Water Temperature at Salmon Spawning Sites

Copper River Delta, Alaska

Luca A. Adelfio

Steven M. Wondzell, Gordon H. Reeves,
Nathan J. Mantua (NOAA)

Water Temperature is Important… Year-Round

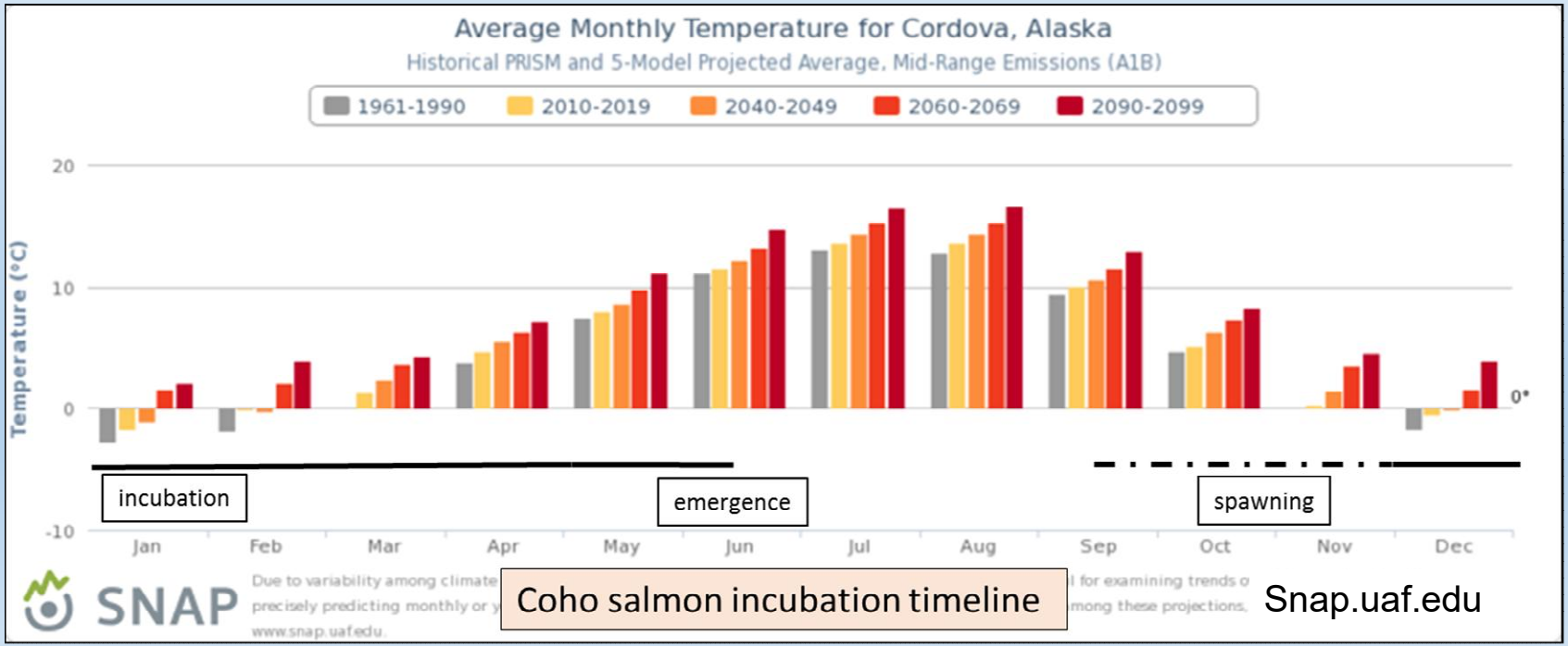
- Water temperature drives growth and metabolic rates
- Lab study: 3°C increase in mean water temperature reduced Coho development time by 40% (>12 weeks)
- Early emergence may have positive or negative implications for juvenile viability
- Recent modelling efforts have identified embryo-fry survival as most vulnerable life stage to climate change.

Murray & McPhail 1988
Beacham & Murray 1990
Leppi et al. 2014
Shanley & Albert 2014

Climate Models Project Rising Temperatures

- **Coho Incubation Period (Oct – May) mean air temperature:**

+3 to +5 °C by 2080



Coho salmon incubation timeline

Snap.uaf.edu

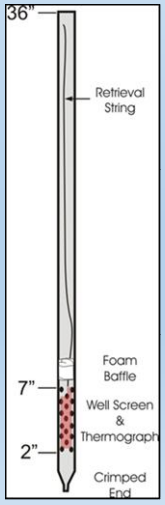
Big Hydrologic Changes Anticipated

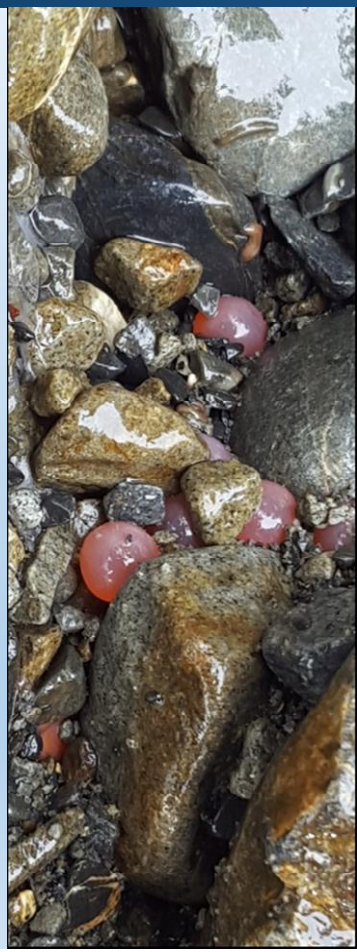
May

February

Temperature Monitoring

- **Year-round, hourly data**
- **3-6 years of record**
- **13 surface & streambed water sites**
- **5 additional surface water sites**
- **Spawning Sites**

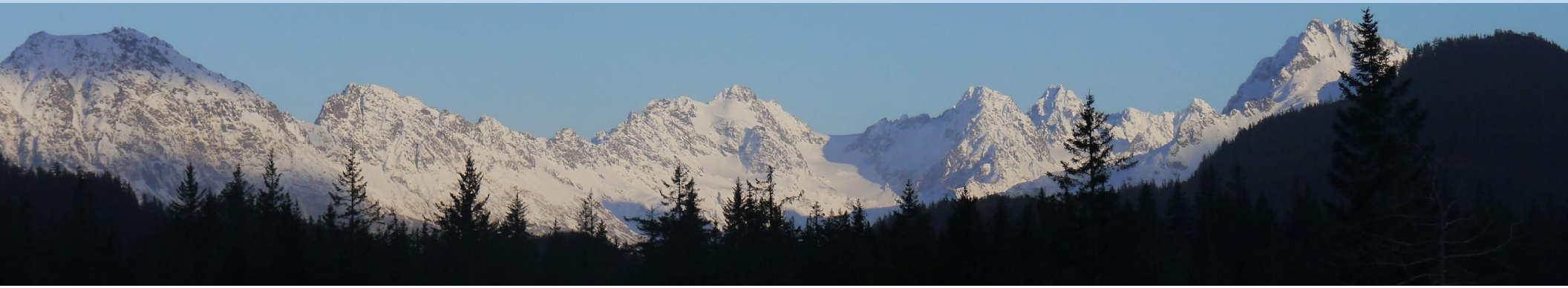




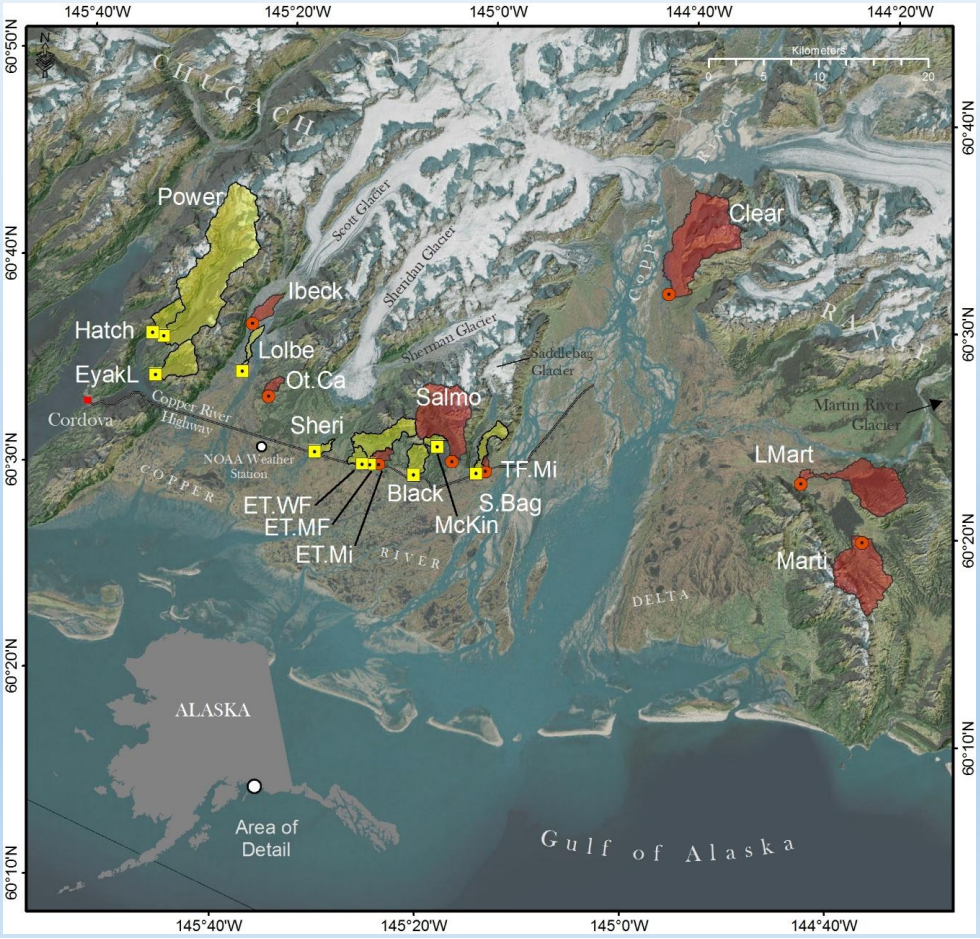
Questions

1) How variable is water temperature on the CRD?
   Can we predict temperature across the landscape?

2) Can we anticipate changes within the incubation environment?
   How does winter severity influence:
      Streambed water temperatures?
      Scour potential?



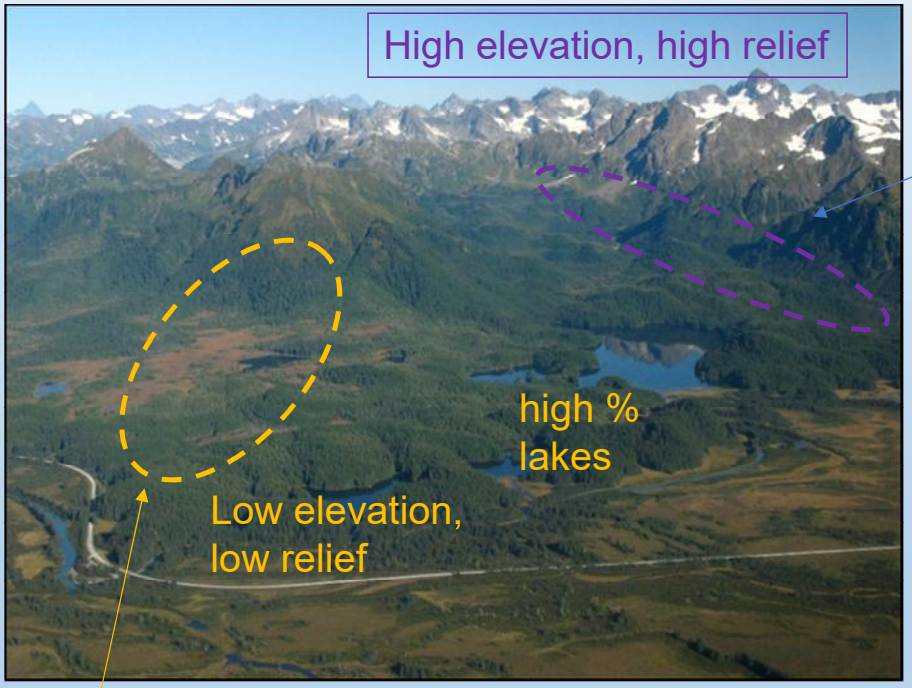
Study Catchments



The 18 study sites had variable catchment geomorphology

Catchment Characteristic	Observed Range
Mean Elevation:	21 - 622 m
Mean Slope:	1 - 28 deg
Area:	61 - 5,426 ha
% Lake Area:	0 - 15.4 %

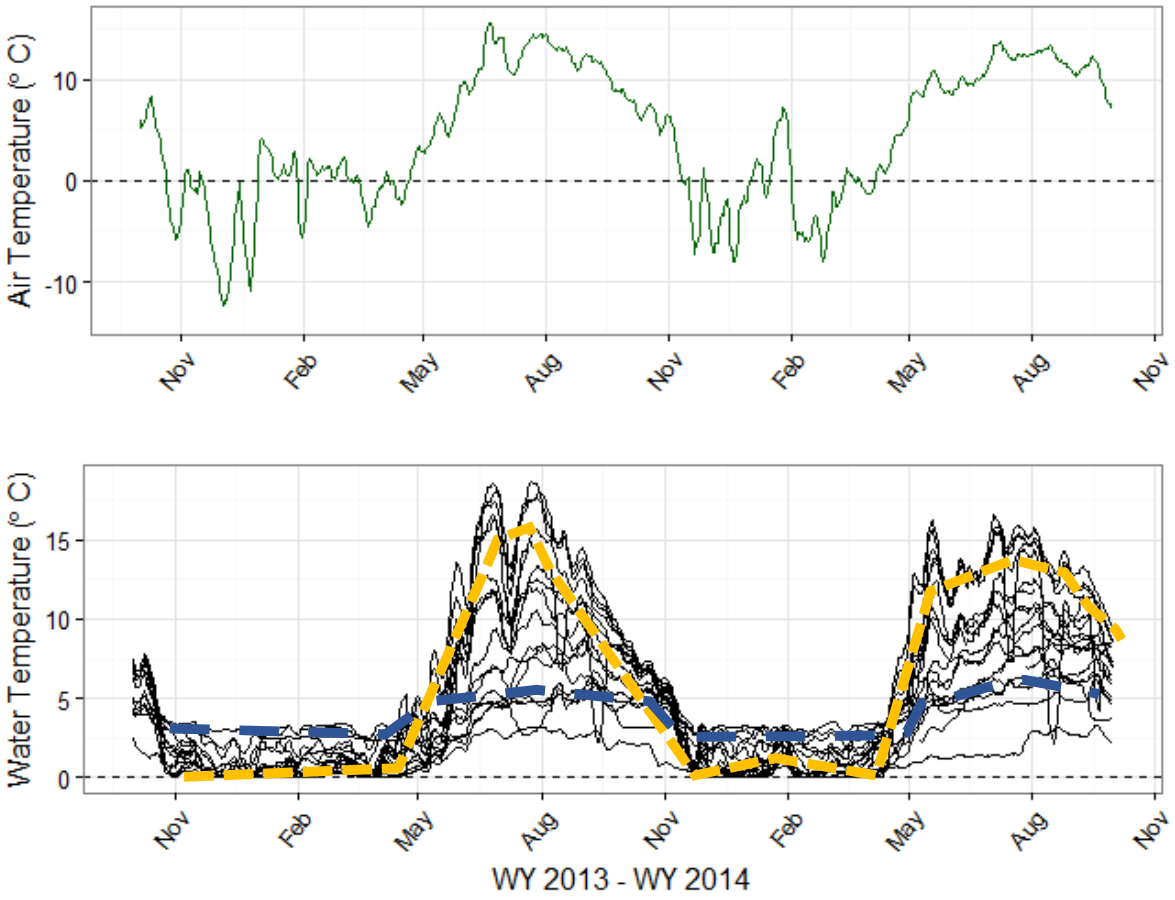
1) Water Temperatures are Variable across Landscape



Cool maximum temperatures &
Lower frequency of freezing

Warm maximum temperatures (20°C) &
High frequency of freezing

1) Water Temperatures are Variable across Landscape & over Time



Shallow flowpath sites: Sensitive to atmospheric conditions

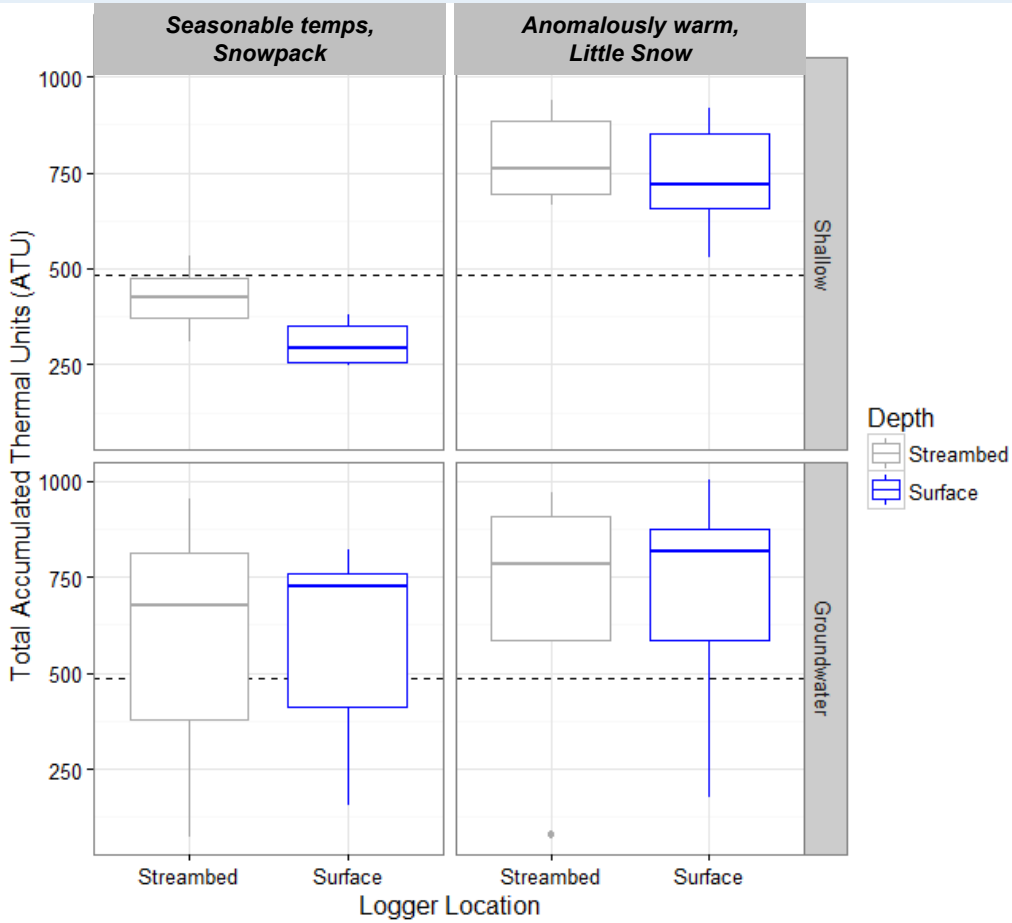
Upwelling Groundwater sites: Effects of atmosphere are buffered

2) Winter severity controls incubation temperatures at some sites

n=4

°C/Day

n=4



Significantly more (*T* test, $p<0.01$) ATU during mild winters at shallow flowpath sites.

Significantly more ATU gained late in the incubation period (Mar 11-May 31)

No significant inter-annual differences in ATU at upwelling groundwater sites

Implications

- Water temperature response to climatic changes is likely to vary across the landscape, even at small spatial scales.
  Anticipate different impacts at different streams. ~~"One size fits all"~~

- Magnitude of climate change impacts may be greatest during the incubation period (Oct-May).
  Reduction in seasonal snow and ice melt == Warming MAM water temperatures
  +6-7°C changes observed in shallow lakes in May

- 2x total ATU observed during warm winters at shallow flowpath sites.
  3x total ATU anticipated under projected climate scenarios (2060-2080)

Genetic and life history diversity of salmon populations across the landscape?

Shorter incubation period vs. warmer rearing habitats?

Plasticity of salmon life history strategies?
Implications for consumers?

Thank You

ladelfio@fs.fed.us