The importance of hydrologic variation to the spawning phenology of salmon and species they support in river systems.
Implication of climate change for ecosystems.

• Can we get away with coarse scale projections (10,000 to 2500km$^2$) or do we need a finer scale understanding (2km$^2$) of climate?
• How much thermal variation do we see at finer spatial scales?

• What are the controls on this variation?
• Is this variation important to wildlife?
Case Study at one Pixel
Wood River Basin
Alaska

Summer stream temperatures

Stream temperature °C

04 Jul  18 Jul  01 Aug  15 Aug  29 Aug
36 streams; Color = Average summer temperature

PC1 (49%)

PC2 (35%)

Slope
Elevation
Particle size
Lake Area
Watershed Area
Sub watersheds set the thermal template in this landscape

Lisi et al. Geomorphology 2013
How does topography influence water source (Rain or Snow) and stream temperature?
Stable isotopes in water $^{18}$O and $^2$H can help determine water source in streams.
stream water source

% Rain
% Snow
stream water source

% Rain

% Snow

average summer temperature (°C)

proportion rain

Wood River Basin

Bristol Bay

Western Alaska LCC
Stream sensitivity to air temperature

Moose Cr.
\[ y = 0.42x + 5.9 \]

Joe Cr.
\[ y = 0.007x + 5.1 \]
Lakes and thermal regimes at river outlets.
Summary:

• Topography influences stream temperature through a variety of controls on residence time and water source conditions.
Is this variation important to wildlife?
Salmon spawn-timing is linked to stream temperature

Salmon spawn earlier in cool streams and several weeks later in warmer streams.

Lisi et al. *Geomorphology* 2013
Does wildlife take advantage of the asynchrony in salmon spawn-timing?
It’s important to eat all you can, when you can.
Salmon complete spawning and die

Salmon start spawning

Few carcasses remaining
Salmon complete spawning and die.
Schindler et al. 2013 Biology letters
• Local adaptation to hydrologic regimes produce population diversity that can triple the time that consumers can eat salmon.
Indirect link between aquatic and riparian biodiversity
spawn timing

bloom timing

Wood River
Alaska
Salmon spawn timing propagates to riparian bloom timing

Lisi and Schindler *Ecosphere* 2011
Local Climate

Heterogeneous landscape
Local Climate

Heterogeneous landscape

Aquatic/terrestrial connections
predicted air temperature departures in 2079-2099

Predictions based on continued rate of anthropogenic CO$_2$.
seasonal precipitation departures in 2079-2099

Winter

Summer

Predictions based on continued rate of anthropogenic CO$_2$.
Landscape diversity can buffer the effects of climate change on aquatic systems.

What can we do?

Protect the processes that create environmental variation

Maintain habitat options for wildlife.
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WHERE DISCOVERIES BEGIN

GORDON AND BETTY MOORE FOUNDATION
Wild Salmon Ecosystems

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