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Salish Sea Ecosystem Conference

2018 Salish Sea Ecosystem Conference  
(Seattle, Wash.)

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Apr 5th, 10:30 AM - 10:45 AM

## Using metapopulation models to estimate the effects of pesticides and environmental stressors to Spring Chinook salmon in the Yakima River Basin, WA

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Mitchell, Chelsea; Chu, Valerie R.; Harris, Meagan J.; Landis, Wayne G.; von Stackelberg, Katherine E.; and Stark, John D., "Using metapopulation models to estimate the effects of pesticides and environmental stressors to Spring Chinook salmon in the Yakima River Basin, WA" (2018). *Salish Sea Ecosystem Conference*. 146.

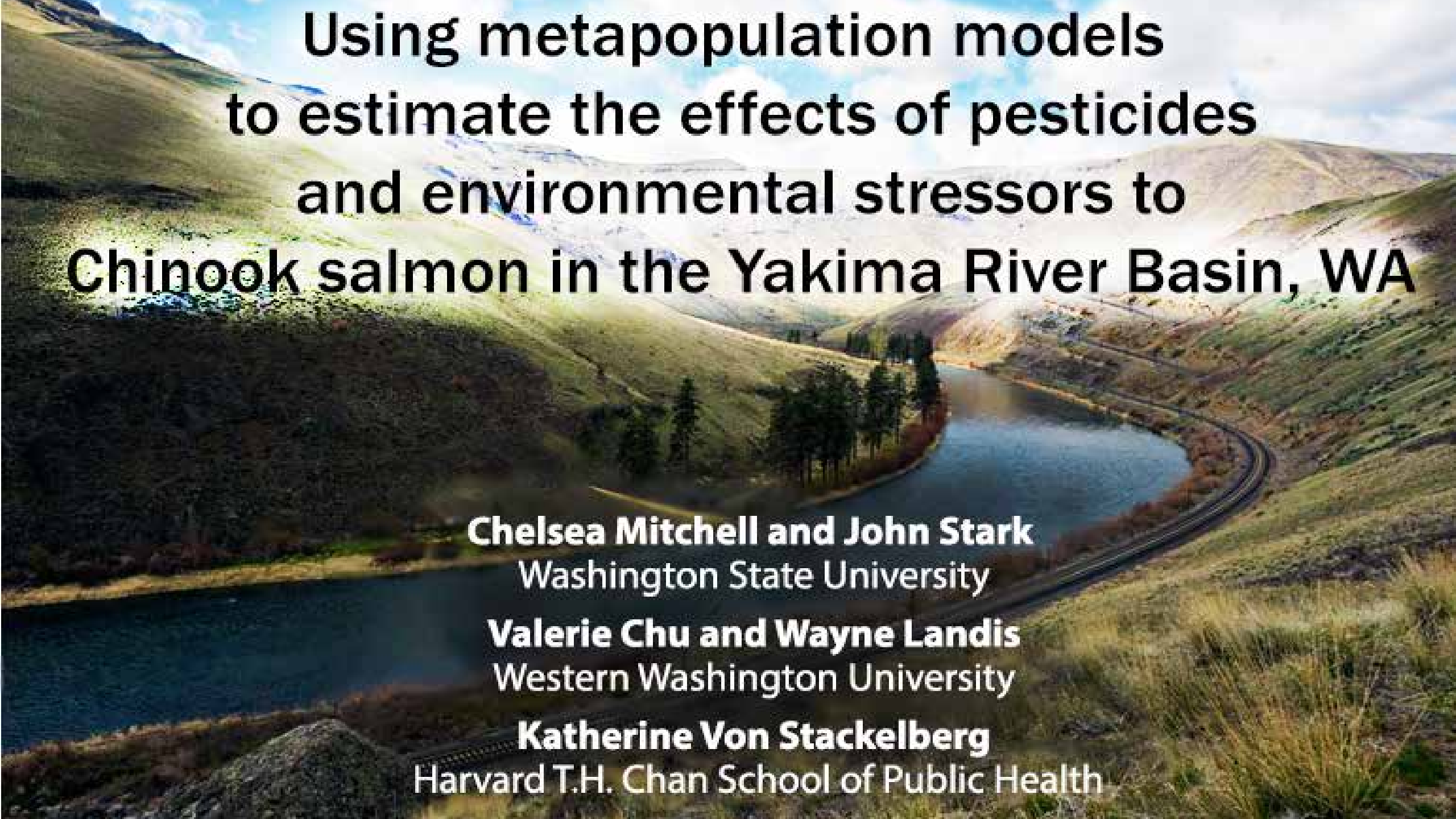
<https://cedar.wwu.edu/ssec/2018ssec/allsessions/146>

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**Speaker**

Chelsea Mitchell, Valerie R. Chu, Meagan J. Harris, Wayne G. Landis, Katherine E. von Stackelberg, and John D. Stark

A scenic landscape of rolling hills and a winding river in the Yakima River Basin, WA. The hills are covered in green grass and some trees, and the river is a deep blue color. The sky is blue with some white clouds.

**Using metapopulation models  
to estimate the effects of pesticides  
and environmental stressors to  
Chinook salmon in the Yakima River Basin, WA**

**Chelsea Mitchell and John Stark**  
Washington State University

**Valerie Chu and Wayne Landis**  
Western Washington University

**Katherine Von Stackelberg**  
Harvard T.H. Chan School of Public Health

# Ecological Risk Assessment:

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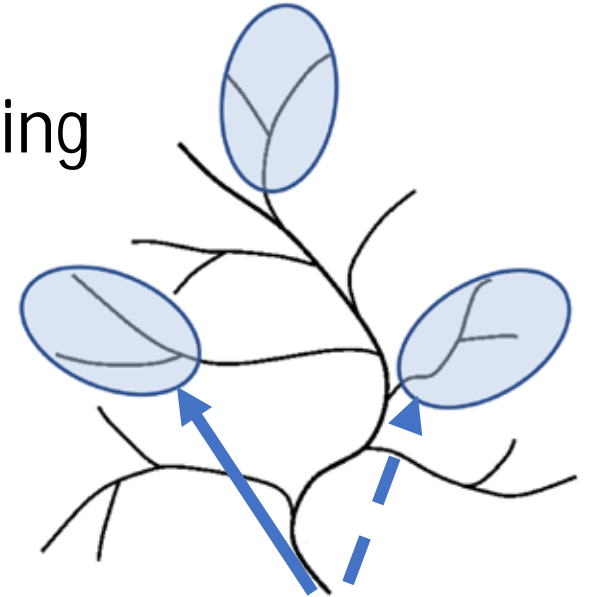
## Previous study:

- Bayesian Network- Relative Risk Model (BN-RRM) (*Landis et al.*)
- **Endpoint:** Chinook salmon populations
- **Toxicants:** Organophosphate insecticides
- **Environmental stressors:** Water temperature & dissolved oxygen
- Single Chinook population models (*Baldwin et al. 2009*)

**This study:** uses site-specific metapopulation as endpoint

# Salmon populations & toxicant exposure

- Salmon connected into **metapopulations** through straying
- **Local adaptation**
  - populations of the same species differ in rates of survival, reproduction, and dispersal
- Salmon habitat conditions change over time

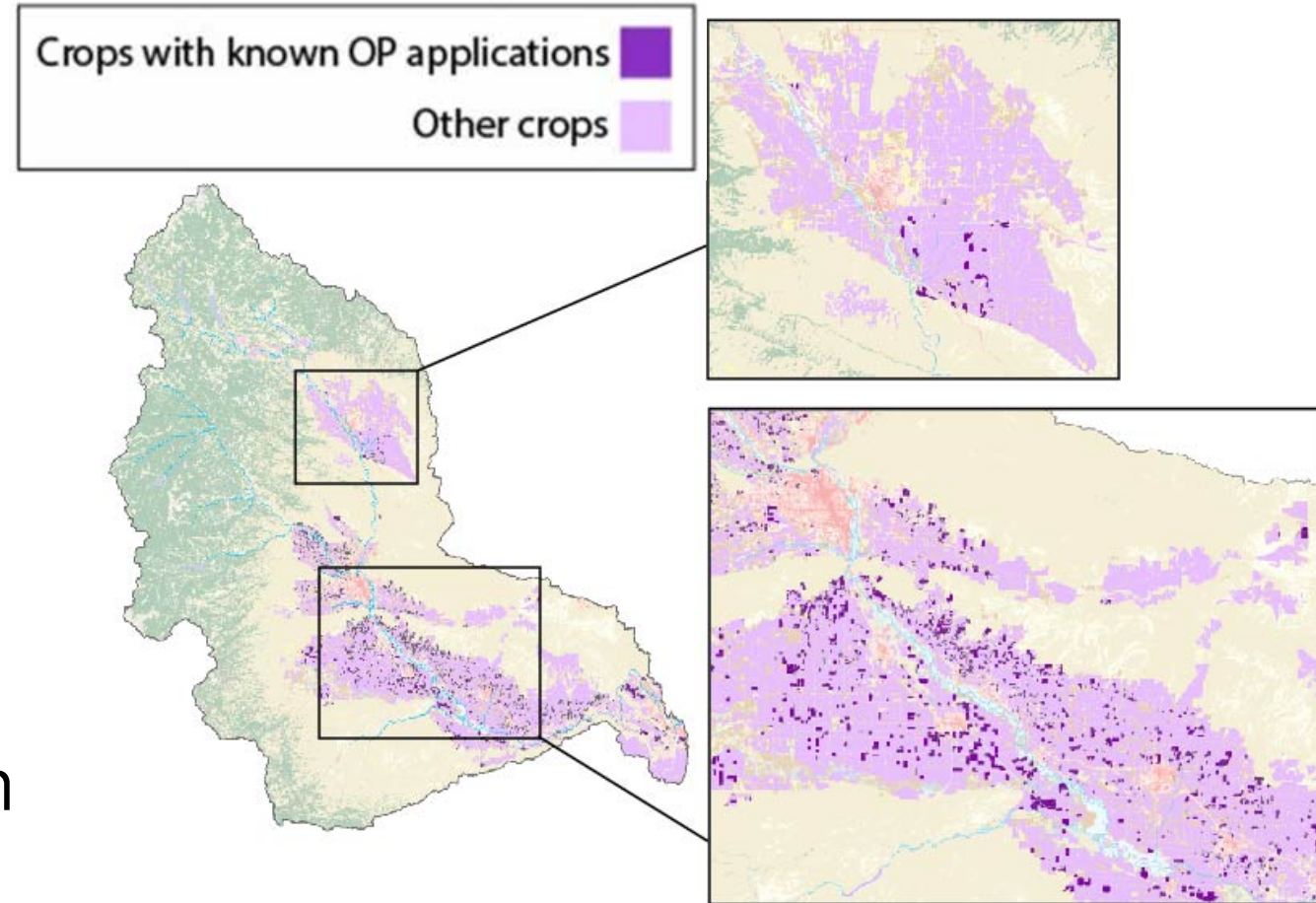


**Question 1:** Does risk differ between subpopulations within the same metapopulation?

**Question 2:** Do seasonal changes in habitat impact risk?

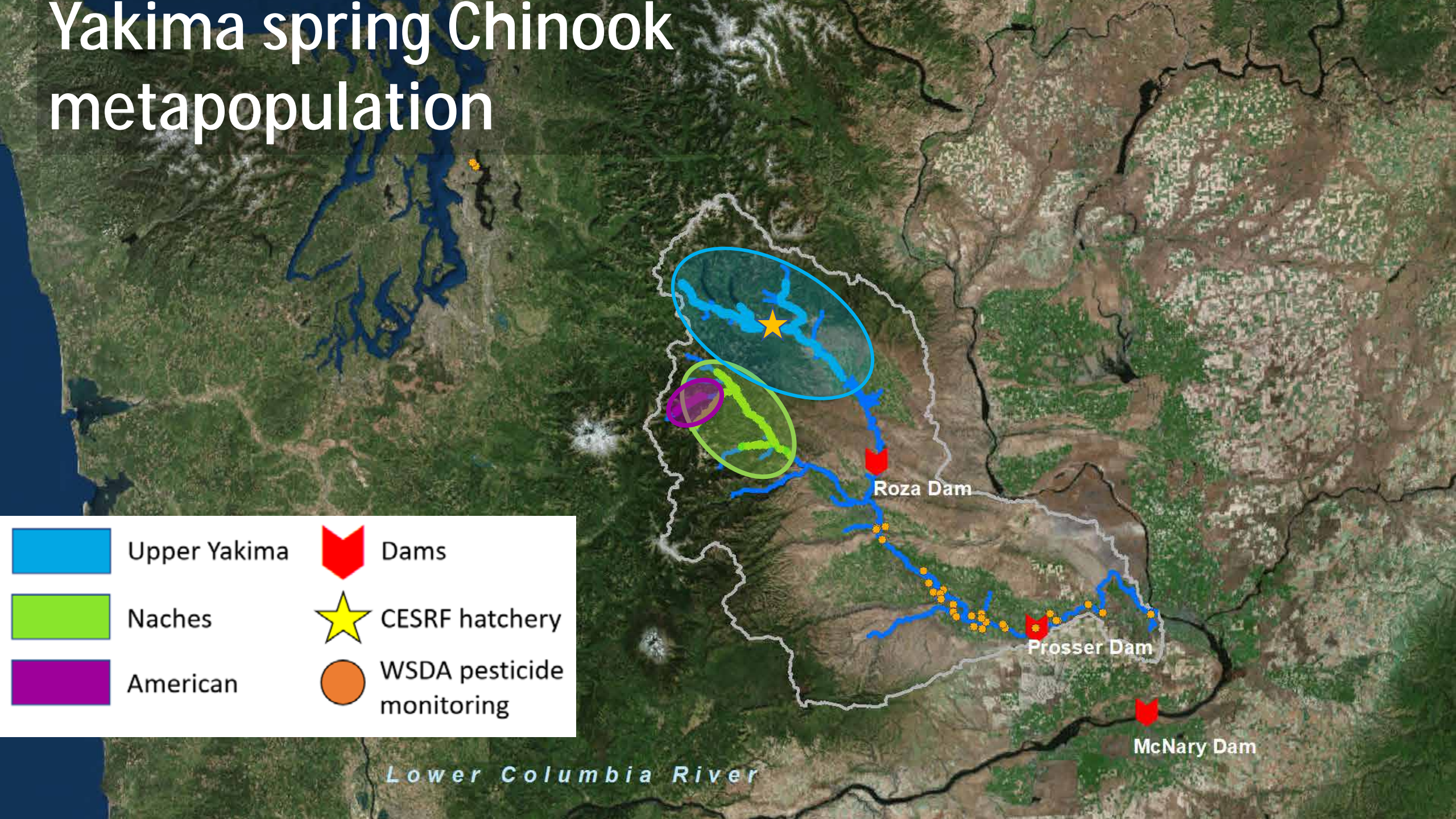
# Case Study: Yakima River Basin (YRB)

- Spring Chinook salmon
- Lower Yakima
  - dense agriculture
  - Habitat use
  - Juveniles rearing and outmigration
  - Adults returning to spawn
- OPs applied throughout Lower Yakima
- This study: Malathion and diazinon





# Yakima spring Chinook metapopulation

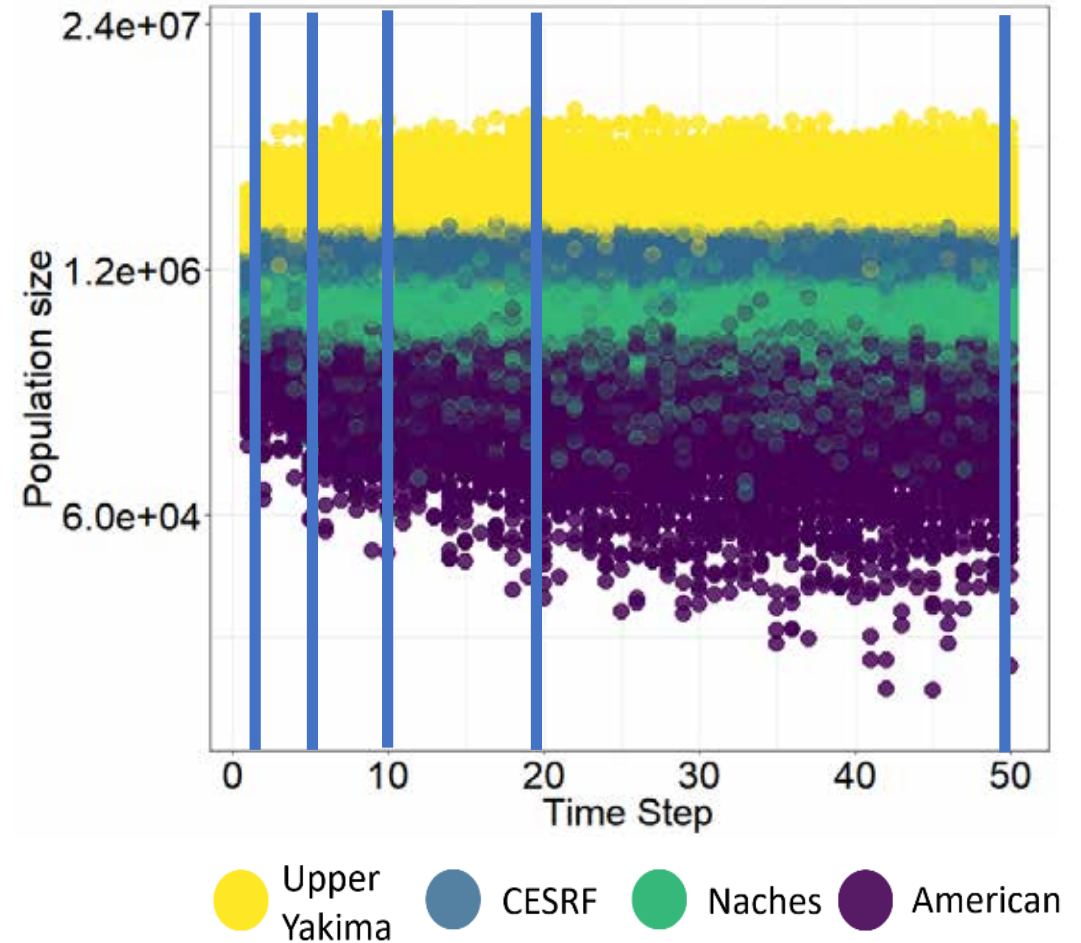


*Lower Columbia River*



# Metapopulation modeling

- Developed age-structure matrix models
  - American, Naches, Upper Yakima, CESRF
  - Stochastic survival, reproduction, and dispersal parameters
- Ran simulations in RAMAS Metapop<sup>©</sup>
  - survival reductions to exposed life stages
  - Incorporated outputs into Bayesian Network



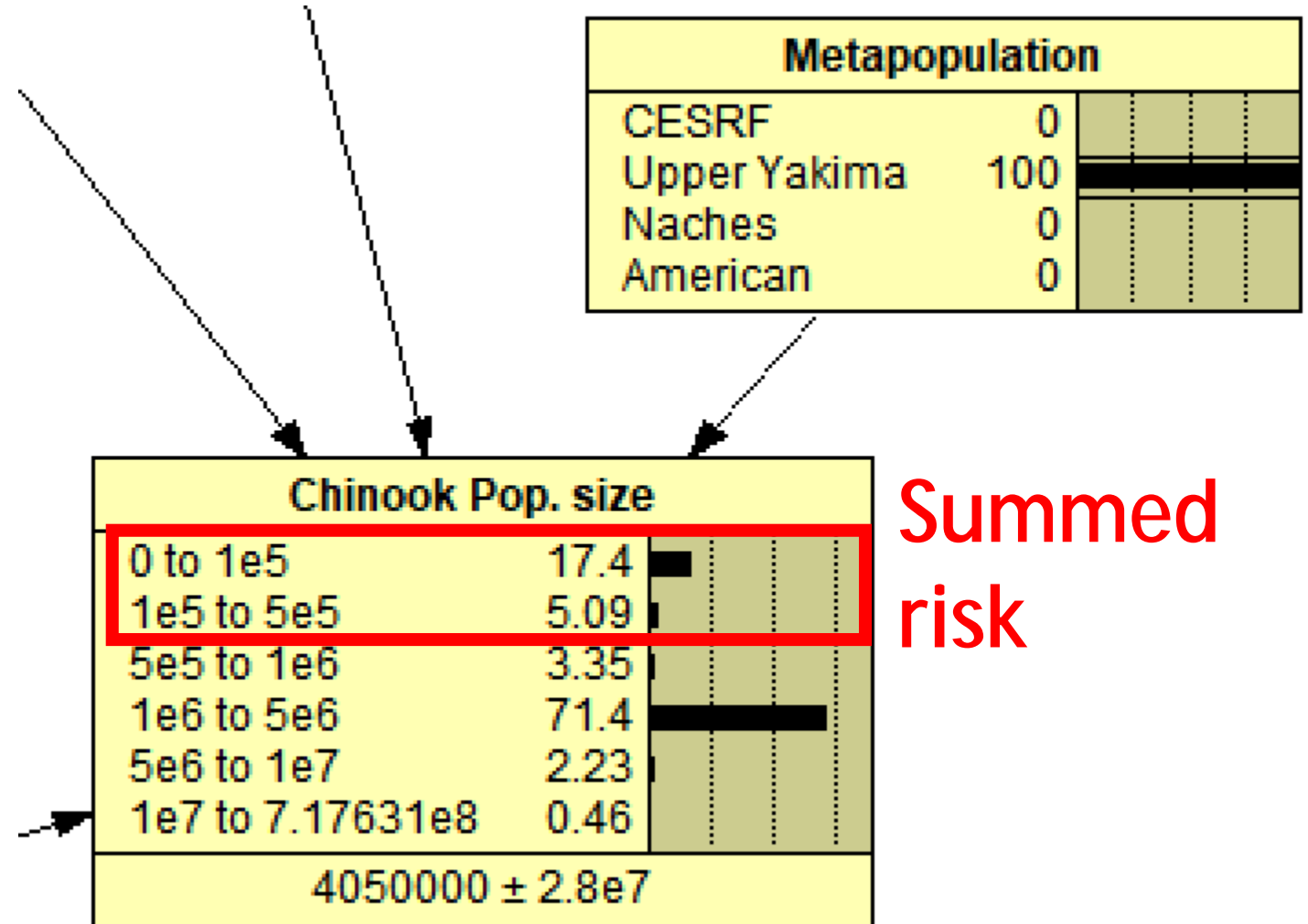


# Bayesian Network-Relative Risk Model

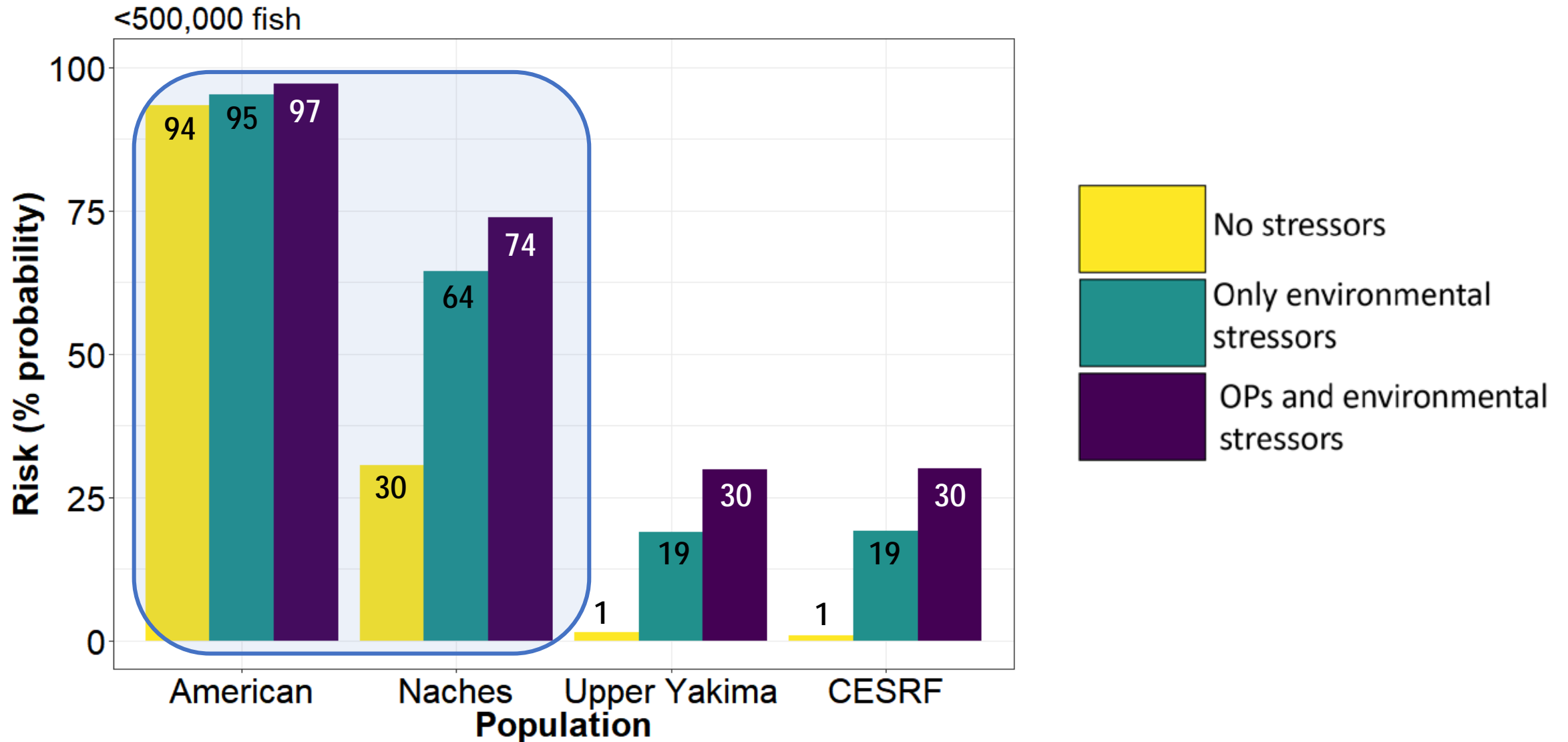
## Risk

- No net loss of Chinook (Puget Sound Partnership)
- Initial abundance = 500,000 fish/population
- Risk of declining from initial abundance of 500,000

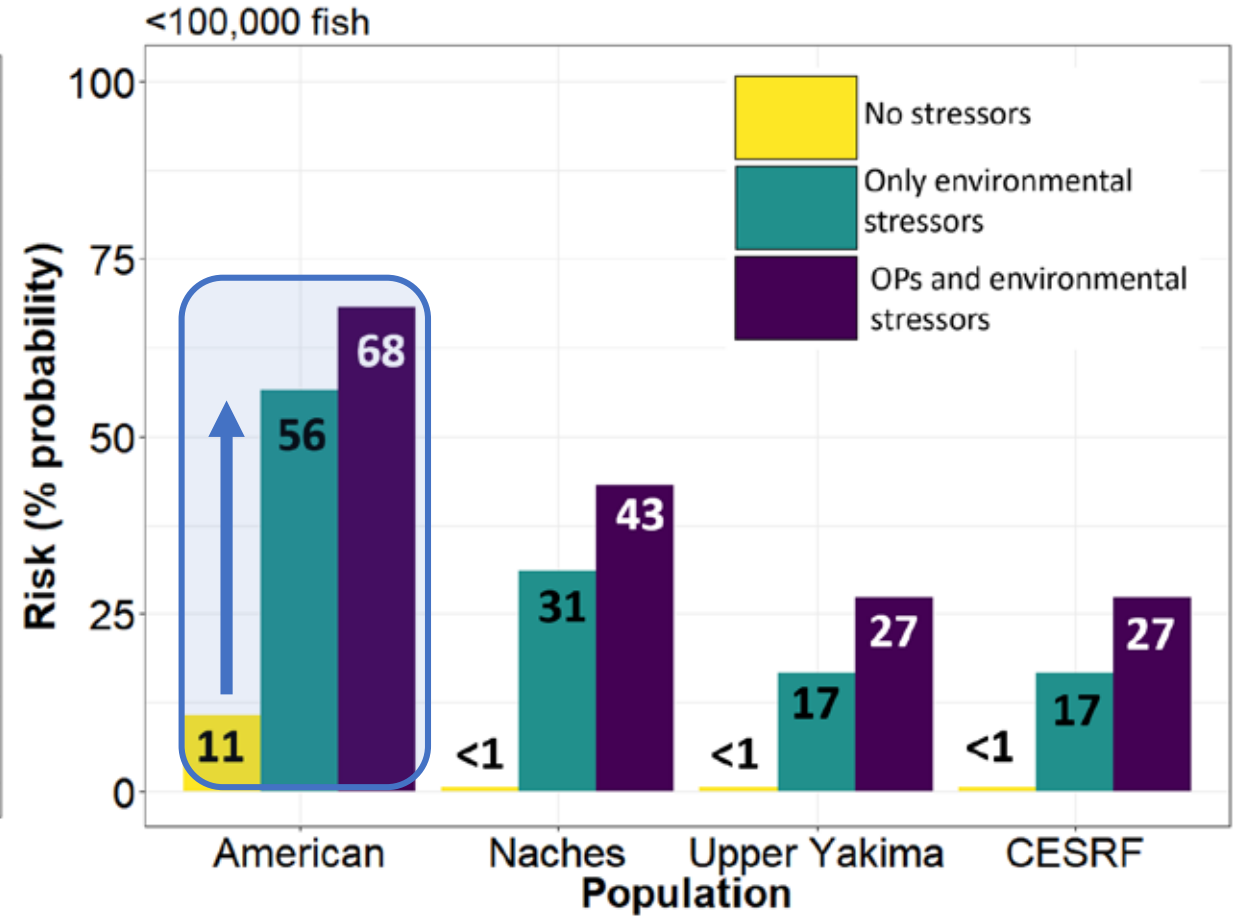
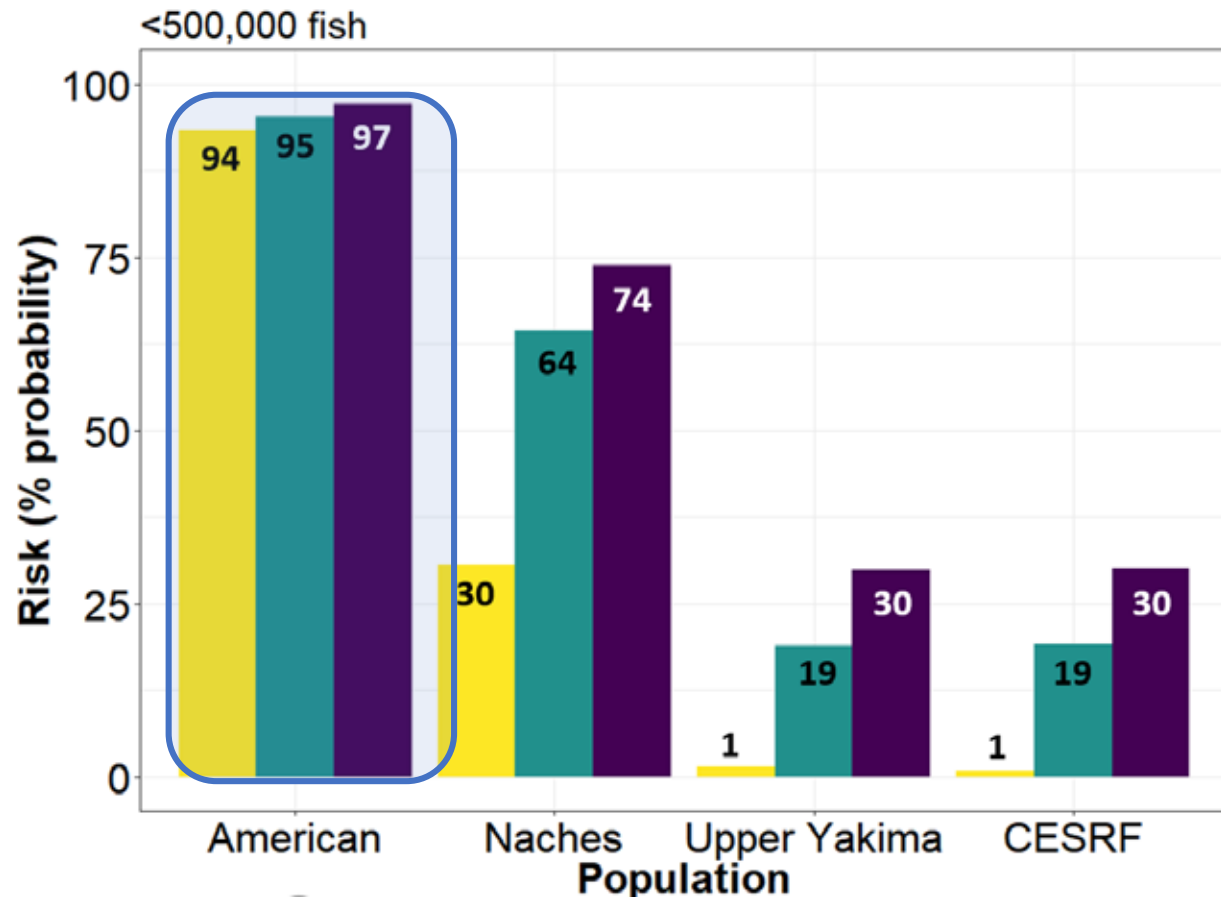
10.9 ± 2.7



# Risk by population (year 20)

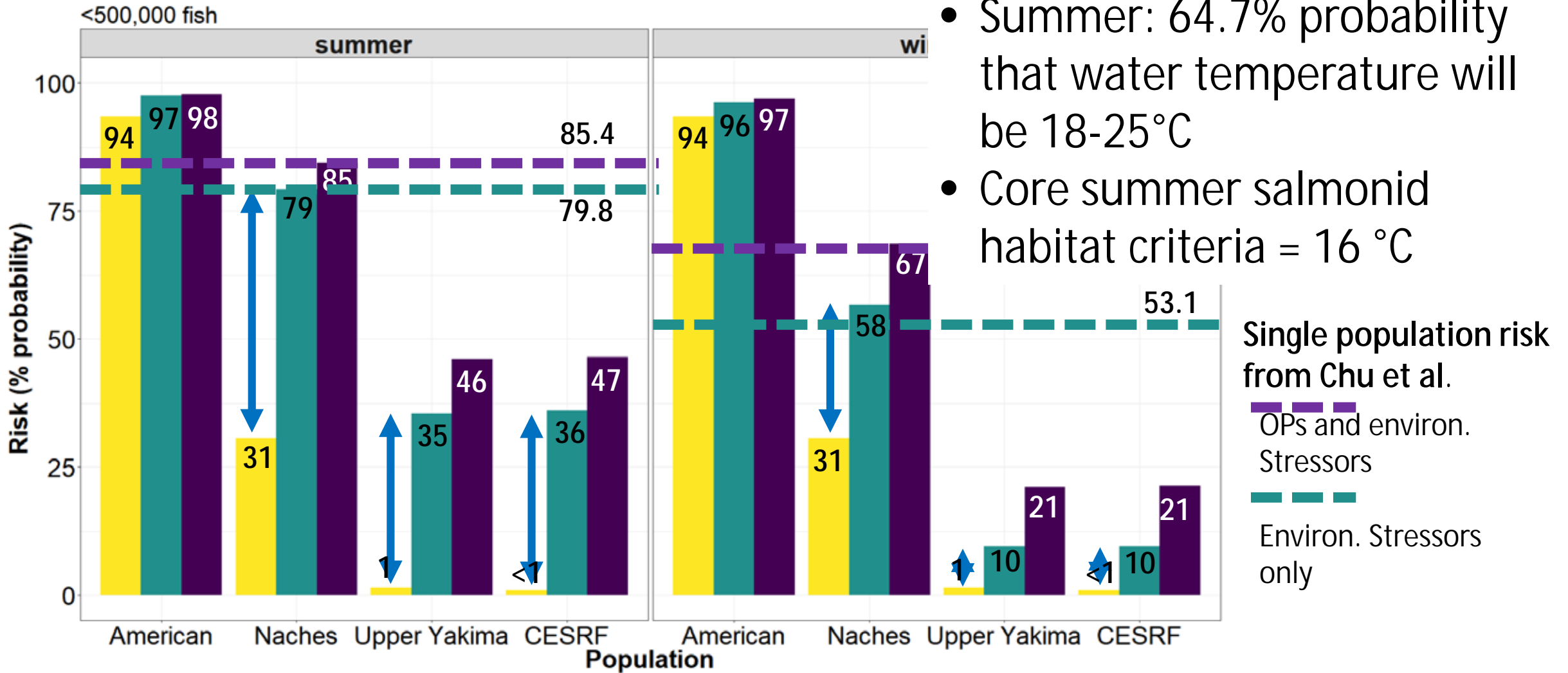


# Risk by population (year 20)





# Risk by population and season (year 20)



- Summer: 64.7% probability that water temperature will be 18-25°C
- Core summer salmonid habitat criteria = 16 °C

# Conclusions

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- *Question 1: Does risk differ between subpopulations within the same metapopulation?*
  - Yes, risk is greater in wild populations
  - Differences driven by differences in vital rates, and lower dispersal of wild populations
- *Question 2: Do seasonal changes in habitat impact risk?*
  - Yes, high temperatures in summer increase risk compared with winter.
- Environmental stressors make a greater contribution to risk than organophosphates
- Measured concentrations of OPs in Lower Yakima still increase risk





# Thank you!

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