

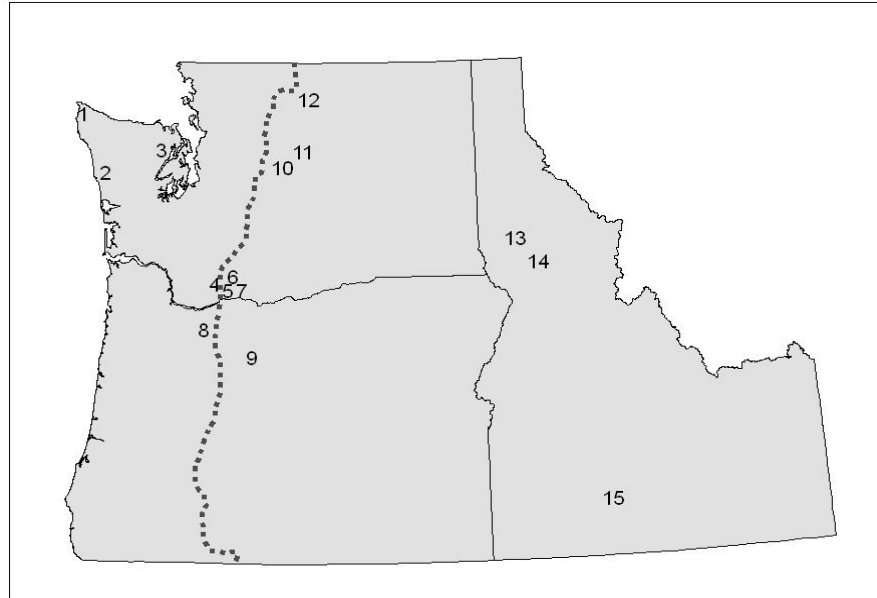


Assessing the vulnerability of NFH's to climate change



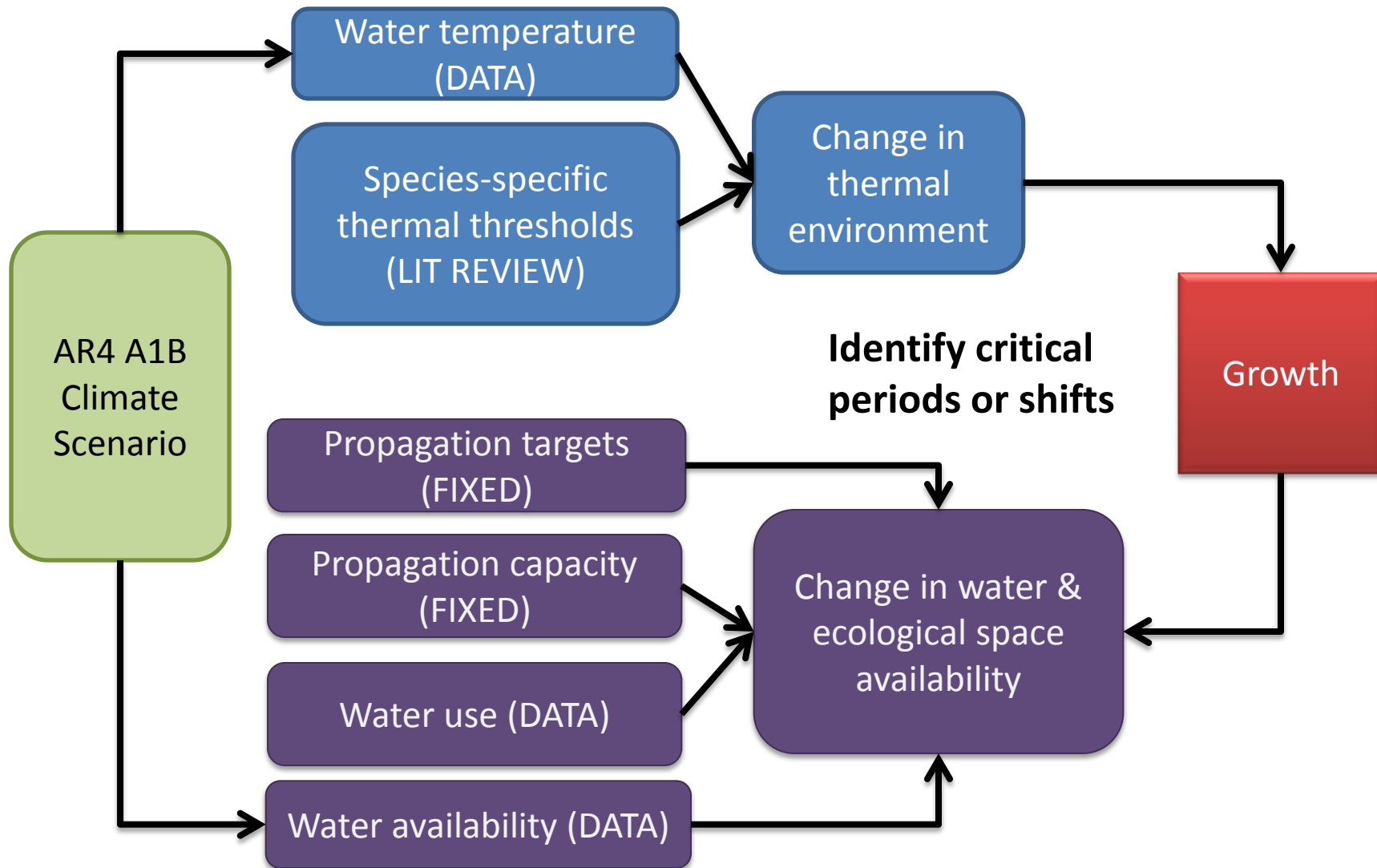
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U.S. Fish and Wildlife Service
Abernathy Fish Technology Center

USFWS National Fish Hatchery System



- 15 facilities in WA, OR, ID
- Annual production of ~60 million salmon
- Production to satisfy multiple legal requirements
 - Tribal treaty requirements
 - Mitigation for population declines due to habitat loss
 - Supplementation for harvest
 - Conservation of ESA-listed species

Integrating the components

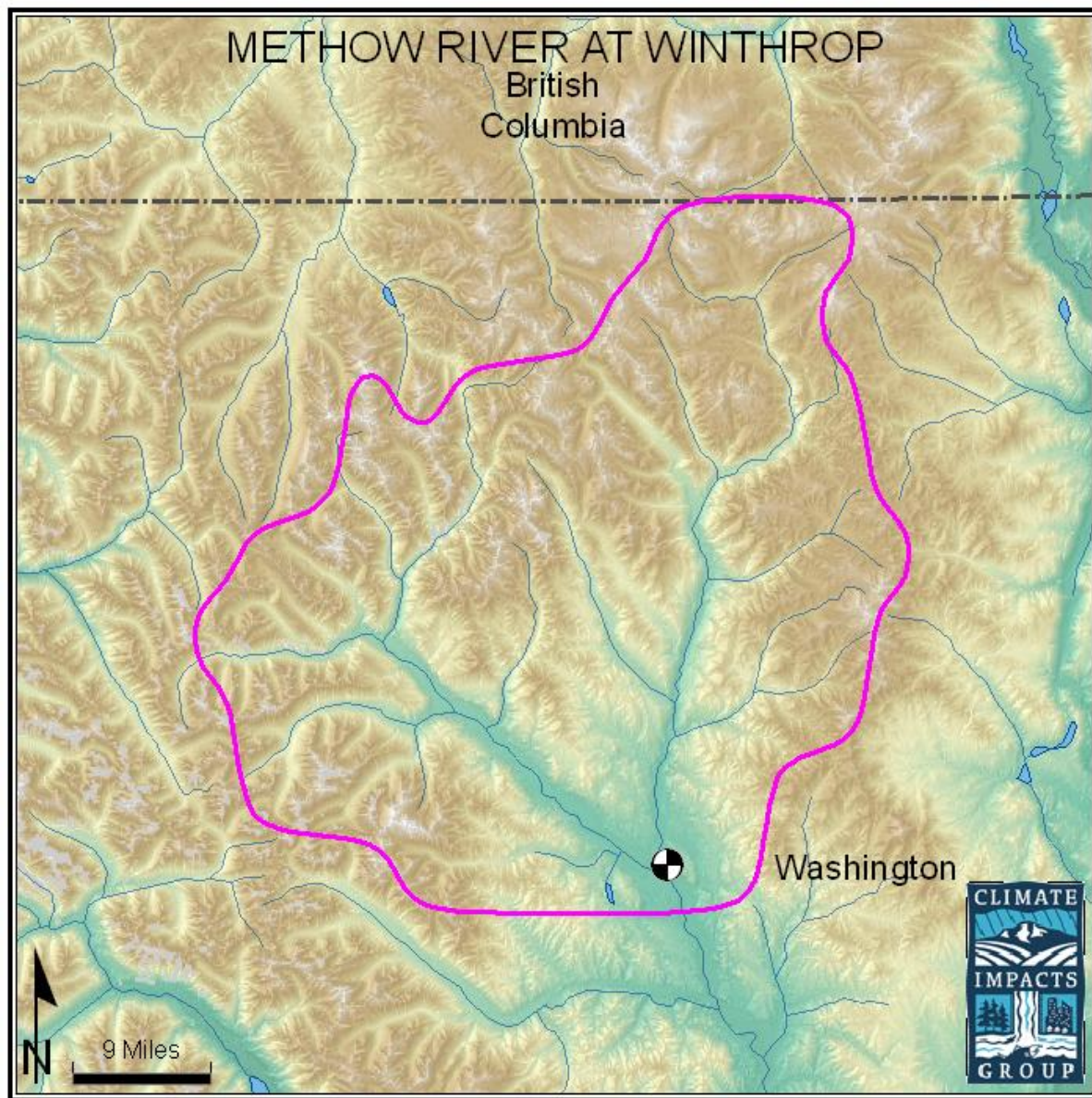


Winthrop NFH



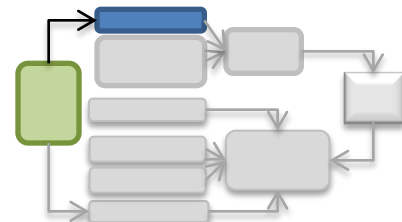
- Located near Winthrop, WA, on Methow River
- Facility opened in 1942
 - Authorized through the Mitchell Act
- Annual production:
 - Spring Chinook – 600,000 fish, 21 month rearing
 - Steelhead – 100,000 fish, 15 and 25 month rearing
 - Coho (Yakama Nation) – 250,00 fish, 19 month rearing

Projected climatic changes

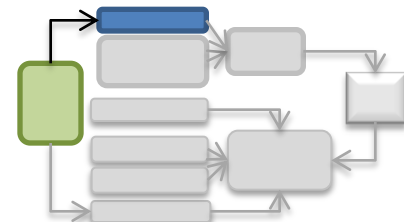
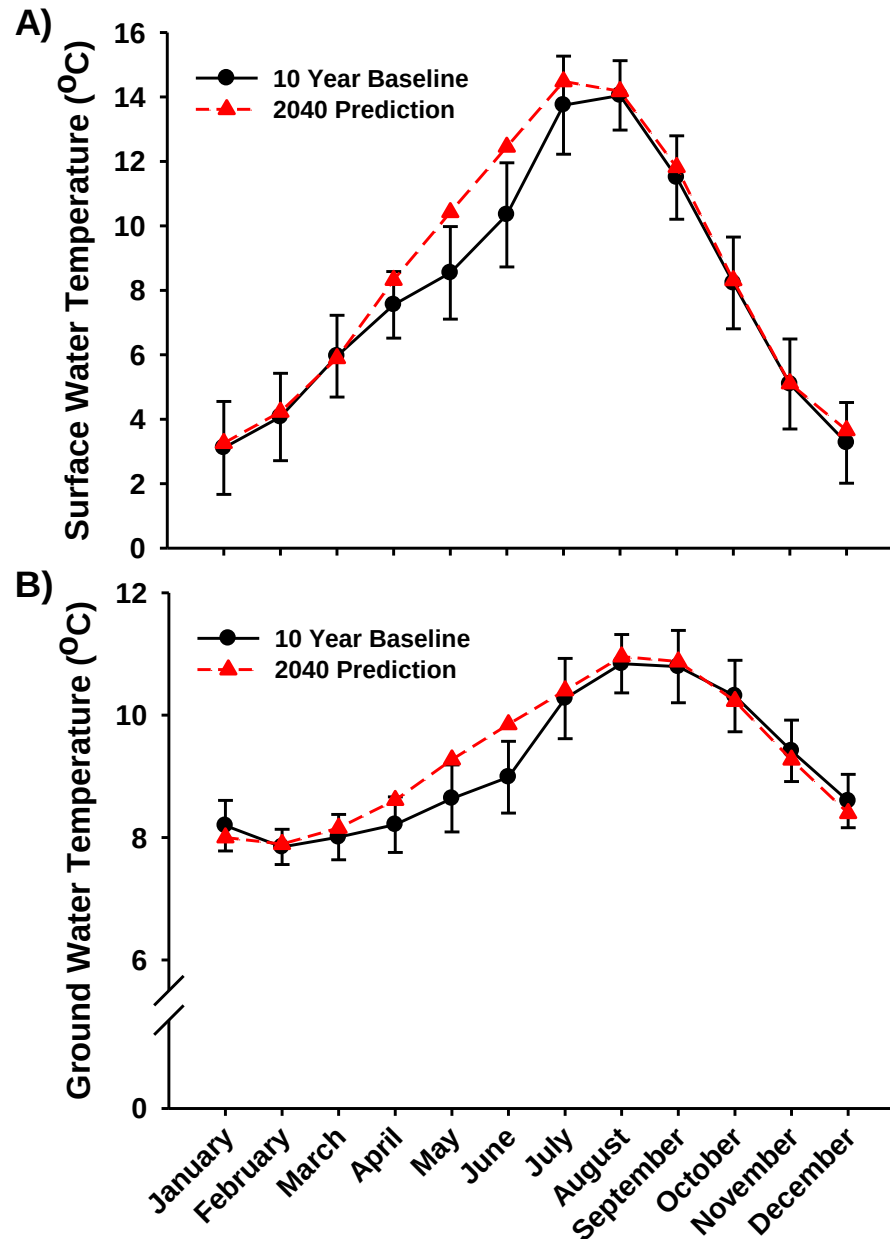


Site Info: METWI (6042)
USGS Id: 12448500
Latitude : 48.4736
Longitude : -120.1761
Area: 1007 mi²

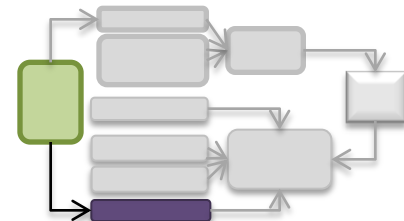
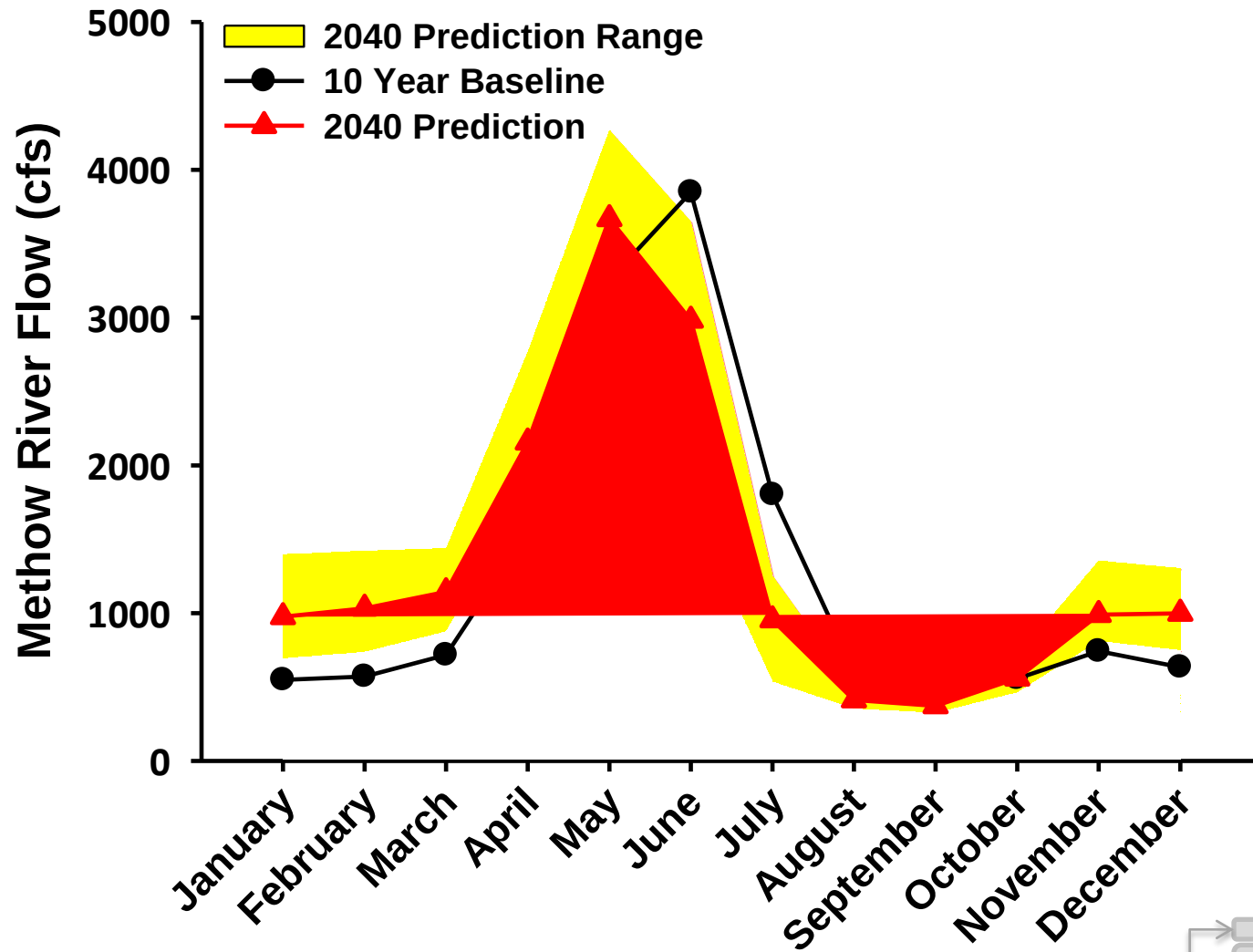
www.hydro.washington.edu/2860/products/sites/?site=6042



Facility climatic changes

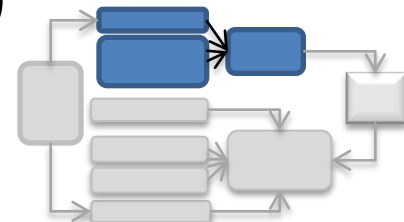


Methow River future hydrology

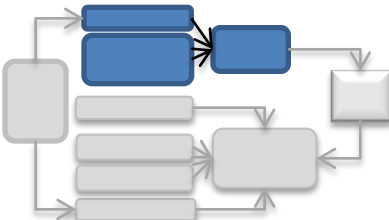


Salmon thermal tolerances

- Literature search for salmon thermal tolerances (August 2011)
 - Data for all cultured Pacific salmon species
 - Information separated by life-history stage (egg/fry, juvenile, adult)
 - Temperatures for optimal growth, optimal development, smoltification limit, optimal spawning, and CTM/ILT
- Literature search for common salmon pathogen thermal tolerances (August 2011)
 - Organism-specific outbreak and optimal temperatures
 - Data for 23 pathogens (bacterial, viral, fungal)



100

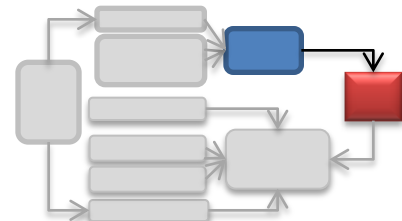


Salmon growth

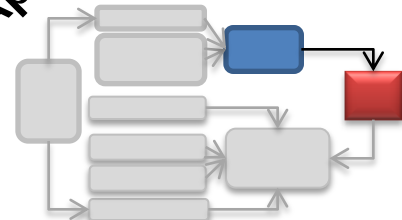
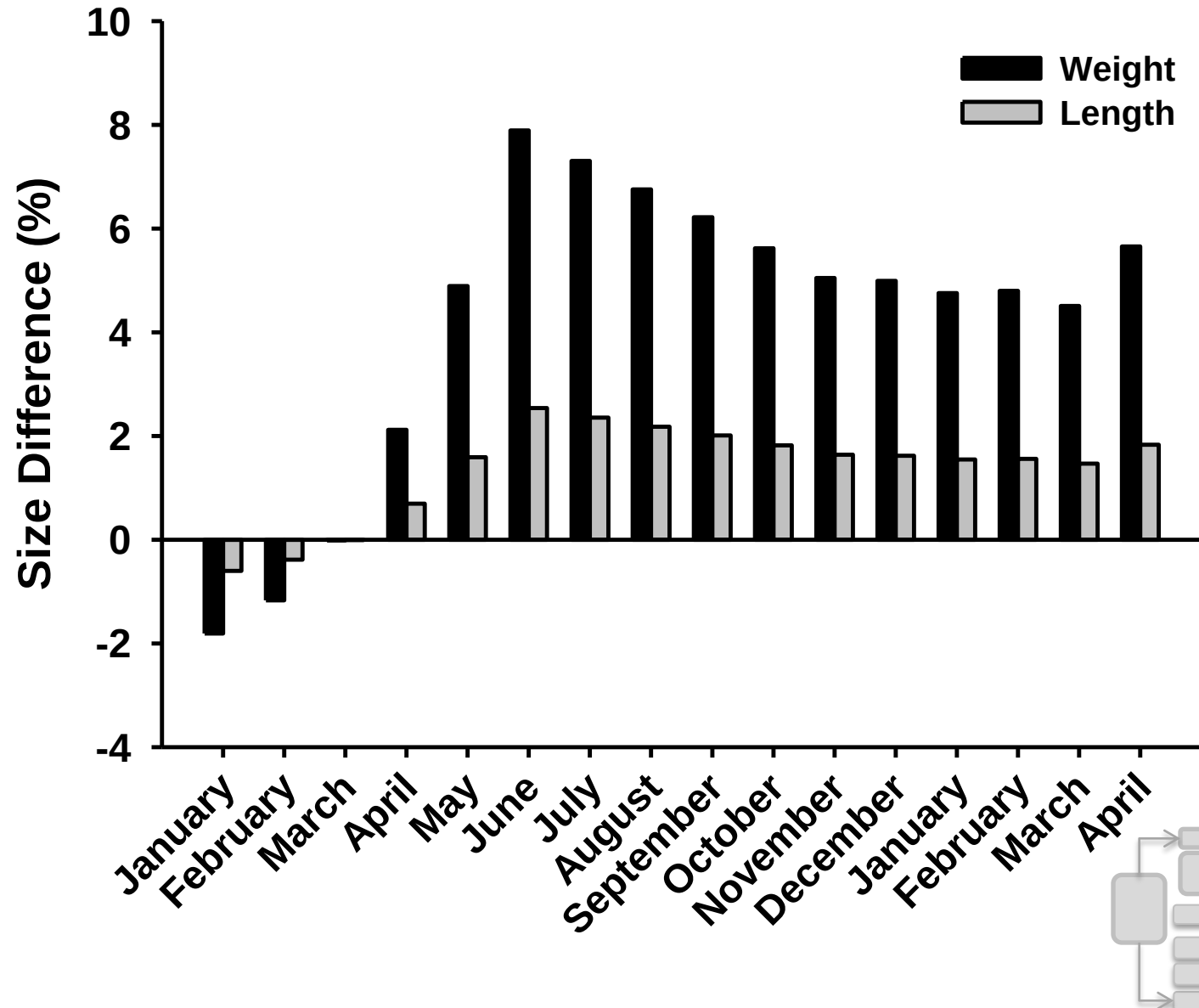
$$W_t^{0.33} = W_0^{0.33} + \left(\frac{T}{1000}\right)t$$

Change in body length derived from body weight using condition factor equation (Anderson and Gutreuter 1983):

$$FL = \left(\frac{W_t}{\left[K / 100,000 \right]} \right)^{0.33}$$



Salmon growth



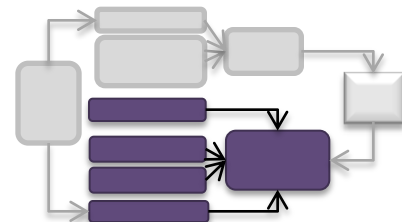
Ecological water requirements

Carrying capacity based on oxygen availability and removal of metabolic waste

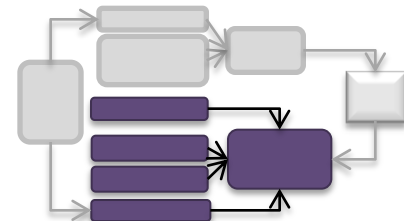
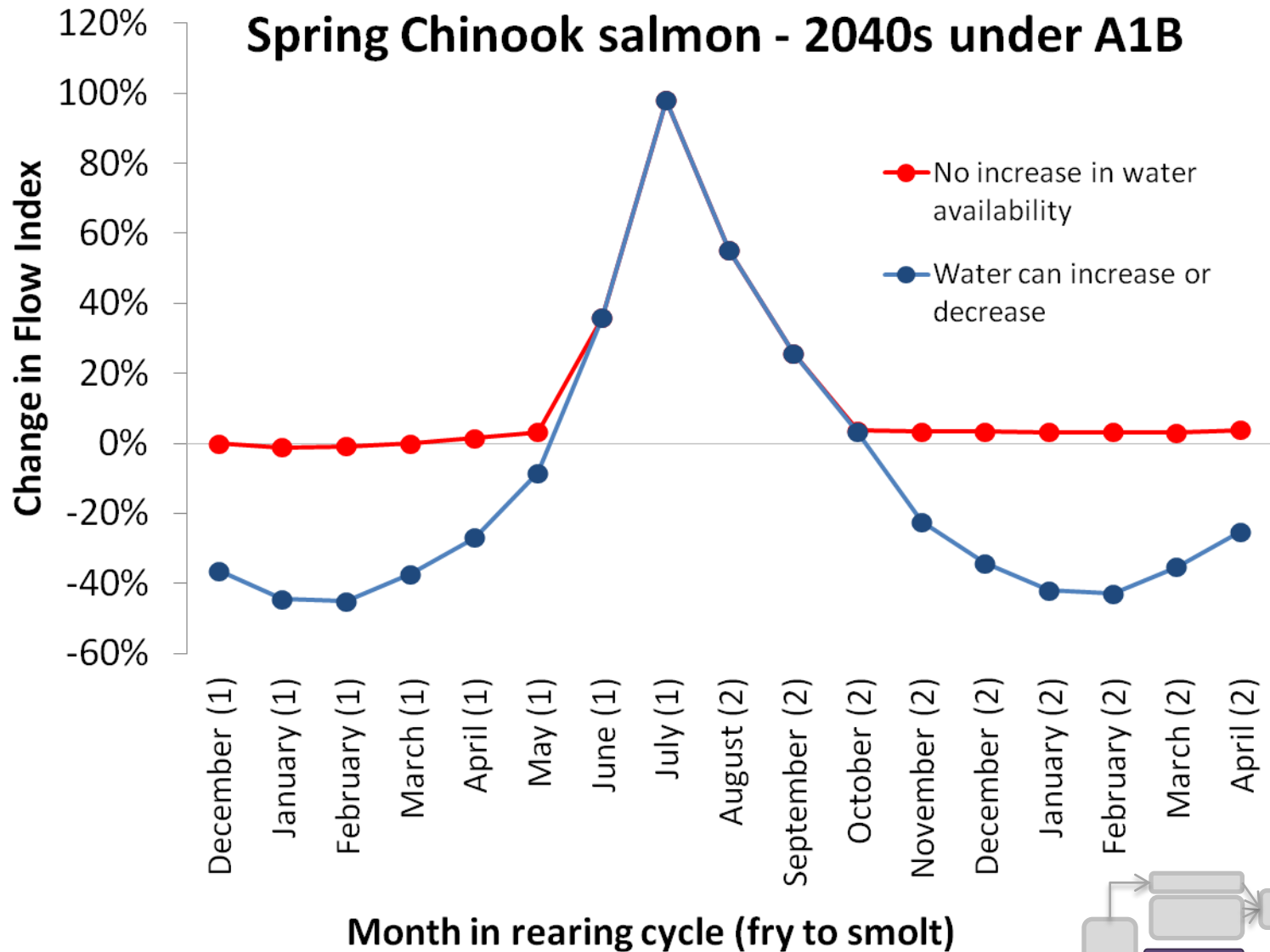
$$\text{Flow Index} = \frac{\text{Total fish mass}}{\text{Mean fish length} \times \text{inflow}}$$

Threshold values arrived at by general guidelines of dissolved oxygen concentration by elevation & temperature; and empirical observations

Piper et al (1982); Wedemeyer (2001), ed.



Ecological water requirements



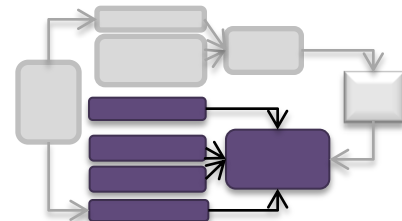
Ecological space requirements

Carrying capacity based on fish loading per unit space

$$\text{Density Index} = \frac{\text{Total fish mass}}{\text{Mean fish length} \times \text{rearing space}}$$

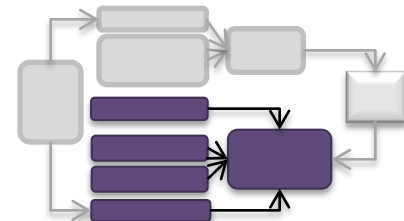
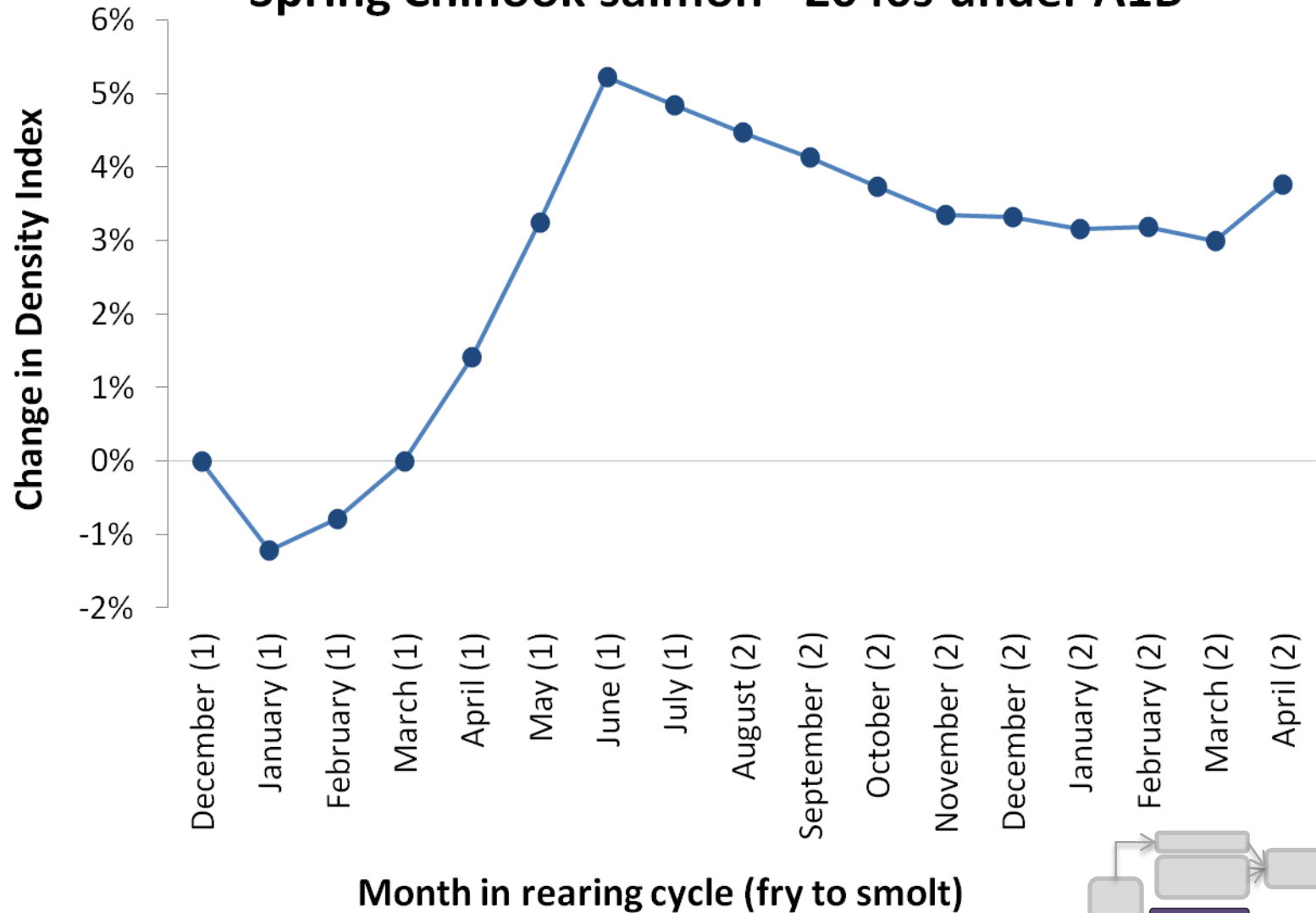
Key concept: Production is influenced by fish behavior and disease

Piper et al (1982); Wedemeyer (2001), ed.



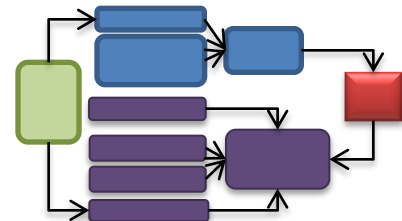
Ecological space requirements

Spring Chinook salmon - 2040s under A1B



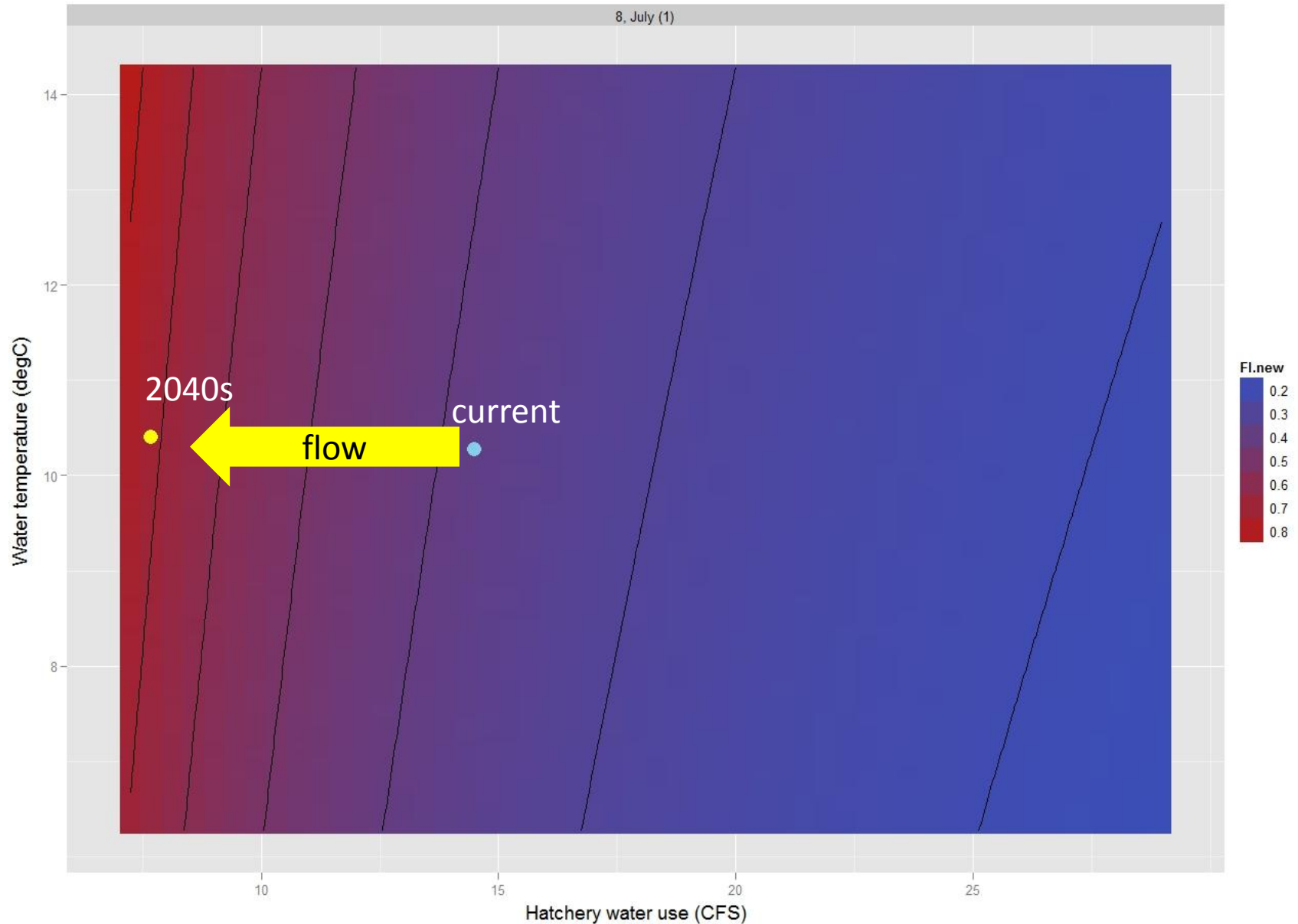
Model-based scenarios vs. general sensitivity

- Mitigation and adaptation planning
 1. *Are there important thresholds across a range of possible future conditions?*
 2. *Where do current conditions and one possible future (A1B) fall in that range?*
- Methods: examine index values across different combinations of temperature, flow, and hatchery capacity; visualize results

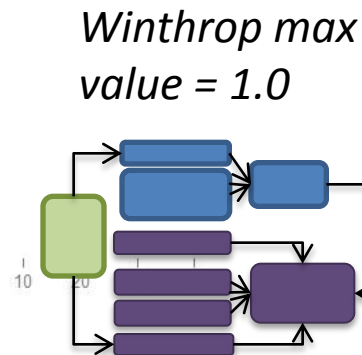


FLOW INDEX – example contour plot

Flow Index - Spring Chinook at Winthrop NFH

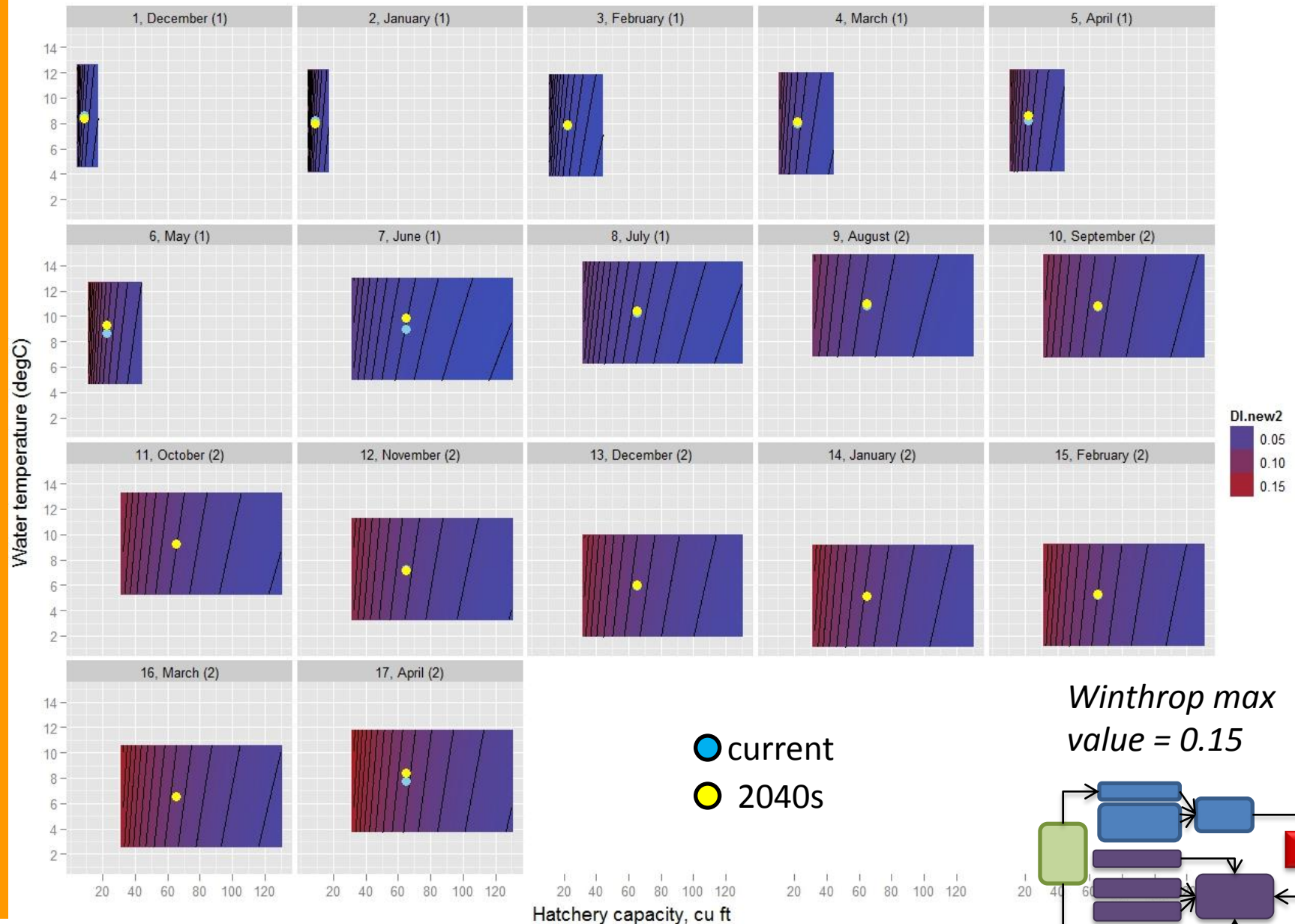


Flow Index - Spring Chinook at Winthrop NFH



DENSITY INDEX – Winthrop chinook

Density Index - Spring Chinook at Winthrop NFH



Preliminary conclusions

- Temperatures not predicted to exceed Chinook thermal tolerances
- Slight temperature increases in most months induce increased fish growth
 - Implications for size at release requirements
 - Implications for residualism
- Altered flow regime predicted to impact water availability and Flow Index
- Increases in growth coupled with changes to water availability may compromise ability to meet targets for Flow Index and Density Index
 - Potential for increased chronic stress and disease

Future directions

- One part of a larger assessment that will include information on natural fish populations, facility legal obligations, value to community, etc.
- Results to be sent to Winthrop NFH Hatchery Evaluation Team for discussion of adaptive management options
- Next assessment will be Quilcene NFH

Acknowledgements

- University of Washington Climate Impacts Group
- Staff at Winthrop NFH
- USFWS Climate Change Planning Team
- USFWS Region 1 Climate Board