How can stream temperature and flow affect the productivity of Alaskan salmon populations?

Daniel Rinella
Anchorage Fish and Wildlife Conservation Office
U.S. Fish and Wildlife Service

Why monitor temperature and streamflow?

- Temp & flow are key features of freshwater habitat
- Freshwater and marine survival contribute equally to variation in run size (Bradford et al. 1995)
- Temp & flow are *directly* altered by climate change
  - Anticipating habitat changes is essential for adaptive responses

Outline

- How can changing temp & flow affect salmon?
  - Example mechanisms
- How are temp & flow changing in salmon streams?
- Evidence/projections for impacts to Cook Inlet salmon

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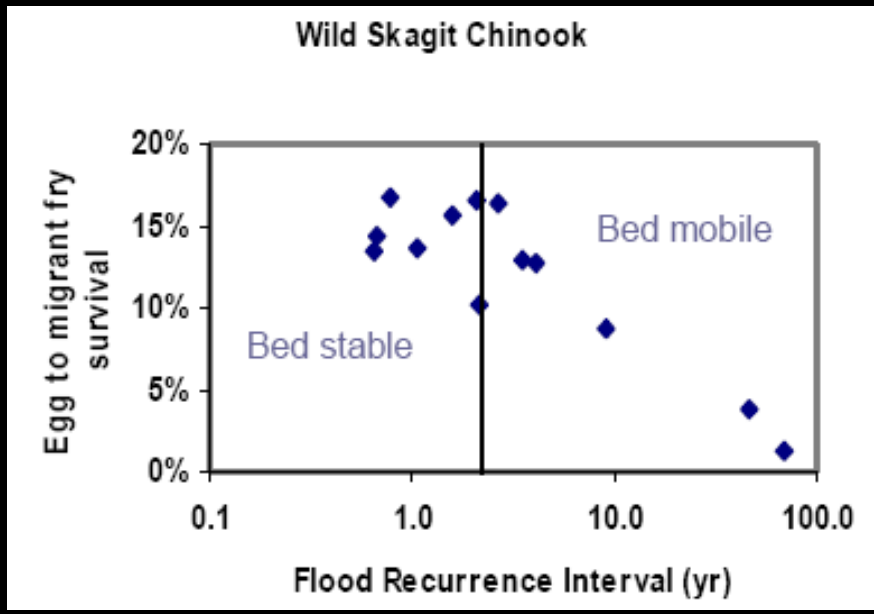
Streamflow

LINKING WATERSHED CONDITIONS TO EGG-TO-FRY SURVIVAL OF SKAGIT CHINOOK SALMON

November 2005

Eric Beamer[1]
Bob Hayman[2]
Steve Hinton[3]



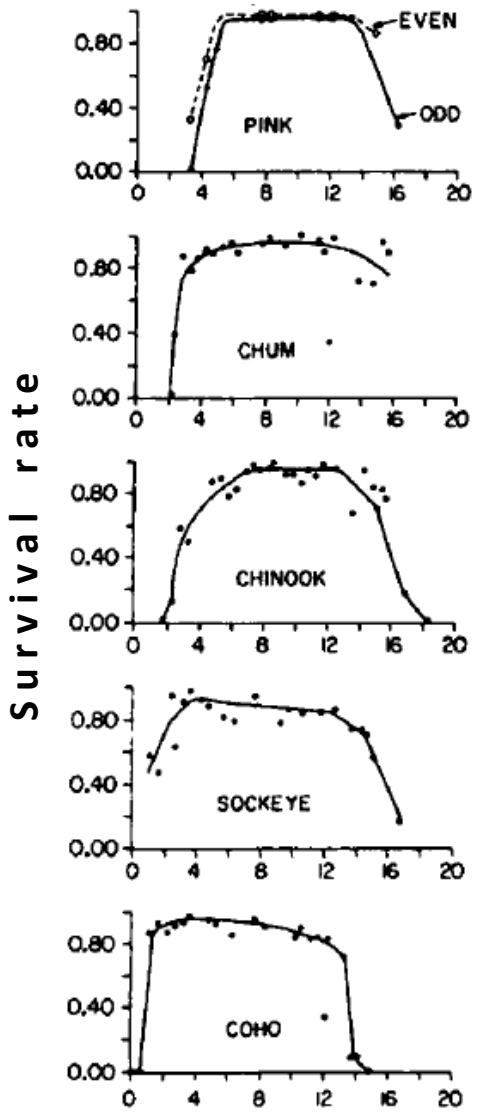
Temperature

Transactions of the American Fisheries Society 119:927–945, 1990

Temperature, Egg Size, and Development of Embryos and Alevins of Five Species of Pacific Salmon: A Comparative Analysis

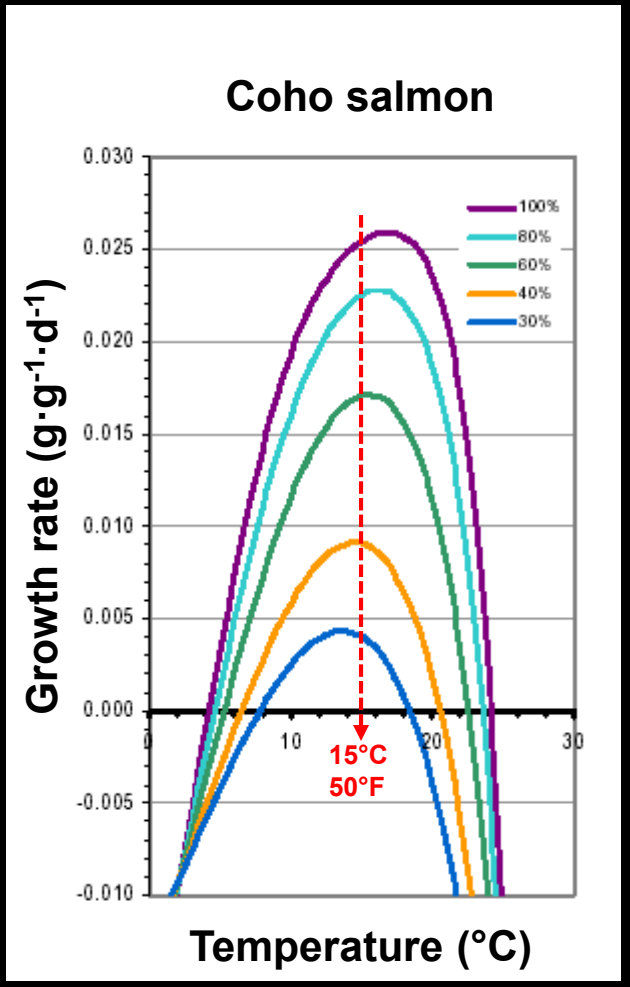
TERRY D. BEACHAM AND CLYDE B. MURRAY

Department of Fisheries and Oceans, Biological Sciences Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6, Canada



Temperature

- Growth potential is highest around 15°C
- Growth = survival



Temperature

Transactions of the American Fisheries Society 135:408–419, 2006
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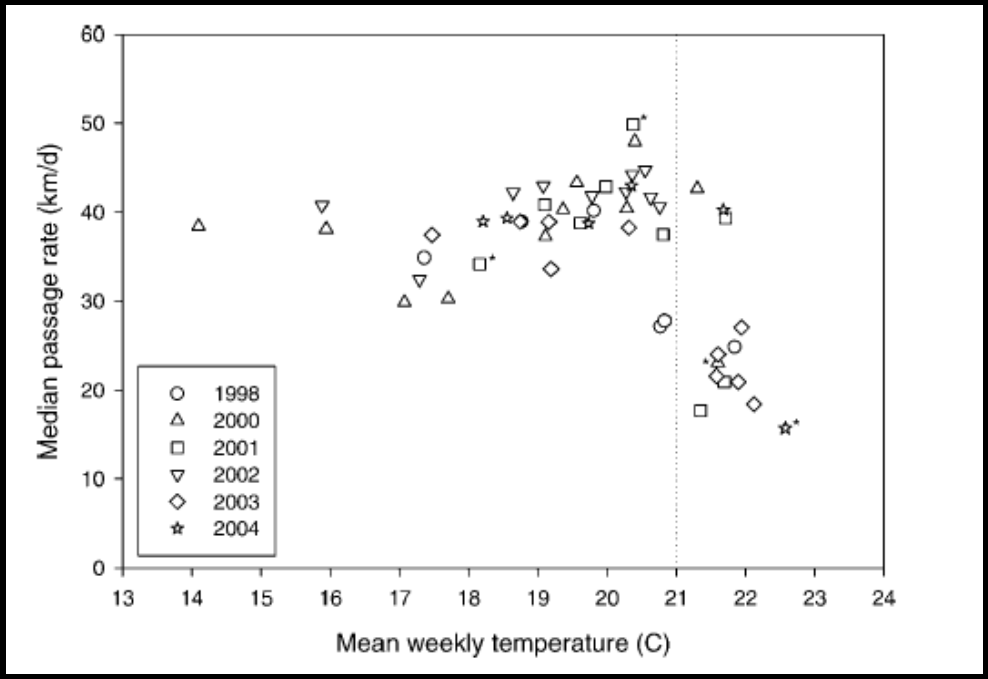
DOI: 10.1577/T04-113.1

Behavioral Thermoregulation and Slowed Migration by Adult Fall Chinook Salmon in Response to High Columbia River Water Temperatures

THOMAS M. GONIEA,[1] MATTHEW L. KEEFER, AND THEODORE C. BJORNN[2]



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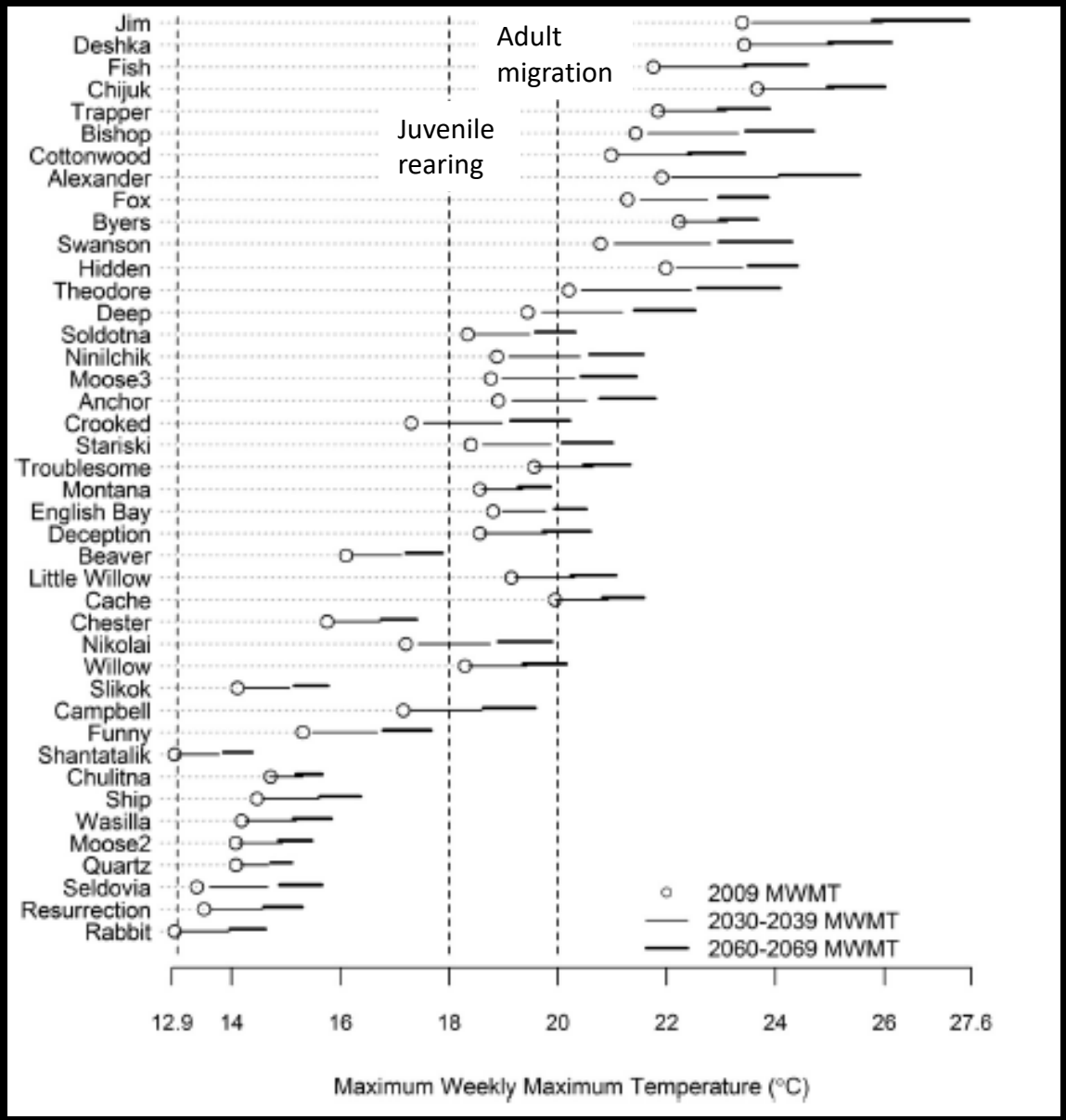
Changing temp & streamflow

NRC Research Press

ARTICLE

Summer temperature regimes in southcentral Alaska streams: watershed drivers of variation and potential implications for Pacific salmon

Sue Mauger, Rebecca Shaftel, Jason C. Leppi, and Daniel J. Rinella

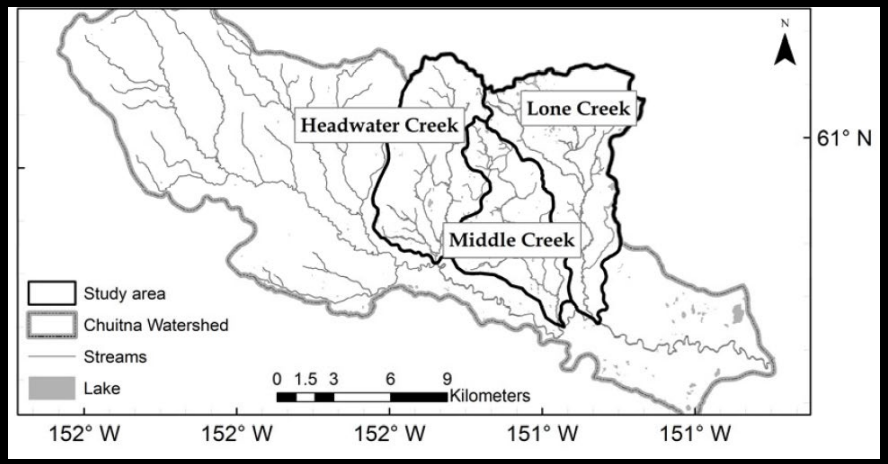


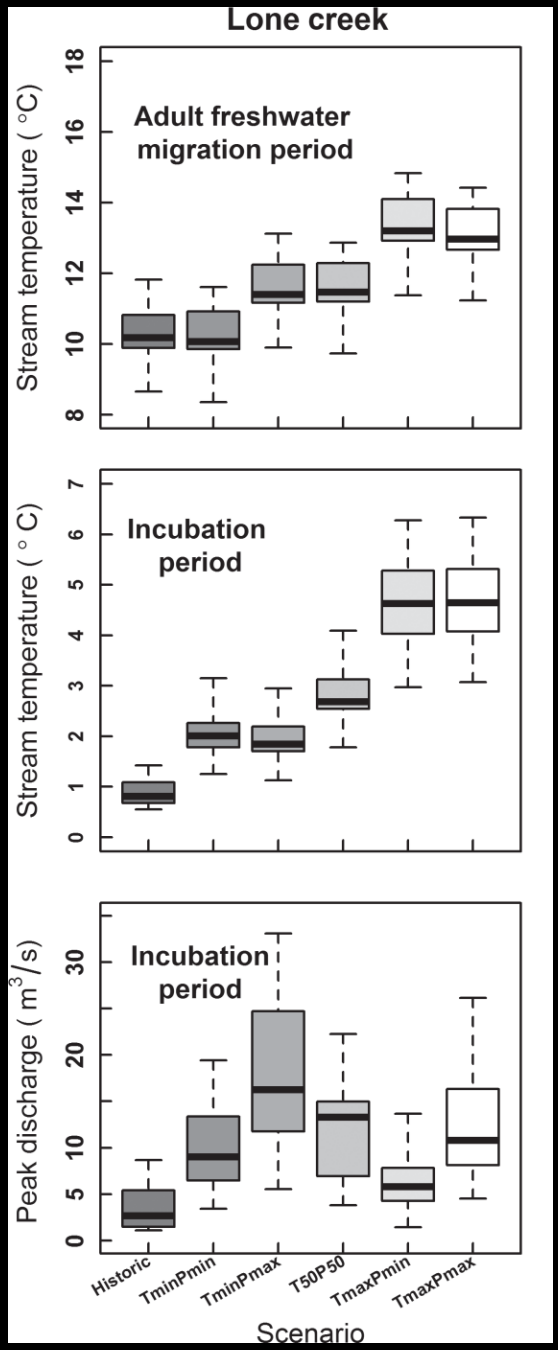
Changing temp & streamflow

Global Change Biology (2014), doi: 10.1111/gcb.12492

Linking climate change projections for an Alaskan watershed to future coho salmon production

JASON C. LEPPI[1], DANIEL J. RINELLA[2], RYAN R. WILSON[1,3] and WENDY M. LOYA[1]





Changing temp & streamflow

RESEARCH ARTICLE

Hydrologic Alterations from Climate Change Inform Assessment of Ecological Risk to Pacific Salmon in Bristol Bay, Alaska

Cameron Wobus[1]*, Robert Prucha[2], David Albert[3], Christine Woll[3], Maria Loinaz[4], Russell Jones[1]

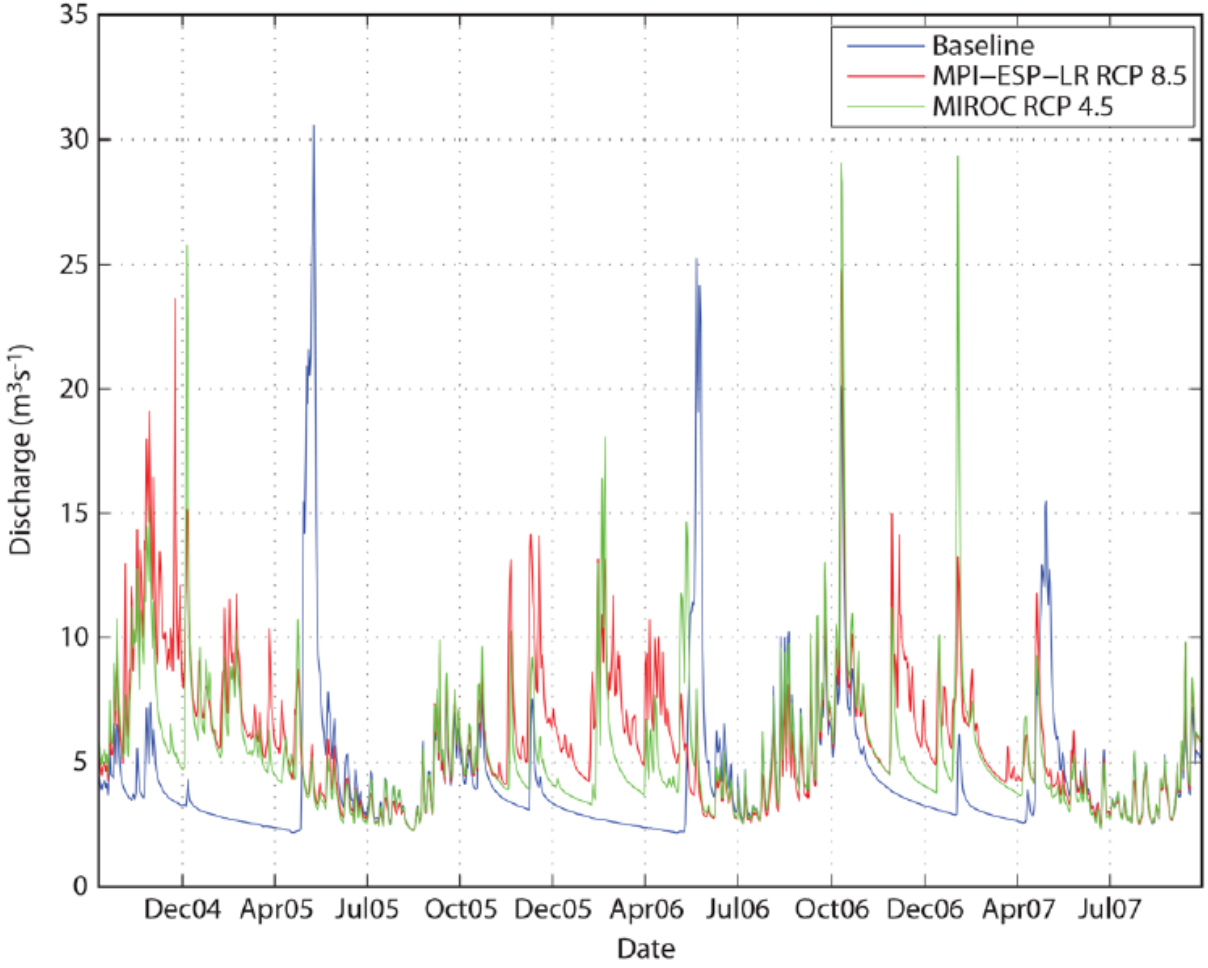


Fig 6. Changes in Hydrograph for Upper Talarik Creek Gage Site in 2100, for Lowest (MIROC, Green Line) and Highest (MPI, Red Line) Temperature Scenarios. Note the loss of the spring freshet in both future climate simulations.

Changing temp & streamflow

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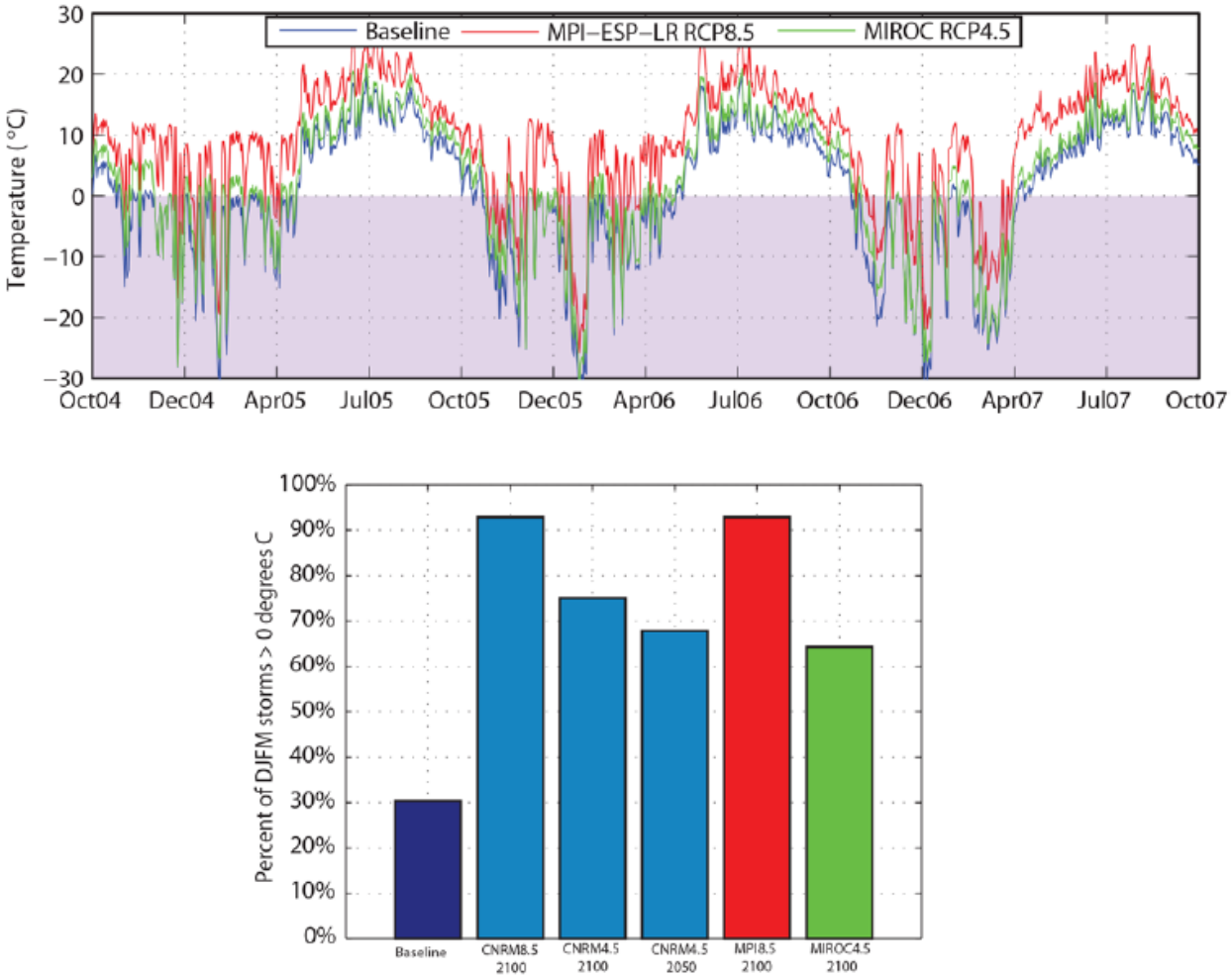

Fig 7. Summary of Baseline and Projected Daily Temperatures (a), and Fraction of Winter Storms Occurring when Temperatures are Above Freezing (b). Purple shading in (a) highlights temperatures below freezing.

Outline

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Modeled impacts to Coho production

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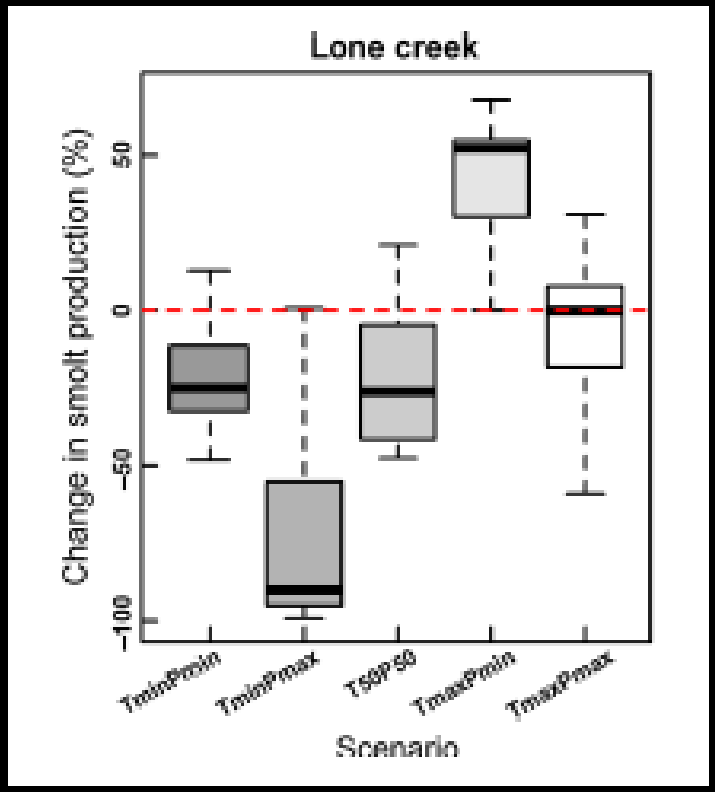


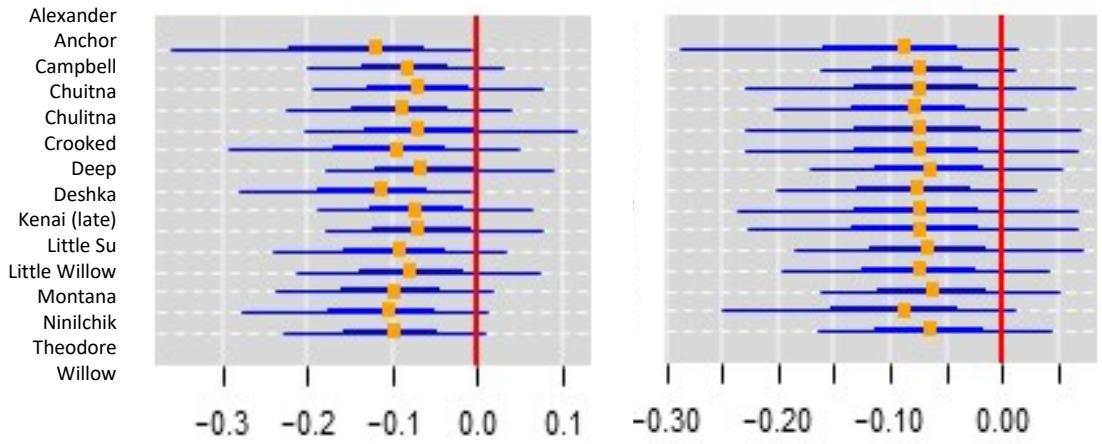
Observed correlations with Chinook production

Temperature and flooding as drivers of freshwater habitat suitability for Cook Inlet Chinook salmon

Erik Shoen[1], Leslie Jones[2], Rebecca Shaftel[2], Curry Cunningham[3], Sue Mauger[4], Dan Rinella[5], and Adam St. Saviour[6]

Maximum weekly temp during spawning

Weeks >15°C during juvenile rearing



Average:

9.1% reduction in R/S per 1-SD increase

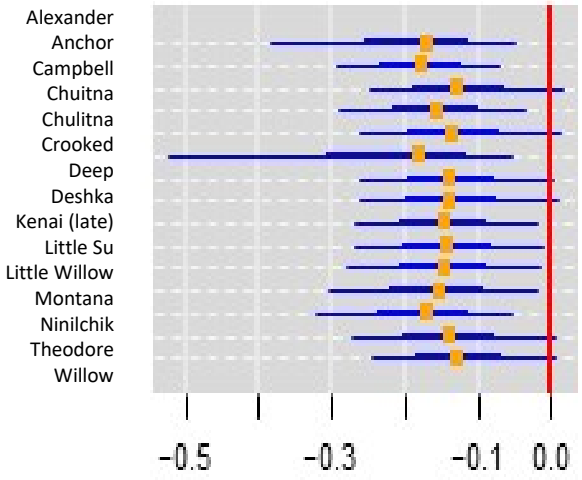
7.7% reduction in R/S per 1-SD increase

Observed correlations with Chinook production

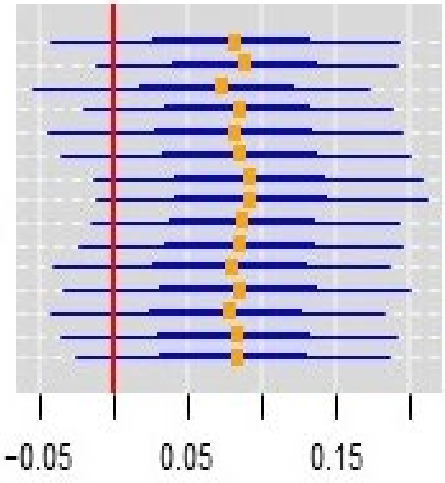
Temperature and flooding as drivers of freshwater habitat suitability for Cook Inlet Chinook salmon

Erik Shoen[1], Leslie Jones[2], Rebecca Shaftel[2], Curry Cunningham[3], Sue Mauger[4], Dan Rinella[5], and Adam St. Saviour[6]

Maximum precipitation during spawning/incubation



Average weekly precipitation during juvenile rearing



Average: 15.4% reduction in R/S per 1-SD increase

8.5% increase in R/S per 1-SD increase

Conclusions

- Temperature and flow regimes are changing
- Salmon populations appear to be responding to these changes
- Continued monitoring is essential for informed landscape and fishery management
  - Identifying key habitats & conservation actions
  - Understanding fish effects
    - Improving escapement goals & pre-season forecasts