

Climate change and Bristol Bay fisheries: what should we expect and what can we do about it?

Daniel Schindler

School of Aquatic and Fishery Sciences

University of Washington

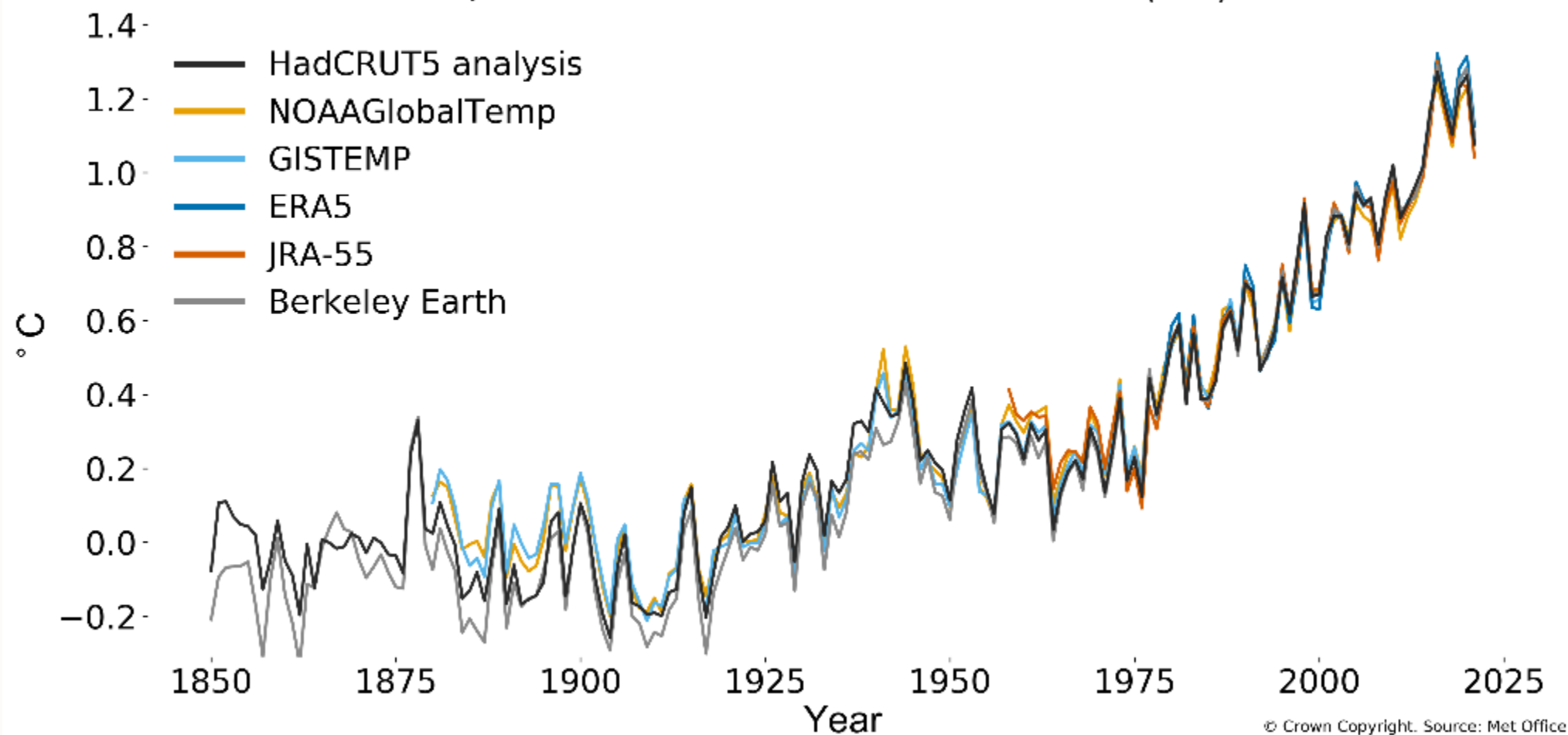
deschind@uw.edu



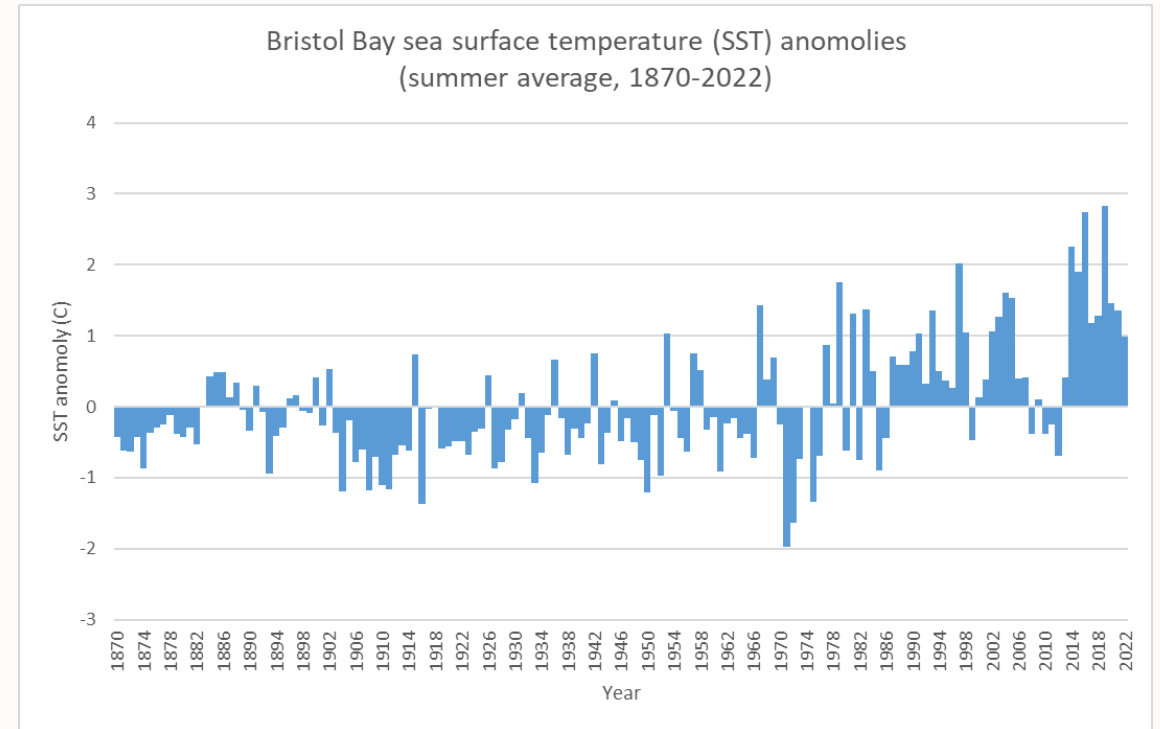
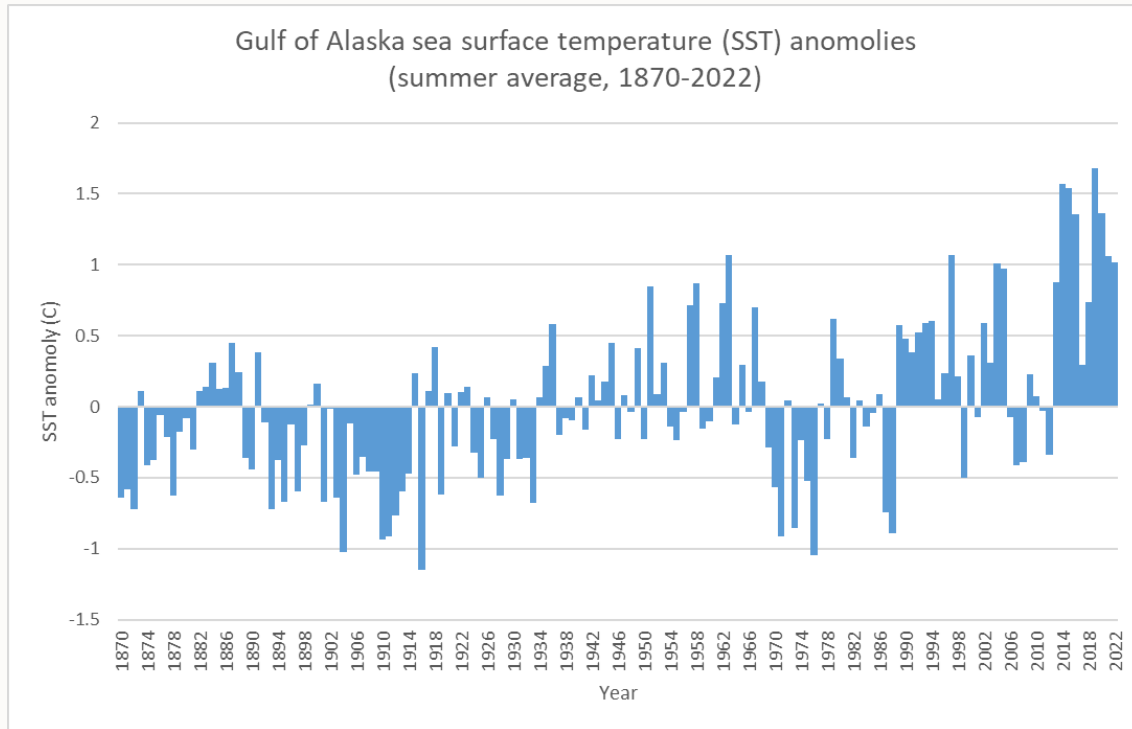
© Karen Ducey Photography

 Met Office

Global mean temperature difference from 1850-1900 (°C)

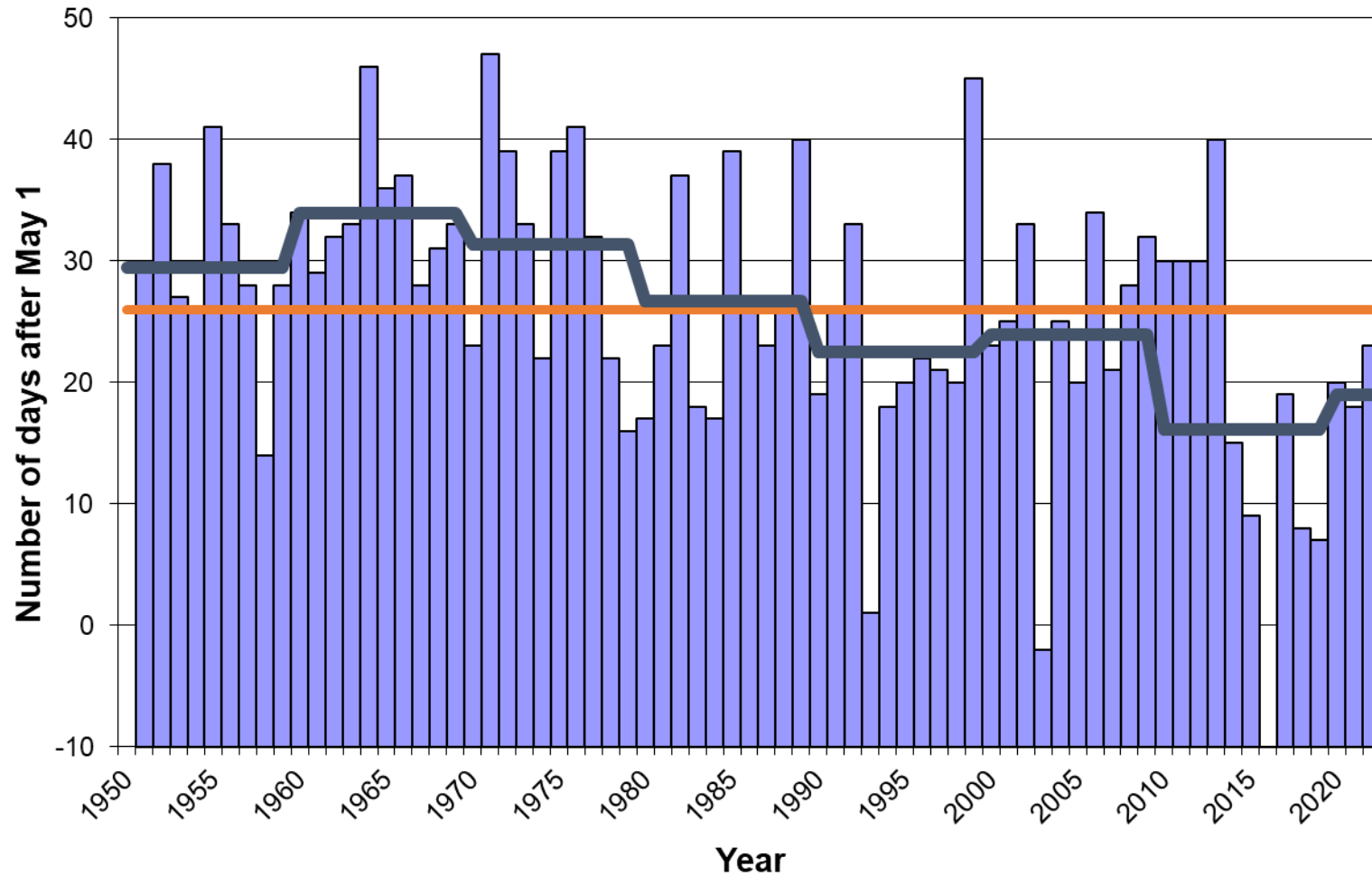


Changes in the water temperature of the Gulf of Alaska and the Bering Sea

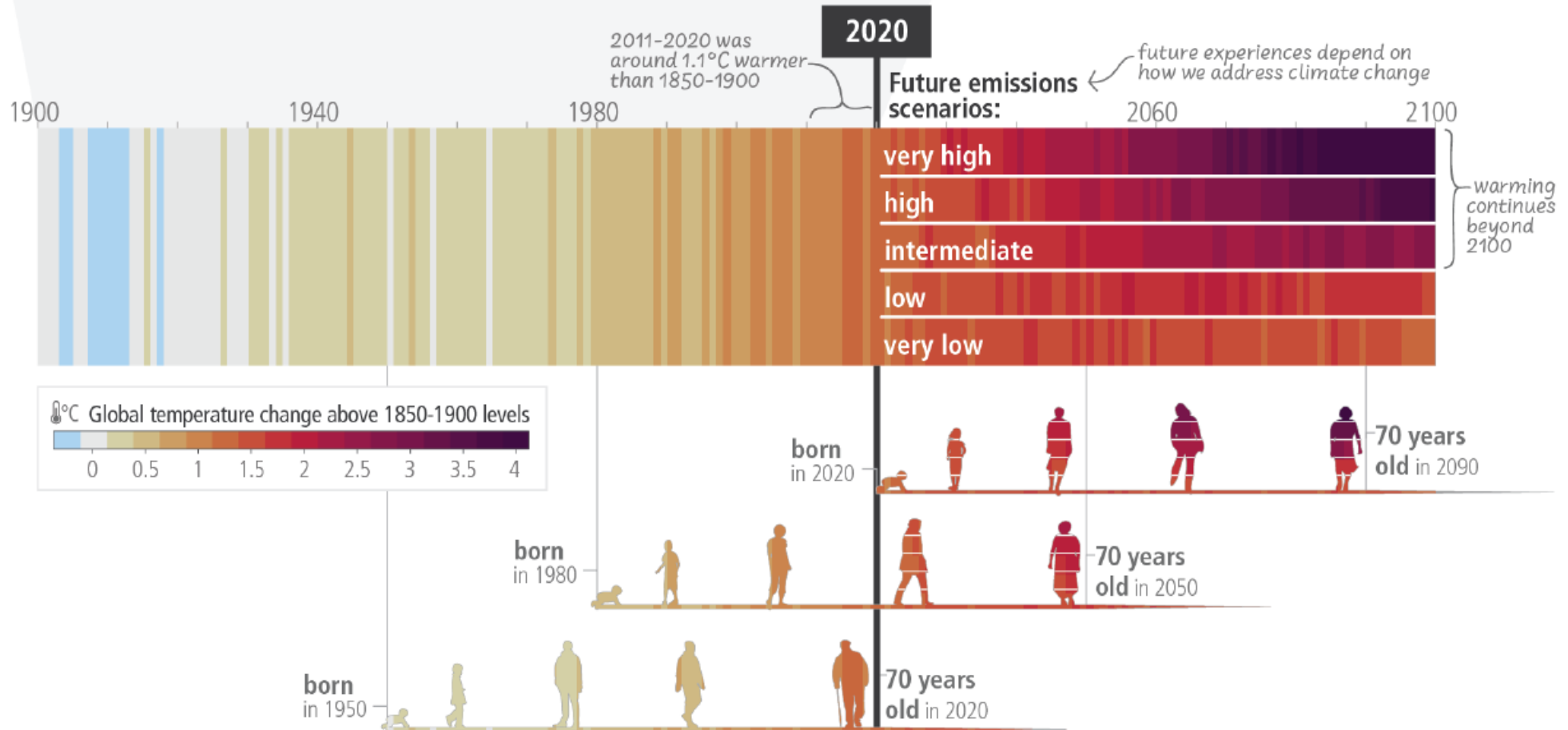


Spring ice breakup on Lake Aleknagik, 1950-2022

(long-term average in orange, decadal averages in black)



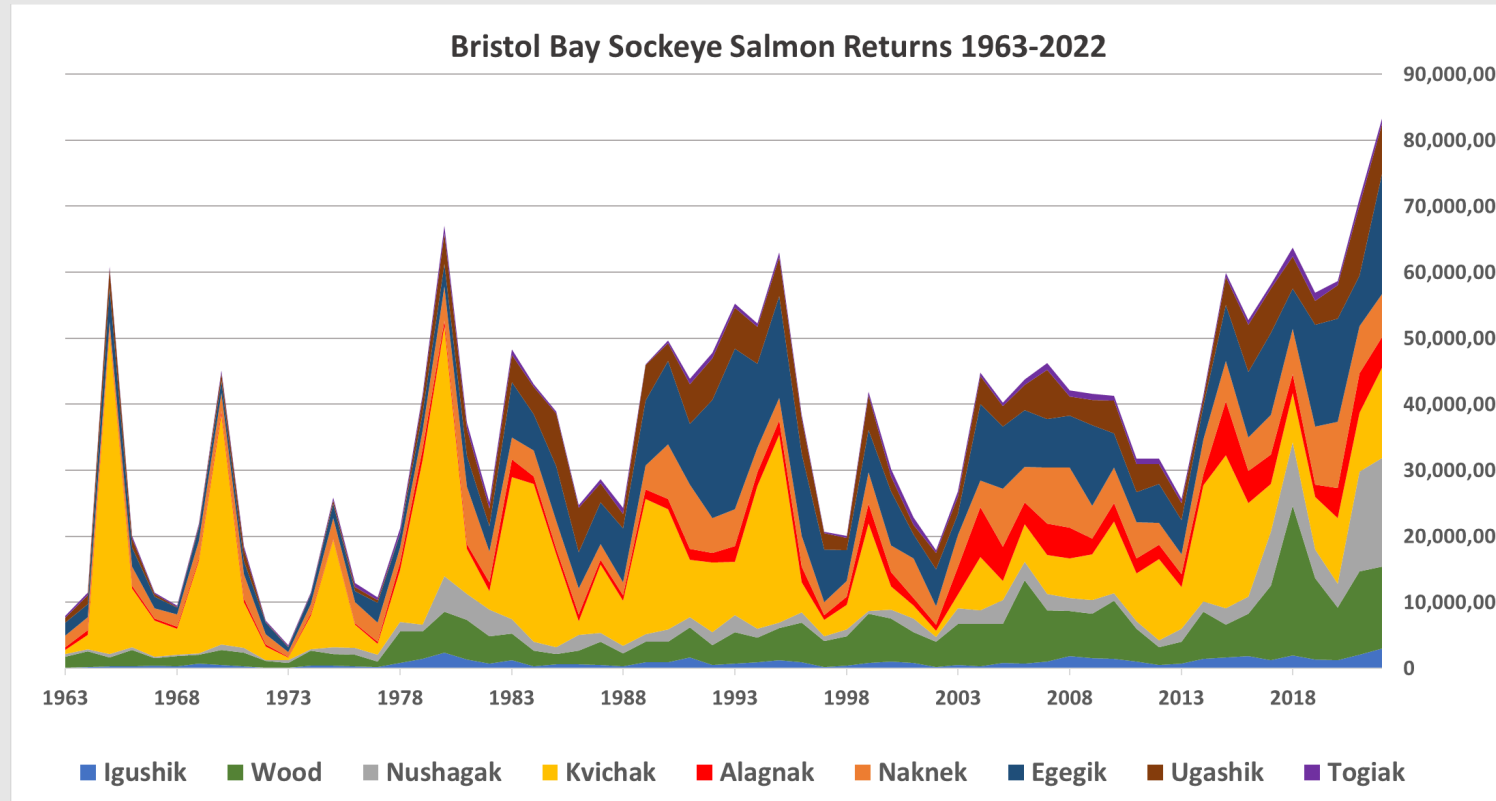
c) The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term





J. Armstrong

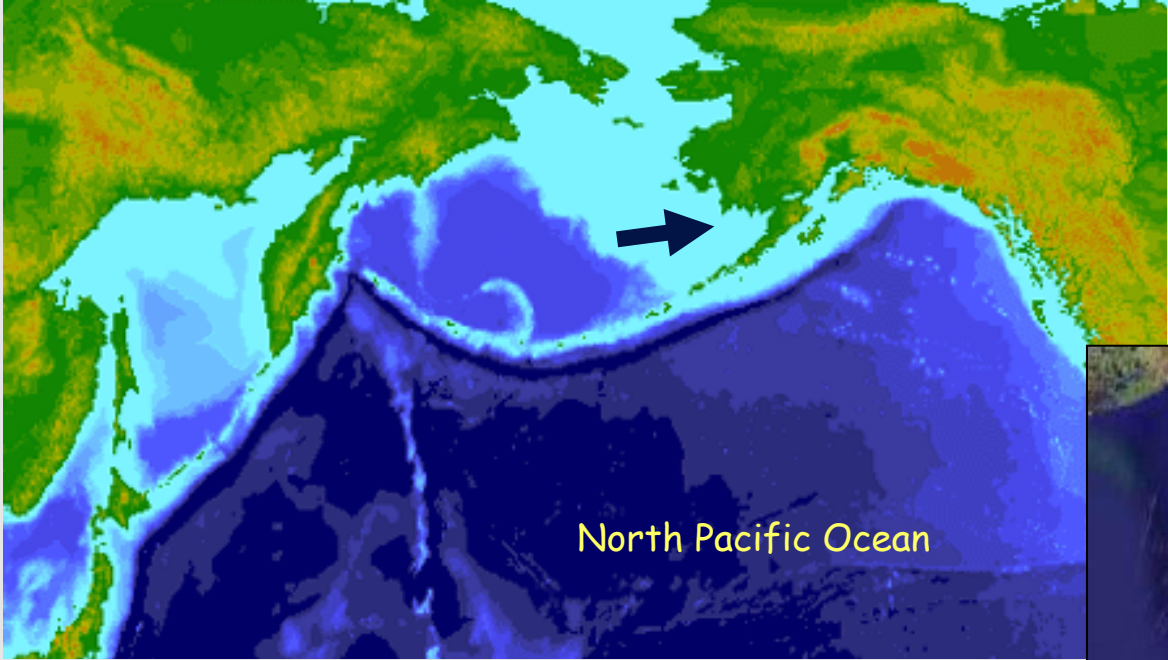
Alaska fisheries are the envy of the world



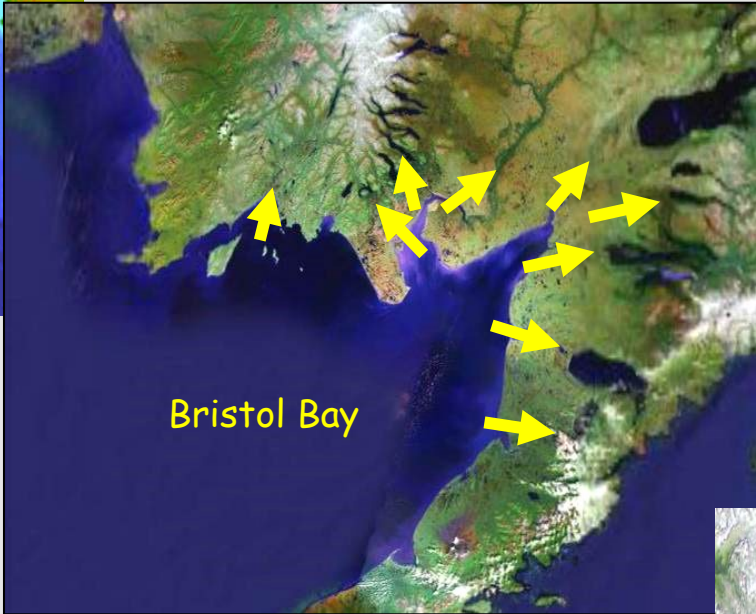
http://www.absc.usqs.gov/research/Fisheries/Lake_Clarck/subsistence.htm



Bristol Bay salmon habitat

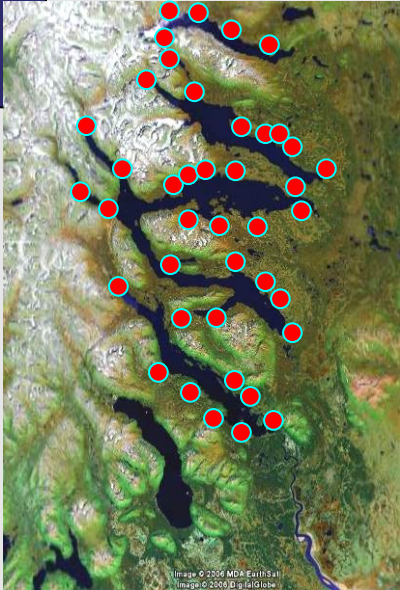
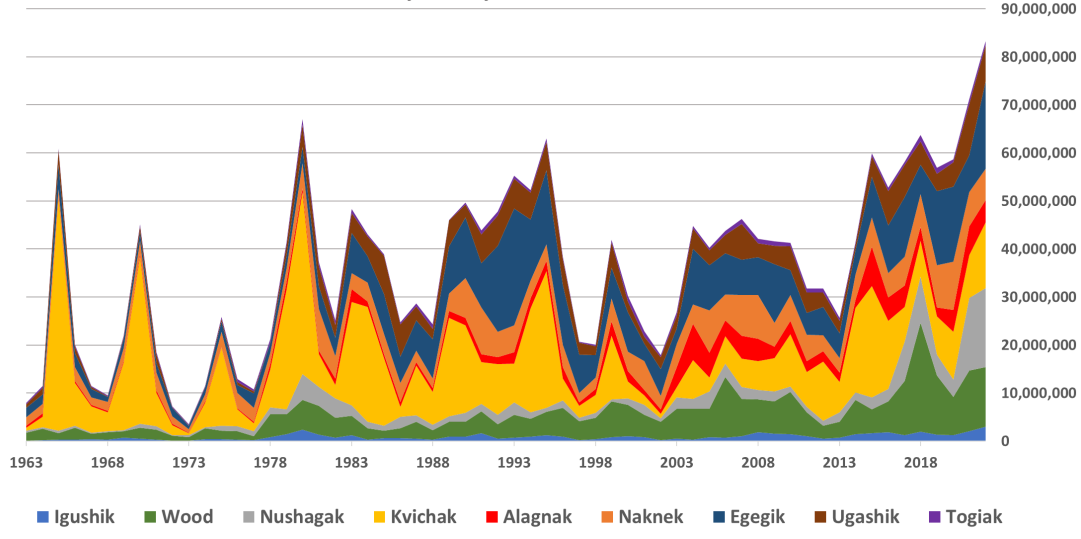


9 major rivers



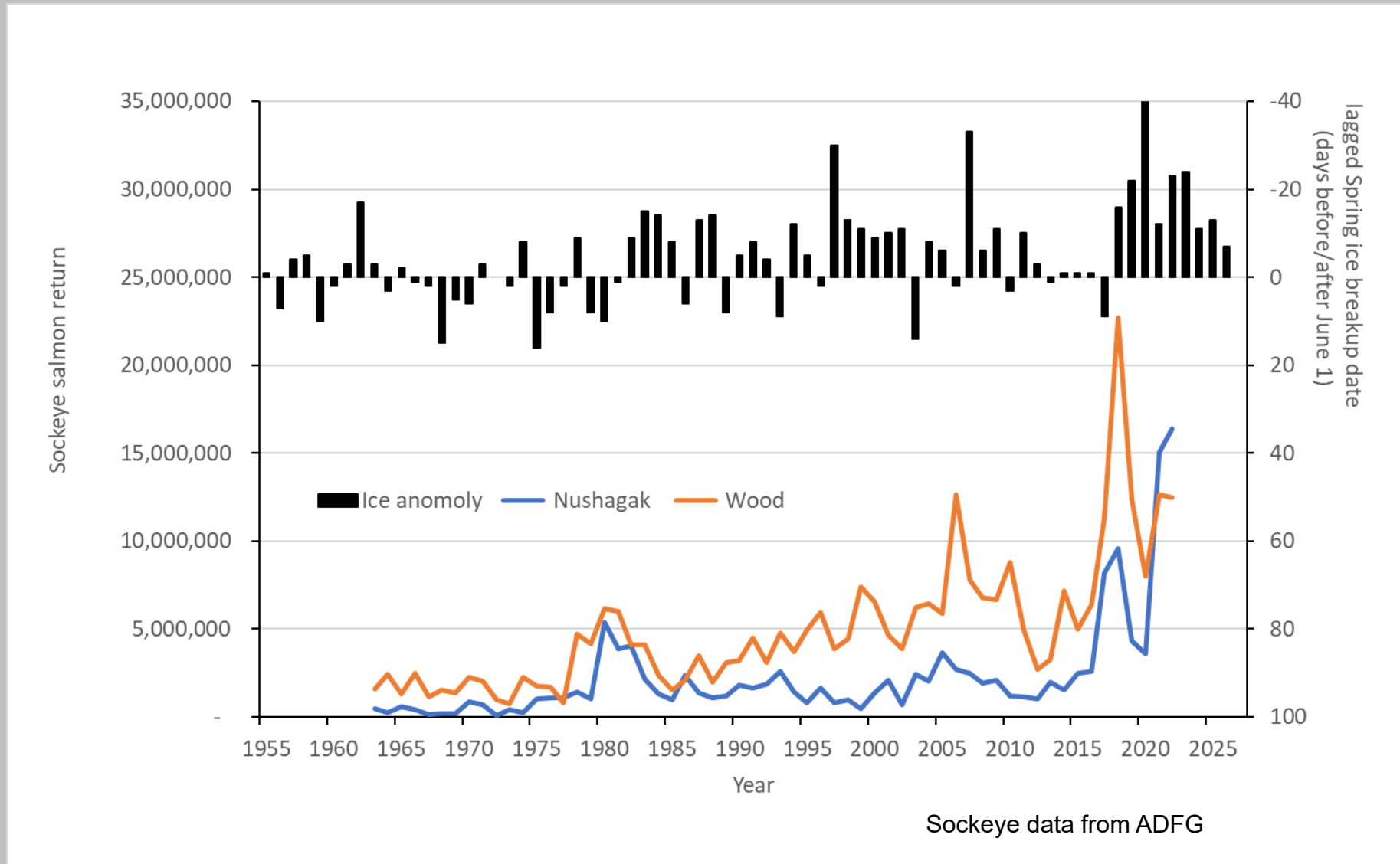
each with many populations

Bristol Bay Sockeye Salmon Returns 1963-2022





Sockeye salmon returns to the Nushagak and Wood rivers



Sockeye data from ADFG



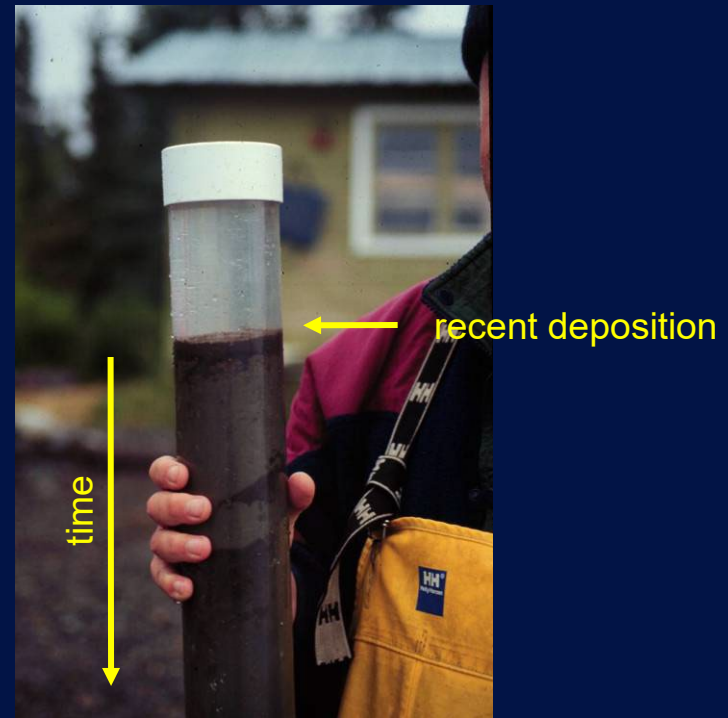
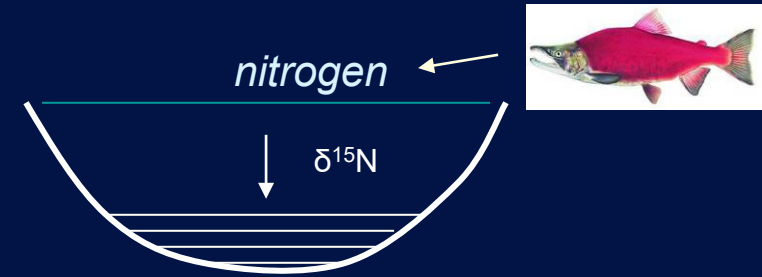
Ice coverage on
May 25, 2022

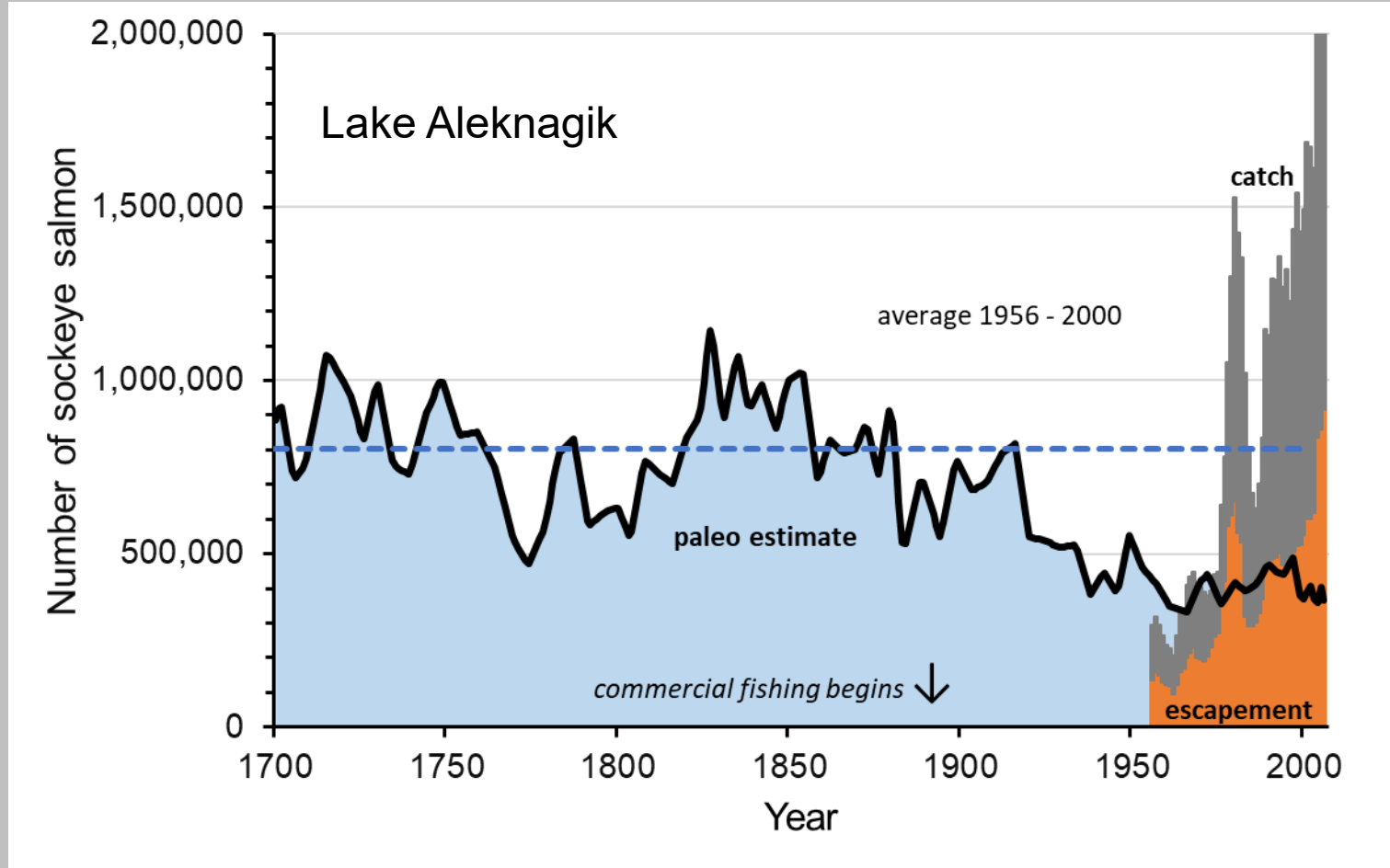
How many sockeye salmon were in Bristol Bay in previous centuries?

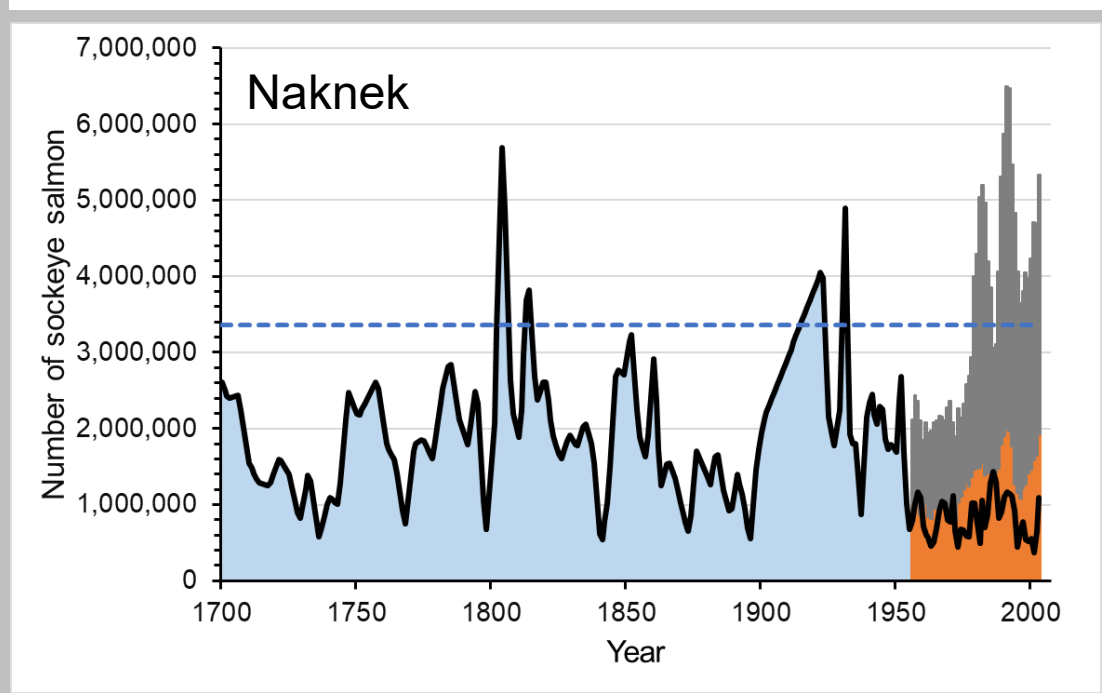
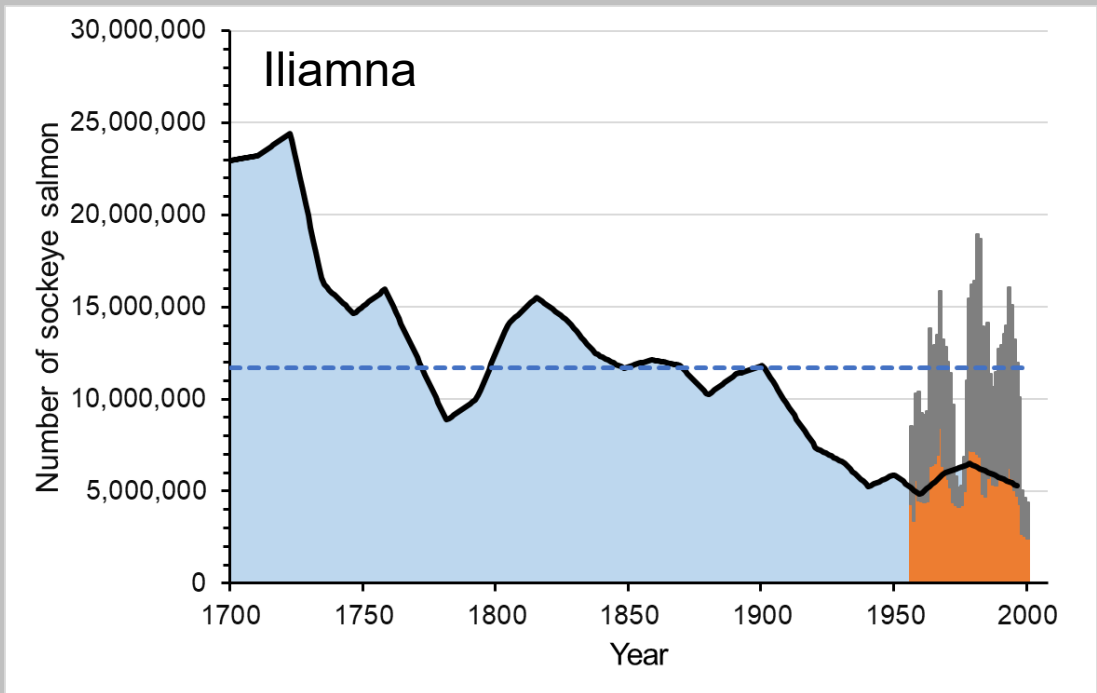
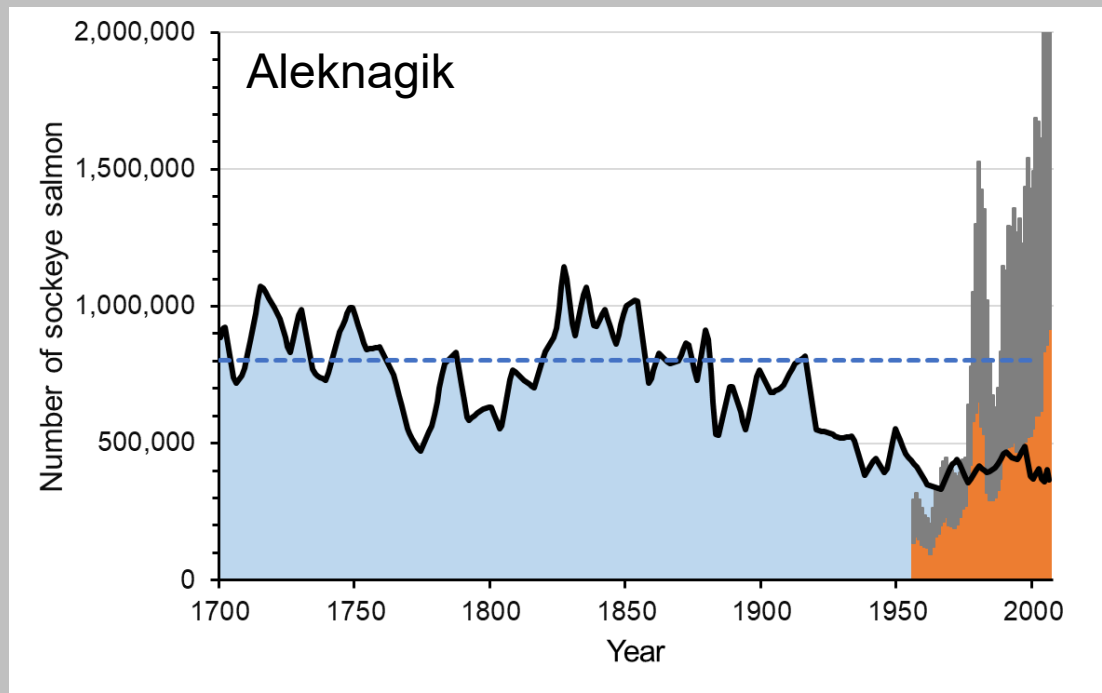
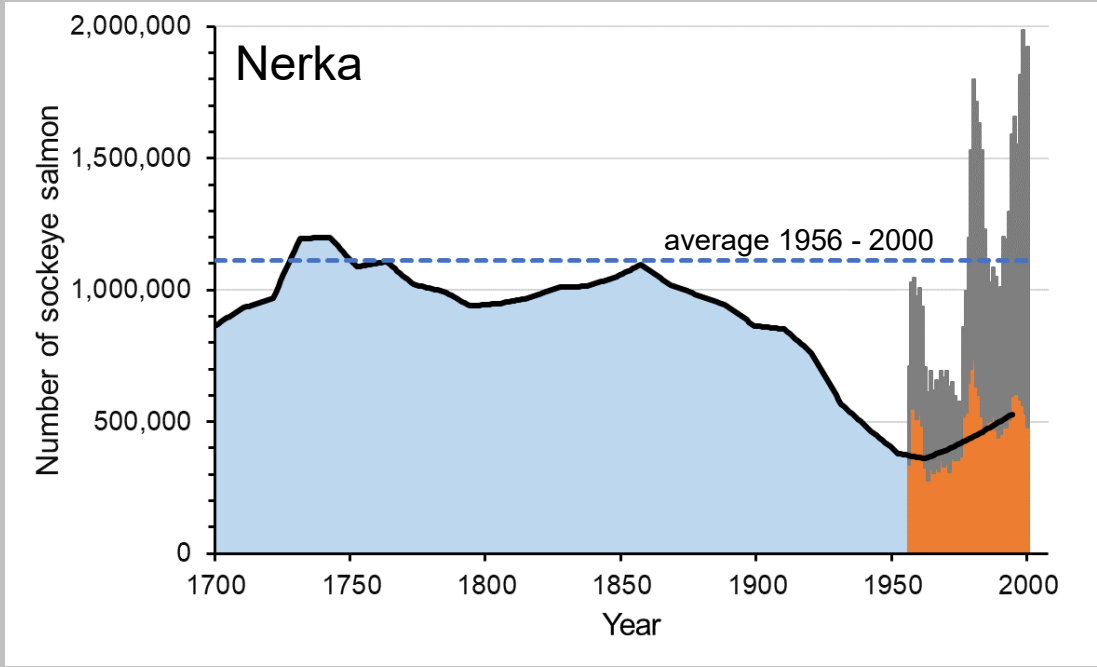


Paleolimnology

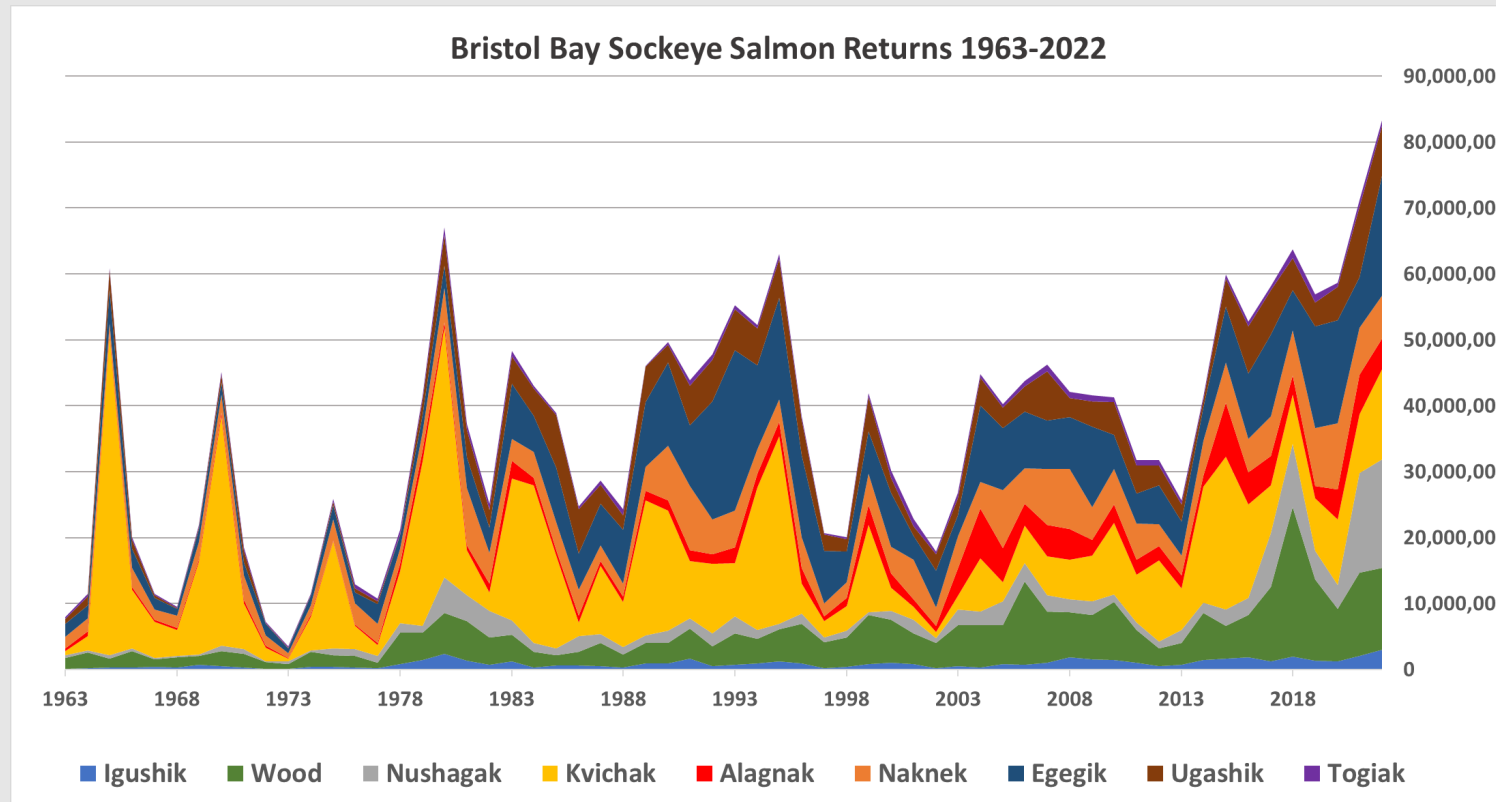
Lake sediments contain a biogeochemical archive that reflects salmon abundance (centuries to millenia)







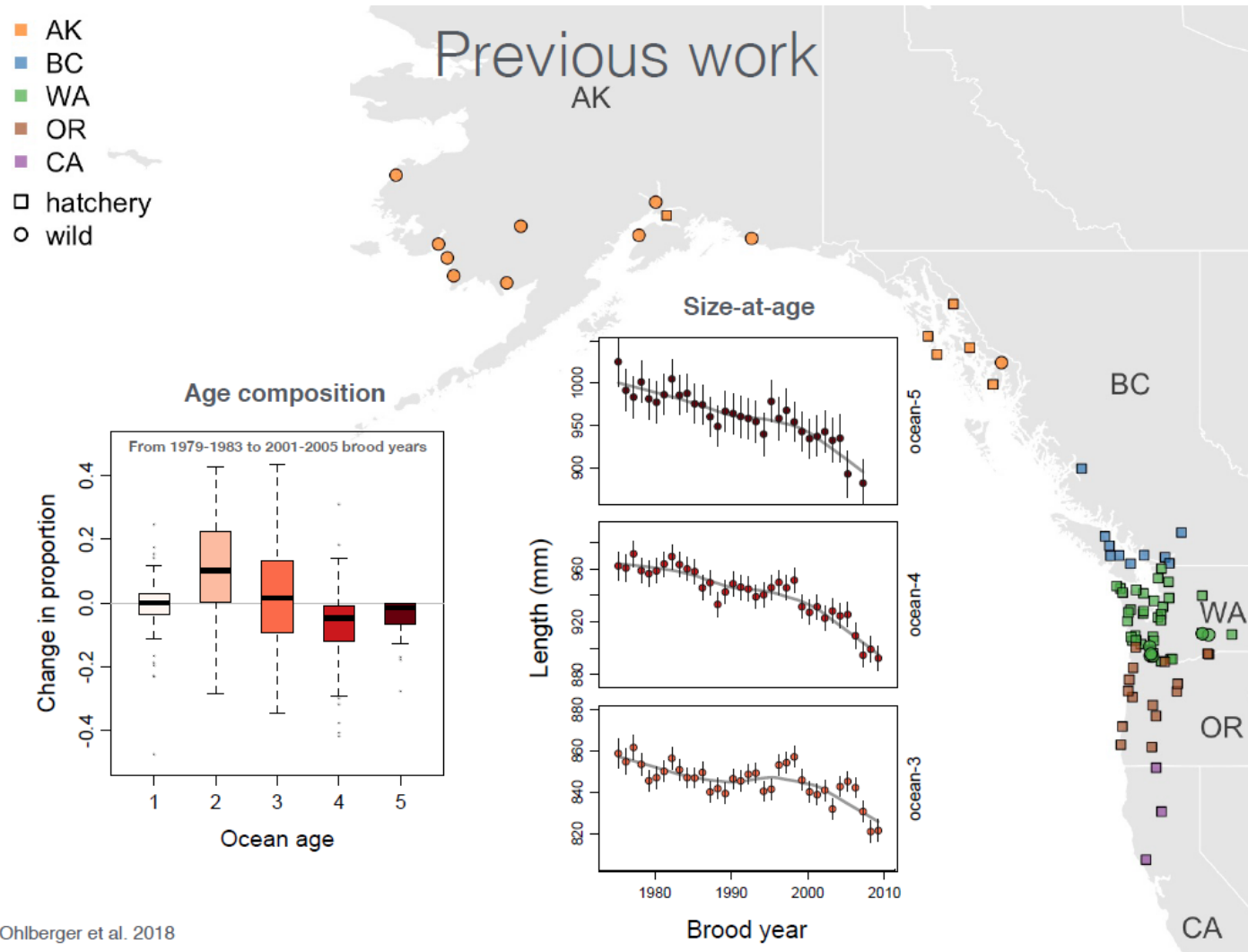
Not all rivers increase and decrease at the same time
(but there are probably more sockeye now than ever before)





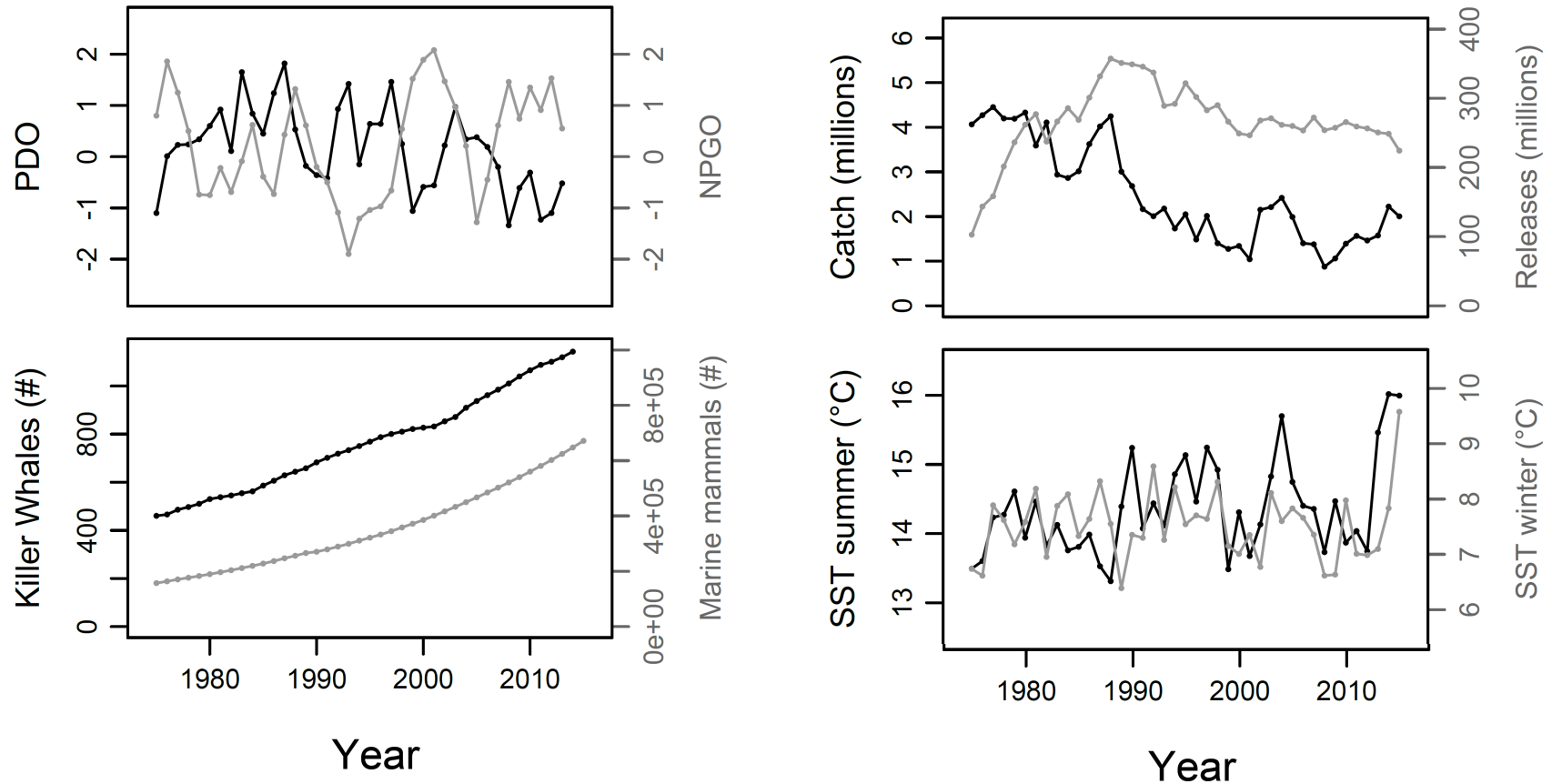
Nushagak River Chinook salmon circa 1884

Declining body sizes in Chinook salmon



Causes of observed change

Hypothesized drivers of declines in mean size and age

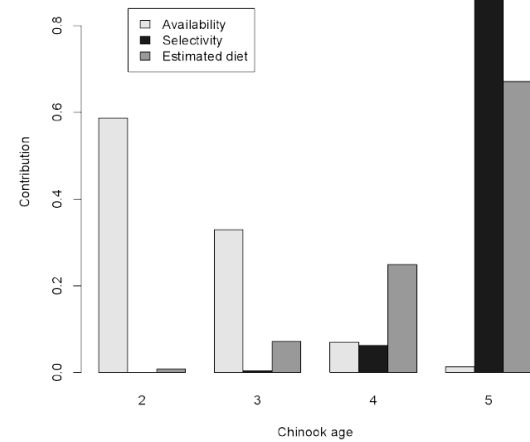


Chinook salmon (Ohlberger et al., Fish & Fisheries, 2018)

Species- and size-selectivity of orcas



Turning selectivity parameters into diet

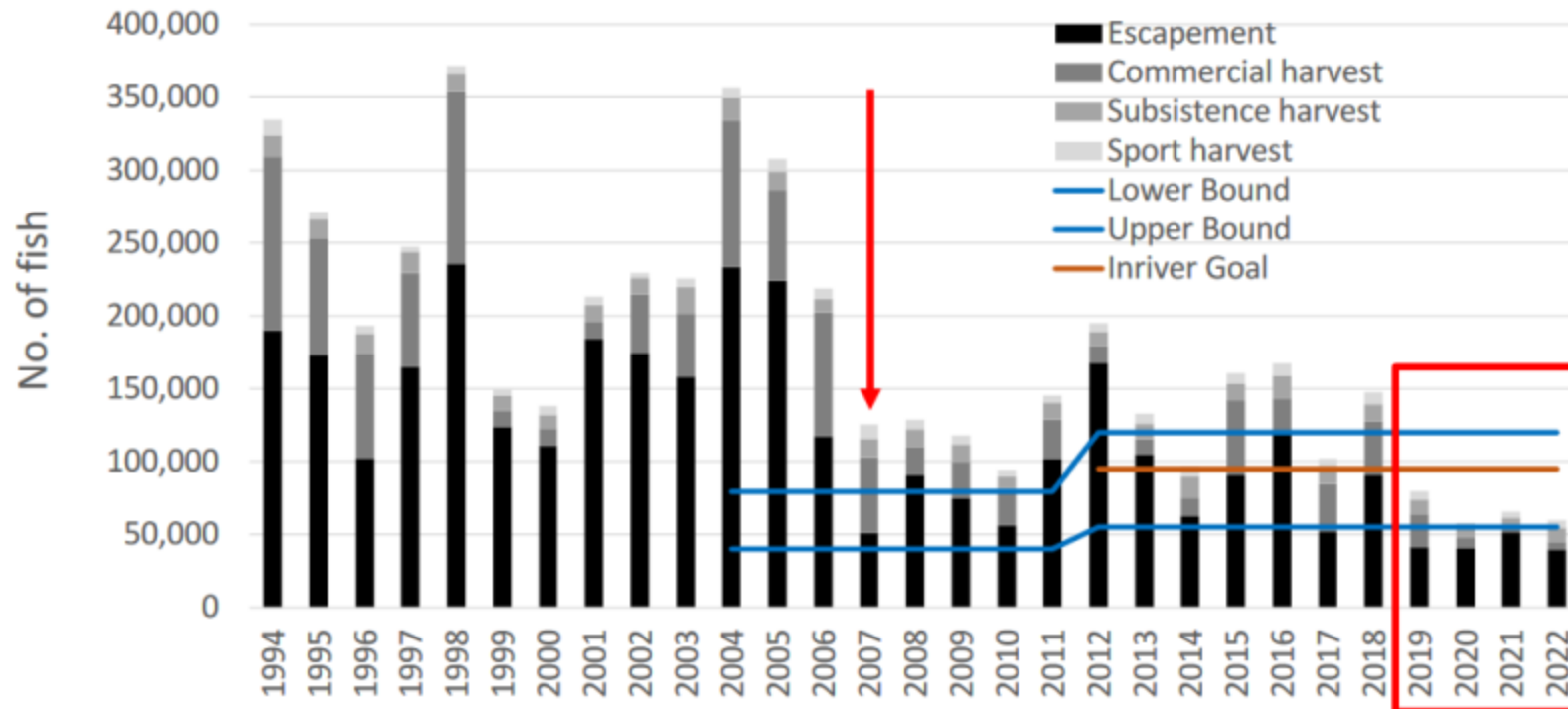


E. Ward

King Salmon Run Size

Figure 3 (Page 29)

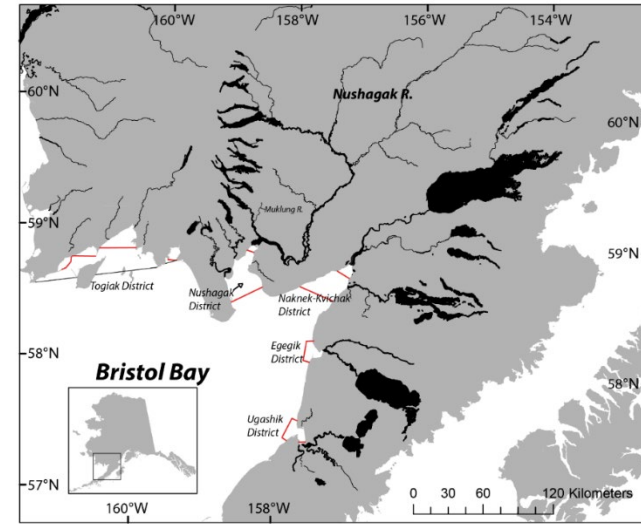
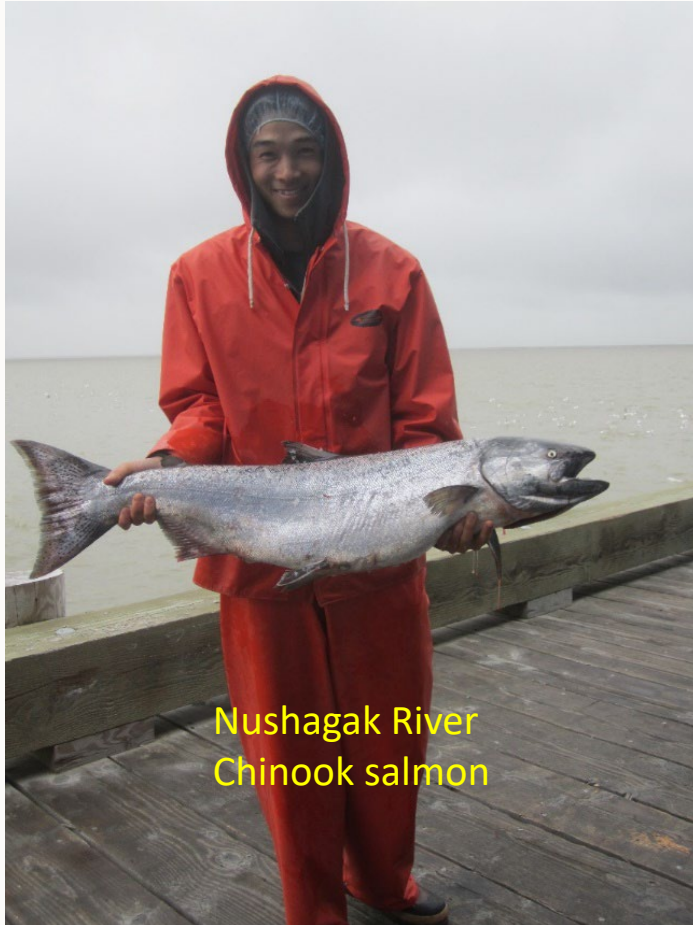
Annual king salmon run components, Nushagak River 1994-2022



- Downturn in productivity – 2007
- Poor assessment - uncertainty if meeting SEG in recent years

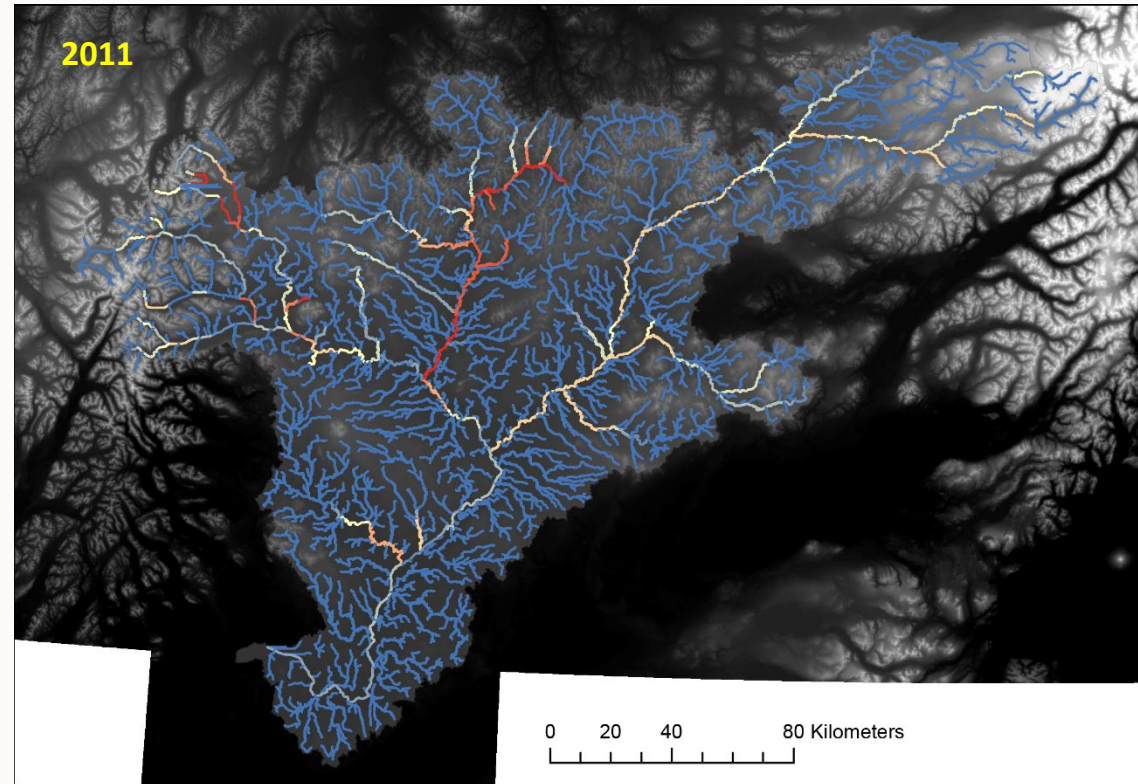


Chinook salmon – habitat use within watersheds (how consistent is production within individual tributaries?)



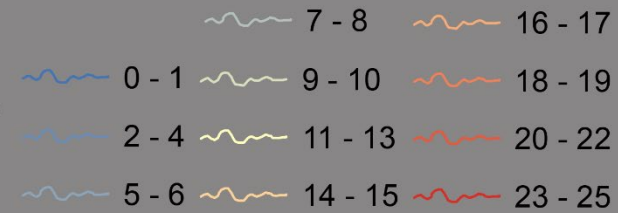
Chinook salmon production in the Nushagak River

Nushagak R.
2011 (n=255)



Normalized assignments

$n = (\text{\#fish}/\text{sum}) * 100000$



RESEARCH

CONSERVATION

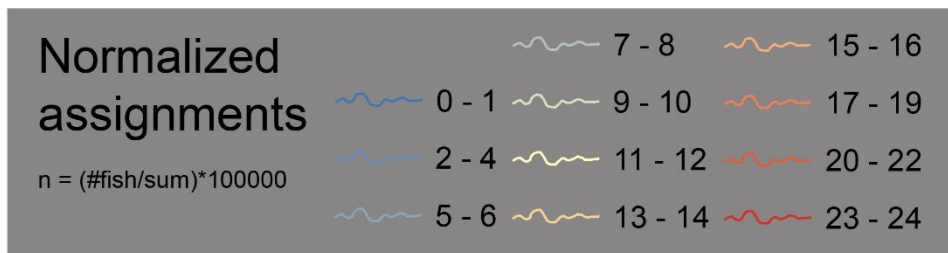
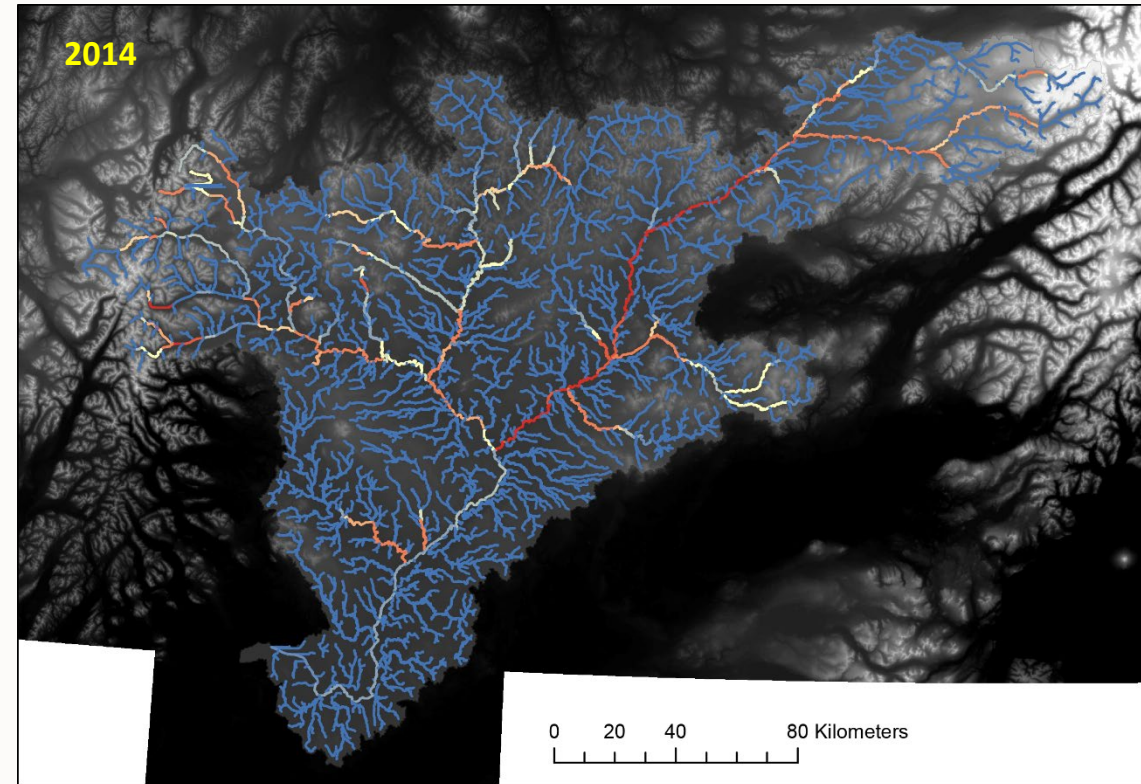
Shifting habitat mosaics and fish production across river basins

Sean R. Brennan^{1*}, Daniel E. Schindler¹, Timothy J. Cline¹, Timothy E. Walsworth¹, Greg Buck², Diego P. Fernandez²

Science (2019)

Chinook salmon production in the Nushagak River

Nushagak R.
2014 (n=279)



RESEARCH

CONSERVATION

Shifting habitat mosaics and fish production across river basins

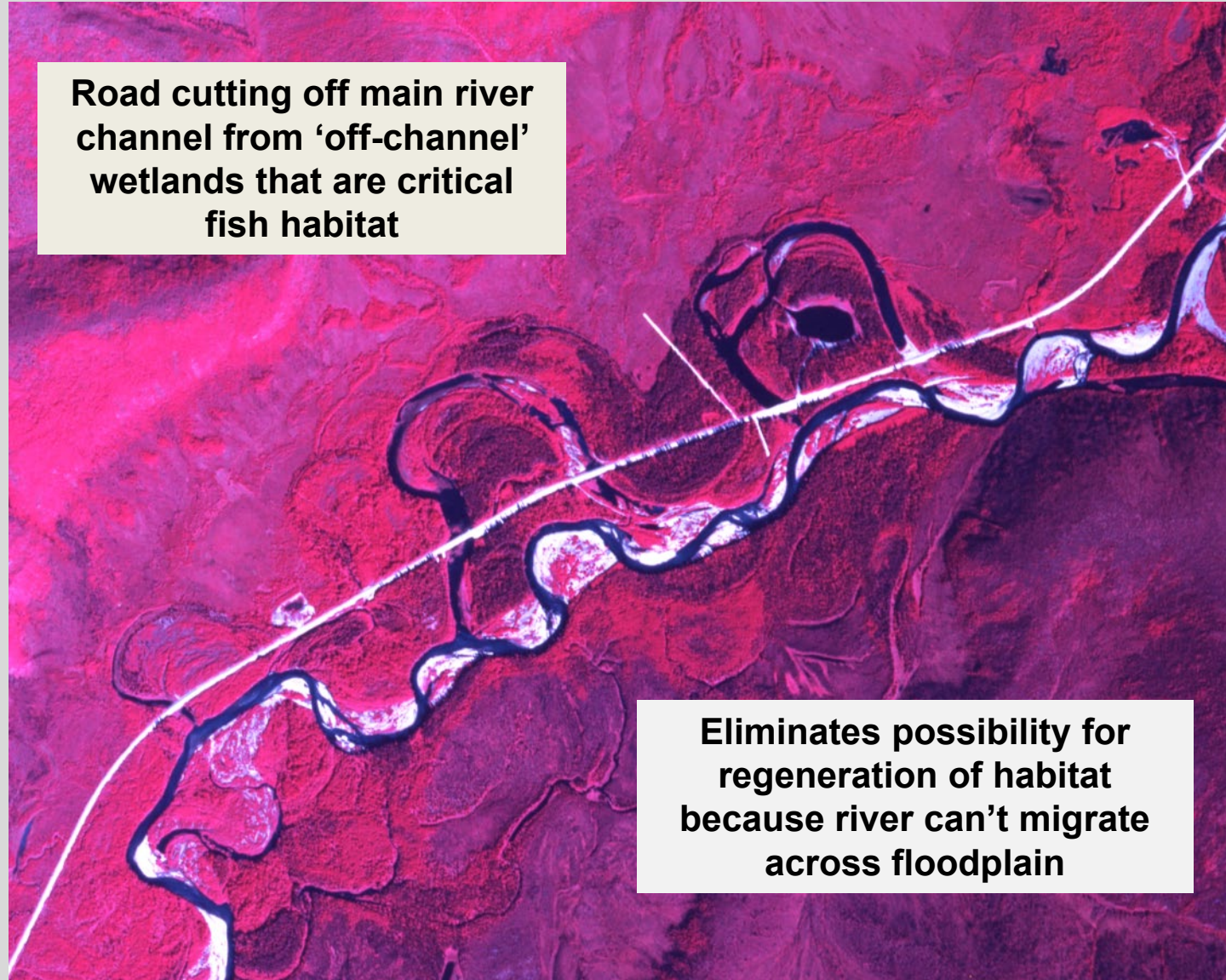
Sean R. Brennan^{1*}, Daniel E. Schindler¹, Timothy J. Cline¹, Timothy E. Walsworth¹, Greg Buck², Diego P. Fernandez²

Science (2019)

Salmon habitat: the aggregate is more stable and productive than the sum of its parts

Chena River, Alaska

Road cutting off main river channel from 'off-channel' wetlands that are critical fish habitat



Eliminates possibility for regeneration of habitat because river can't migrate across floodplain

Stability and productivity derive from diverse and changing habitat

Bristol Bay, Alaska



Columbia River



NOAA

Bristol Bay sockeye salmon

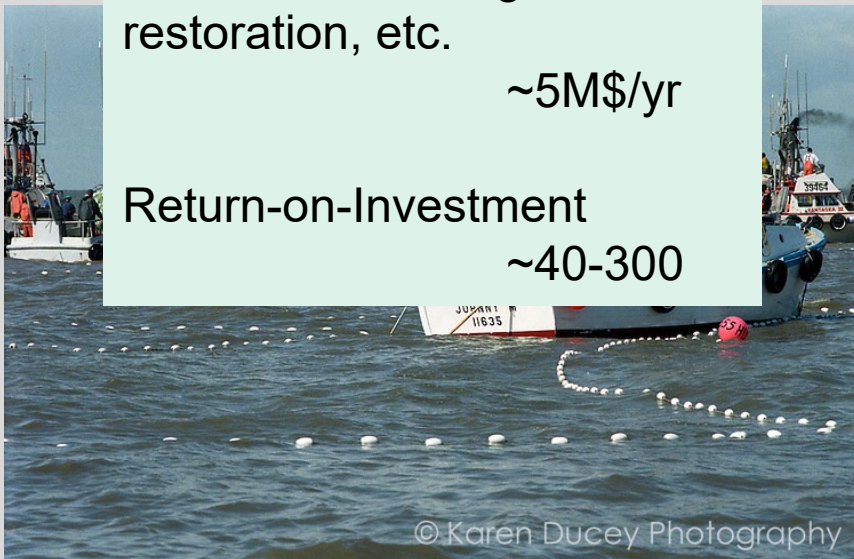


Fisheries revenues
~200-1500M\$/yr

Management, science,
conservation, mitigation,
restoration, etc.

~5M\$/yr

Return-on-Investment
~40-300



© Karen Ducey Photography

Columbia River salmon

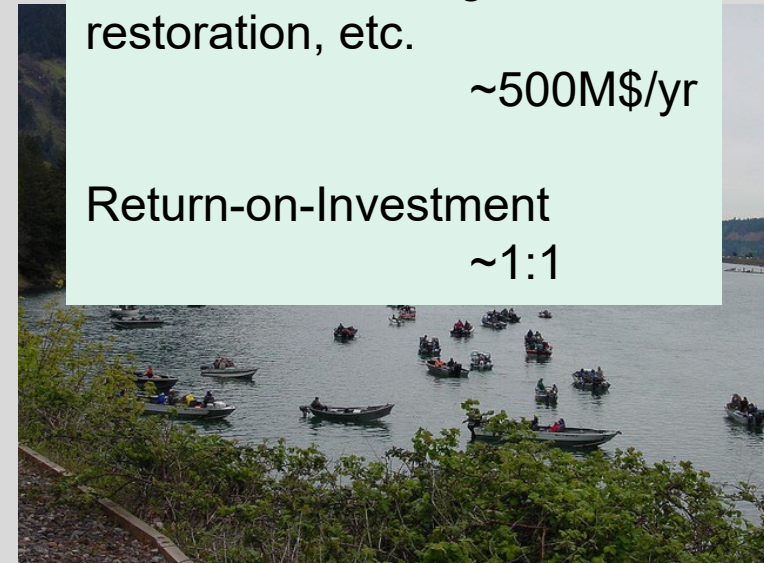


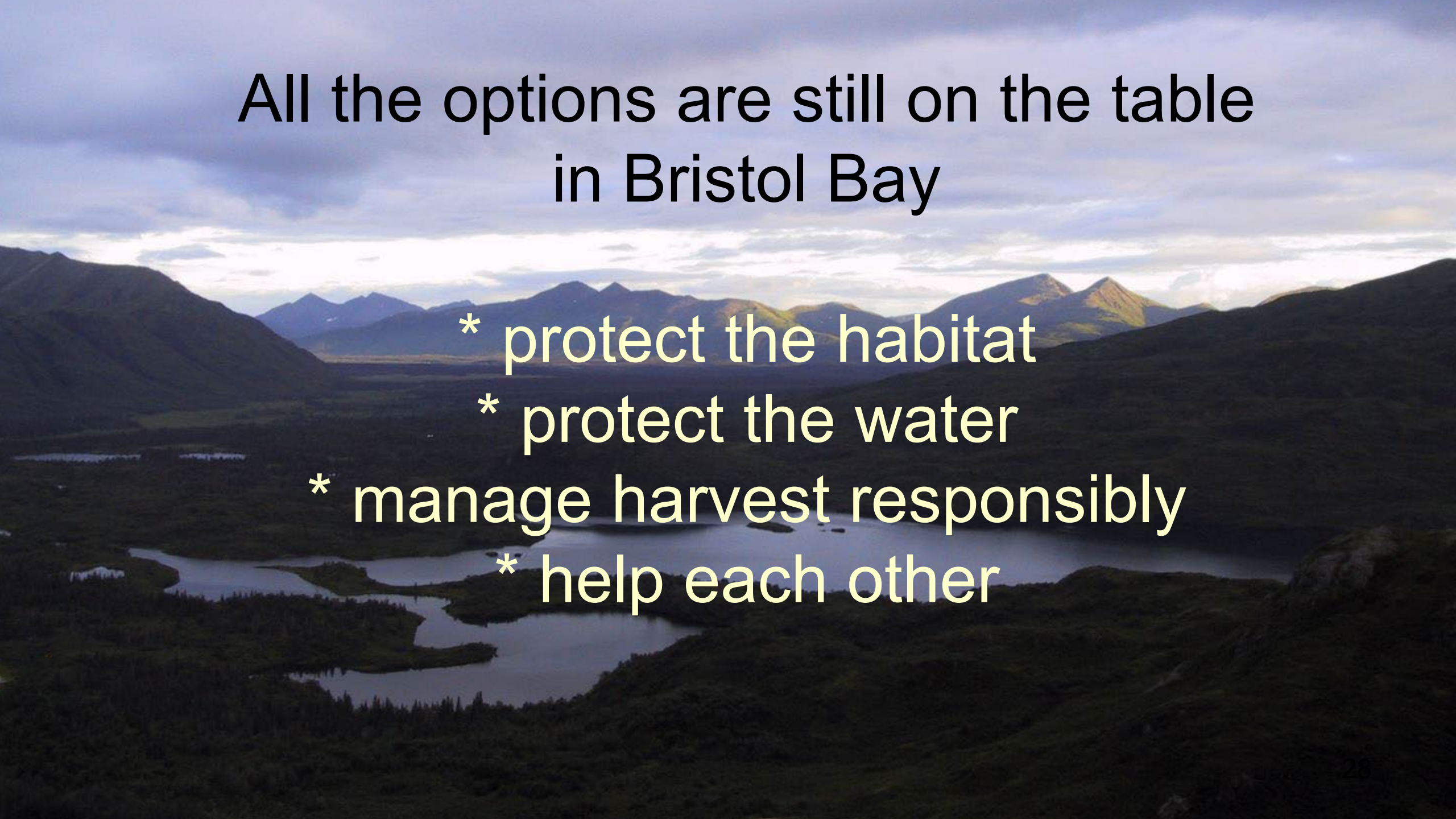
Fisheries revenues
~300-500M\$/yr

Management, science,
conservation, mitigation,
restoration, etc.

~500M\$/yr

Return-on-Investment
~1:1





All the options are still on the table in Bristol Bay

- * protect the habitat
- * protect the water
- * manage harvest responsibly
- * help each other



Thanks to: Alaska Salmon Processors, Gordon and Betty Moore Foundation, National Science Foundation, AYK Sustainable Salmon Initiative, Bristol Bay RSDA, Bristol Bay SRI, Alaska Dept. of Fish & Game, US Fish & Wildlife Service (LCC), Wood-Tikchik SP, University of Washington