



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.

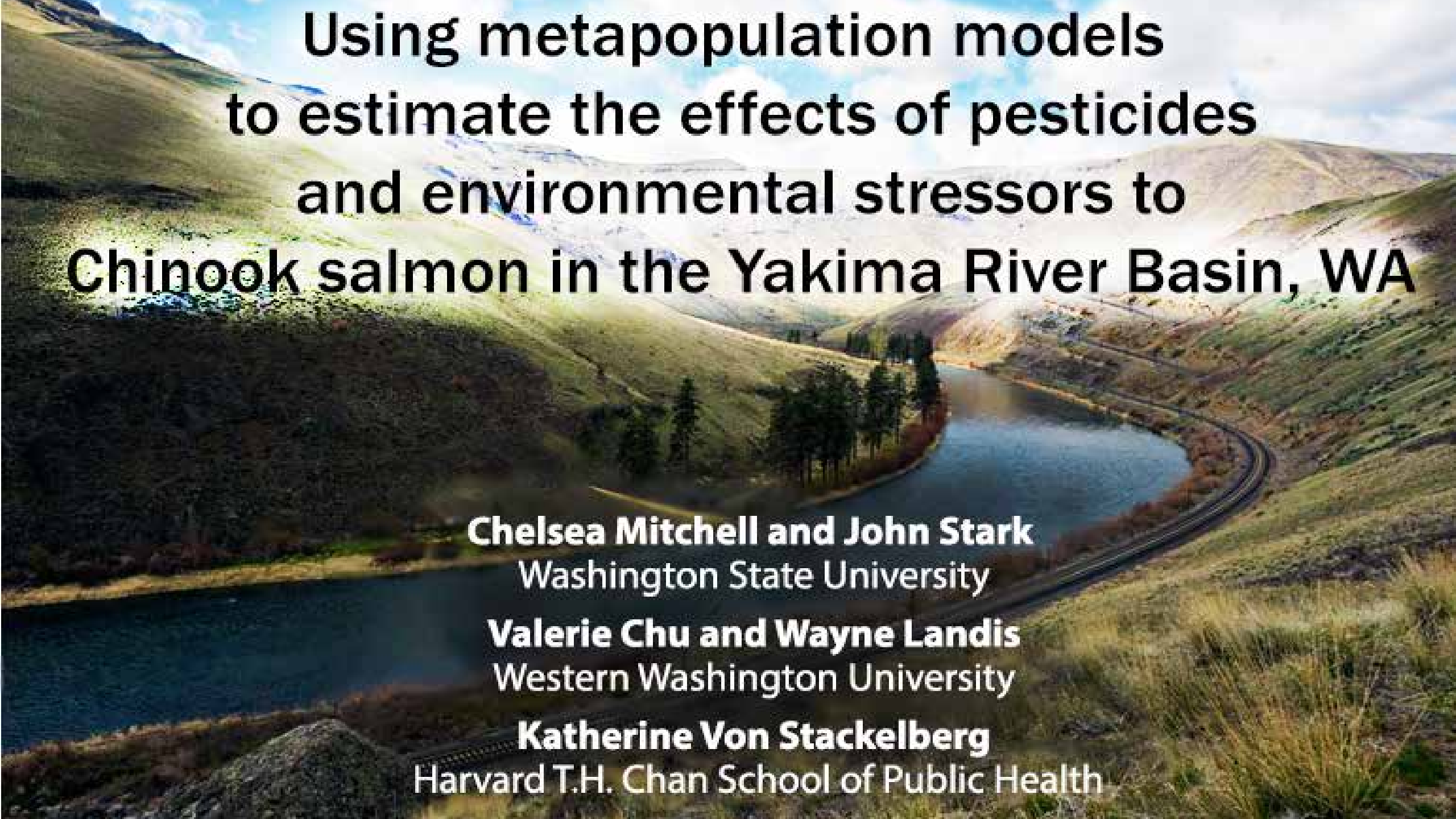
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**Speaker**

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 flows through the valley. The sky is blue with some 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**  
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# Ecological Risk Assessment:

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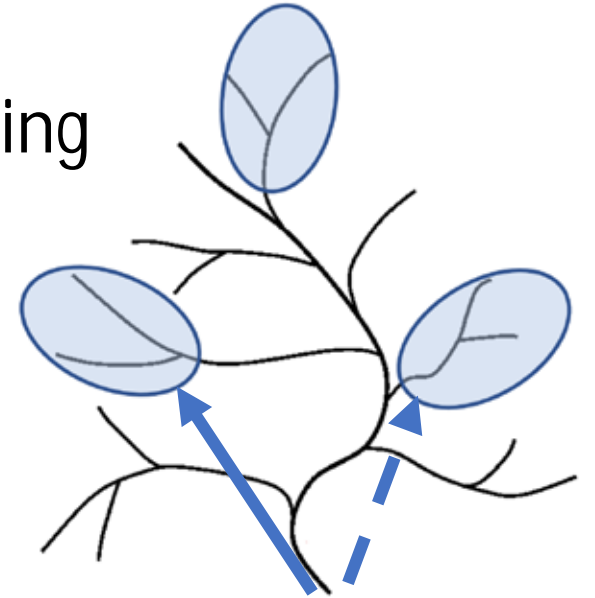
## Previous study:

- 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

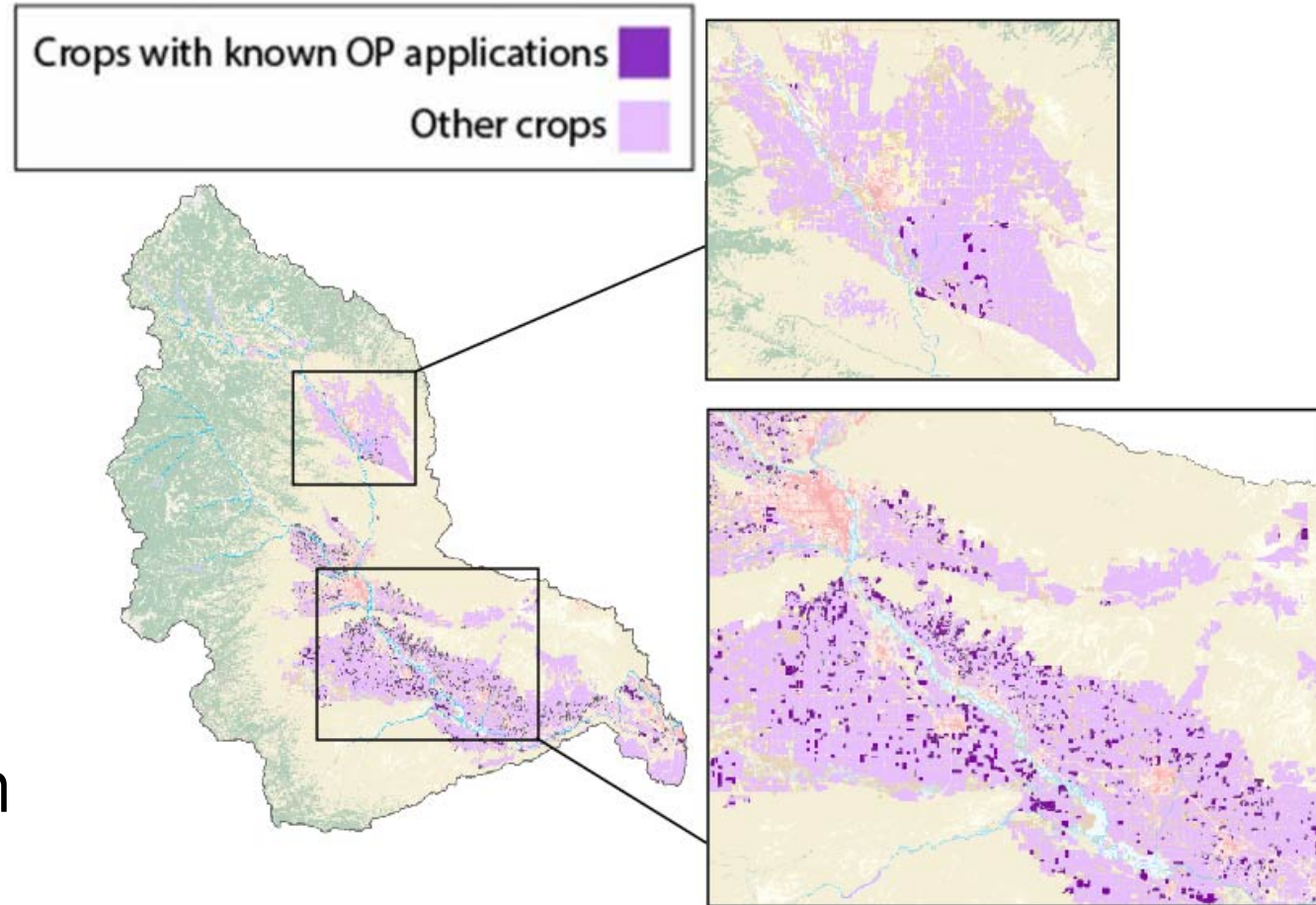


**Question 1:** Does risk differ between subpopulations within the same metapopulation?

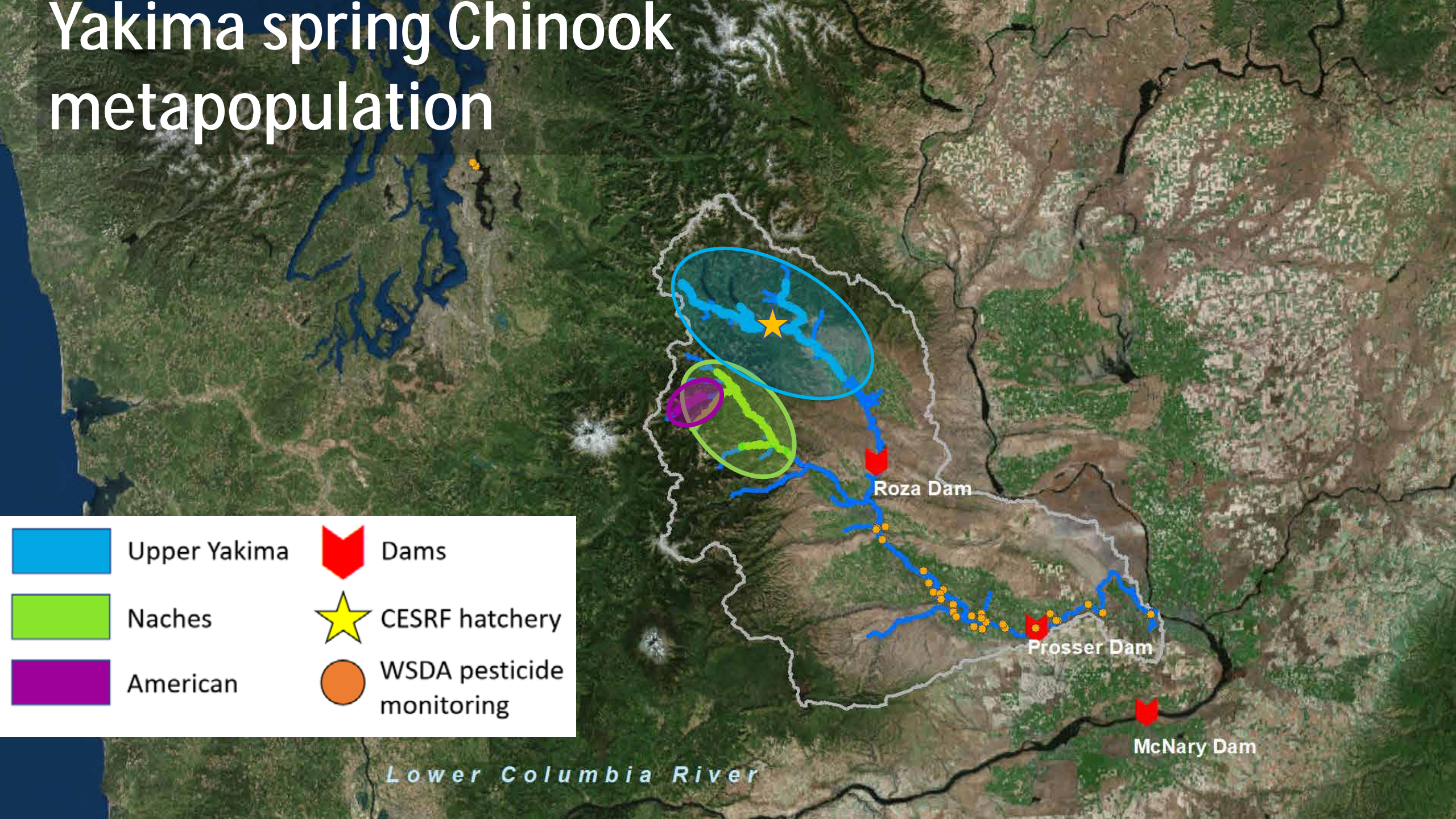
**Question 2:** Do seasonal changes in habitat impact risk?

# 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



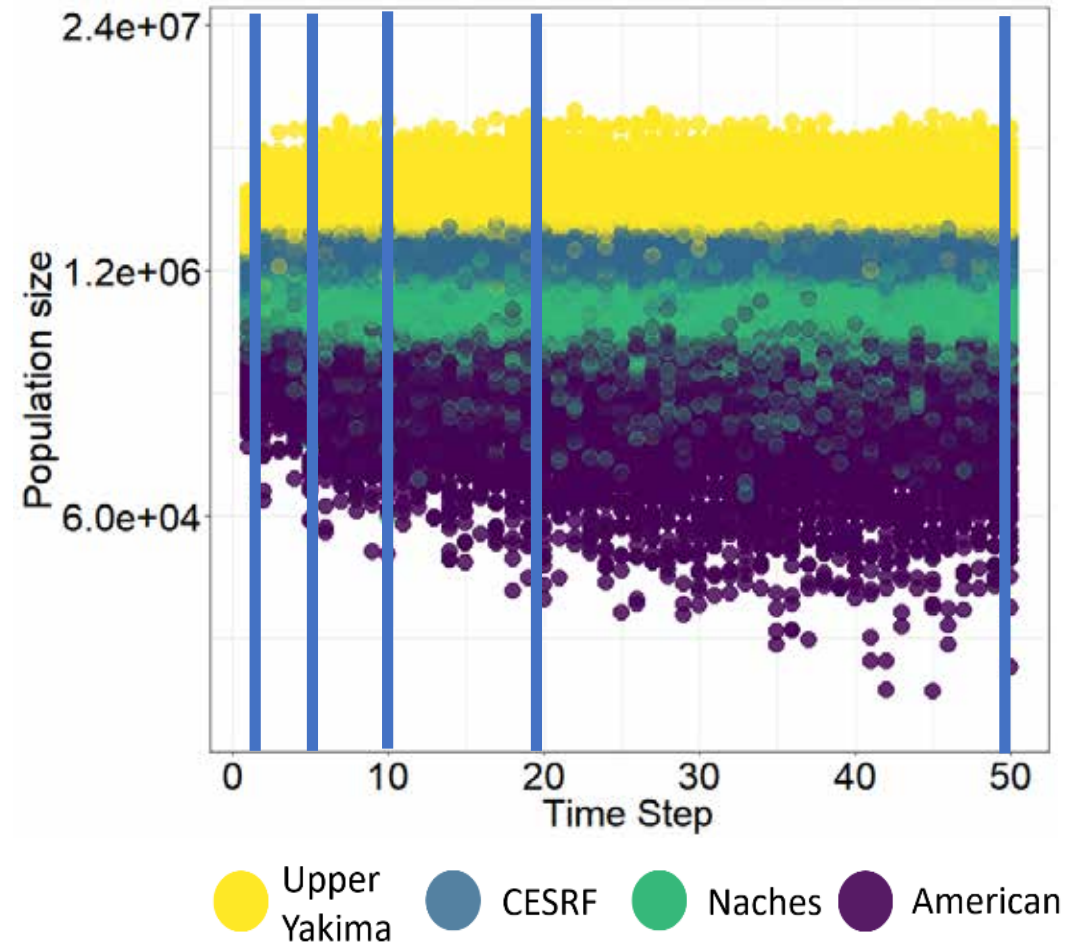
# Yakima spring Chinook metapopulation



*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



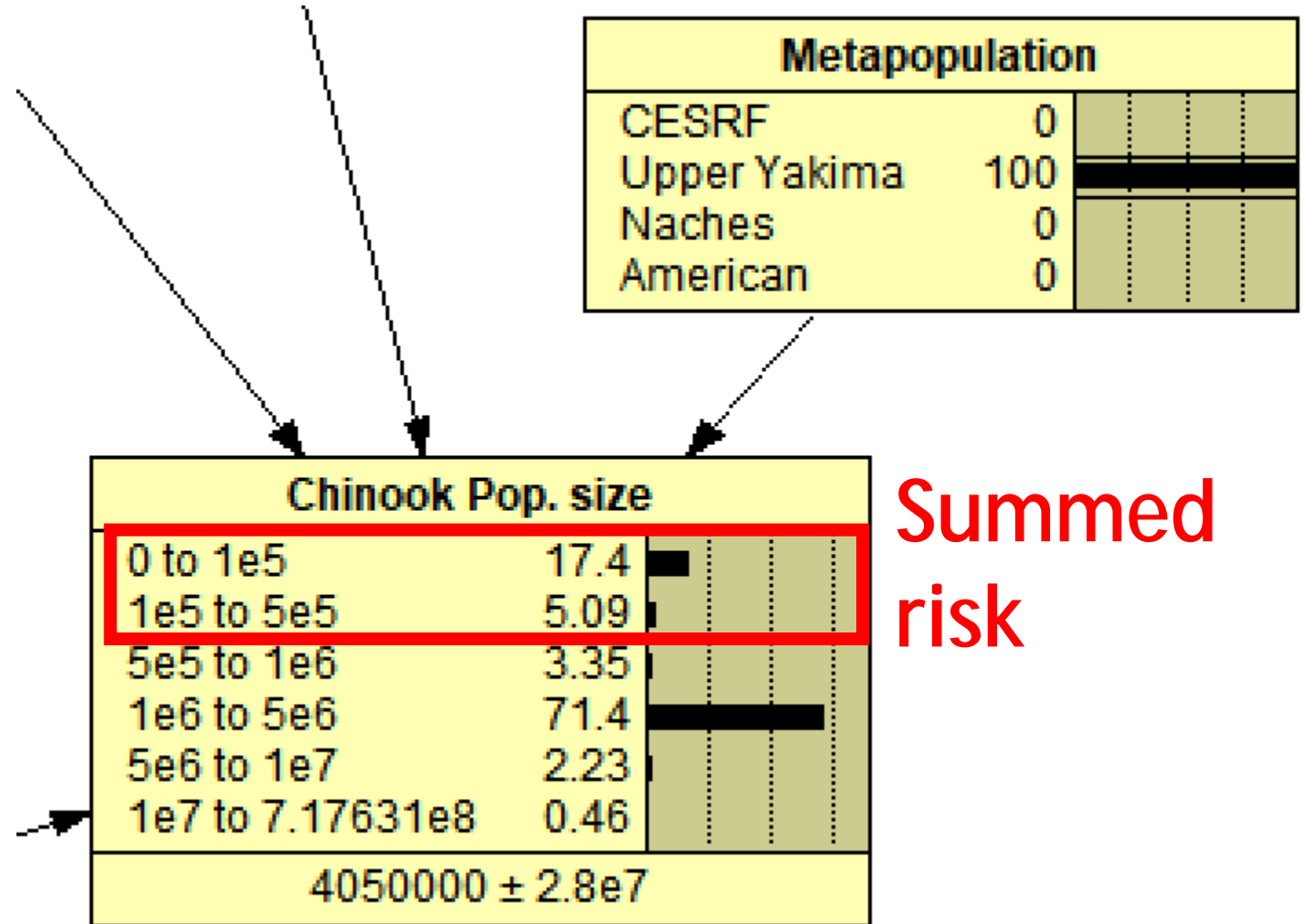


# Bayesian Network-Relative Risk Model

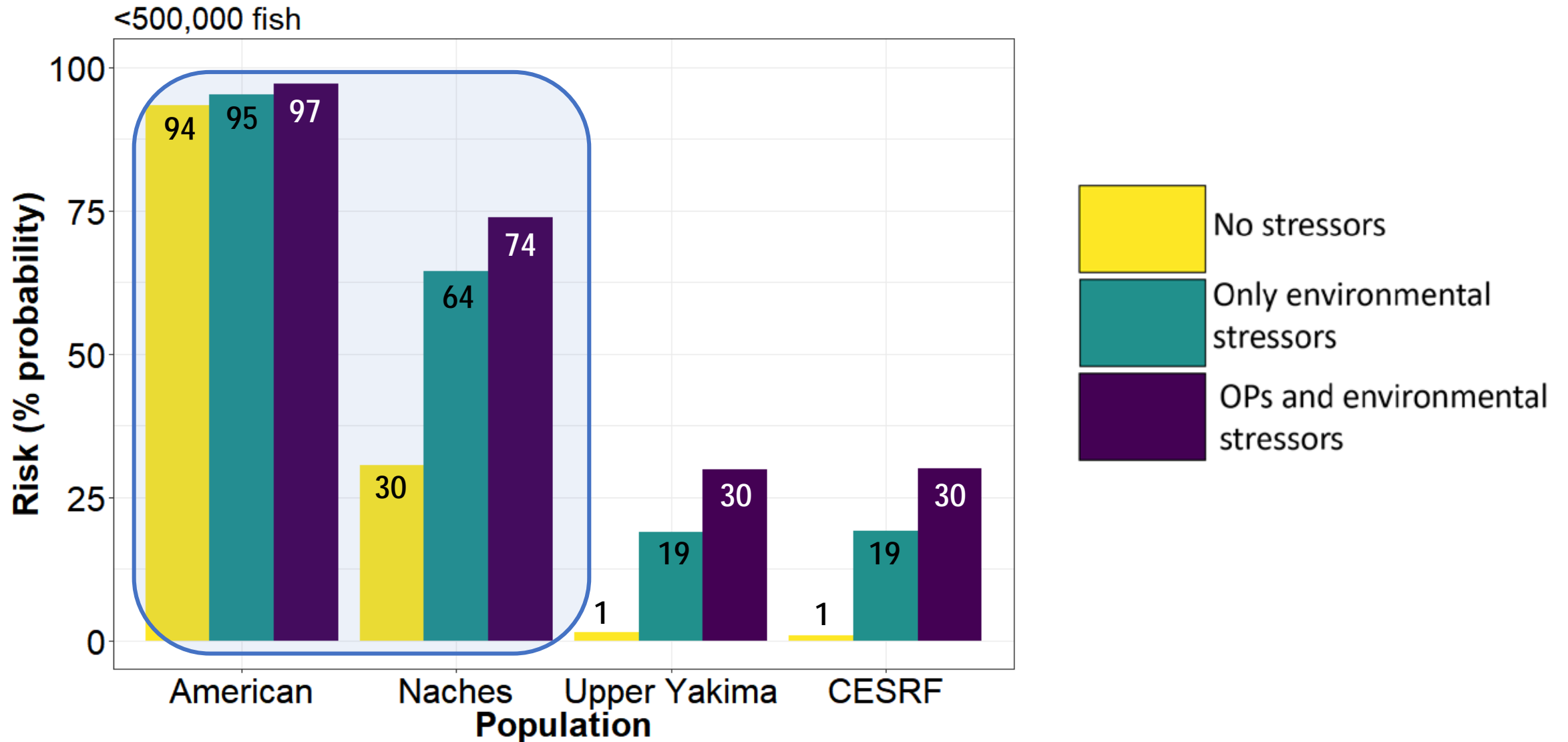
## Risk

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

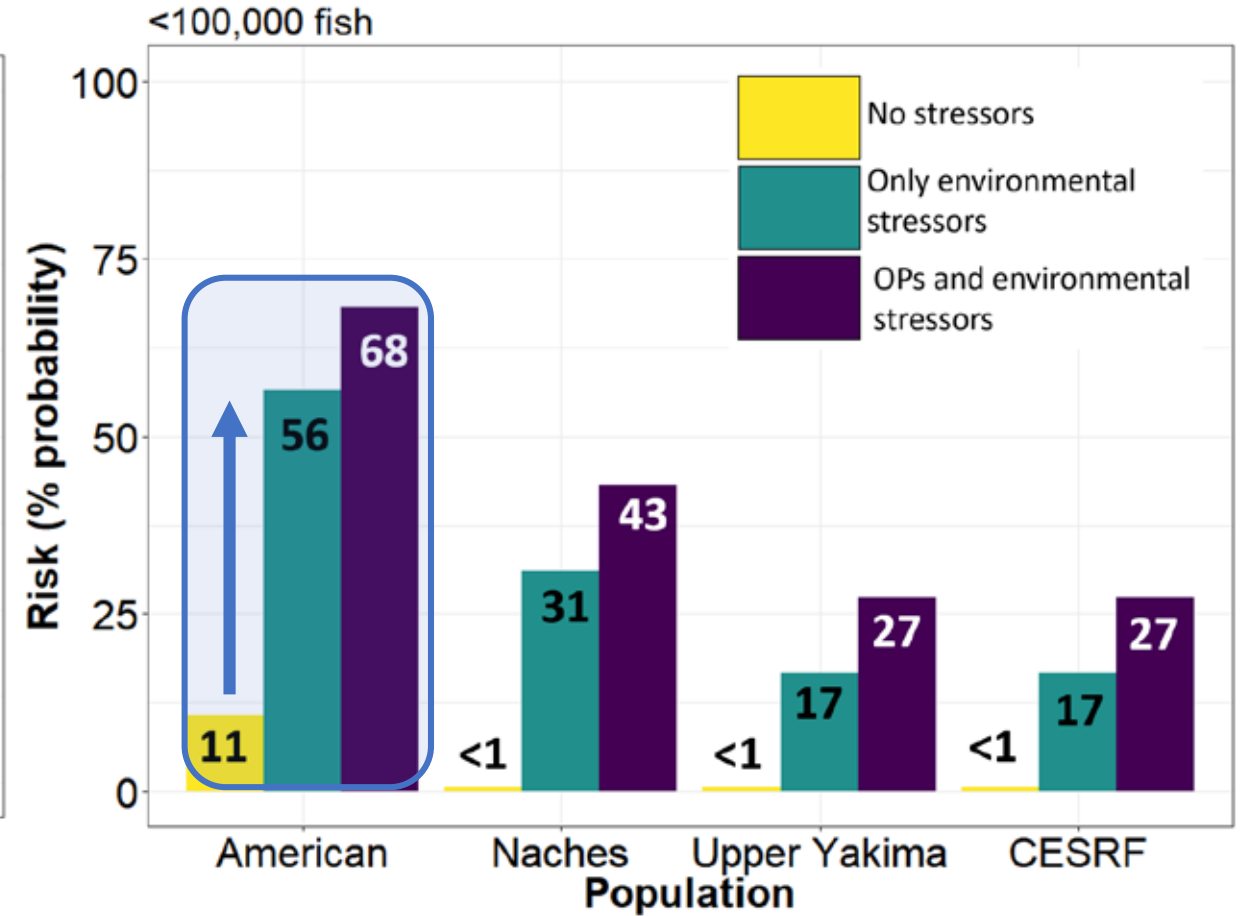
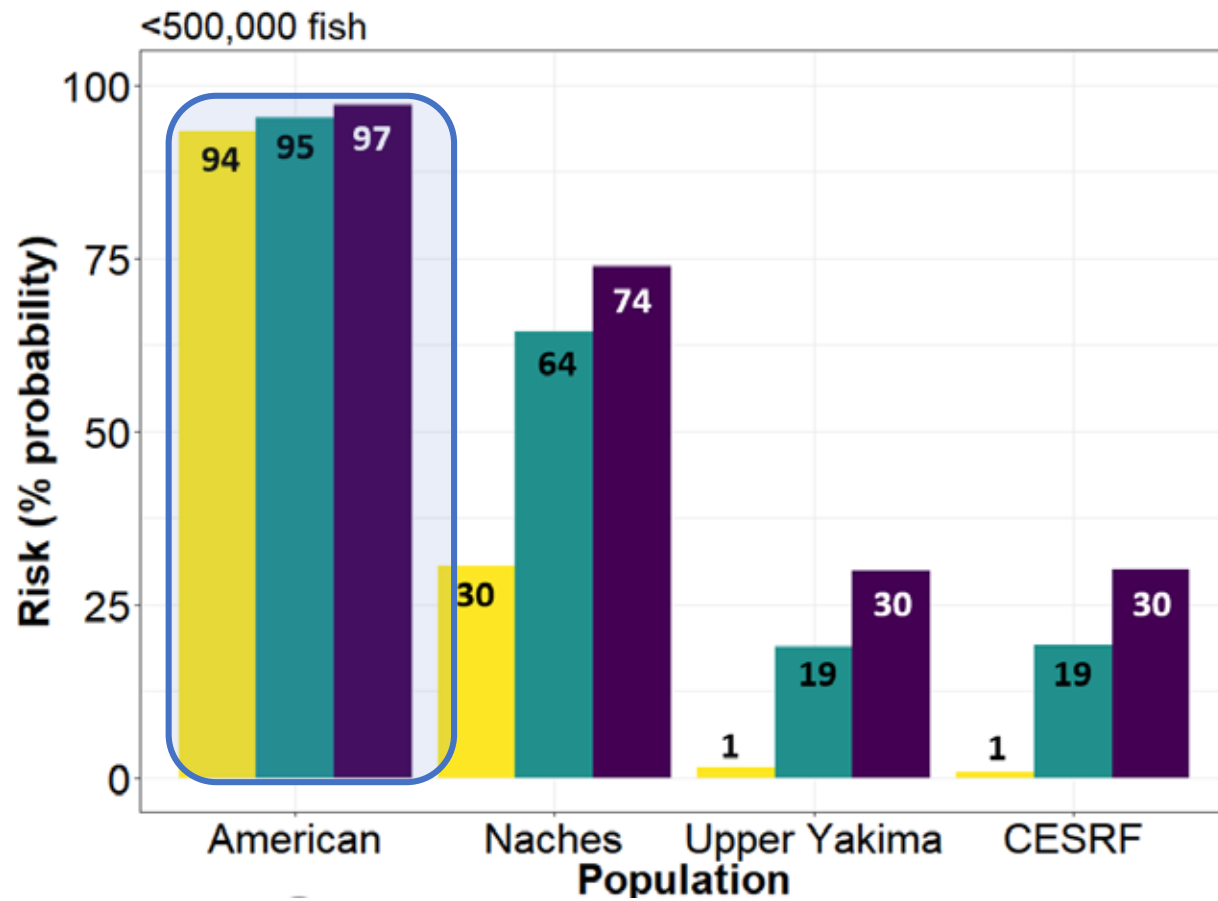
10.9 ± 2.7



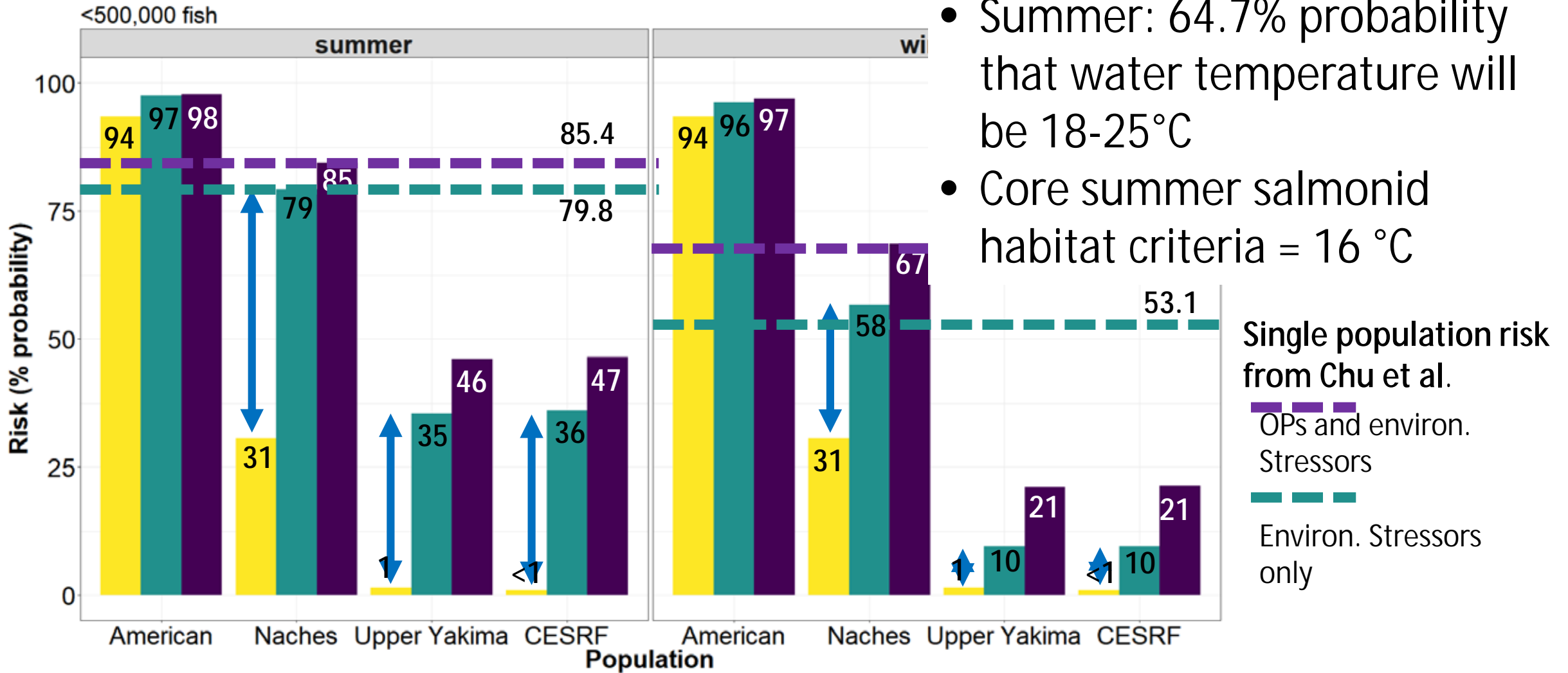
# Risk by population (year 20)



# Risk by population (year 20)



# Risk by population and season (year 20)



# 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!

Thanks and acknowledgements:

EPA STAR Grant & research team

Julann Spromberg, *NOAA*

Abigail Nickelson, *WA Dept. Agriculture*

Cathy Laetz, *NOAA*

Erin Rechisky, *Kintama Research Services*

Andy Dittman, *NOAA*

Phil Roni, *Cramer Fish Sciences*