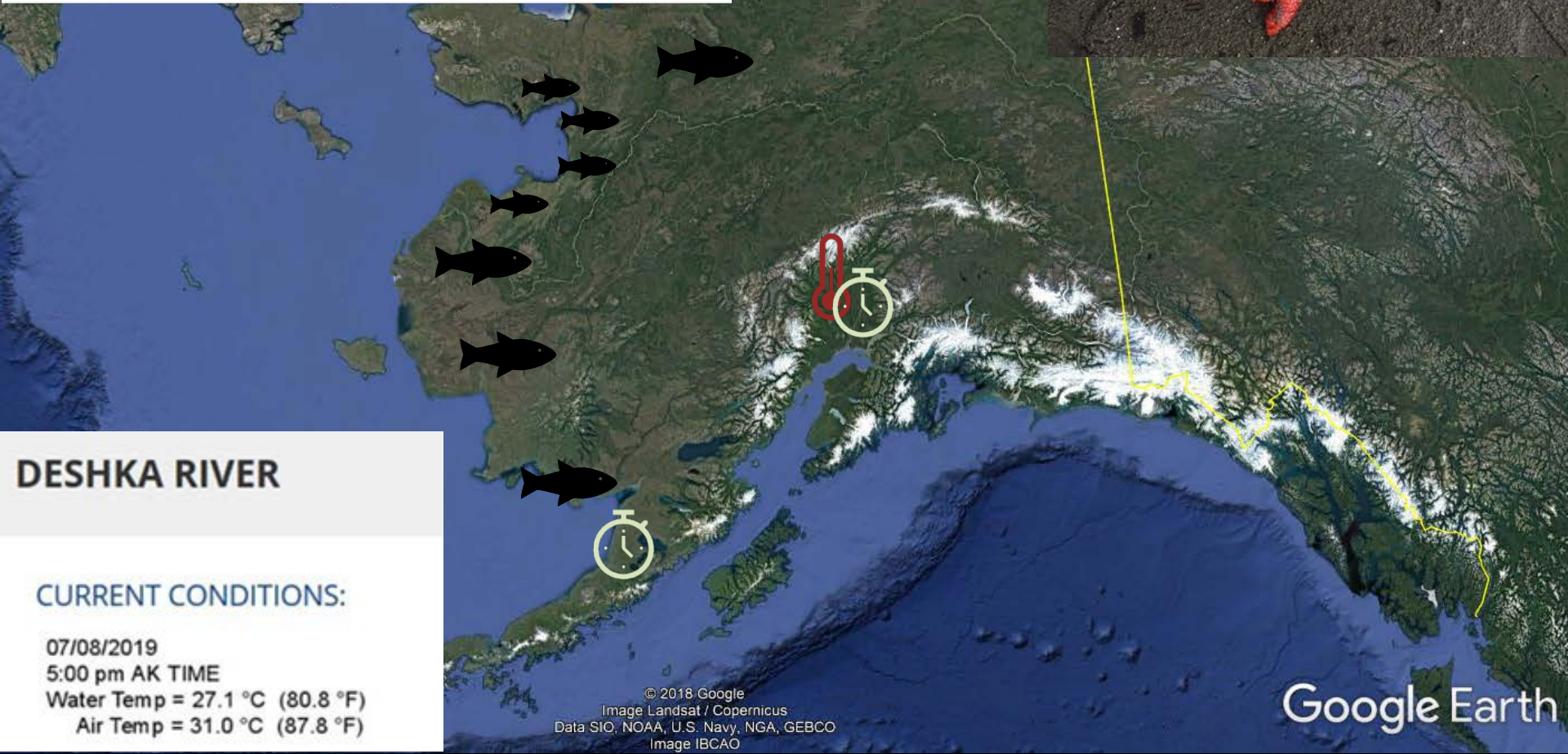


Photo credit: Stephanie Quinn-Davidson



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Deshka River 2019

— Chinook count — average daily water temperature



Photo credit: Stephanie Quinn-Davidson

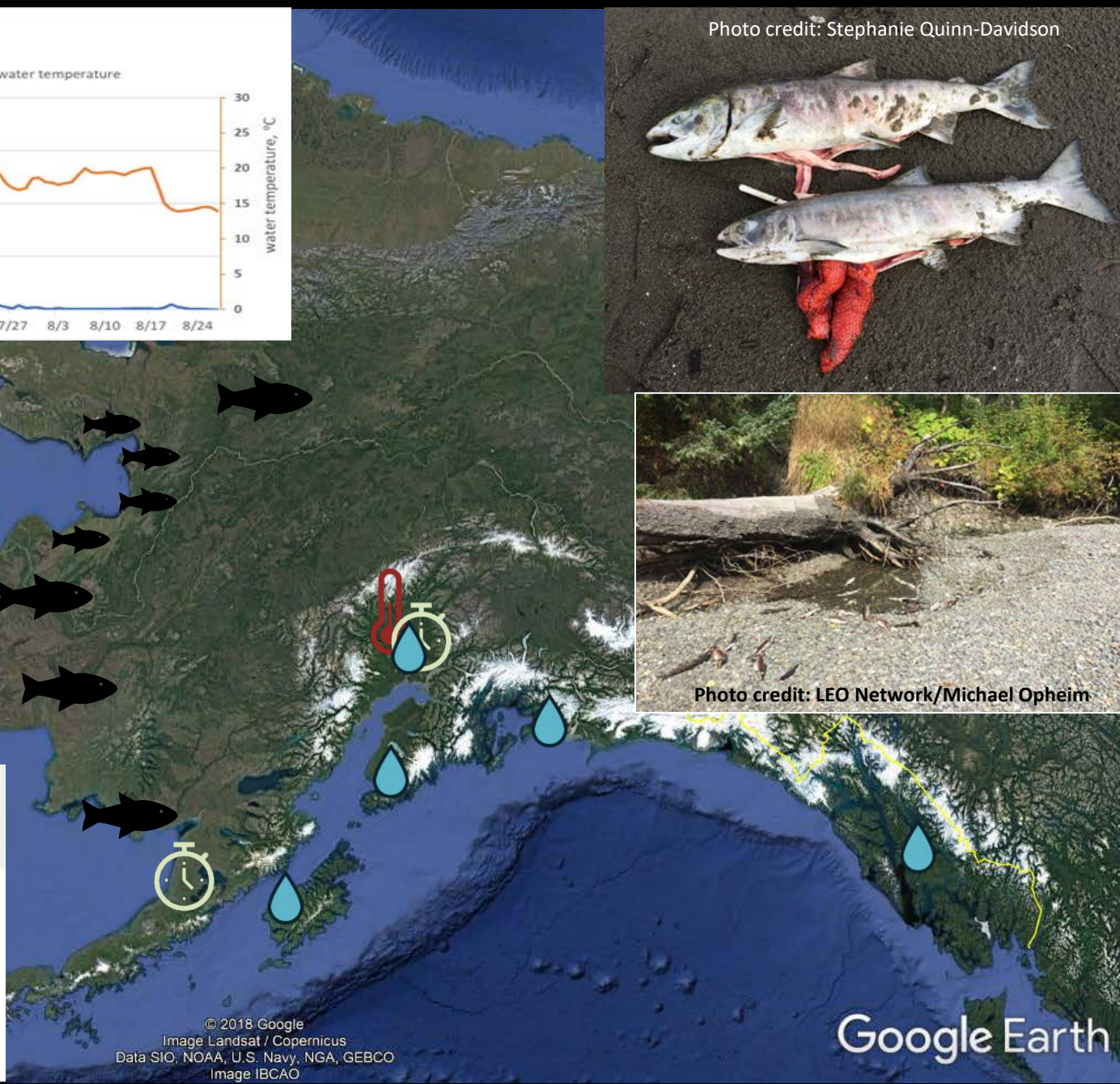


Photo credit: LEO Network/Michael Opheim

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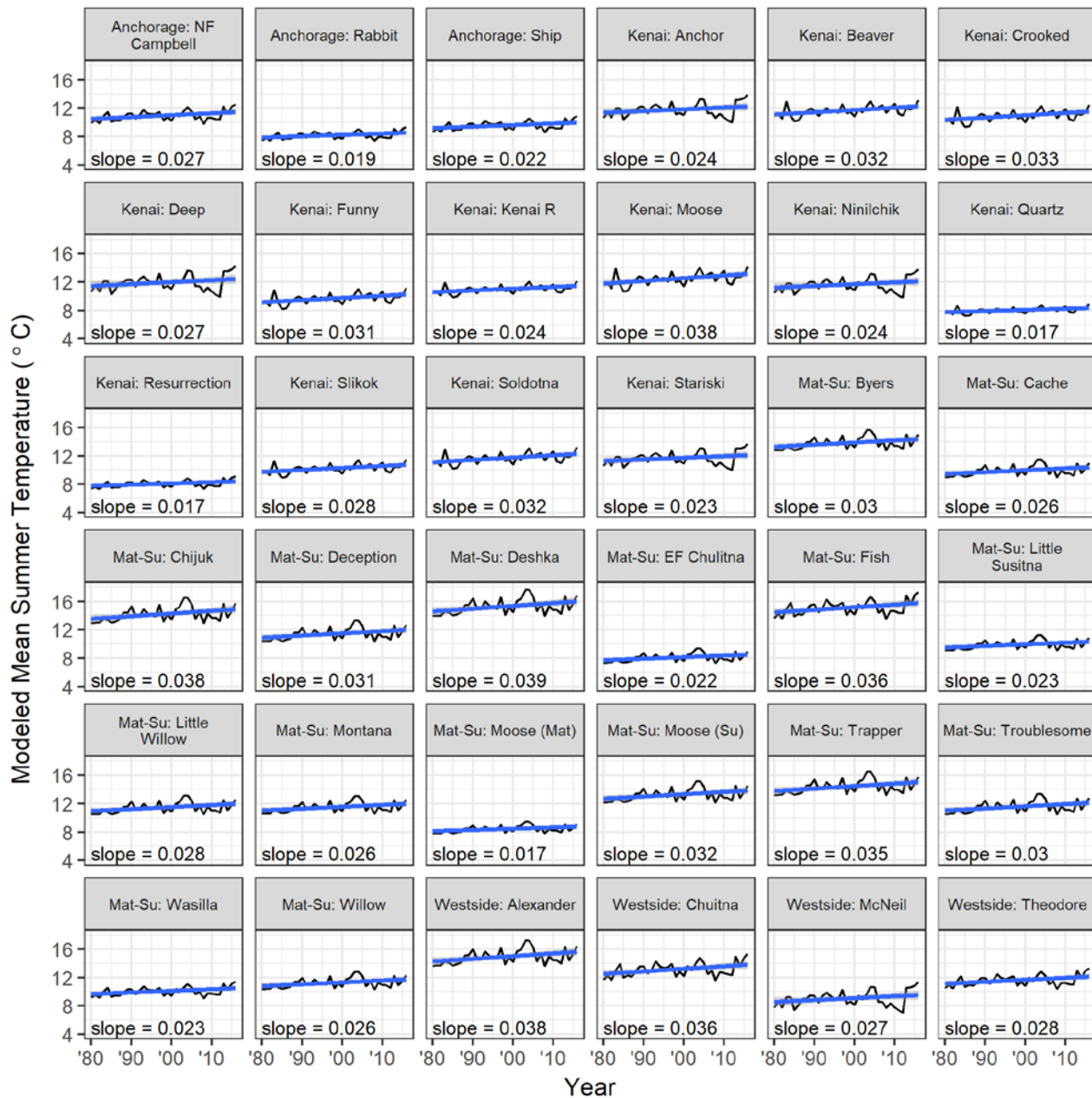


Summer of 2019

Warm and low freshwater conditions led to both physiological and behavioral responses by adults of all 5 species of wild Alaska salmon around the state and impacted commercial, sport and subsistence fishermen. Impacts to egg and juvenile life stages are unknown.

Stream Temperature Monitoring Network for Cook Inlet Salmon Streams

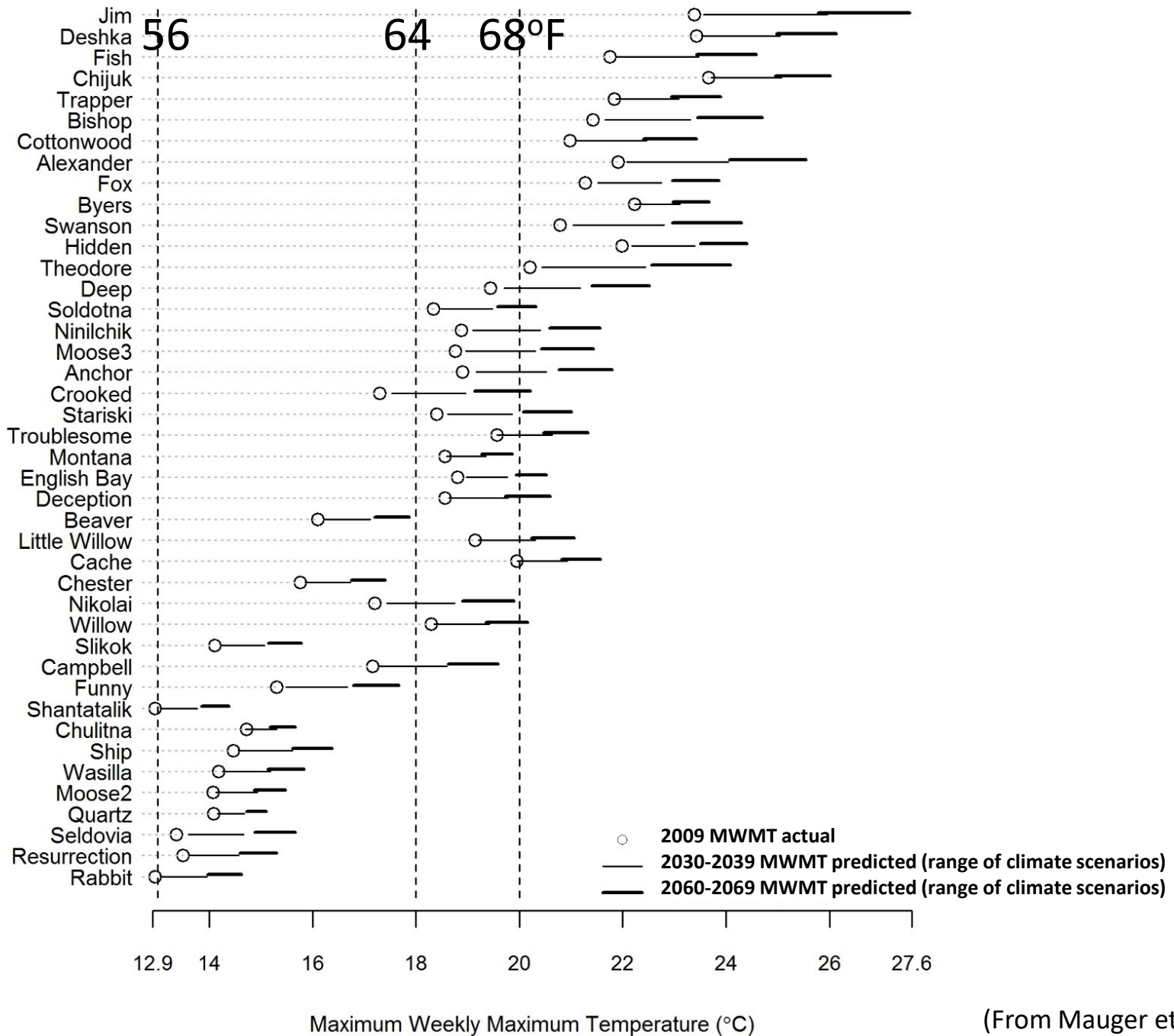




Average summer temperatures have increased by 0.5°F per decade since 1980 in non-glacial stream of Cook Inlet.

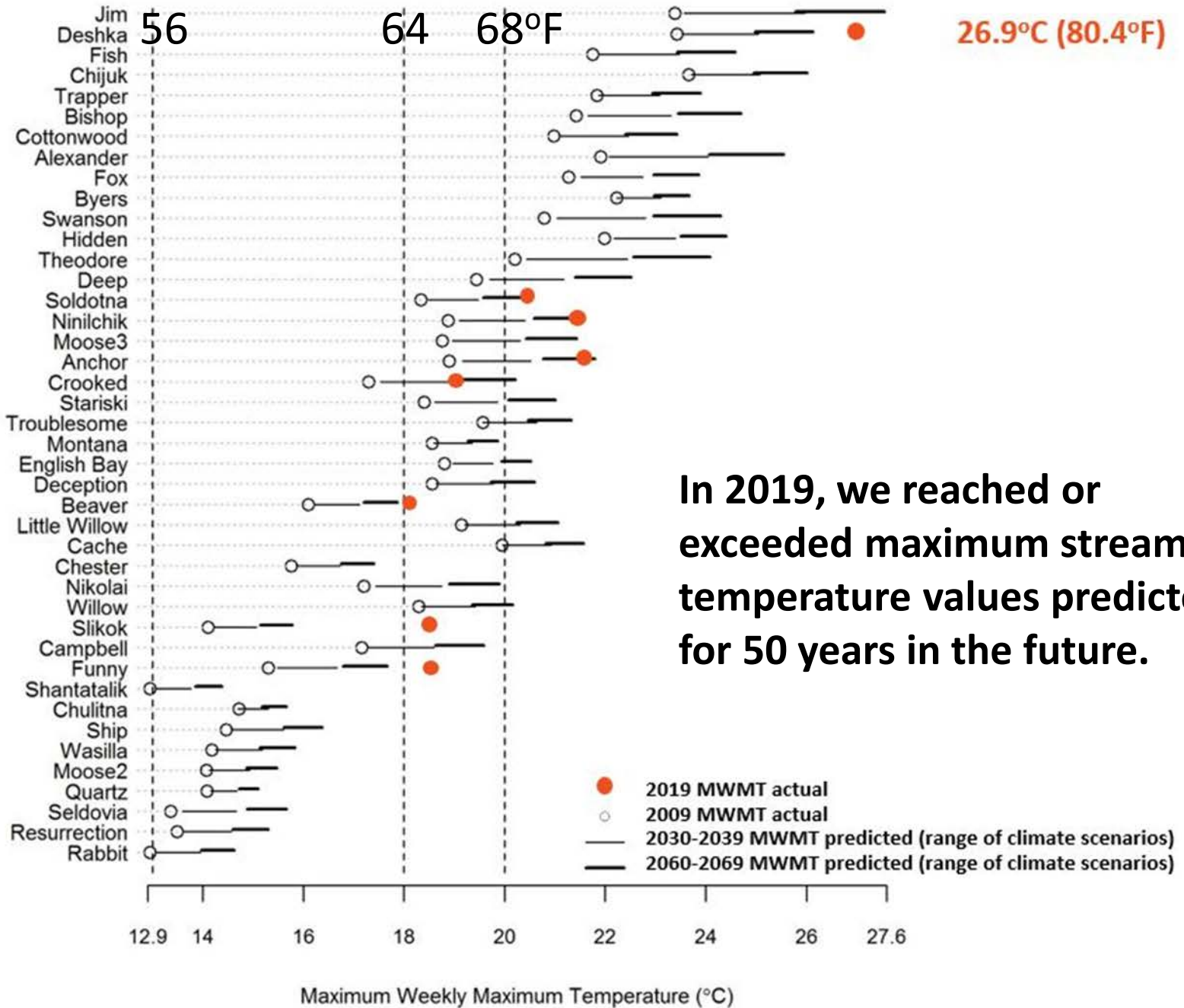


non-glacial Cook Inlet streams



(From Mauger et al. 2017)

non-glacial Cook Inlet streams



In 2019, we reached or exceeded maximum stream temperature values predicted for 50 years in the future.

Regional and watershed-scale climate drivers influence Chinook salmon productivity in southcentral Alaska



Leslie Jones, Erik Schoen, Rebecca Shaftel, Curry Cunningham, Sue Mauger, Daniel Rinella, and Adam St. Saviour

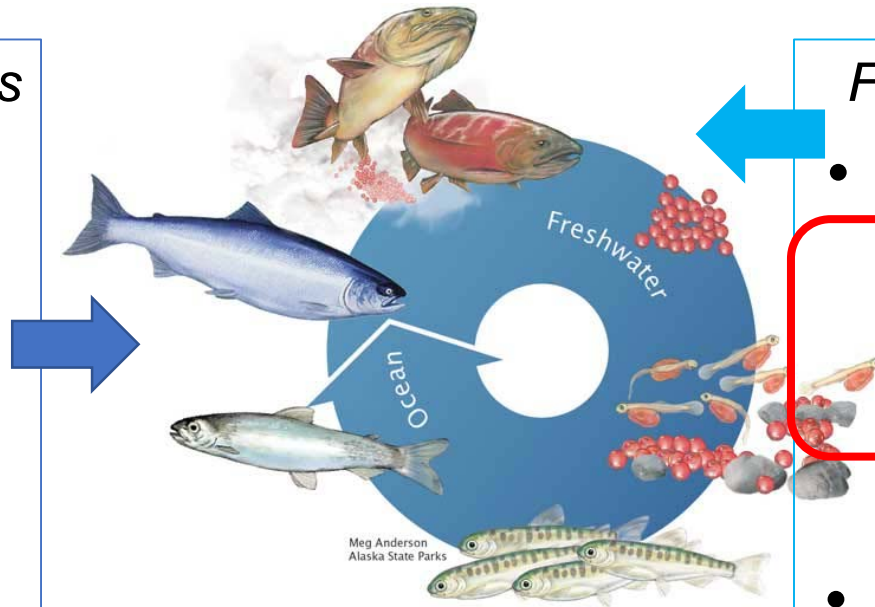
(Global Climate Change, in review)



Chinook salmon populations in Cook Inlet have declined during a period of rapid change

Ocean conditions

- Ocean climate
- Competition with pink salmon
- Predation
- Bycatch



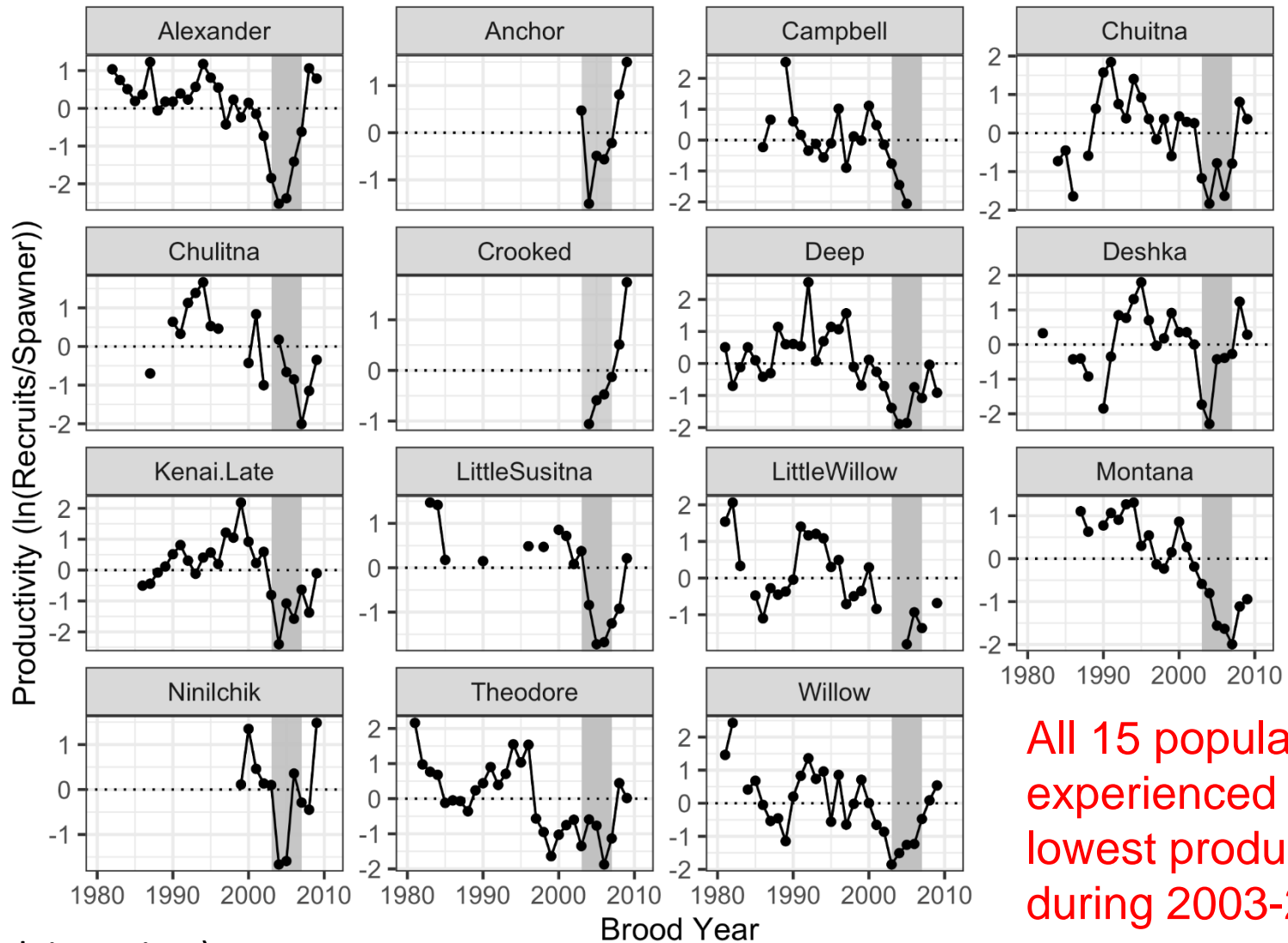
Freshwater conditions

- Spawner abundance
 - Warming stream temperatures
 - Precipitation
- Invasive species
- Human development

A prominent viewpoint:
“Salmon declines are due to problems in the ocean”

Can we rule out freshwater processes as important drivers of Chinook salmon productivity?

How has the **productivity** of each population changed over time?





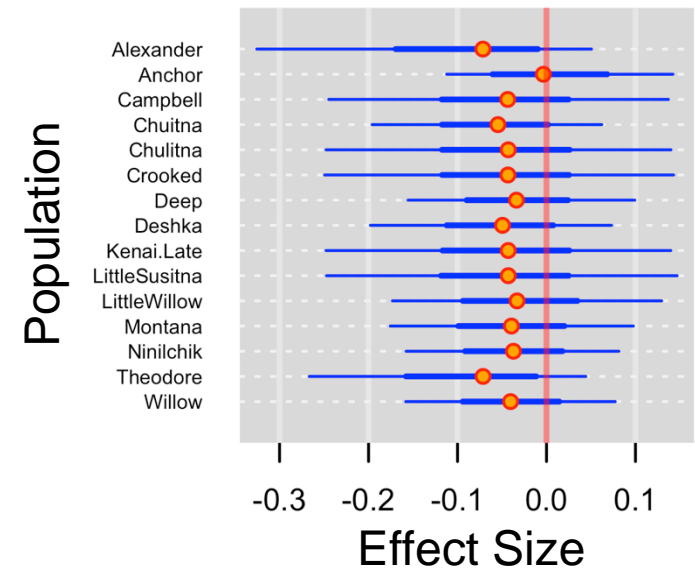
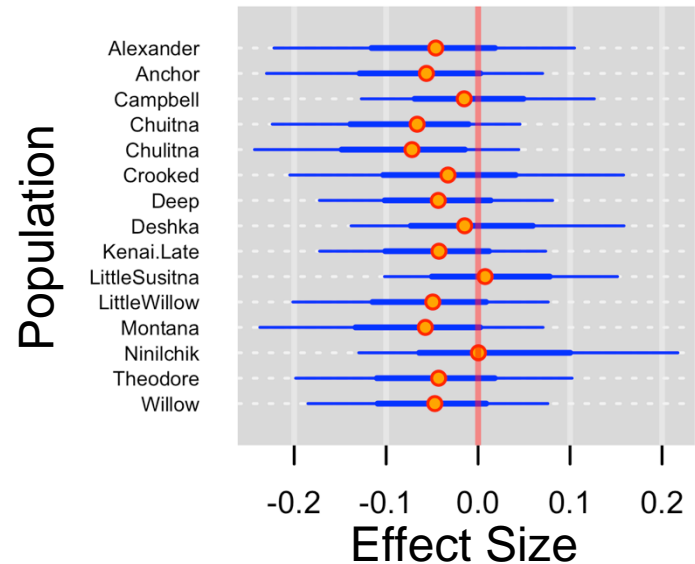
Results: Stream temperature

Maximum temperature during spawning had a moderate negative effect

- 4% reduction in productivity per 1-SD increase
- High temperatures → increased mortality of migrating adults or eggs

Number of weeks > 15°C (59°F) during juvenile rearing had a moderate negative effect

- 5% reduction in productivity per 1-SD increase
- High temperatures → reduced juvenile growth → poor survival





Results: Precipitation

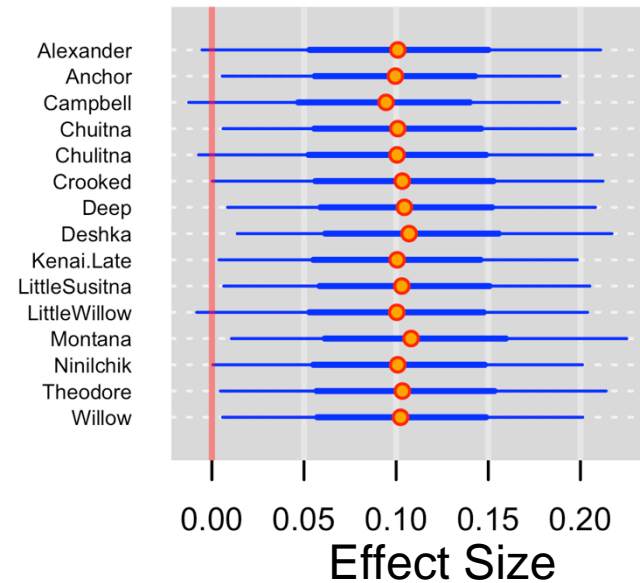
Greater average precipitation during juvenile rearing had a **strong positive effect**

- 10% increase in productivity per 1-SD increase (dome shaped)
- Moderate summer rains → increased habitat connectivity → beneficial for juvenile rearing
- Very high or low rain is harmful

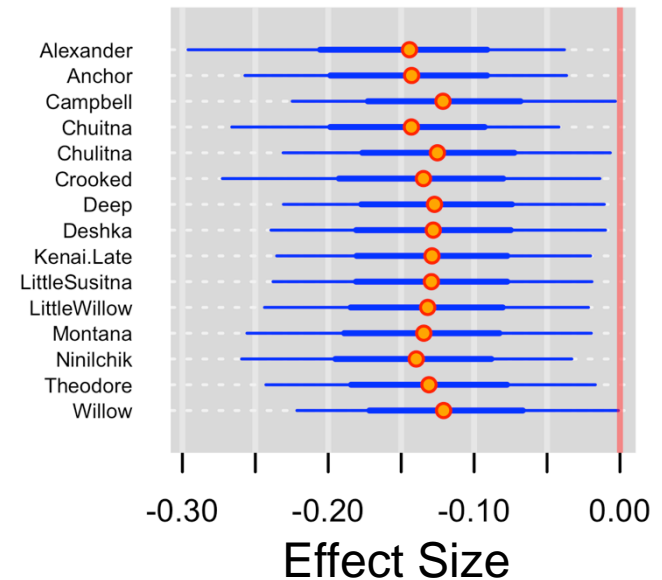
Greater maximum precipitation during spawning / incubation had a **strong negative effect**

- 13% reduction in productivity per 1-SD increase
- Heavy rains → redd scour, siltation, or toxic urban runoff

Population



Population



Mitigating adverse freshwater conditions through management and conservation

- Management tools

 - real-time temperature stations to support in-season decision making

- Conservation tools

 - To build resilience against high temperatures, maintain riparian vegetation for shade and protect cool-water habitats

 - To build resilience again high/low flows, support strong wetland protections and riparian buffers and increase green stormwater infrastructure

Warmer waters threaten to make the commercial salmon fishery less predictable

✍ Author: Laine Welch | Fish Factor ⓘ Updated: September 17 📅 Published September 17



Two Bristol Bay fishermen pull sockeye salmon from a net near Naknek in this undated file photo. (AP Photo/Al Grillo)

“Unpredictable” is the way salmon managers describe Alaska’s 2019 salmon season, with “very, very interesting” as an aside.