

How Will Climate Change Affect Trophic Processes and Productivity in Freshwater-Riparian Ecosystems?

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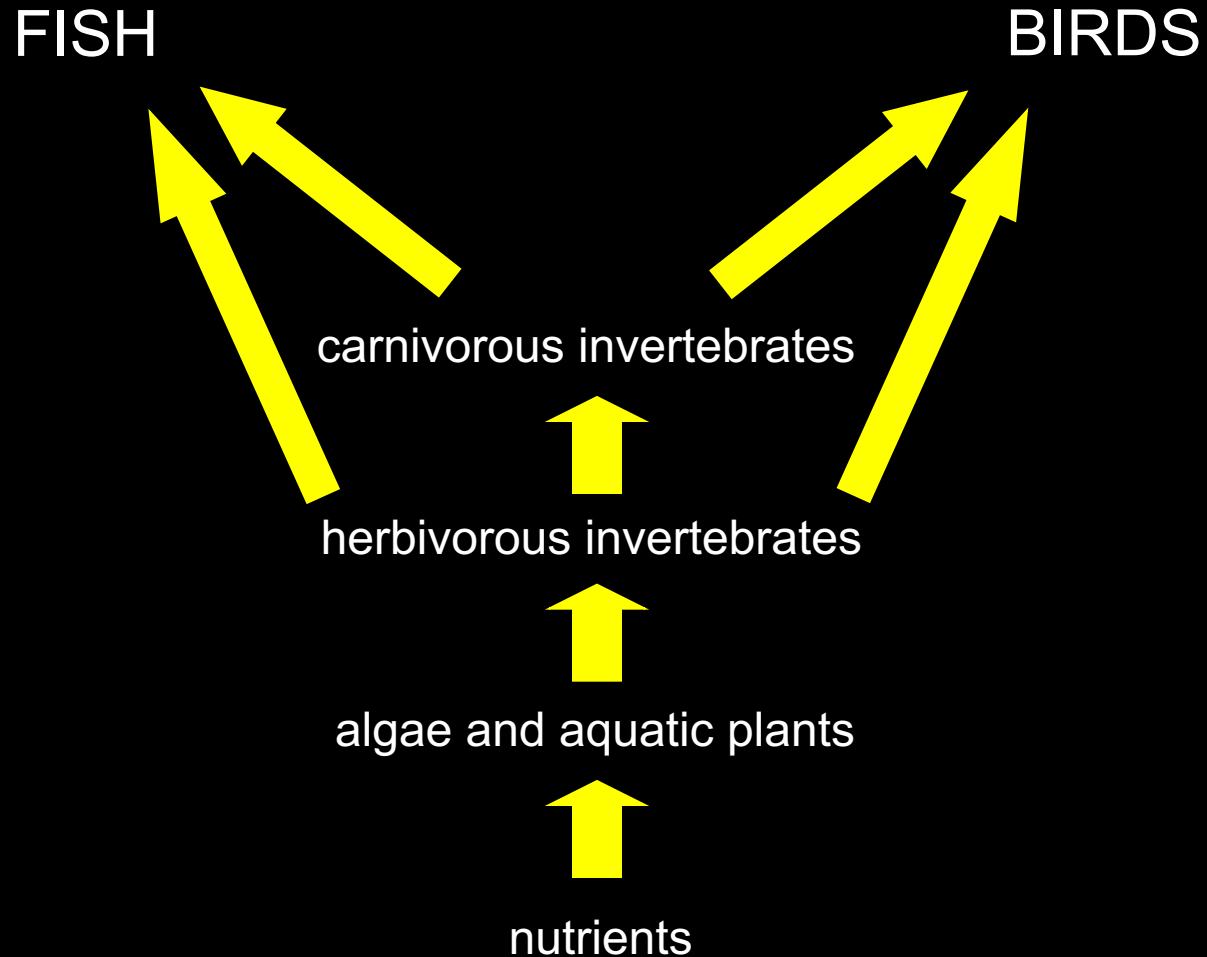
Today's talk

I. Aquatic Food Webs

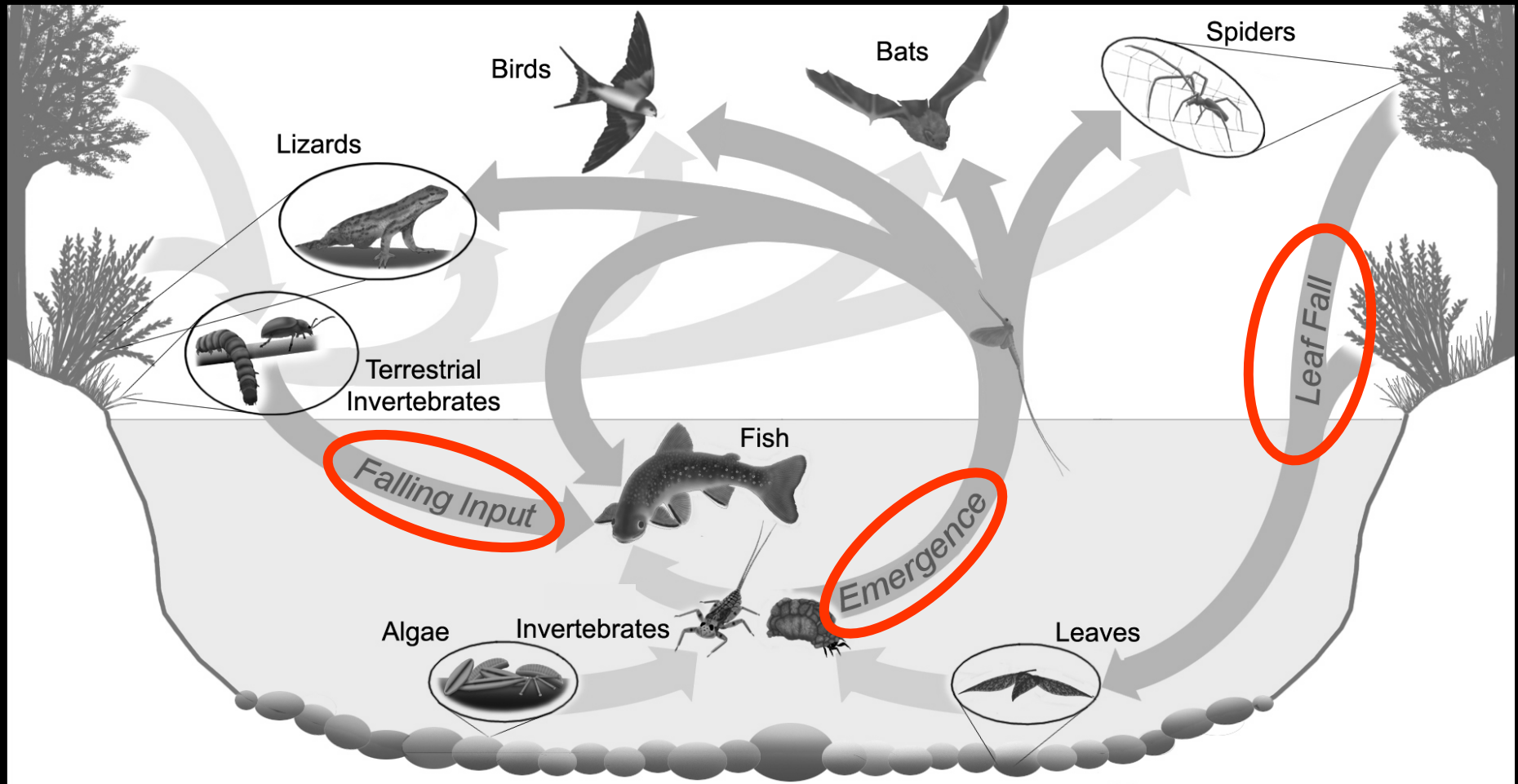
II. Climate Change Effects on Food Webs

- Freshwater habitat loss from drying
- Water temperature increases
- Terrestrial vegetation cover changes
- Nutrient loading – from land and sea

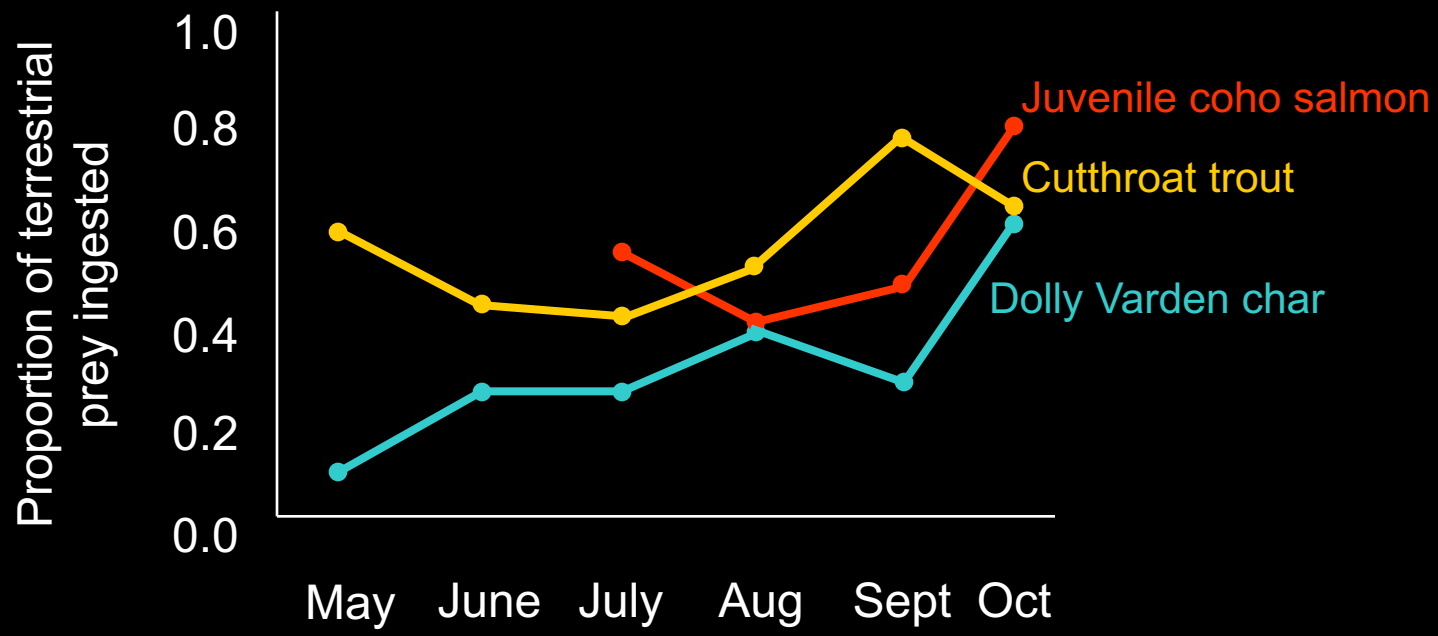
Aquatic food web (streams, wetlands)



Aquatic food web & riparian linkages



Terrestrial prey ingestion by fishes



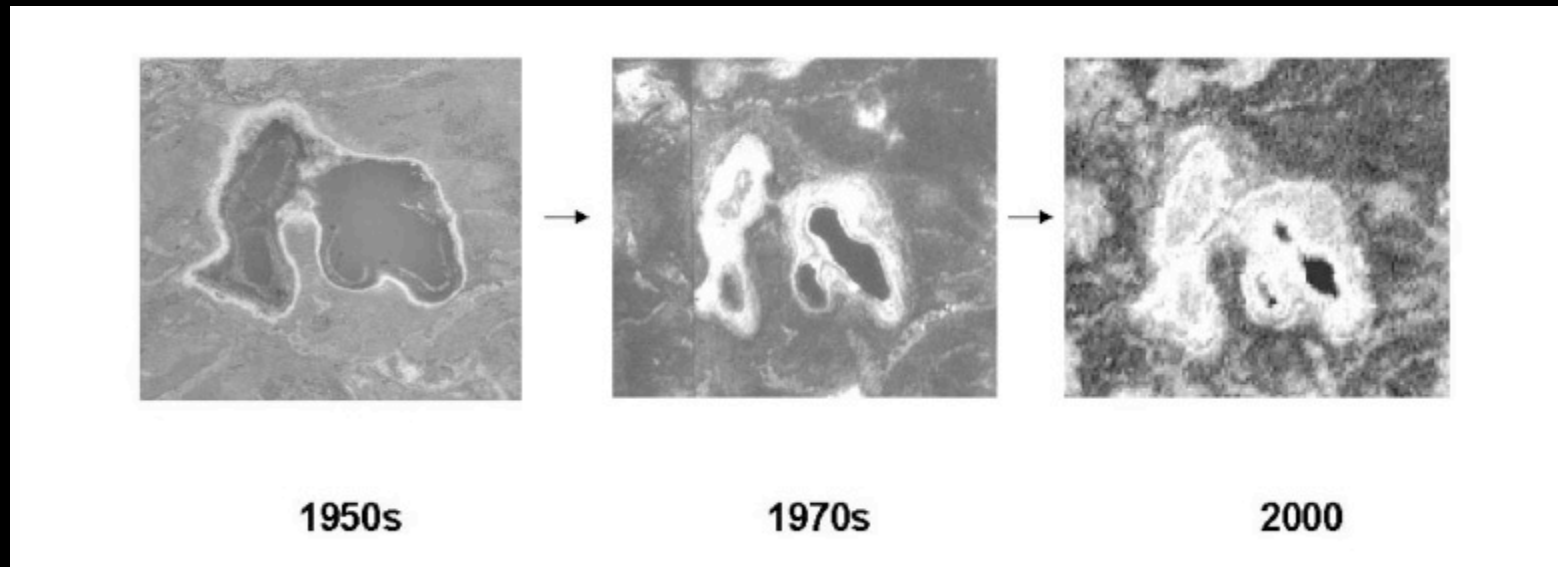
Wipfli 1997

Climate Change Effects

- Freshwater habitat loss from drying
- Water temperature increases
- Terrestrial vegetation cover changes
- Nutrient loading – from land and the sea

Climate Change Effects

- Freshwater habitat loss from drying



Riordan et al. 2006

Result: ↑ drying = ↓ aq habitat, ↓ aq production

Climate Change Effects

- Water temperature increases

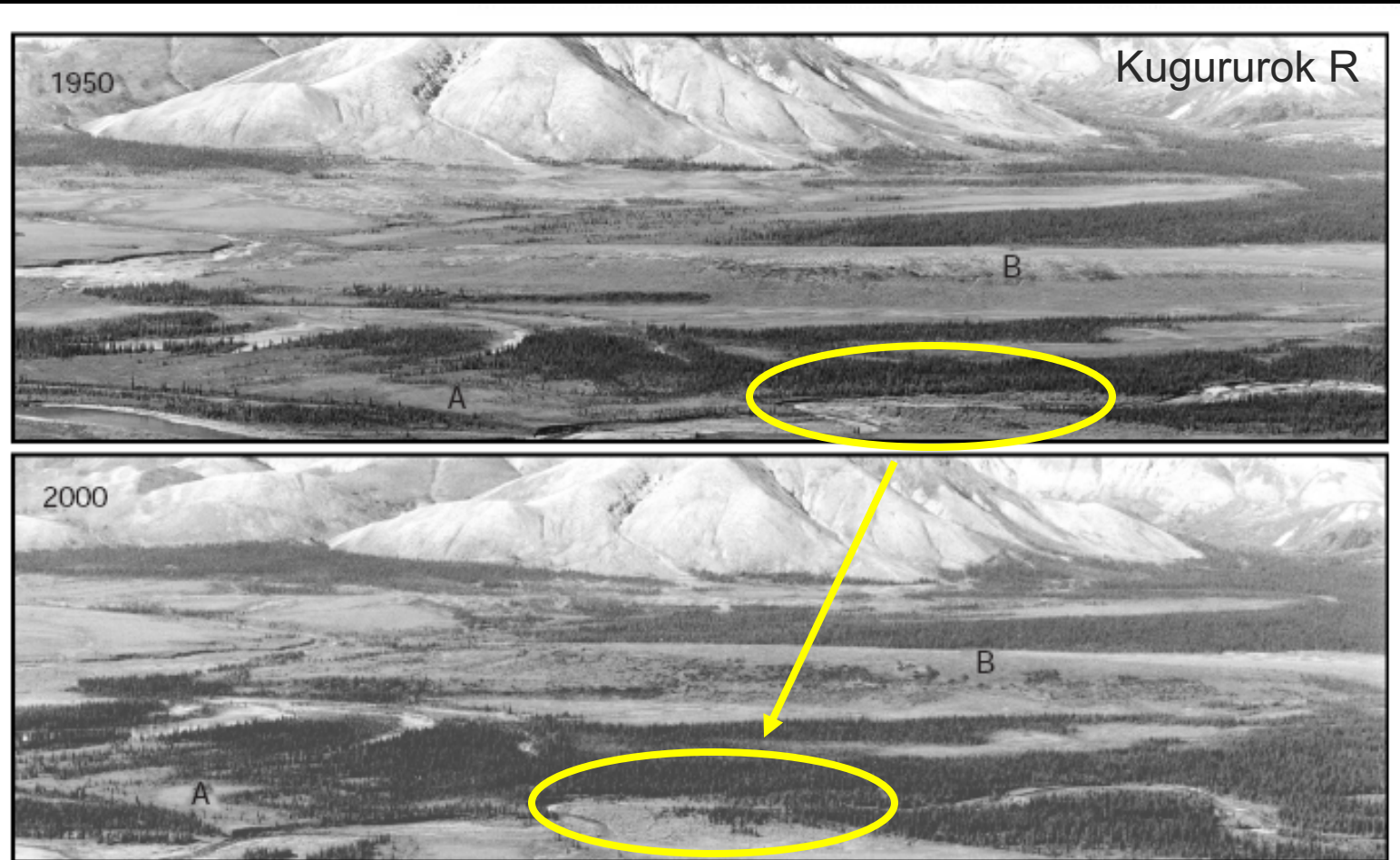
Shrinking water body size, warmer soil and air temps, and longer growing seasons will all likely lead to higher water temperatures

Result:

↑ temps = ↑ aq production (to a point), Δ community composition

Climate Change Effects

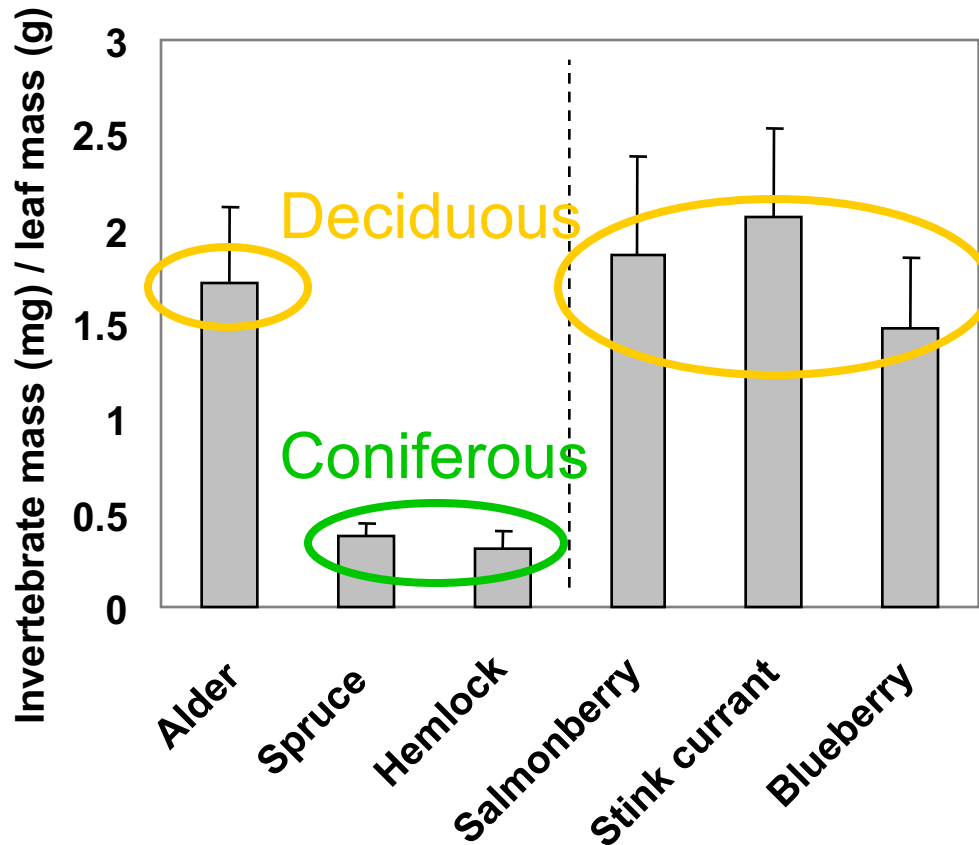
- Terrestrial vegetation cover changes (*valley bottom*)



- Expansion of shrubs (alder, willow, dwarf birch) and spruce along aquatic habitats.

Sturm et al. 2001

Invertebrates on riparian plants



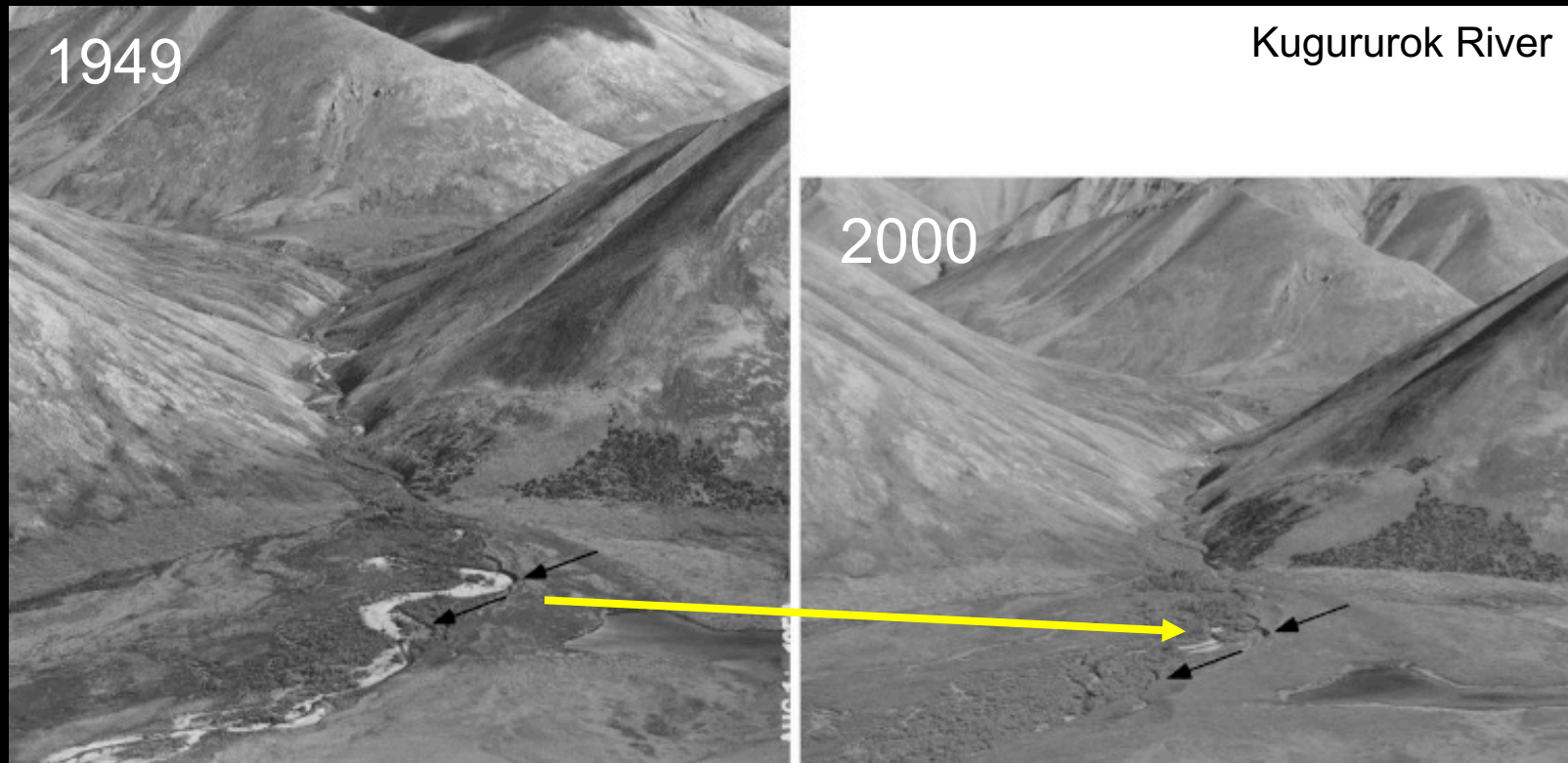
Result:

- ↑ rip veg = Δ food supply
- ↑ litter
- ↑ invert production (?)
- Δ invert community comp

Climate Change Effects

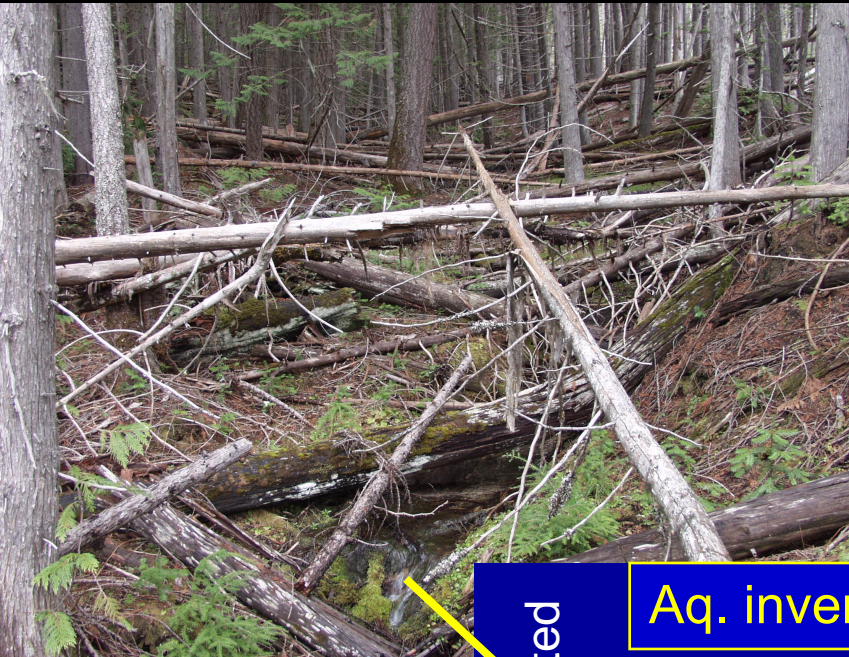
- Terrestrial vegetation cover changes (*headwaters*)

Active stream channels and gravel bars in 1949 are now colonized by shrubs – alder, willow, dwarf birch.



Tape et al. 2006

Spruce riparian



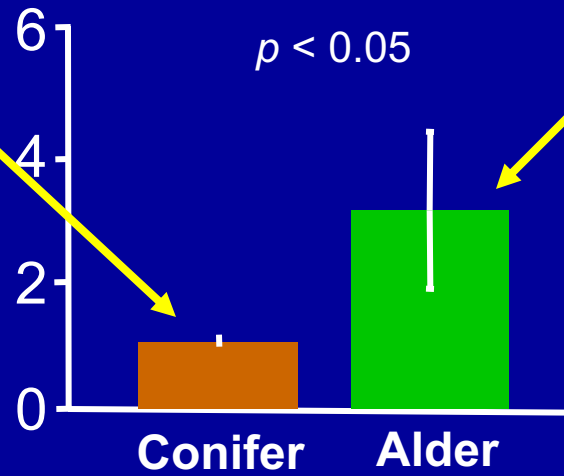
Alder riparian



Maybeso Drainage

Aq. invertebrate drift density

Invertebrate biomass exported
(mg dry mass · m⁻³ water)

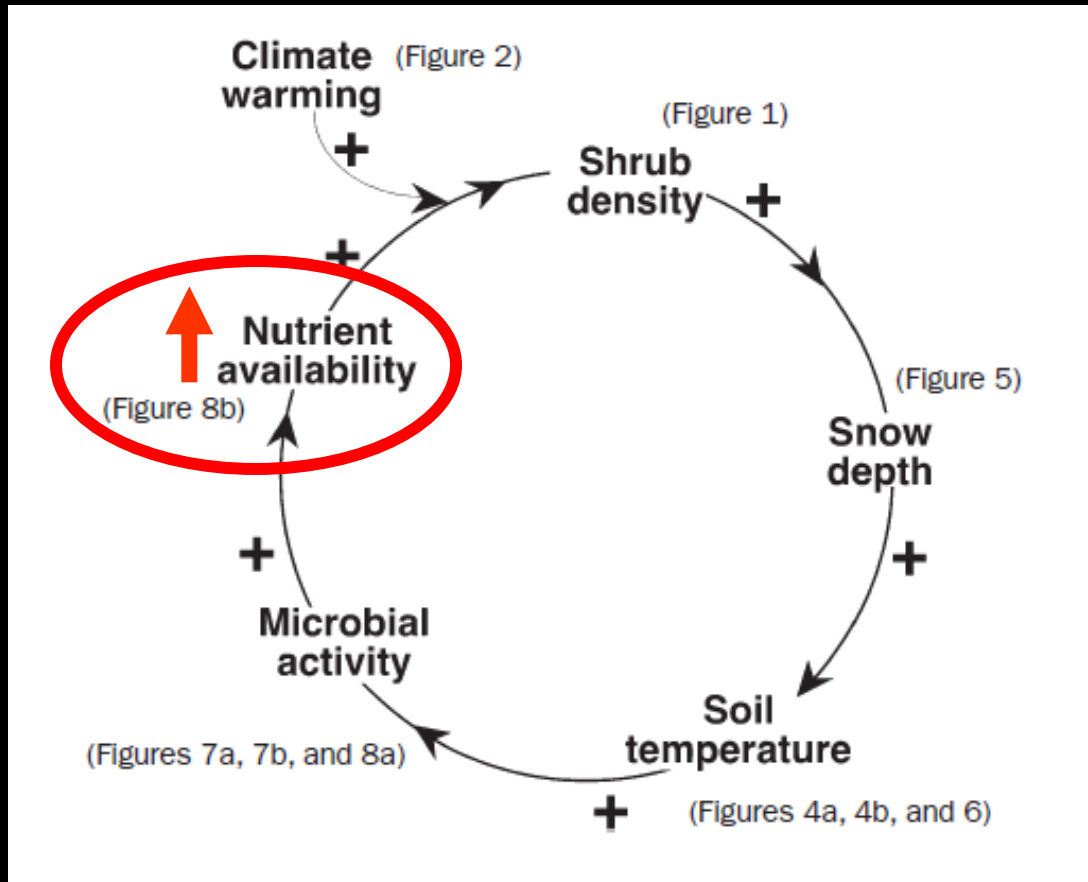


Result:

↑ deciduous veg =
↑ food for aq consumers

Climate Change Effects

- Nutrient loading – from land



Sturm et al. 2005

Stream nutrient addition studies led to higher aq production in Kuparuk studies. *Hobbie et al. 1999*
Benstead et al. 2005

Result (?):

↑ nutrients (N + P) =
↑ aq production
Δ invert composition

Anadromous fish runs enrich streams with nutrients

- Shown to increase aquatic productivity in Alaska & the PNW



↑ nutrients (N + P) =

↑ aq production (all trophic levels)

↑ fish growth rates, production,
lipid levels

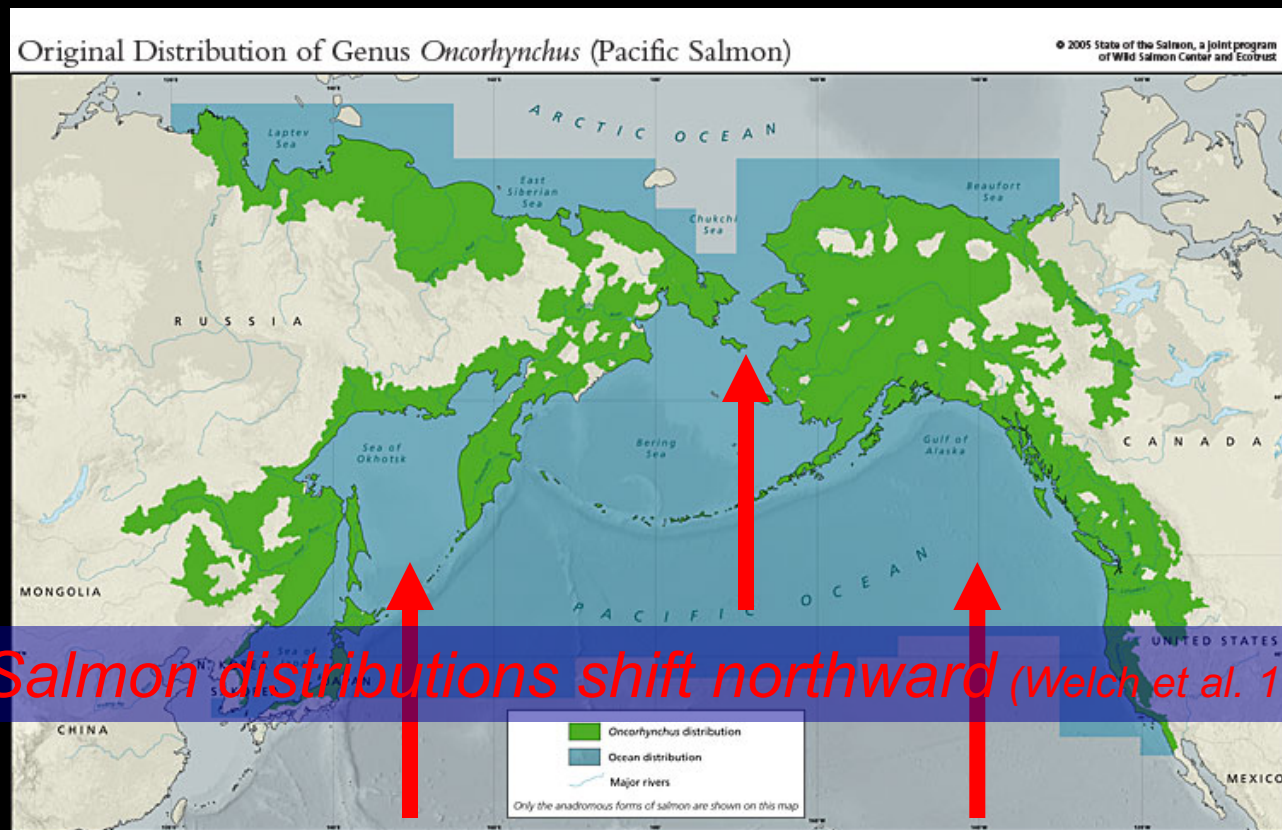
Bilby et al. 1996, 1998

Heintz 2004

Wipfli et al. 1998, 2003, 2004

Climate Change Effects

- Warming ocean currents



Salmon distributions shift northward (Welch et al. 1998)

Climate Change Effects

- Nutrient loading – from the sea



Result (?):

↑ nutrients (N + P) =

↑ aq production

Δ invert community composition

Summary – hypothesized climate change effects

- Increased temperatures = \uparrow invertebrate production
 - Δ invertebrate community composition
 - Δ seasonal occurrence

Summary – hypothesized climate change effects

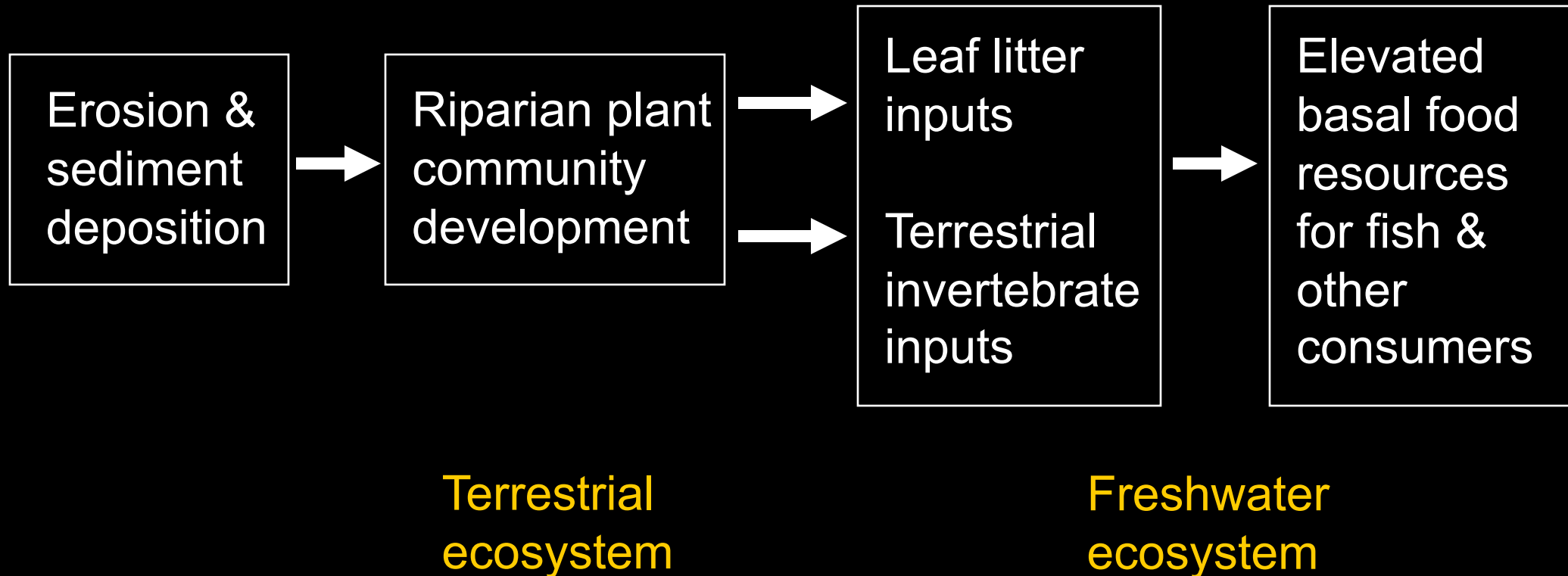
- Increased temperatures = ↑ invertebrate production
 - △ invertebrate community composition
 - △ seasonal occurrence
- Terrestrial veg expansion = ↑ invertebrate abundance
 - △ invertebrate community composition
 - △ seasonal occurrence

Summary – hypothesized climate change effects

- Increased temperatures = ↑ invertebrate production
 Δ invertebrate community composition
 Δ seasonal occurrence
- Terrestrial veg expansion = ↑ invertebrate abundance
 Δ invertebrate community composition
 Δ seasonal occurrence
- Nutrient loading = ↑ invertebrate production
 Δ invertebrate community composition
 Δ seasonal occurrence

Summary – hypothesized climate change effects

Physical processes dictate biological outcomes in riverine systems





Questions?!?