Daniel Rinella ~ University of Alaska Anchorage

The Interaction of multiple drivers of environmental change: hydrological dynamics, aquatic ecology, and human dynamics of the Kenai River, Alaska.

The Kenai River watershed in southcentral Alaska exemplifies the interactions of multiple drivers of change and their effects – creating what has been termed a complex or "messy" social-ecological system. These drivers include global and regional temperature and precipitation changes; salmon population fluctuations; a recent tourism downturn; recreational pressure from Anchorage; shrinking wetlands and successional change; spruce beetle outbreaks; and forest fire dynamics. In this multi-year research initiative, funded by NSF's EPSCoR program, we will use an interdisciplinary approach to help understand these changes, their consequences for human communities, and the adaptive capacity necessary to respond to change. Salmon studies will focus on understanding and anticipating how changes in land cover, temperature, and hydrology will affect the abundance and stability of salmon returns and, in turn, the communities that rely on them.

The interaction of multiple drivers of environmental change:

Hydrological dynamics, aquatic ecology, landscape change, and human dynamics of Kenai Peninsula, Alaska

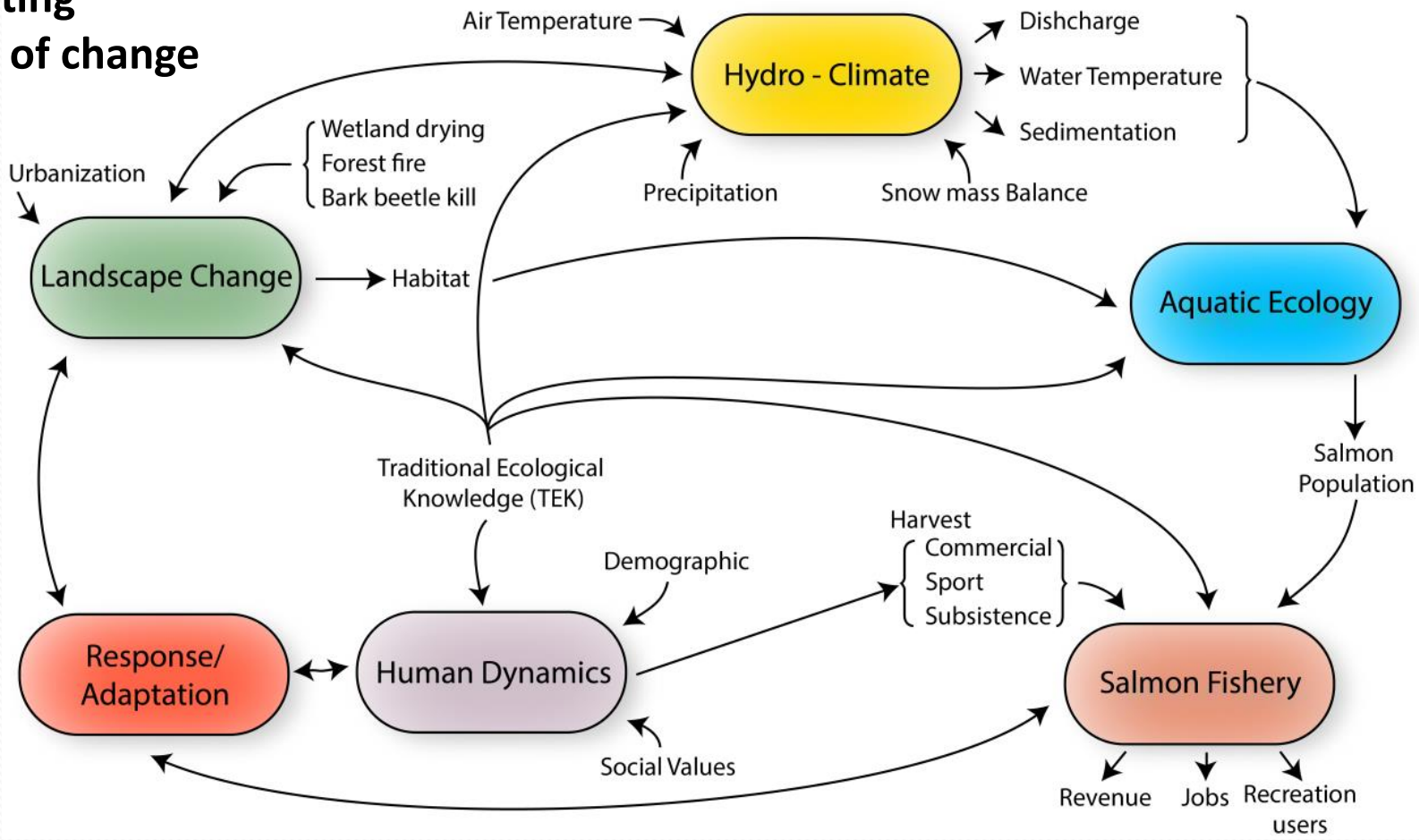
Daniel Rinella, Anaru (Andy) Kliskey, Kacy Krieger, and Holly McQuinn

*The Southcentral (Kenai) test case provides a **place-based examination** of multiple drivers of **social-ecological change** that will contribute to the development of research capacity for adaptation to change in Alaskan communities.*

Research Questions

- ***Q-1 (Changing Environment):*** How do changing climate and landscape affect salmon habitat and salmon populations in the Kenai River watershed?
- ***Q-2 (Societal Consequences):*** What are the consequences of these changes to communities in the watershed?
- ***Q-3 (Adaptive Capacity):*** How does the ability of Kenai River communities to perceive, project and respond to anticipated change affect adaptive capacity?

Interacting drivers of change



Outline:

- Landscape change
- Hydro-climate change
- Linking change and aquatic ecology

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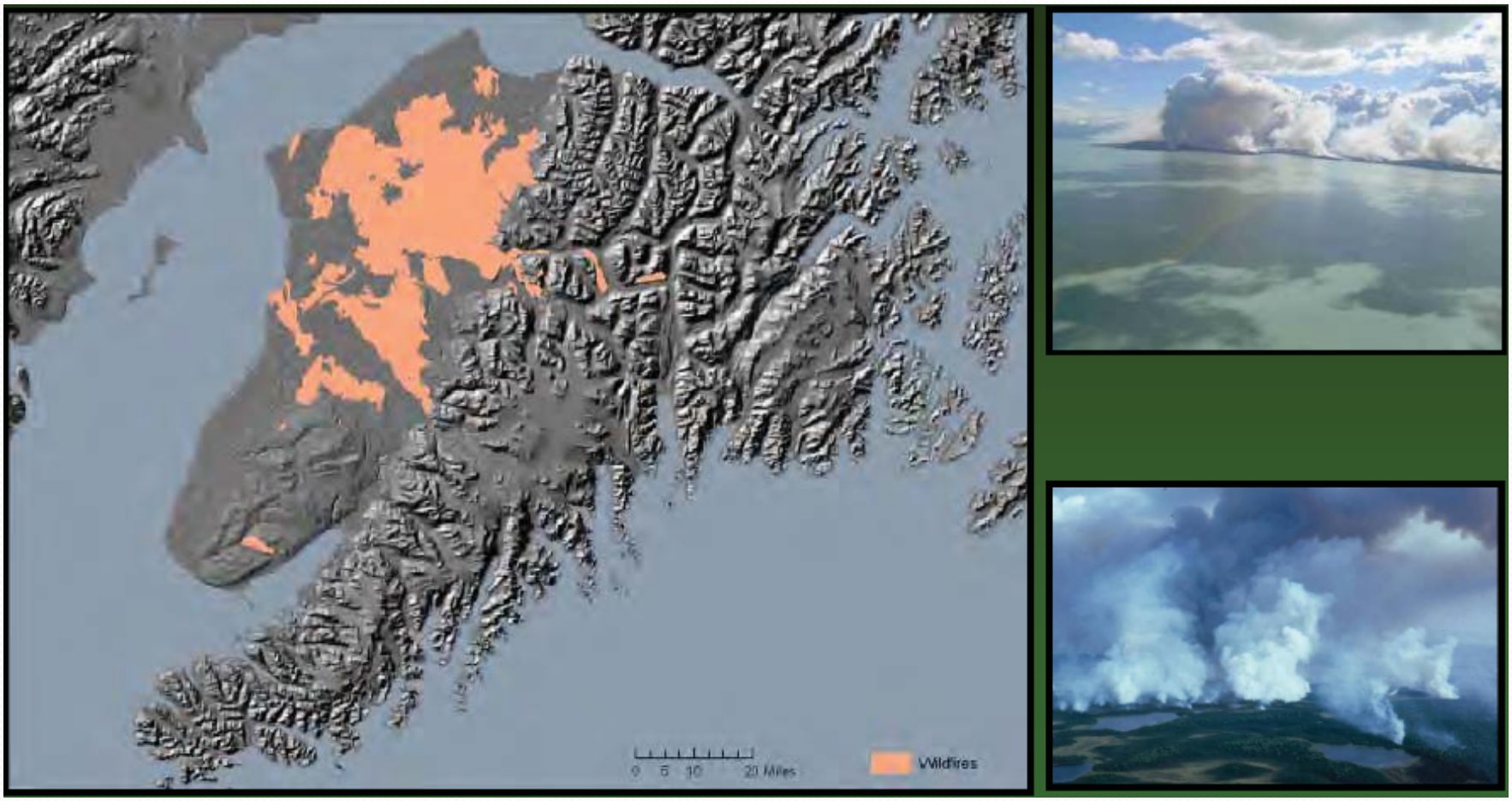
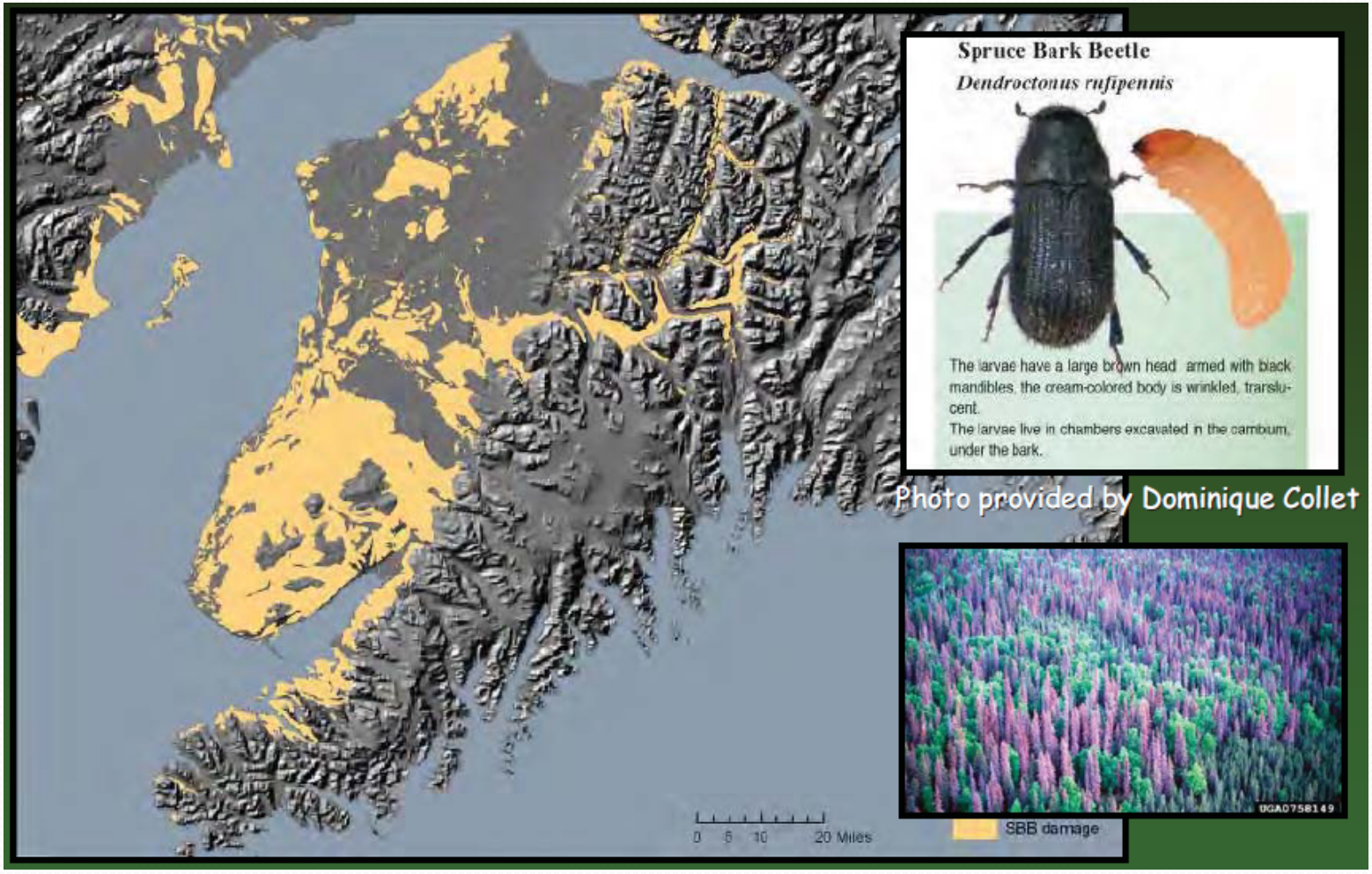
Wildfire



Source: Kenai Watershed Forum

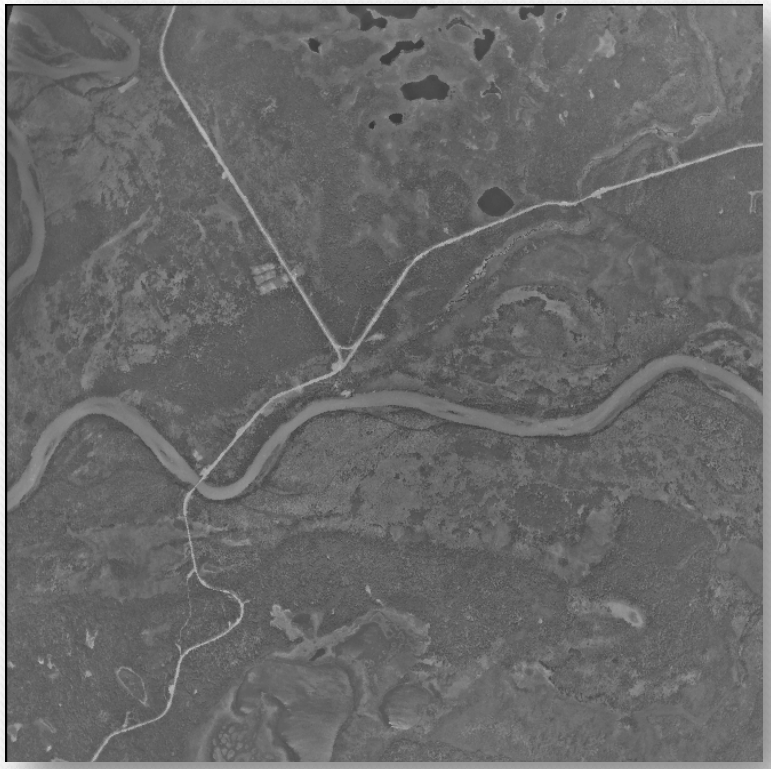
Spruce bark beetle



Source: Kenai Watershed Forum

Urban/suburban development

Soldotna 1950

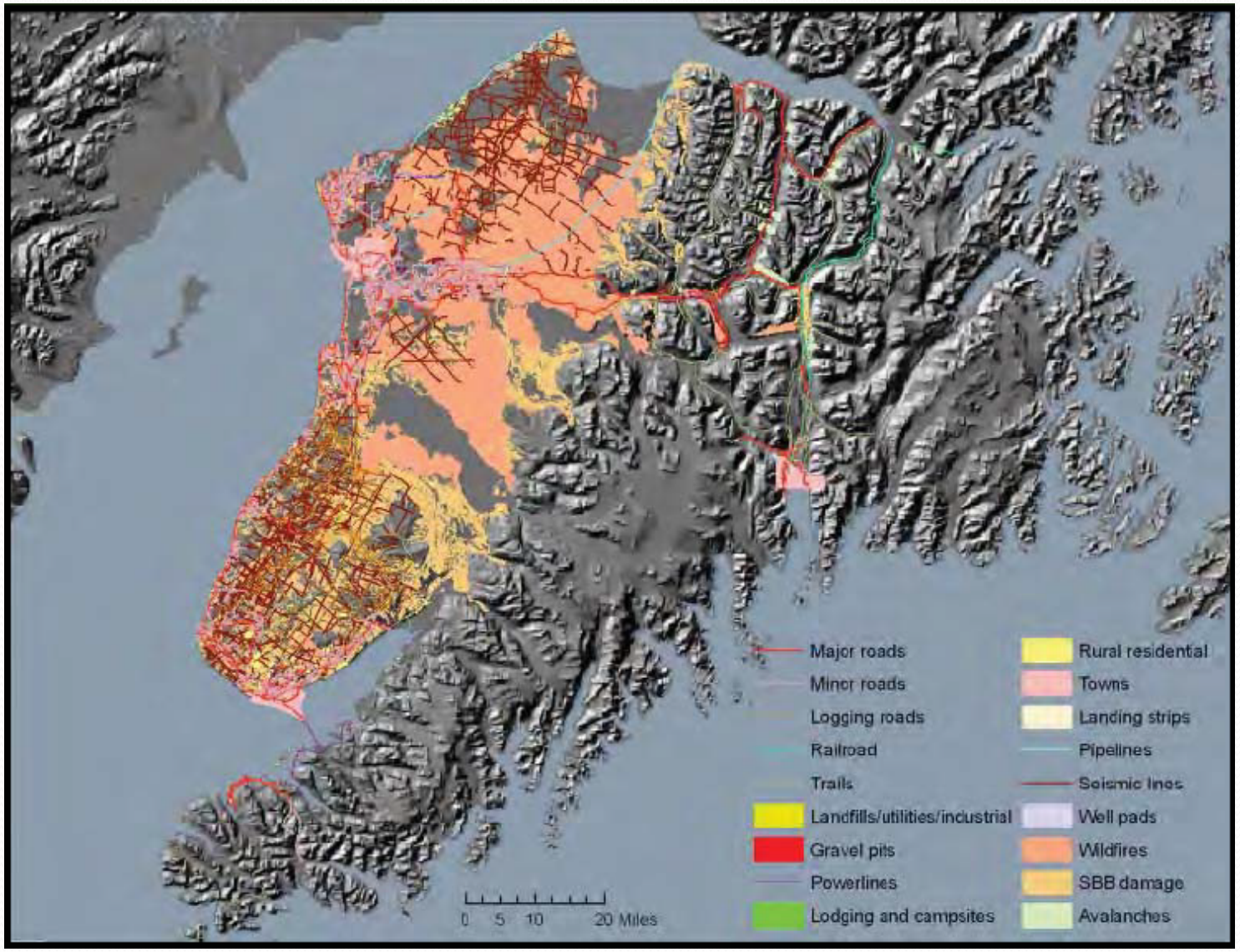


Historic black and white air photo

Soldotna 2009

Recent color air photo

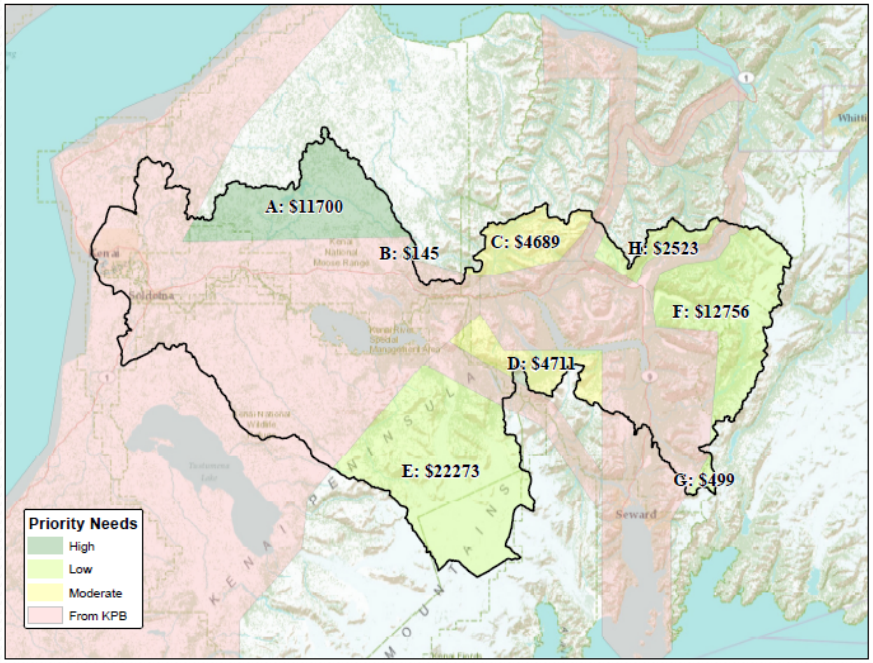
Cumulative change: direct/indirect anthropogenic and natural



Source: Kenai Watershed Forum

Landscape change: measuring the magnitude and pattern over time

- 1950s: aerial photography
- 1970s – 80s: Landsat imagery
- 2000s: IKONOS high resolution imagery
- 2012 – 2014: high resolution digital orthophotos



Hydro-climate change

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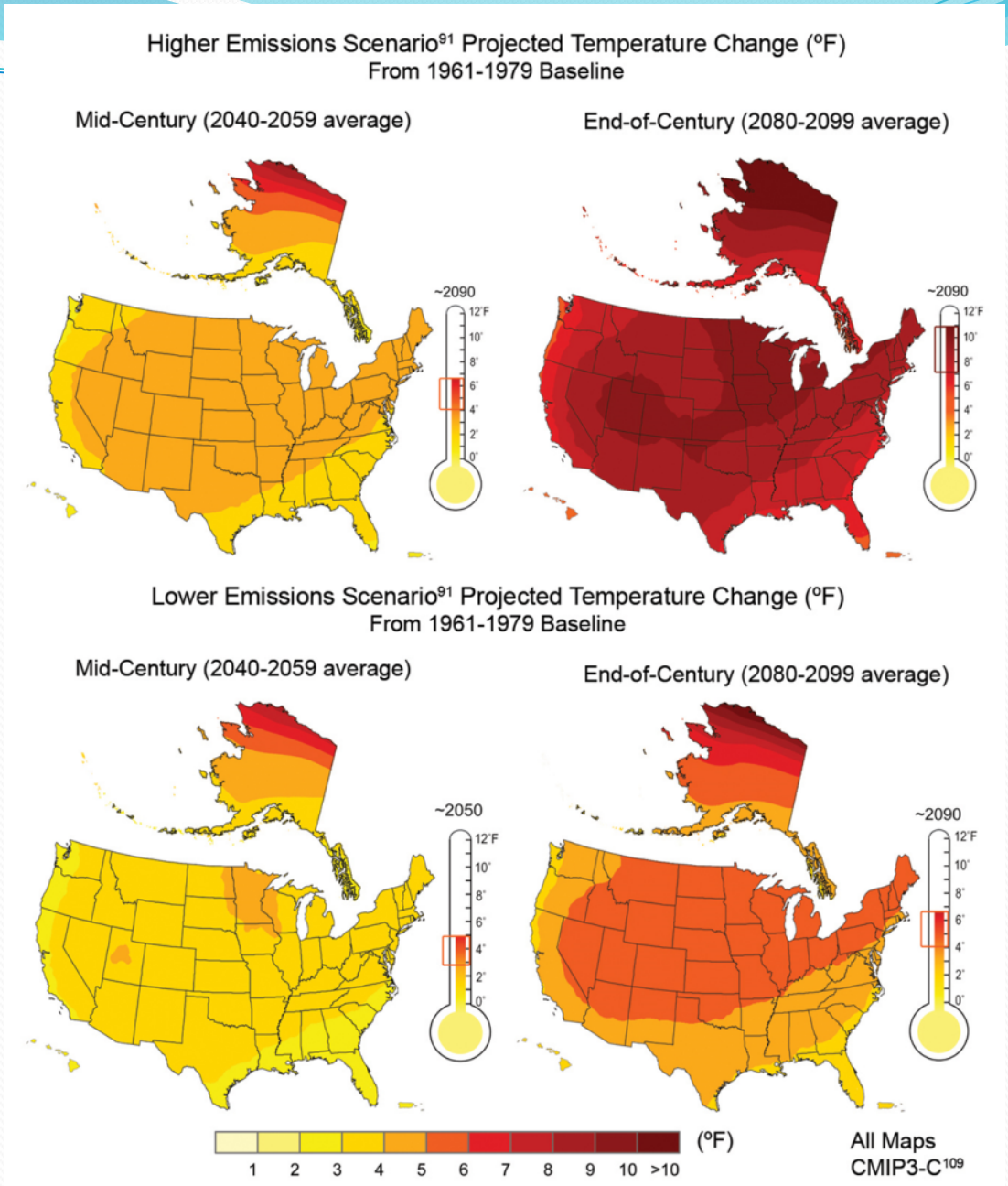
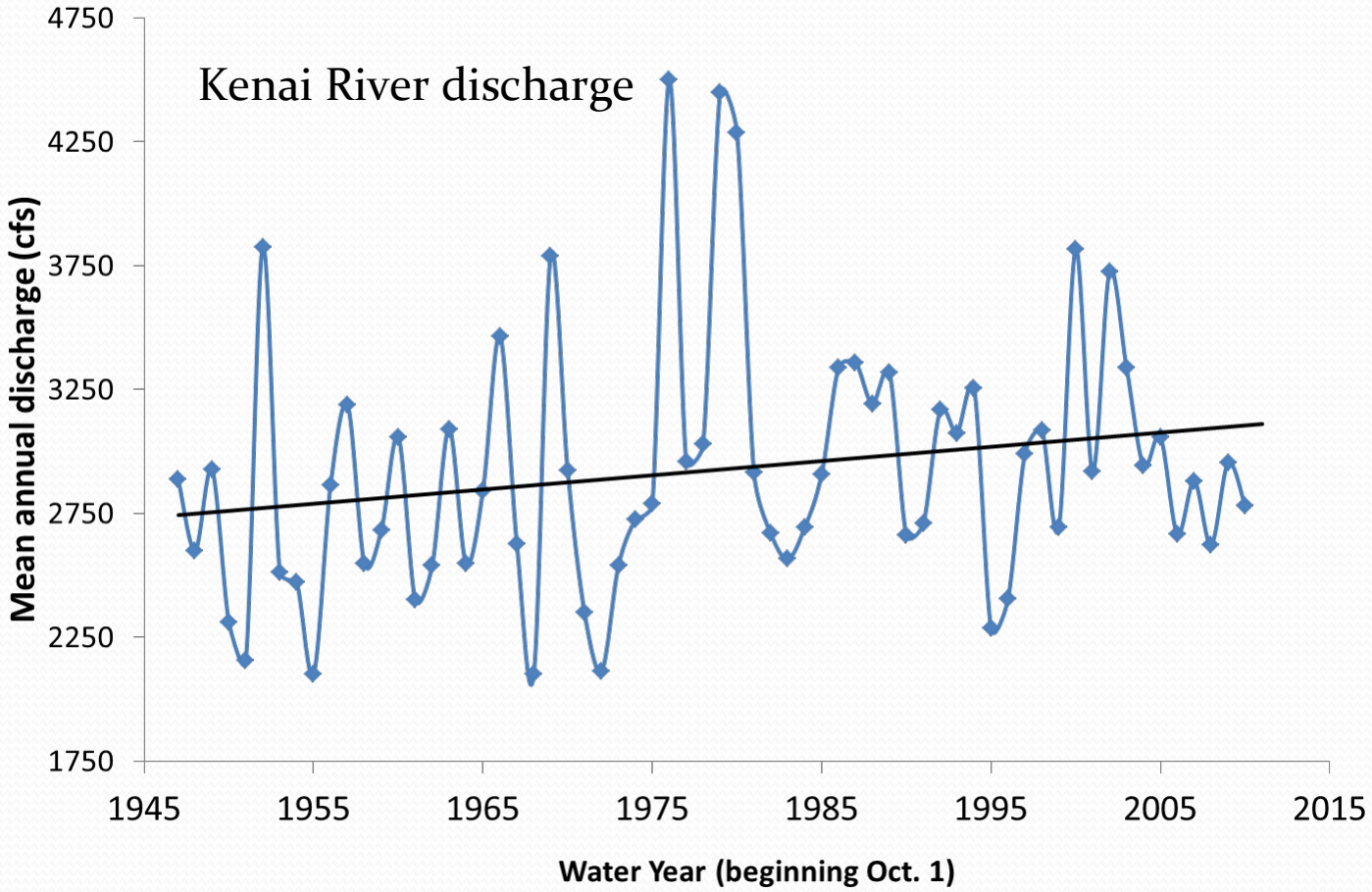
Global climate change



Source: U.S. Global Change Research Program; globalchange.gov

Hydrologic change



Flooding Strikes Kenai Peninsula

By Ellen Lockyer, KSKA - Anchorage | September 21, 2012 - 5:32 pm

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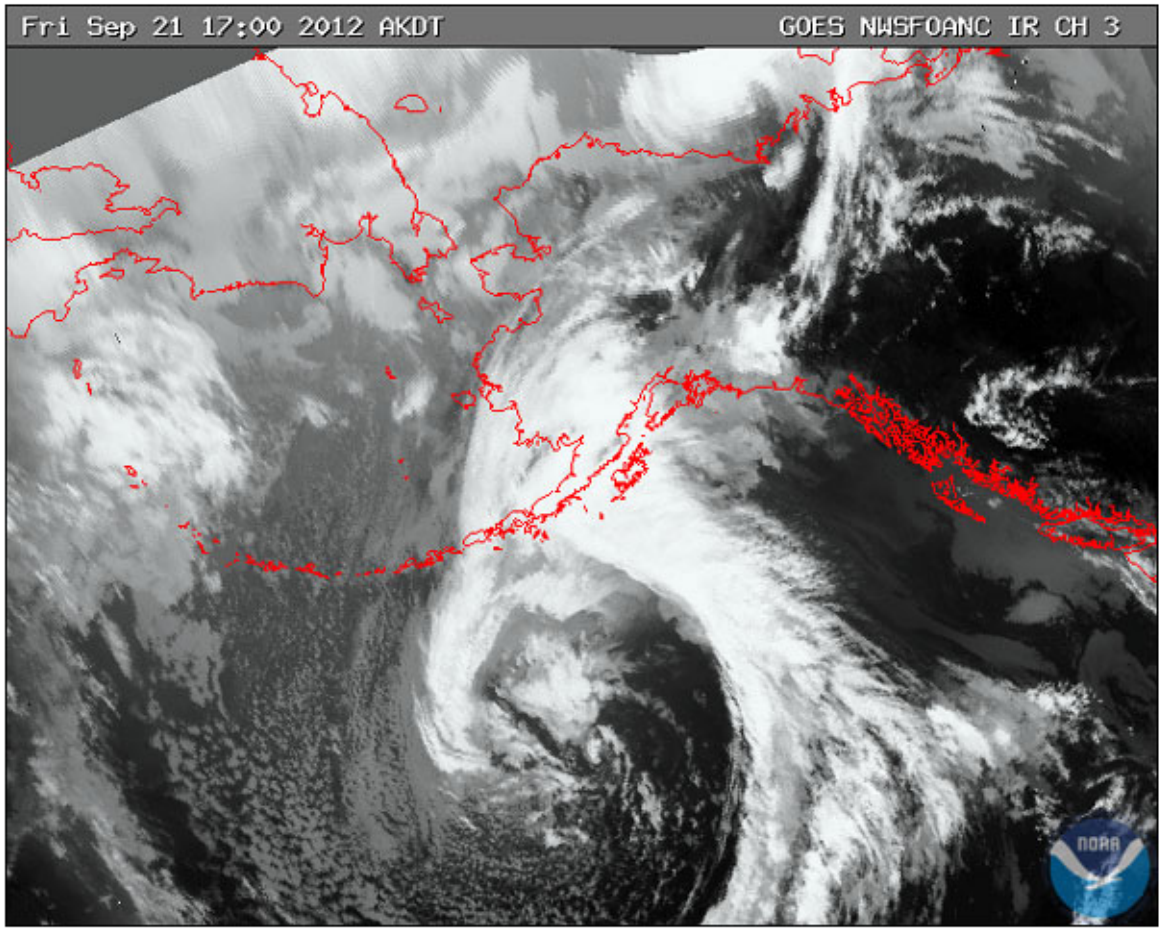
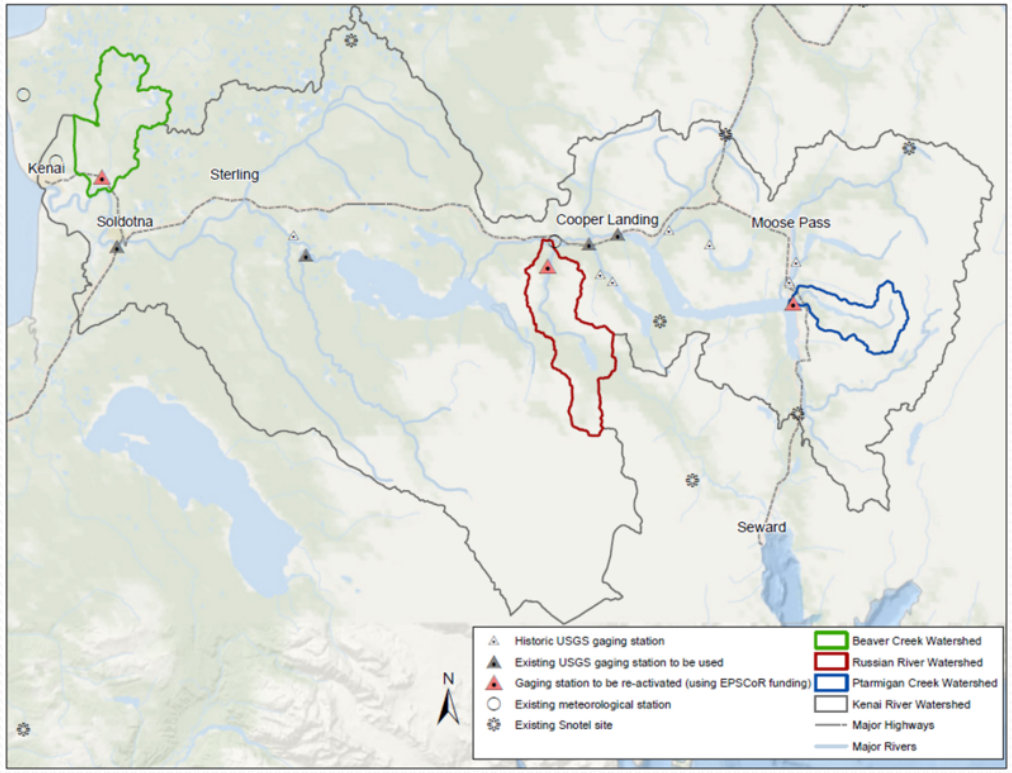


Graphic by the National Weather Service

Hydro-climate change:
measuring the magnitude and pattern over time

- Analyze patterns in streamflow data (1940s to present)
  - Reestablish gages in 3 sub-basins with historic records
- Compile all available climate records
- Downscale SNAP PRISM data
- Model past and future climate & streamflow
  - Hindcast 50 years & forecast 50 years



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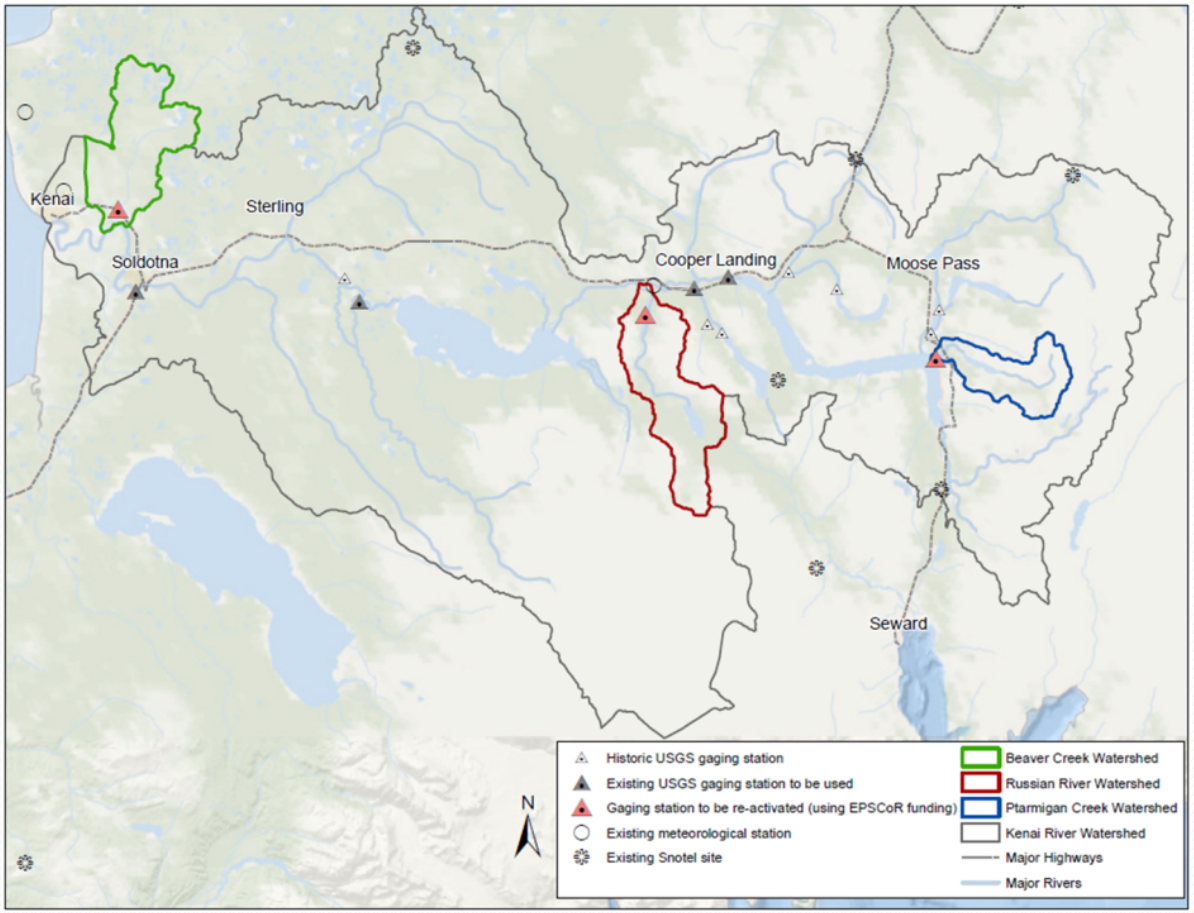
Landscape study

Characterize salmon production and key habitat attributes across land cover and hydro-climate gradients

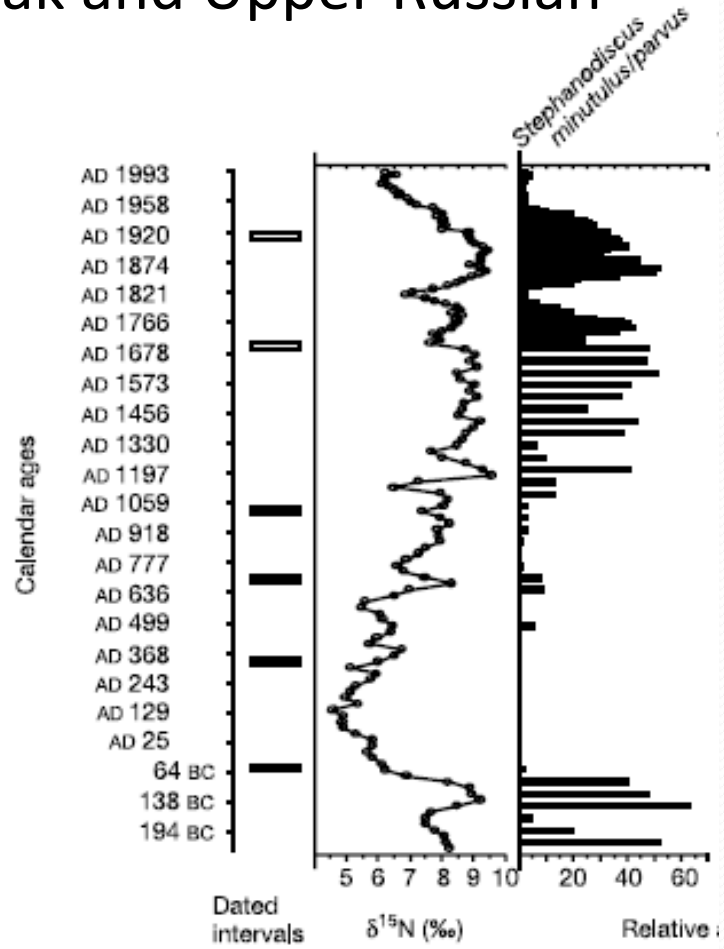
- Lowlands → uplands
- Characterize:
  - Juvenile salmon abundance
    - Focus on Chinook and coho
  - Growth rates/age structure
  - Thermal regime
  - Hydrologic regime
  - Prey abundance
  - Physical habitat
- Use models to forecast salmon growth and production under climate scenarios



Paleolimnology study

Reconstruct sockeye run sizes for Skilak and Upper Russian lakes over the past ~2000 years

- Measure multiple proxies of spawner abundance in lake sediment cores
  - $\delta^{15}N$, diatoms, C:N
- Correlate inferred spawner abundance with published (and new?) paleo-climate records
- Link to future climate scenarios



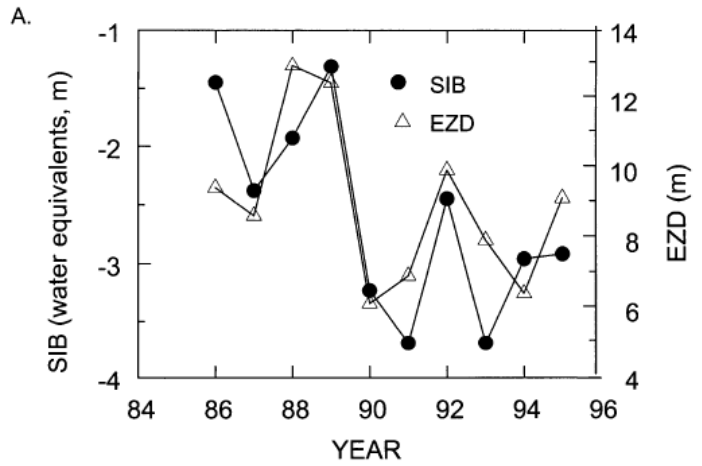
Source: Finney et al. 2002; Nature 416:729–733

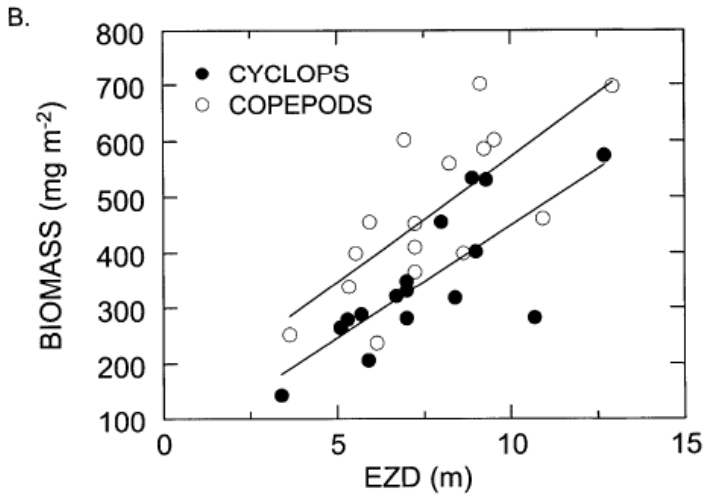
Paleolimnology study

Historic data suggest decreased prey production in glacial Skilak Lake during warm periods

- Euphotic zone depth tracks glacial summer ice balance (A)
- Plankton areal biomass is proportionate to euphotic zone depth (B)
- Possible mechanism for historic and prehistoric variation in sockeye production

Source: Edmundson et al. 2003, EVOS report





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  - SC team – Jonathan Alevy, Debbie Boege-Tobin, Alan Boraas, Chad Farrell, Gennady Gienko, Lance Howe, Tony Lack, Sveta Stuefer, Horacio Toniolo, Mark Wipfli
- Community Partners
  - Kenai Watershed Forum
  - Kenai Peninsula Borough
  - Kenaitze Indian Tribe
  - Kenai National Wildlife Refuge
  - U.S. Forest Service