Restoring salmon in a changing climate

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Outline

- Guiding questions
- Predicted climate change effects
- Salmon vulnerability to climate change
- Adapting restoration plans to accommodate climate change

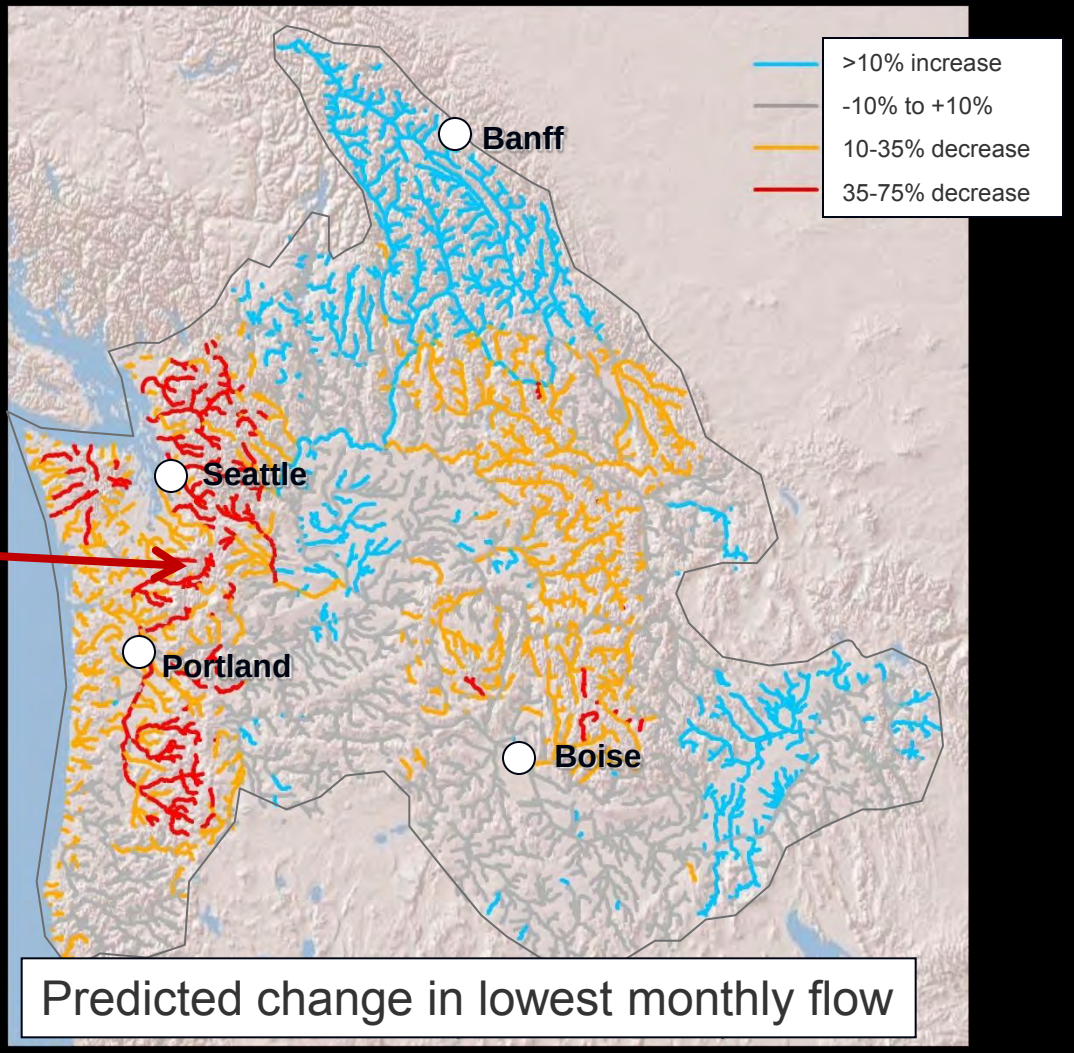
Do climate change predictions alter restoration plans?

- What habitat factors limit salmon recovery?
- What are local predicted climate change effects?
- Do proposed restoration actions reduce climate change effects?
- Do proposed restoration actions increase habitat diversity or ecosystem resilience?

Projected change in low flow

- Change in lowest monthly flow between 1980s and 2080s

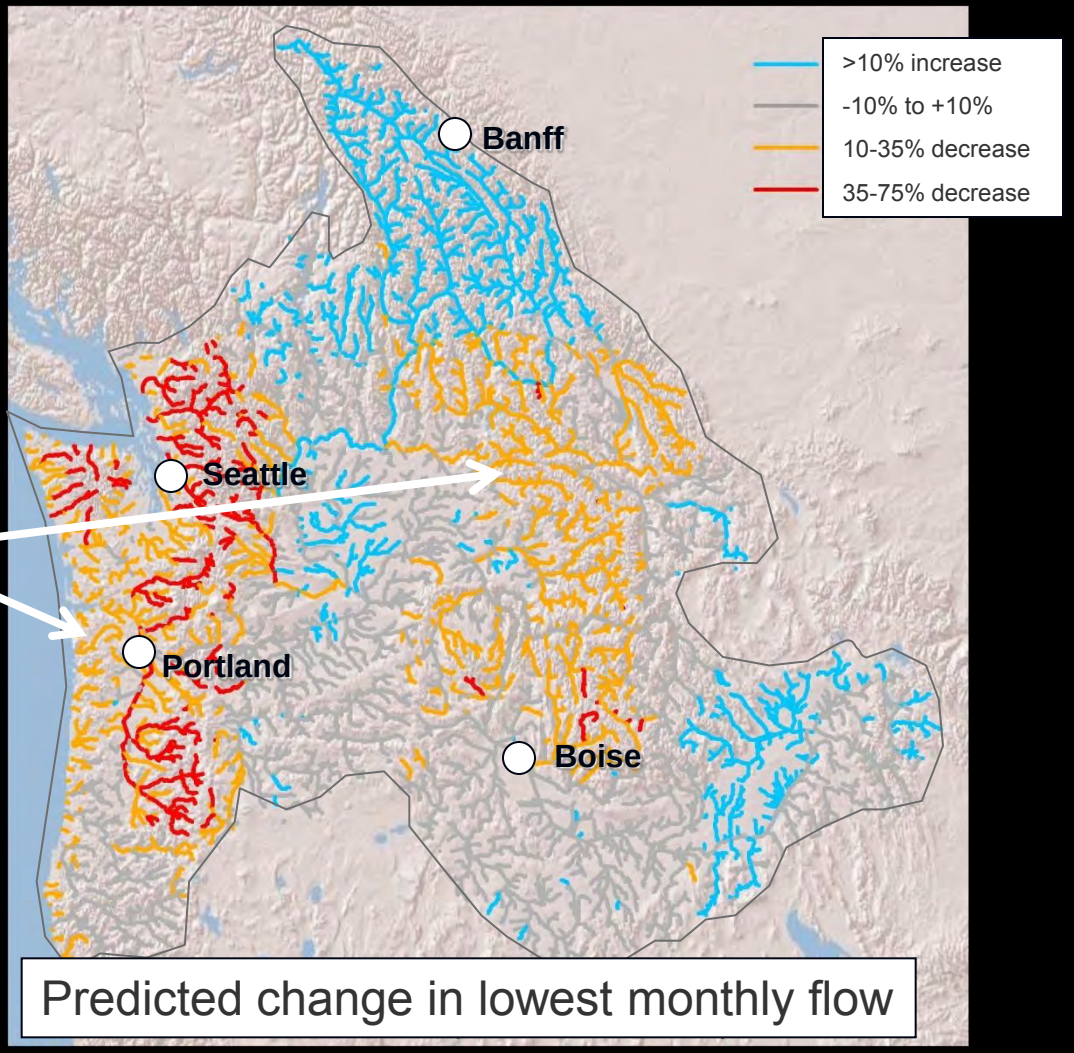
35-75% Decrease



Projected change in low flow

- Change in lowest monthly flow between 1980s and 2080s

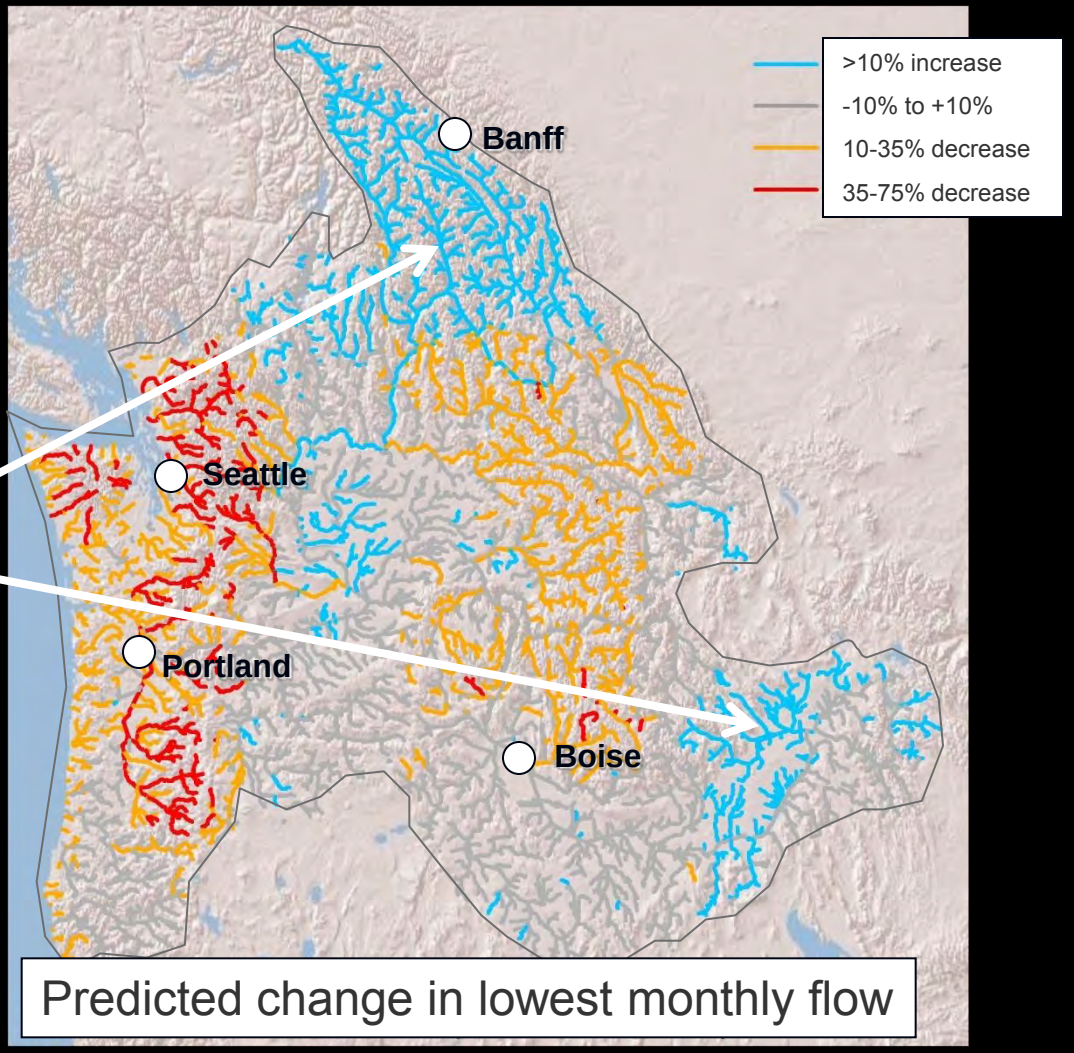
10-35% Decrease



Projected change in low flow

- Change in lowest monthly flow between 1980s and 2080s

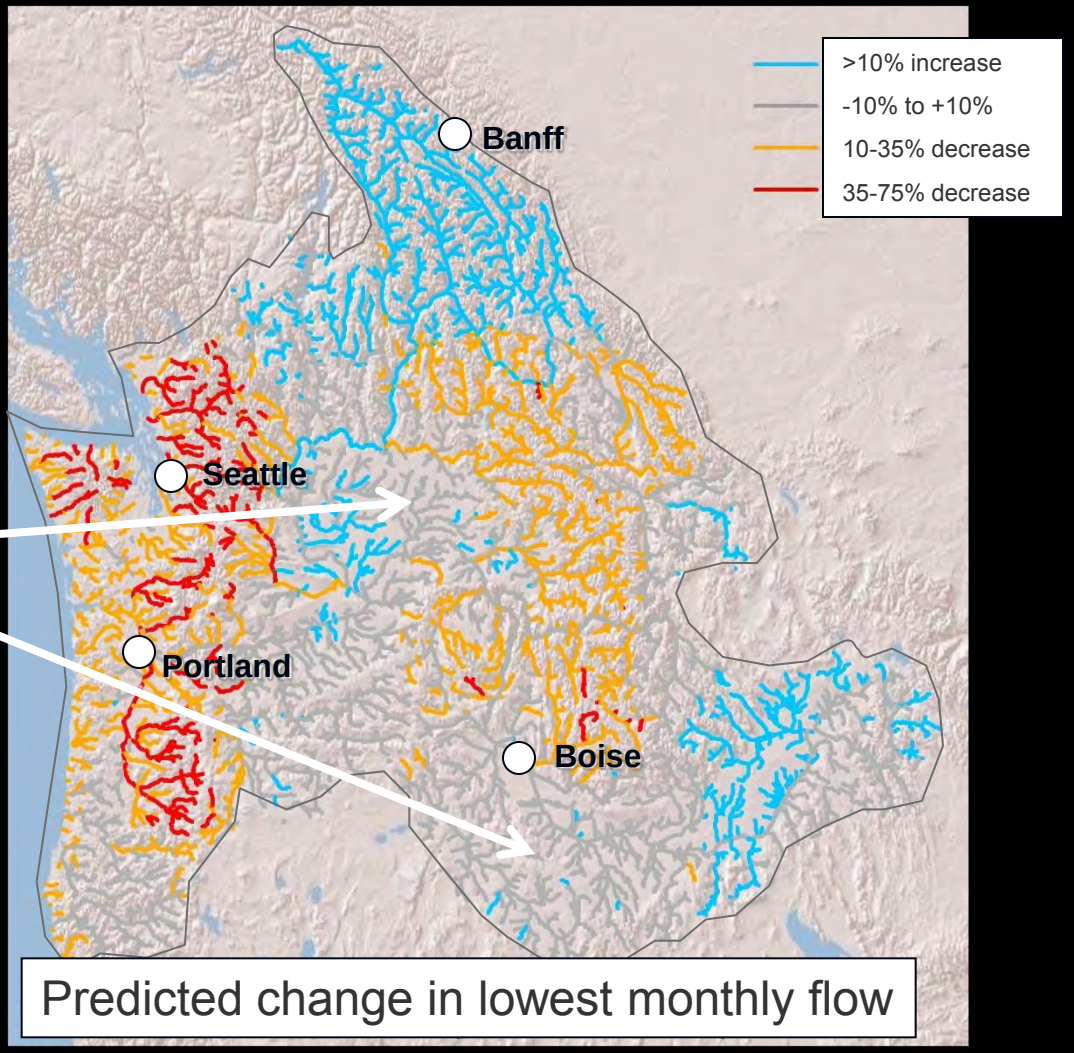
>10% Increase



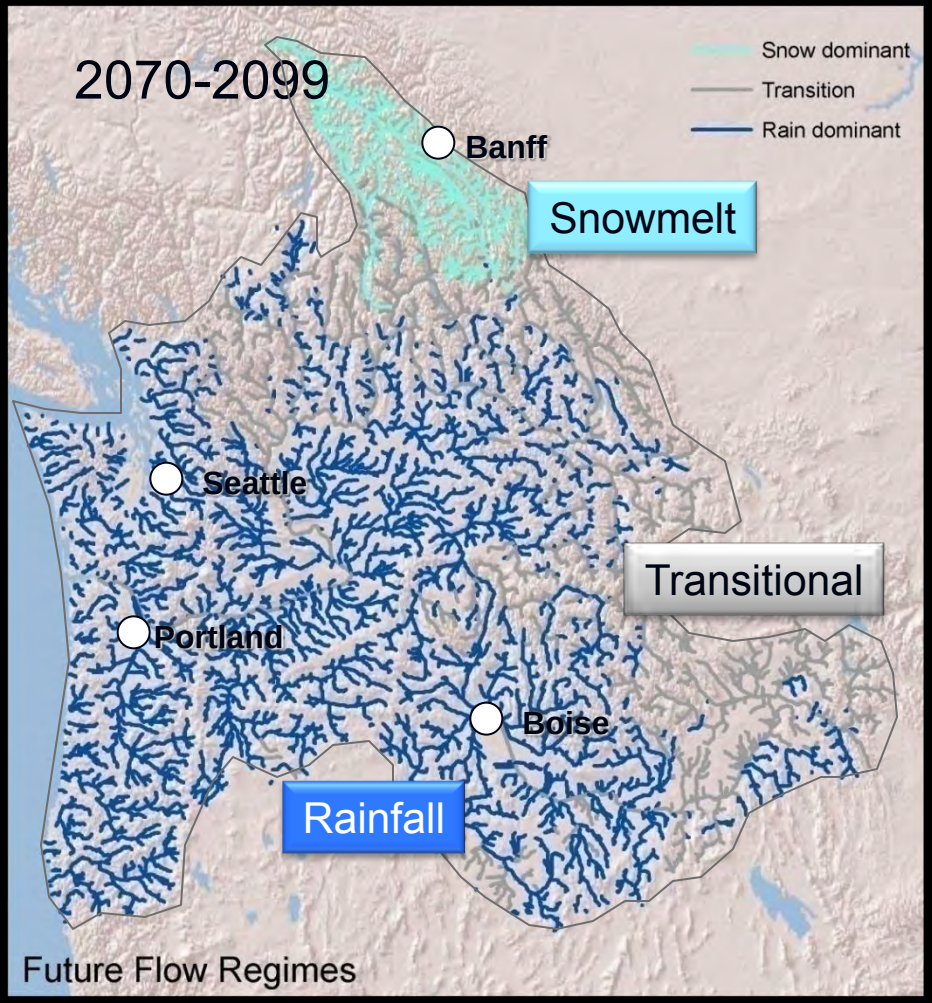
Projected change in low flow

- Change in lowest monthly flow between 1980s and 2080s

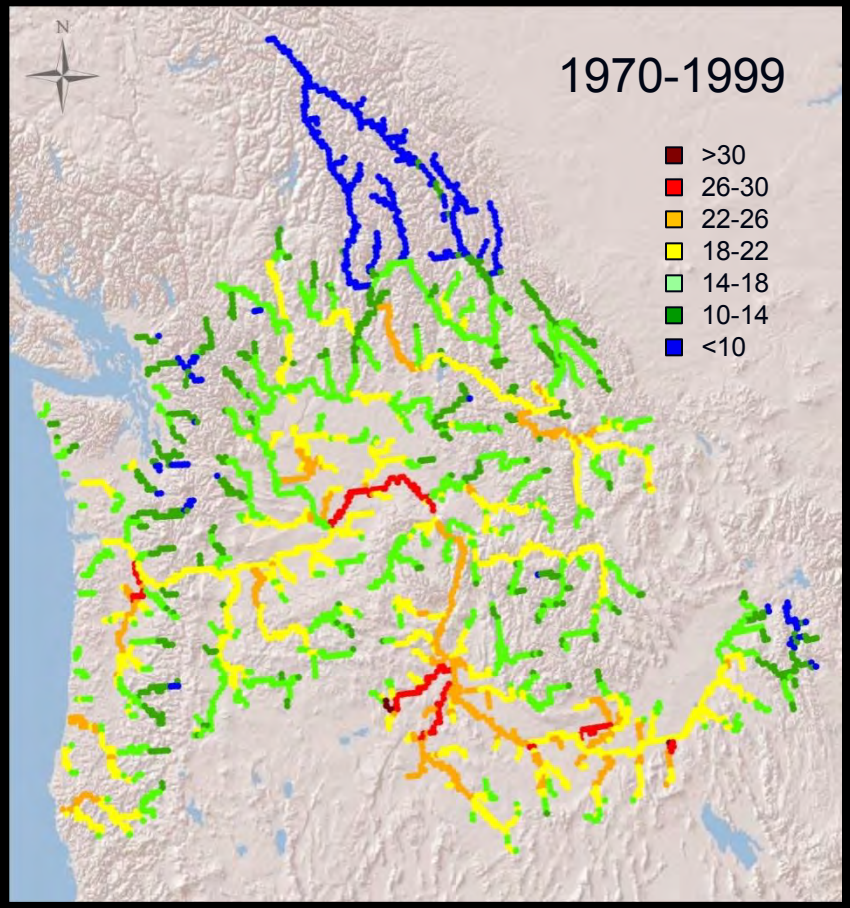
No change

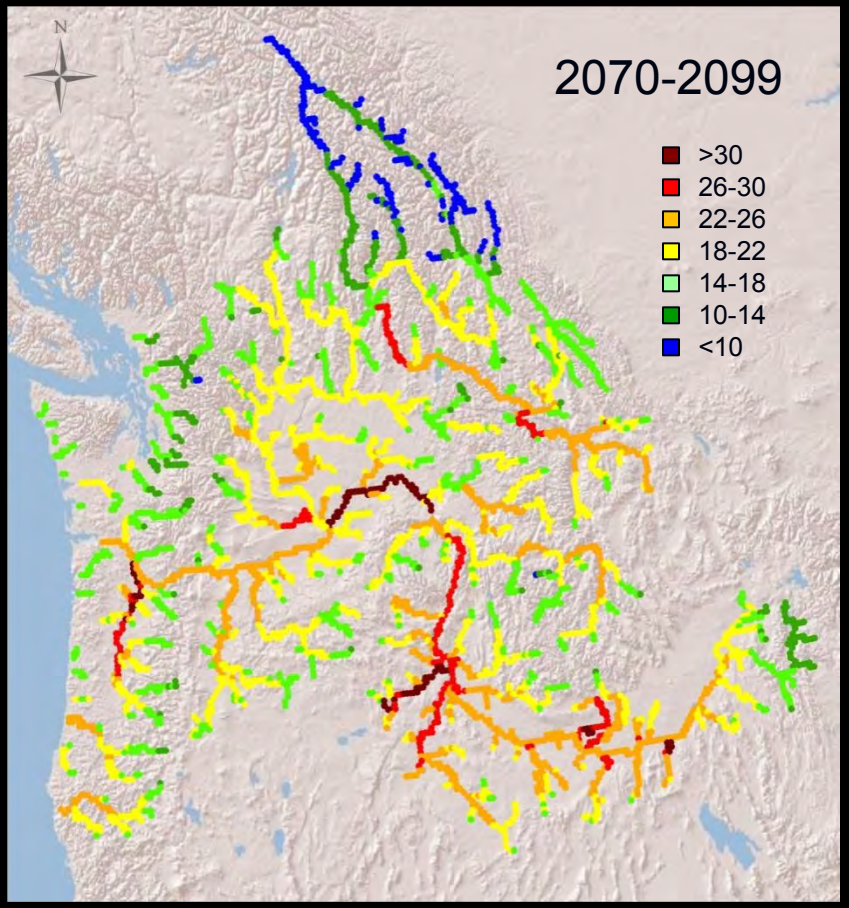


Projected change in flow regime



Projected summer temperature change





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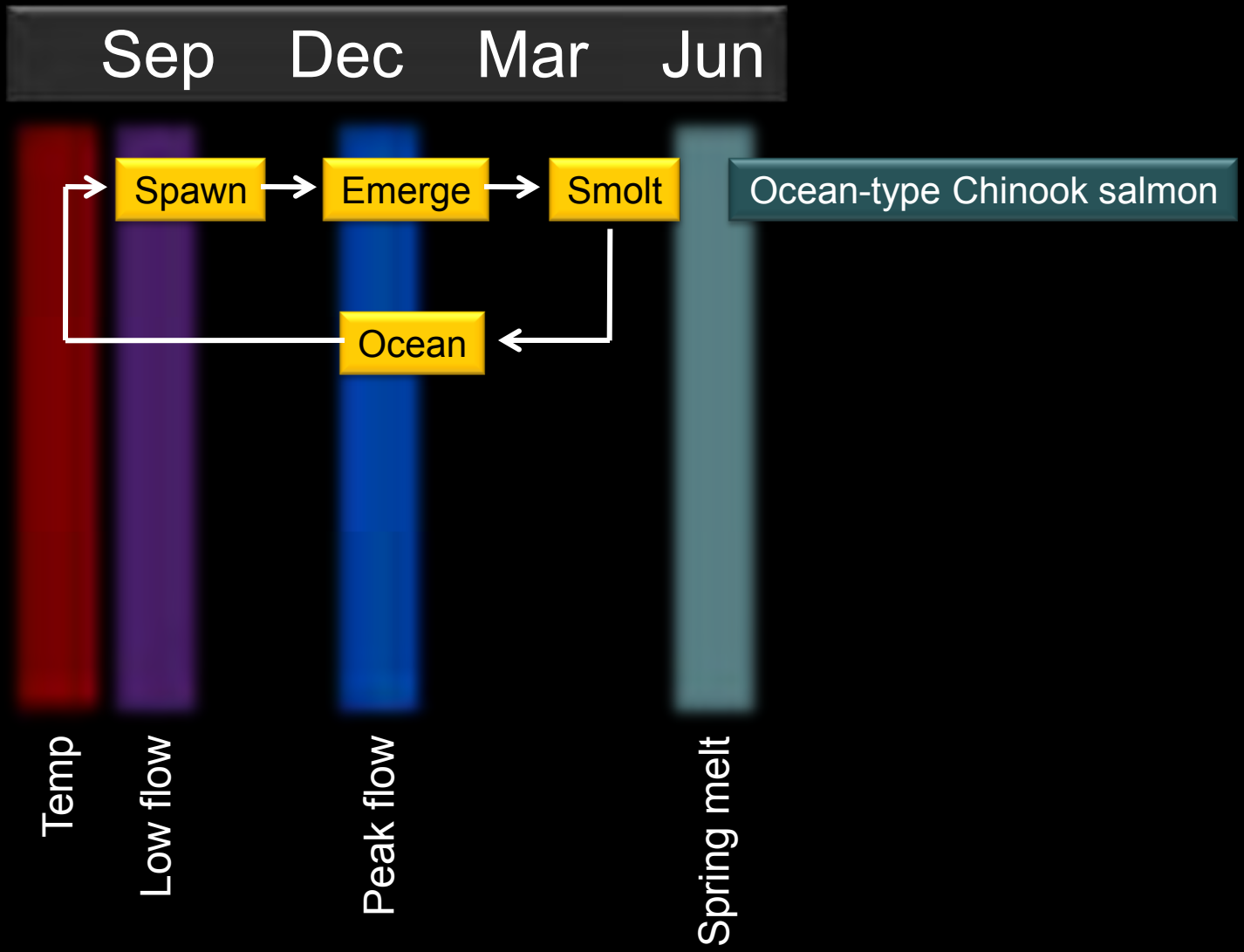

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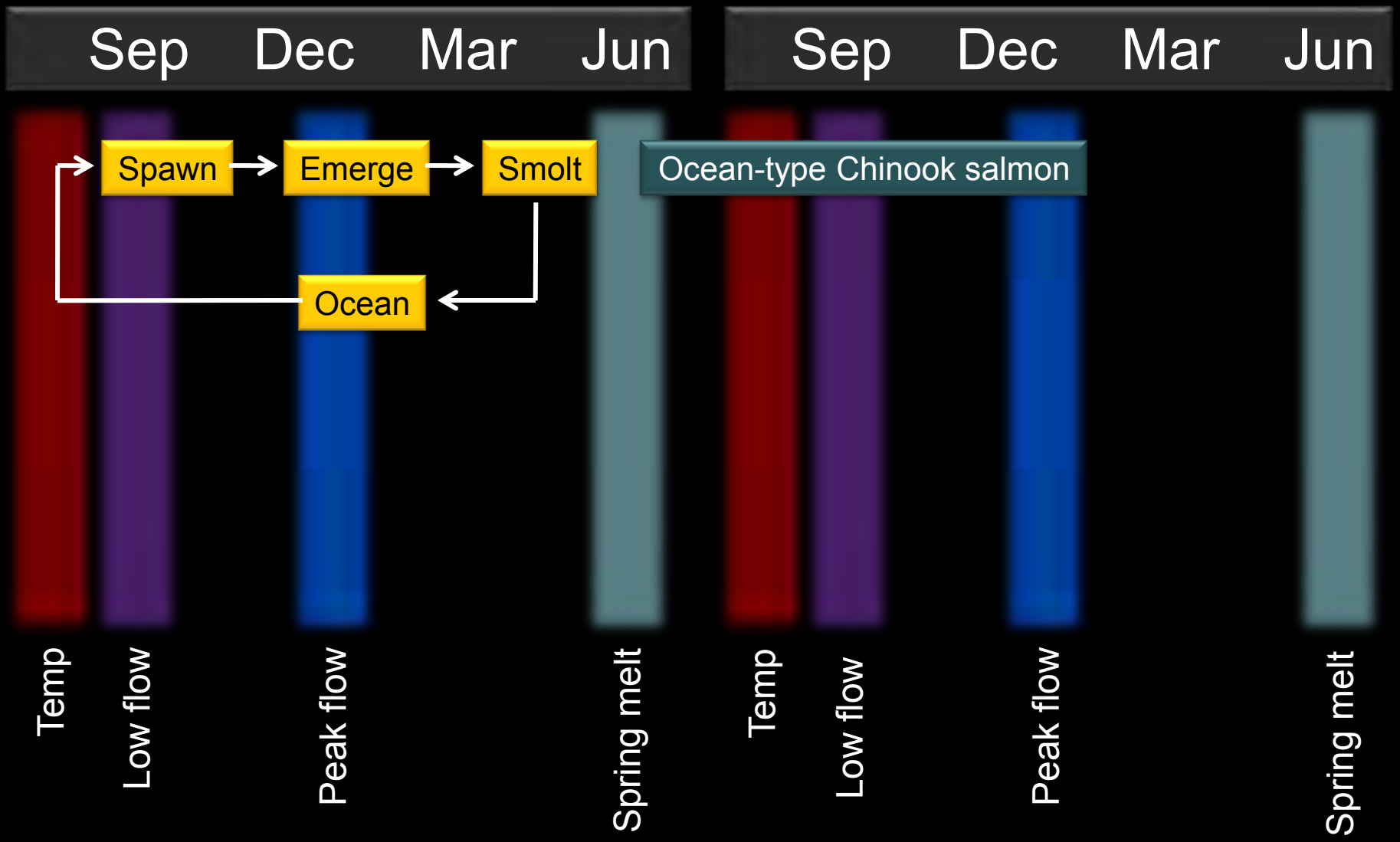

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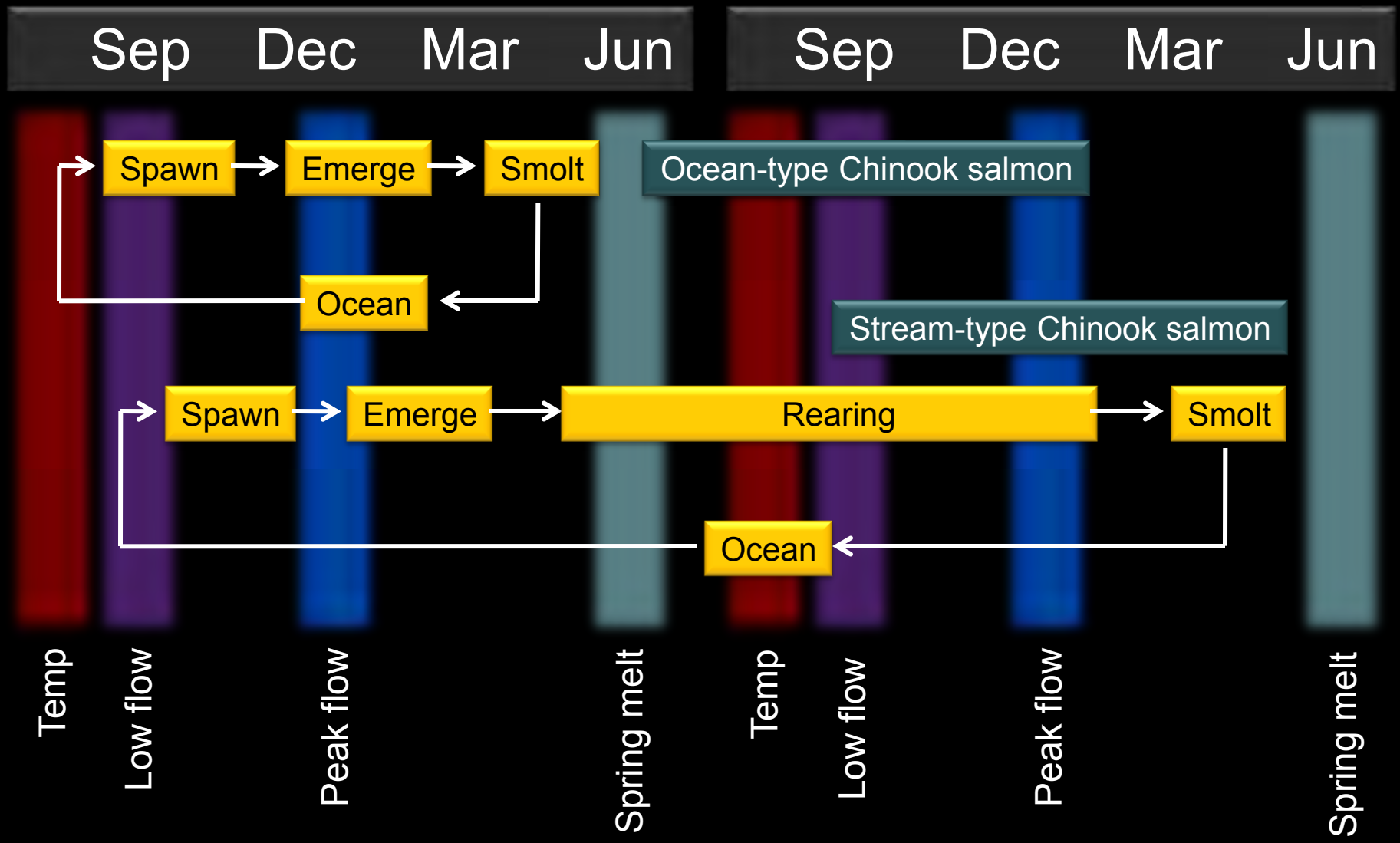
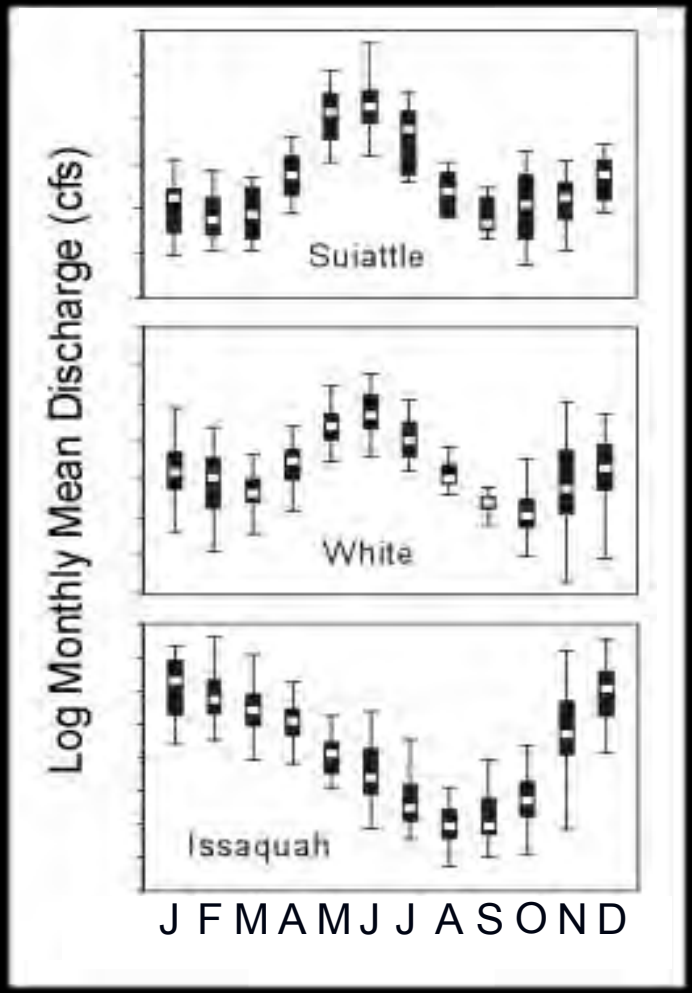


Flow regime and Chinook life history

Stream-type Chinook

Ocean-type Chinook



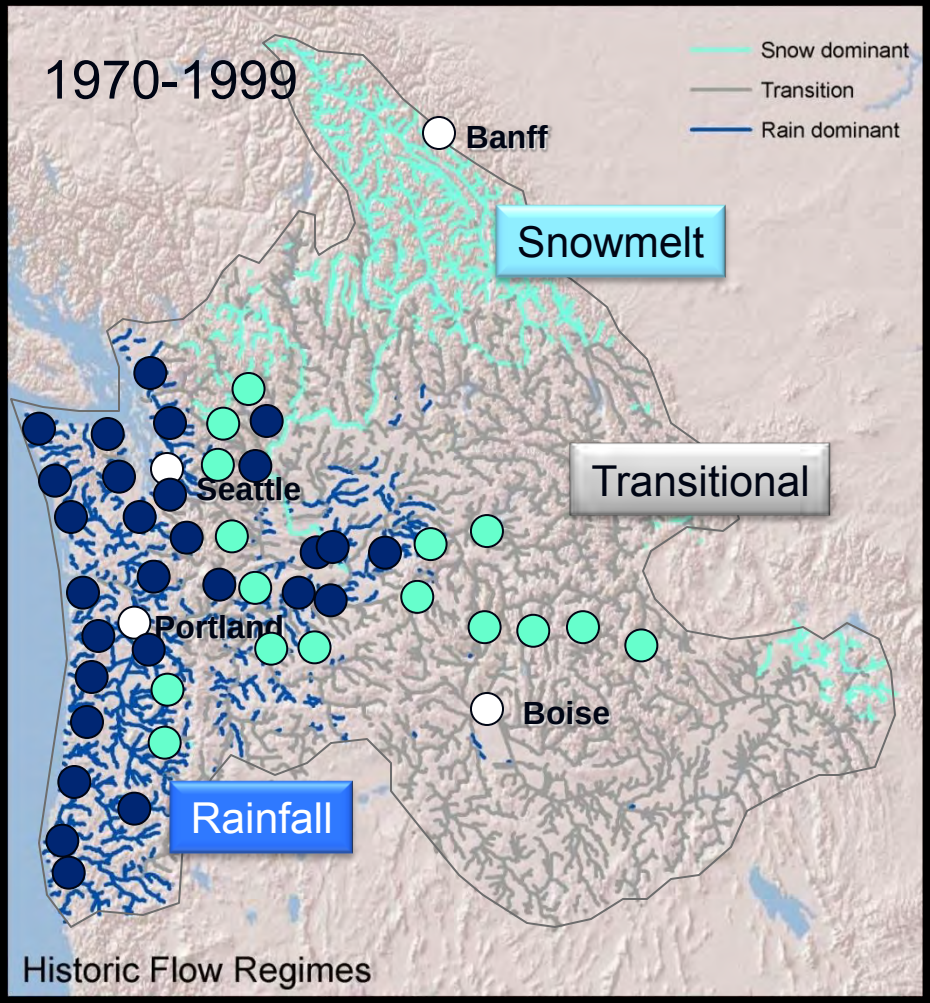
Snowmelt

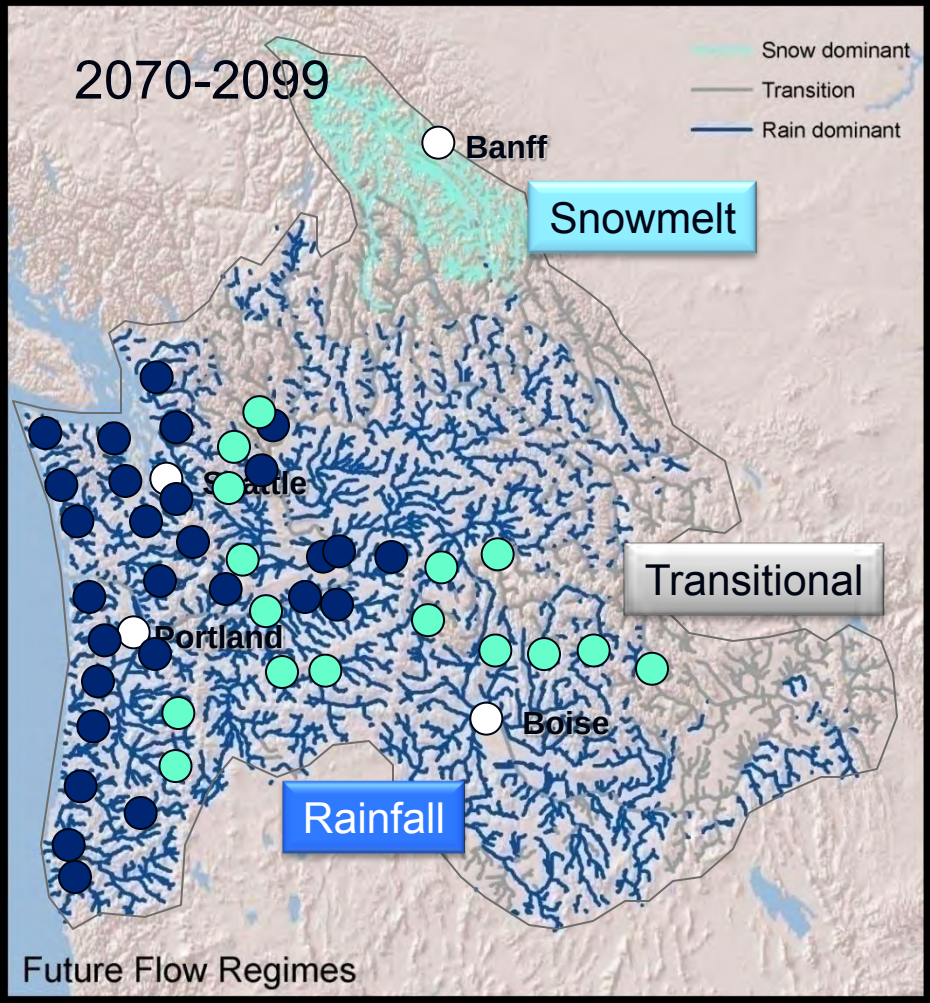
Transitional

Rainfall

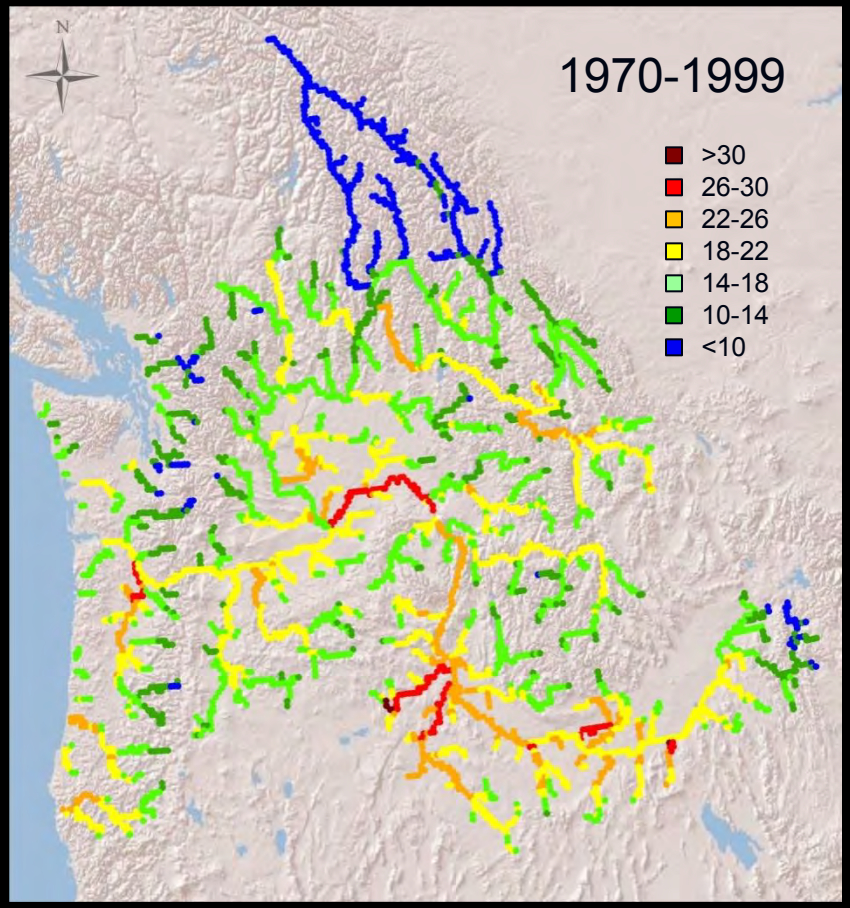
Beechie et al. 2006

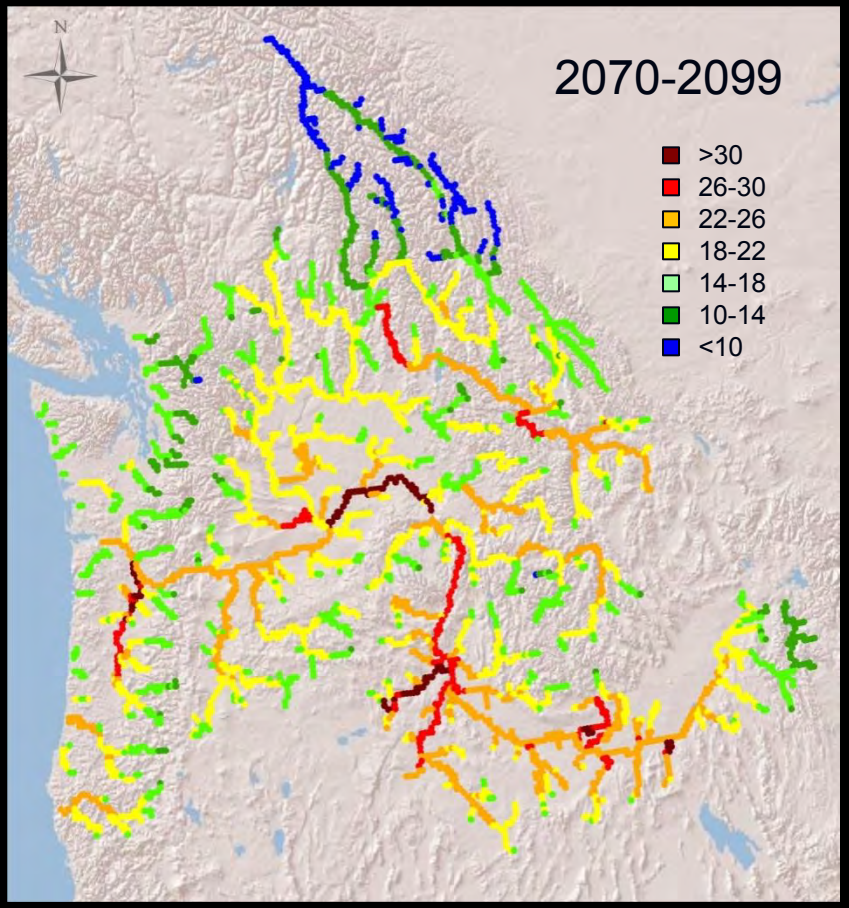
Flow regime and Chinook life history





Temperature change and salmon



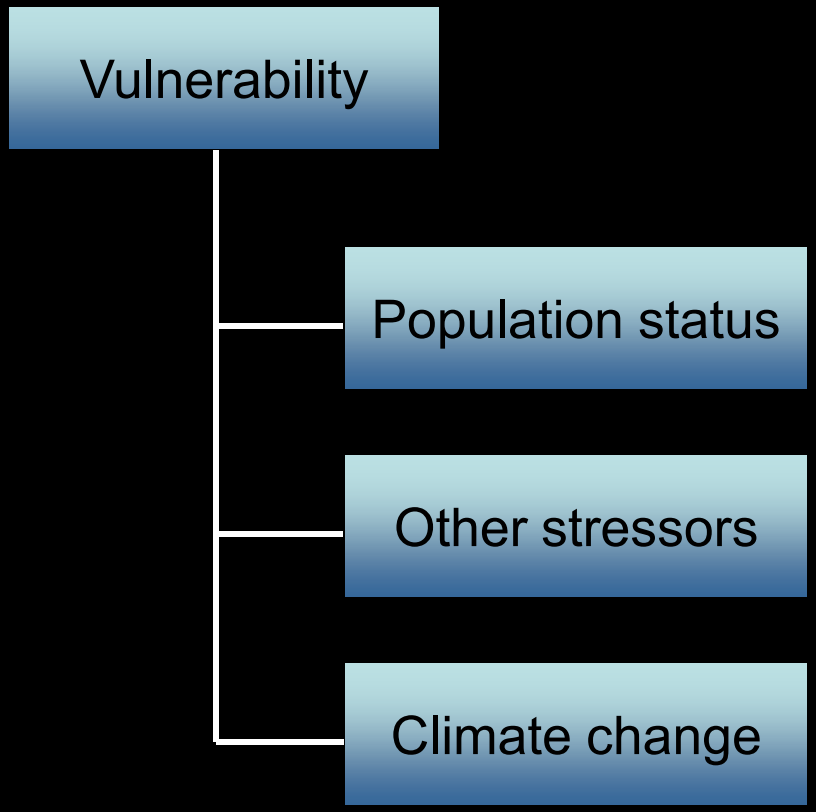


Below threshold
- <10°C
- 10-14°C
- 14-18°C

Near threshold
- 18-22°C

Above threshold
- 22-26°C
- 26-30°C
- >30°C

Salmon vulnerability to climate change

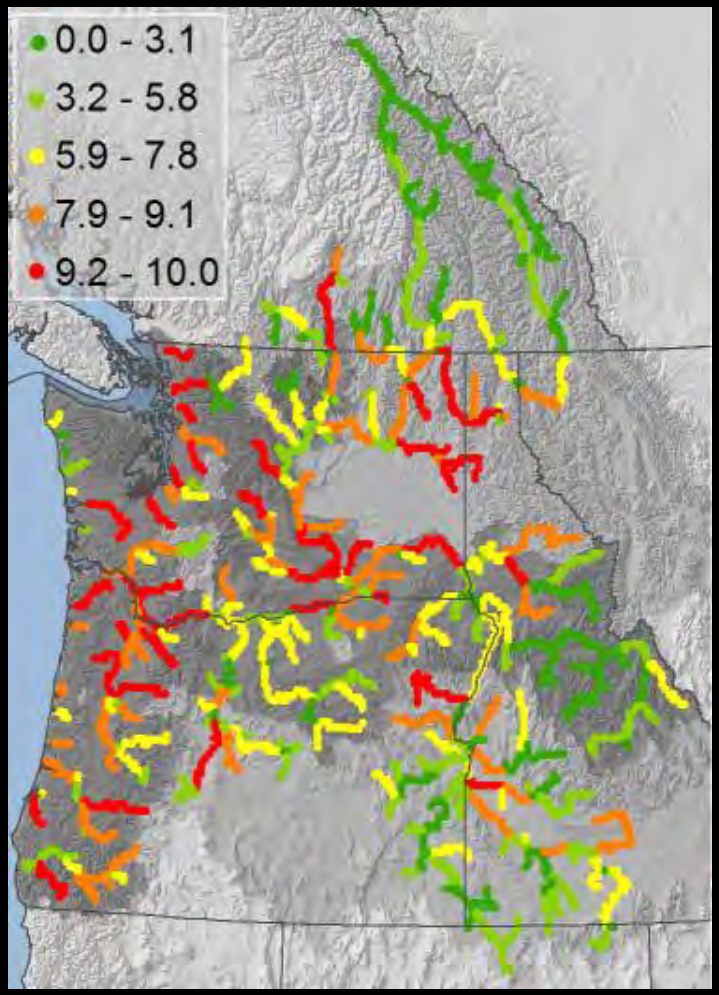


- Conceptual basis:

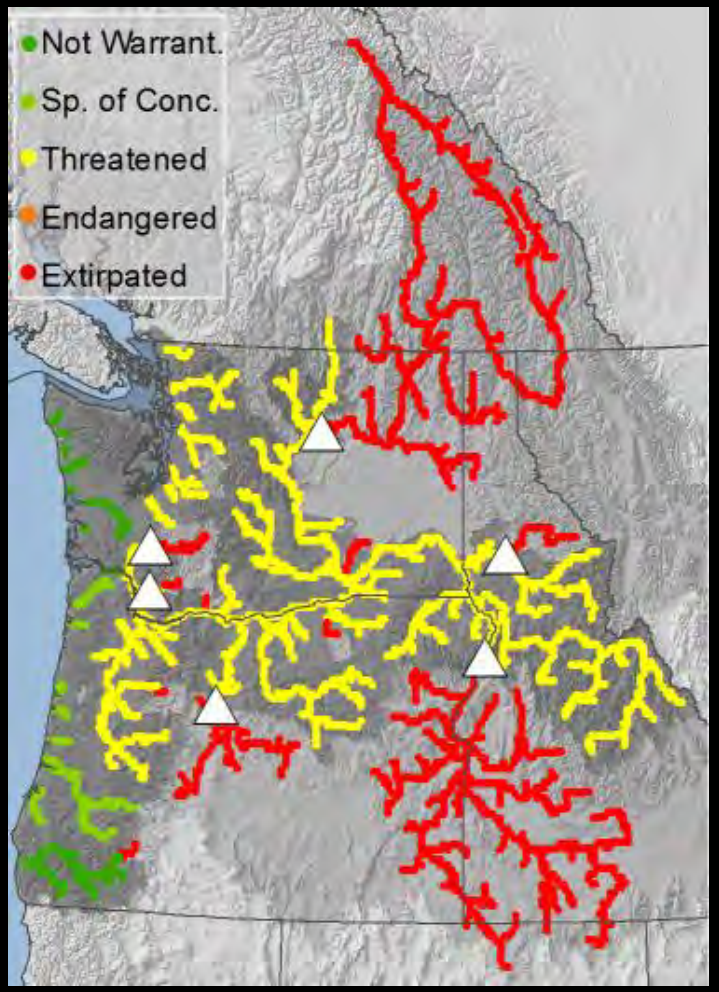
  Existing stresses reduce salmon's ability to respond to climate change

Vulnerability patterns

Habitat stress



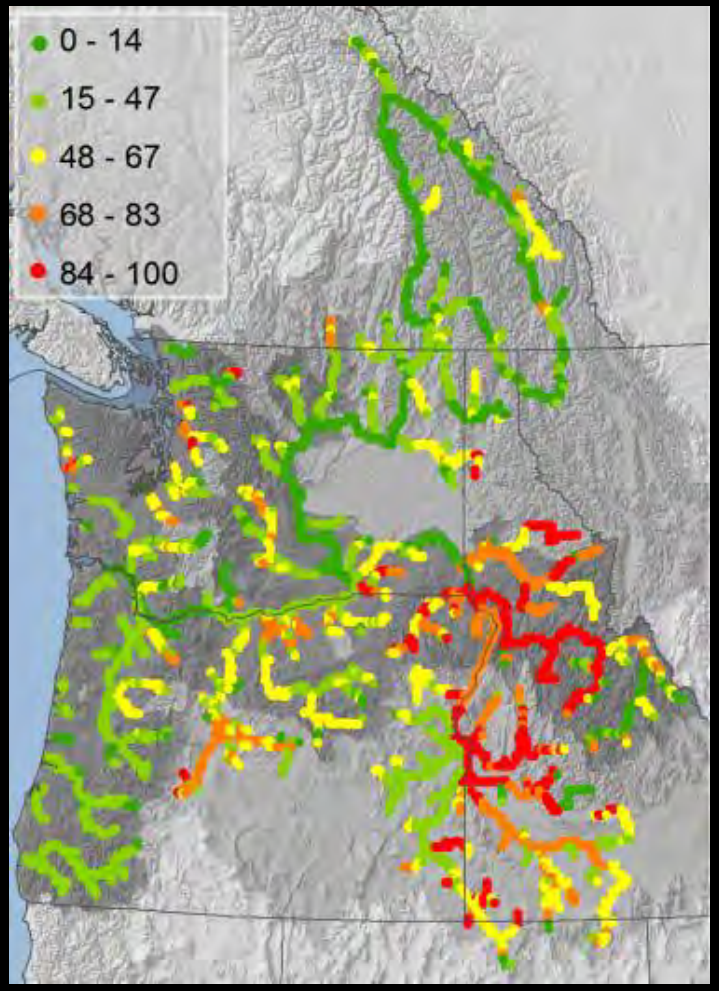
Stock status stress



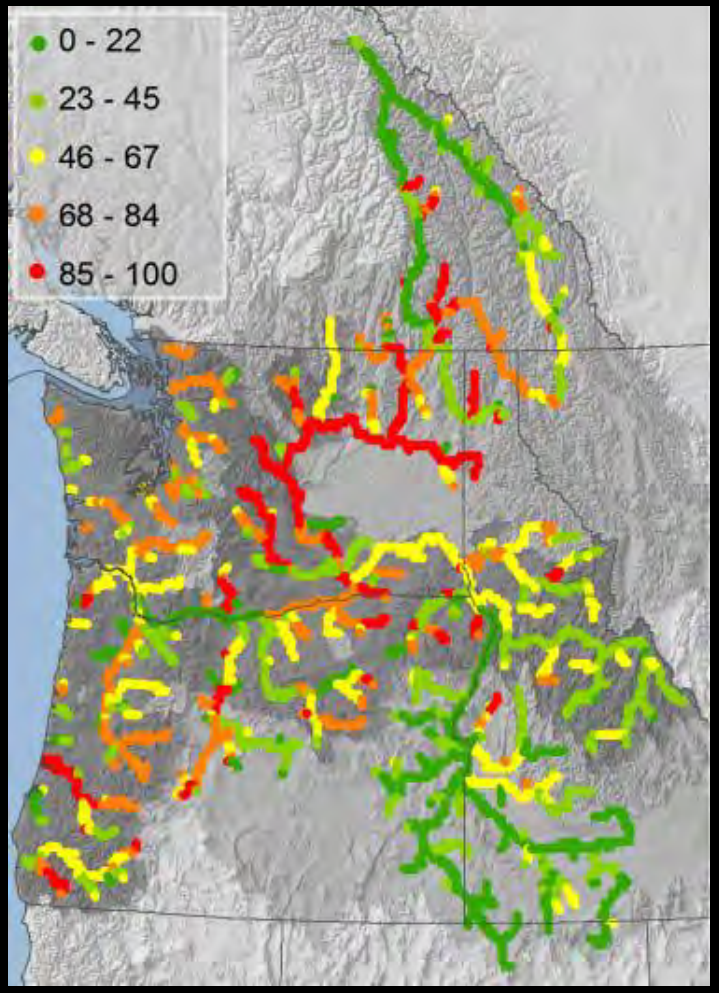
Wade et al. in prep

Vulnerability patterns

Future temperature stress (2040s)

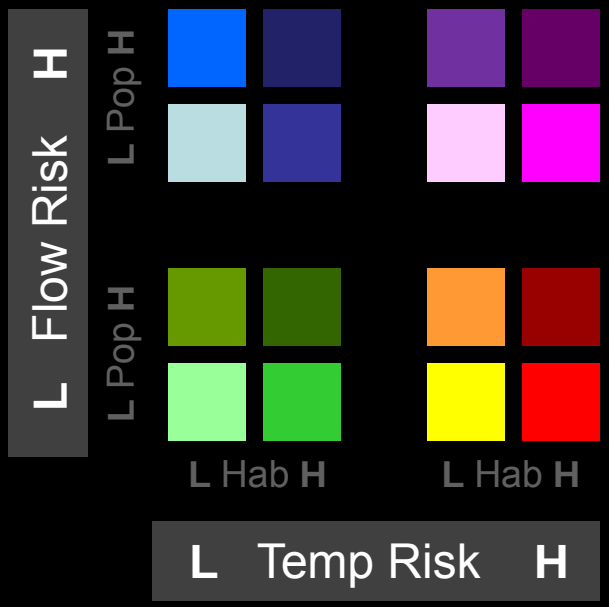


Future flow stress (2040s)

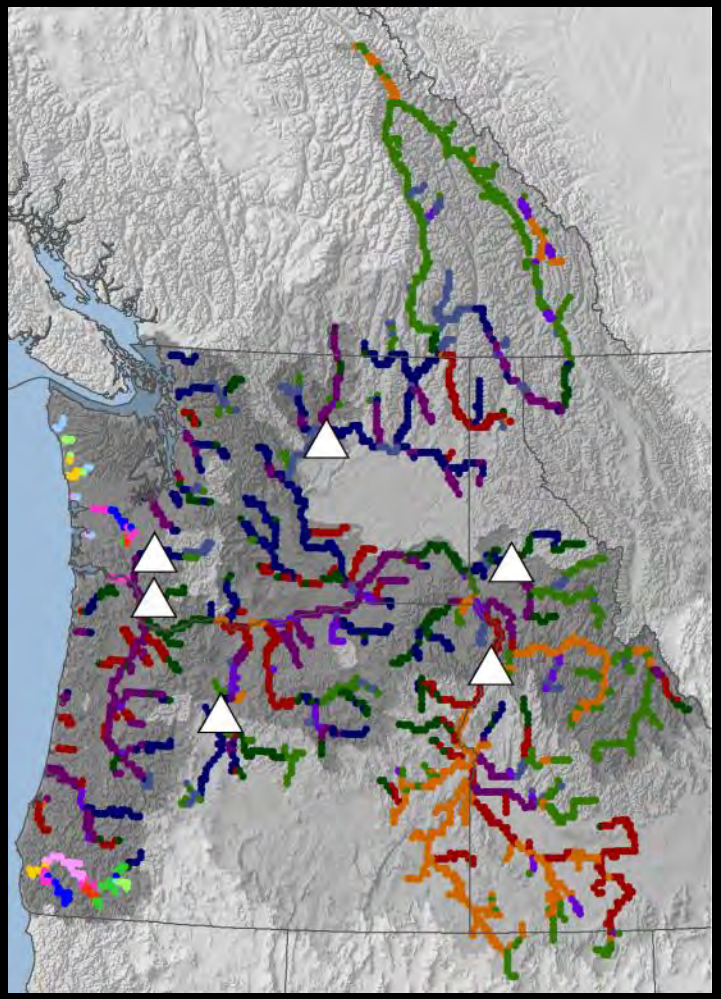


Wade et al. in prep

Steelhead vulnerability patterns



Steelhead vulnerability (2040s)



Wade et al. in review


Adapting salmon recovery plans

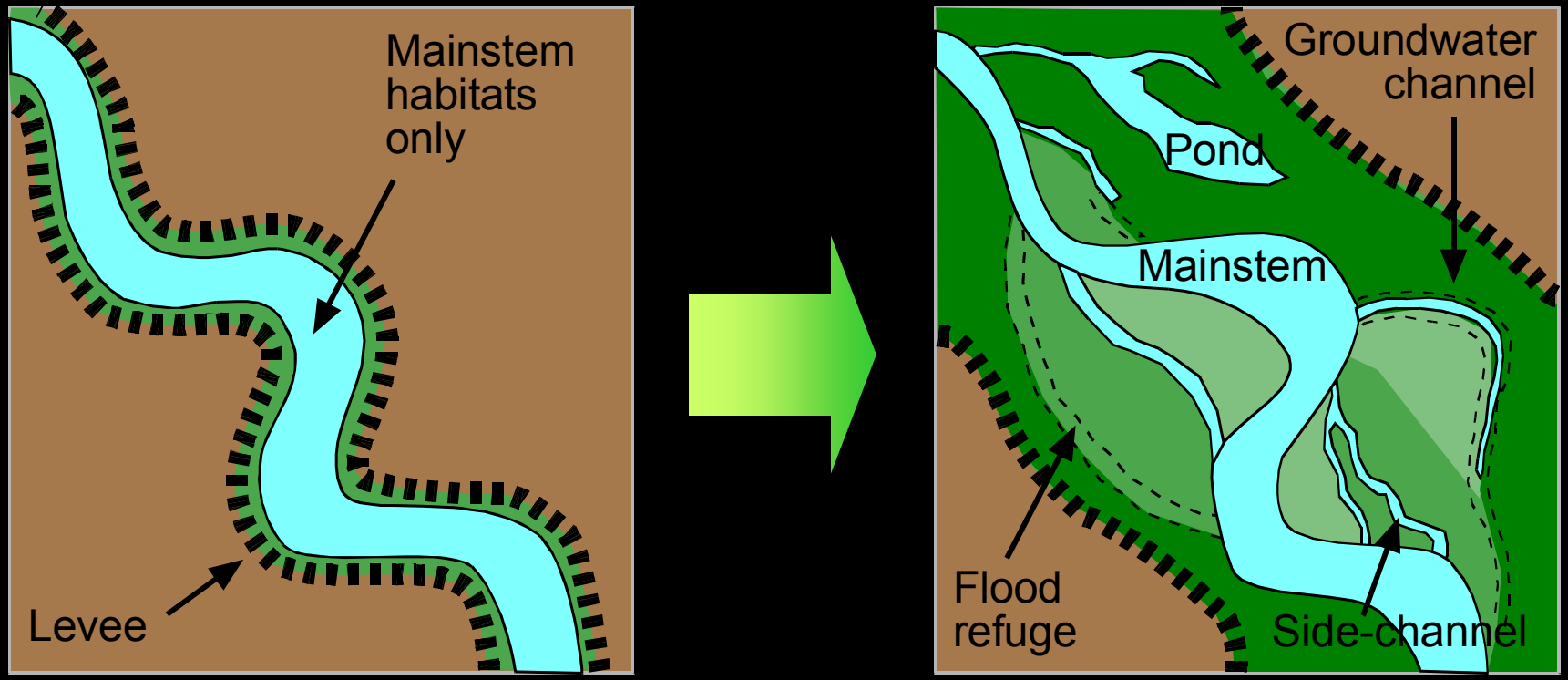
Key questions

- What habitat factors limit salmon recovery?
- What are local predicted climate change effects?
- Do proposed restoration actions reduce climate change effects?
- Do proposed restoration actions increase habitat diversity or ecosystem resilience?

Literature review

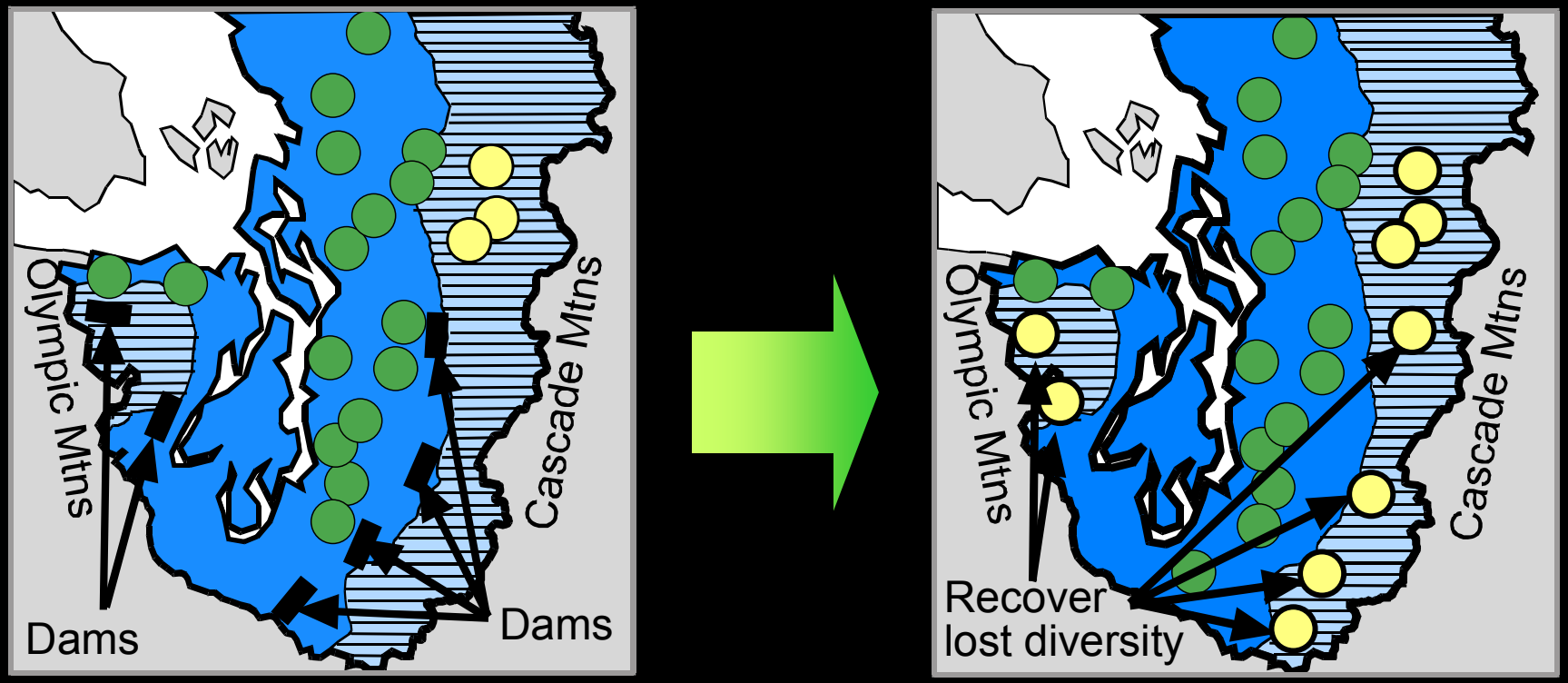
- Does the action ameliorate a climate effect?
  - Increased peak flow
  - Decreased low flow
  - Increased stream temperature
- Does the action increase habitat diversity and population resilience?
  - Must increase habitat diversity enough to accommodate additional species or life-history types

Increase habitat diversity



Waples et al. 2008

Restore access to diverse habitats



Rainfall/transitional hydrologic regime

Ocean-type Chinook population

Snowmelt hydrologic regime

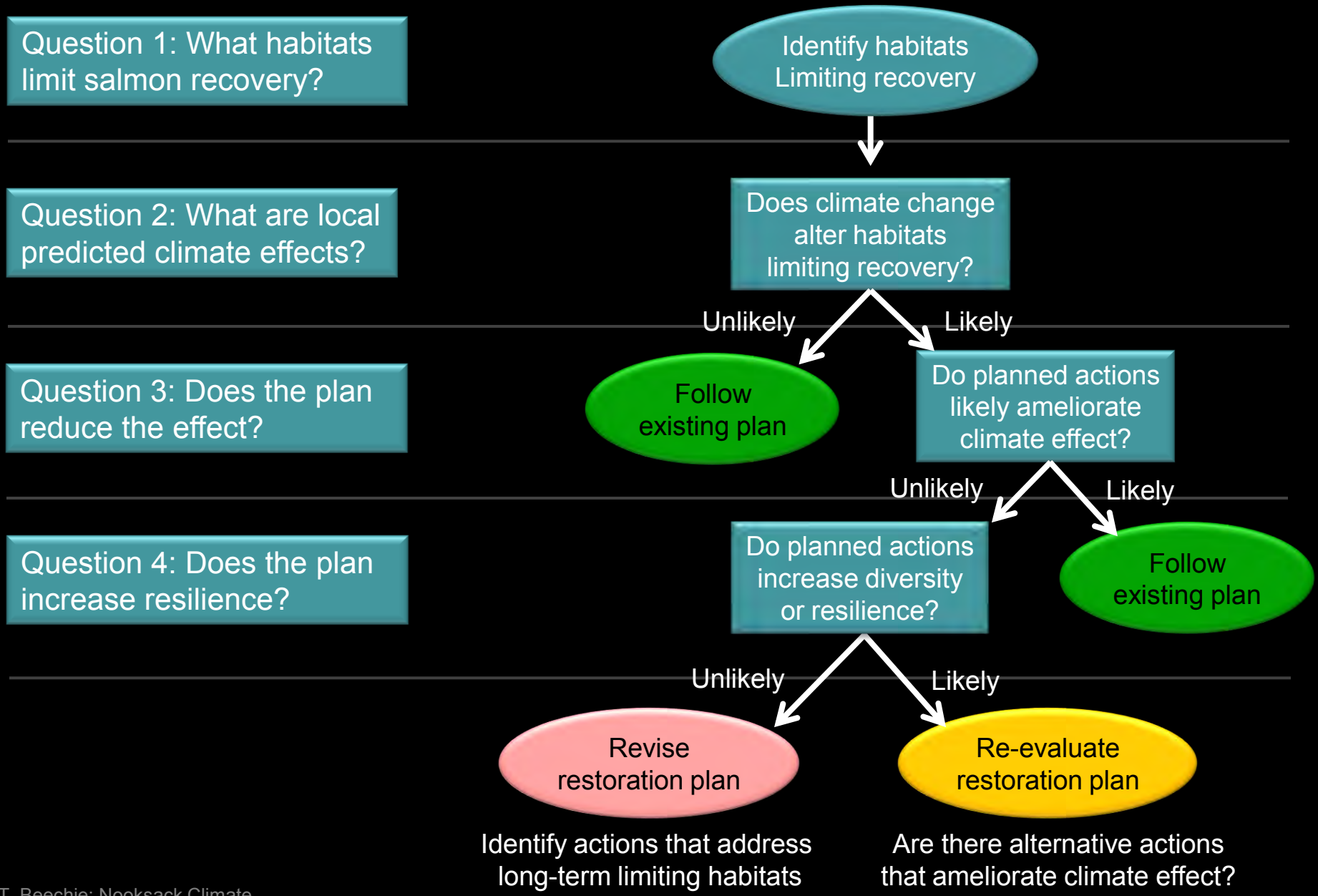
Stream-type Chinook population

Waples et al. 2008

Restoration actions and climate change

Restoration action	Temperature increase	Low flow decrease	Peak flow increase	Increase resilience
Longitudinal connectivity	Y	Y	N	Y
Floodplain connectivity	Y	N	Y	Y
Restore incised channel	Y	Y	Y	Y
Restore in-stream flow	Y	Y	N	N/Y
Riparian rehabilitation	Y	N/Y	N	N
Sediment reduction	N	N	N	N
In-stream habitat	N	N	N	N
Nutrient enrichment	N	N	N	N

Evaluating a restoration plan



Summary

- Does climate change alter restoration plans?
  - Climate change effects vary across the region
  - Restoration actions vary in their ability to ameliorate climate change effects
- Restoration strategies to increase resilience
  - Restore connectivity
  - Increase habitat diversity (floodplains)
  - Restore flow regimes

References

- Beechie, T, H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney, N. Mantua. 2012. Restoring salmon habitat for a changing climate. River Research and Applications. DOI: 10.1002/rra.2590.

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