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

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

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Ecological Risk Assessment:

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
Metapopulation modeling

• Developed age-structure matrix models
  • American, Naches, Upper Yakima, CESRF
  • Stochastic survival, reproduction, and dispersal parameters
• Ran simulations in RAMAS Metapop©
  • 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
Risk by population (year 20)

- **American**: 94, 95, 97
- **Naches**: 64, 74
- **Upper Yakima**: 19, 30
- **CESRF**: 19, 30

**Legend**
- Yellow: No stressors
- Teal: Only environmental stressors
- Purple: OPs and environmental stressors

Risk (% probability) for populations with different categories of stressors.
Risk by population (year 20)

- American: 94, Naches Population: 64, Upper Yakima: 1, CESRF: 30
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

Single population risk from Chu et al.
OPs and environ. Stressors
Environ. Stressors only
Conclusions

**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
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