Nonnative Fish Distribution Model Reveals a Potentially Overlooked Predation Threat to Native Salmonids
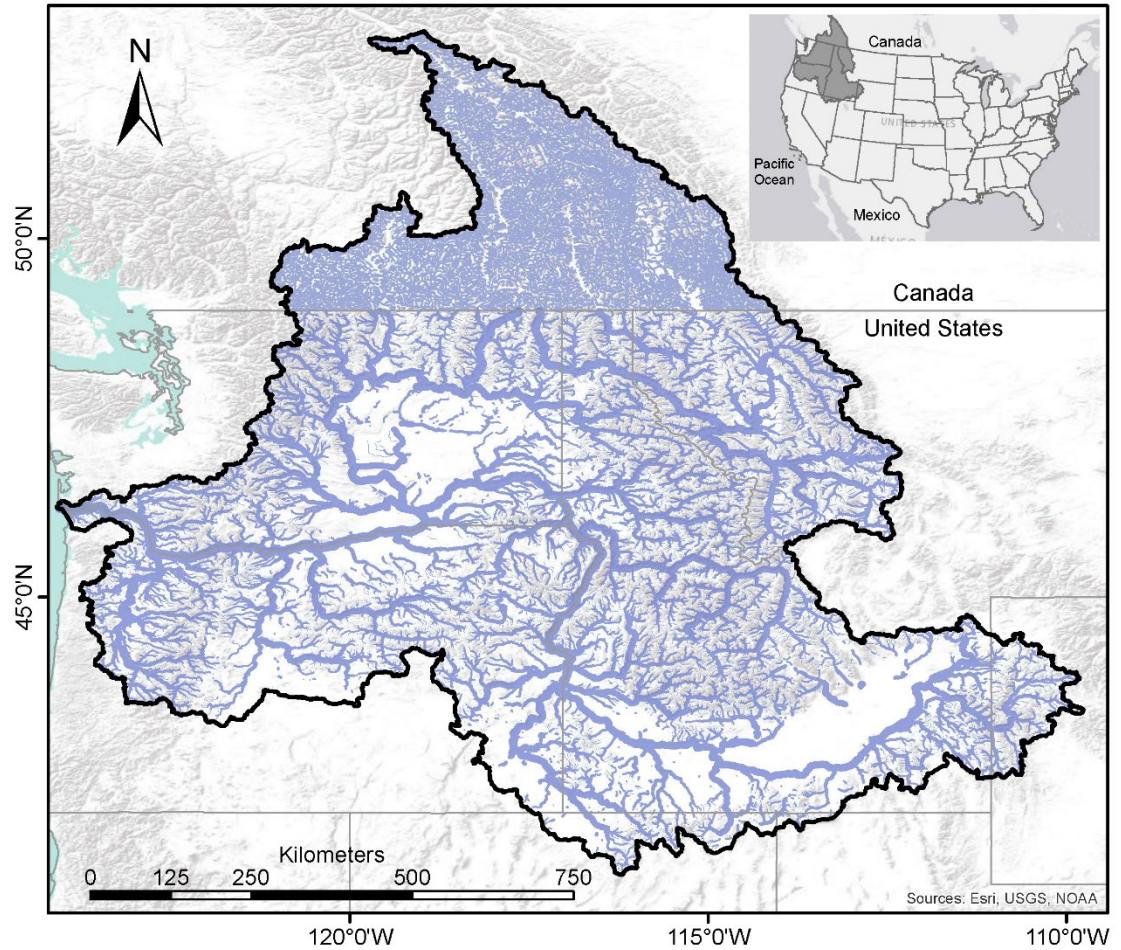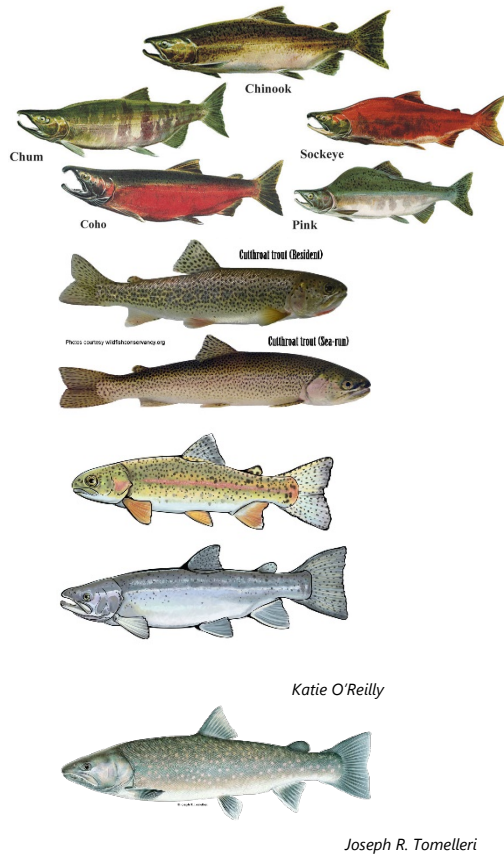
Erika S. Rubenson, Ph.D.
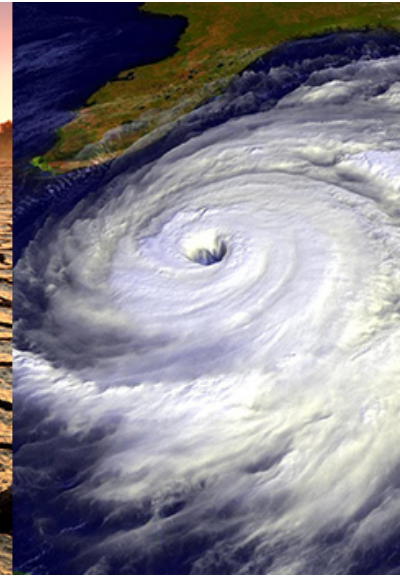
Julian D. Olden, Ph.D.

Fish Without Borders II Workshop
March 1, 2021

Columbia River Basin

Chinook

Sockeye

Chum

Coho

Pink

Cutthroat trout (Resident)

Photos courtesy wildfishconservancy.org   Cutthroat trout (Sea-run)

Katie O'Reilly

Joseph R. Tomelleri

N

Canada

Pacific Ocean

United States

Mexico

Canada

United States

50°0'N

45°0'N

Kilometers
0   125   250   500   750

120°0'W   115°0'W   110°0'W

Sources: Esri, USGS, NOAA

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Threats to Salmonids

Nonnative Fish Species

Sanderson et al. 2009
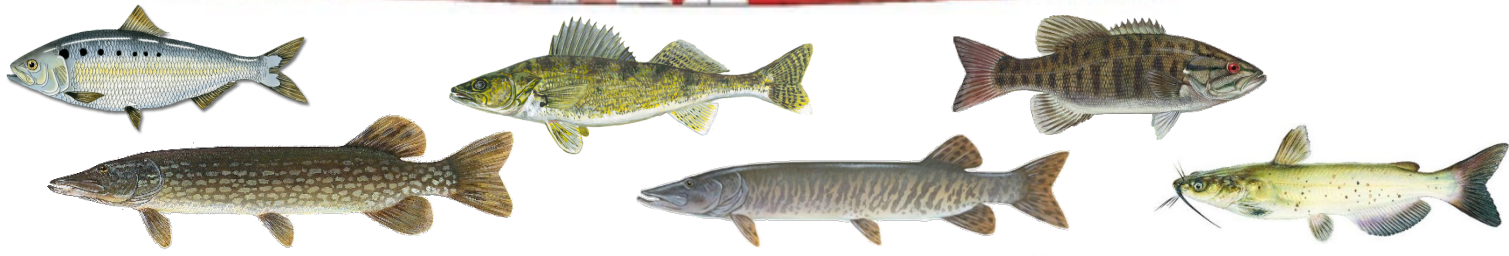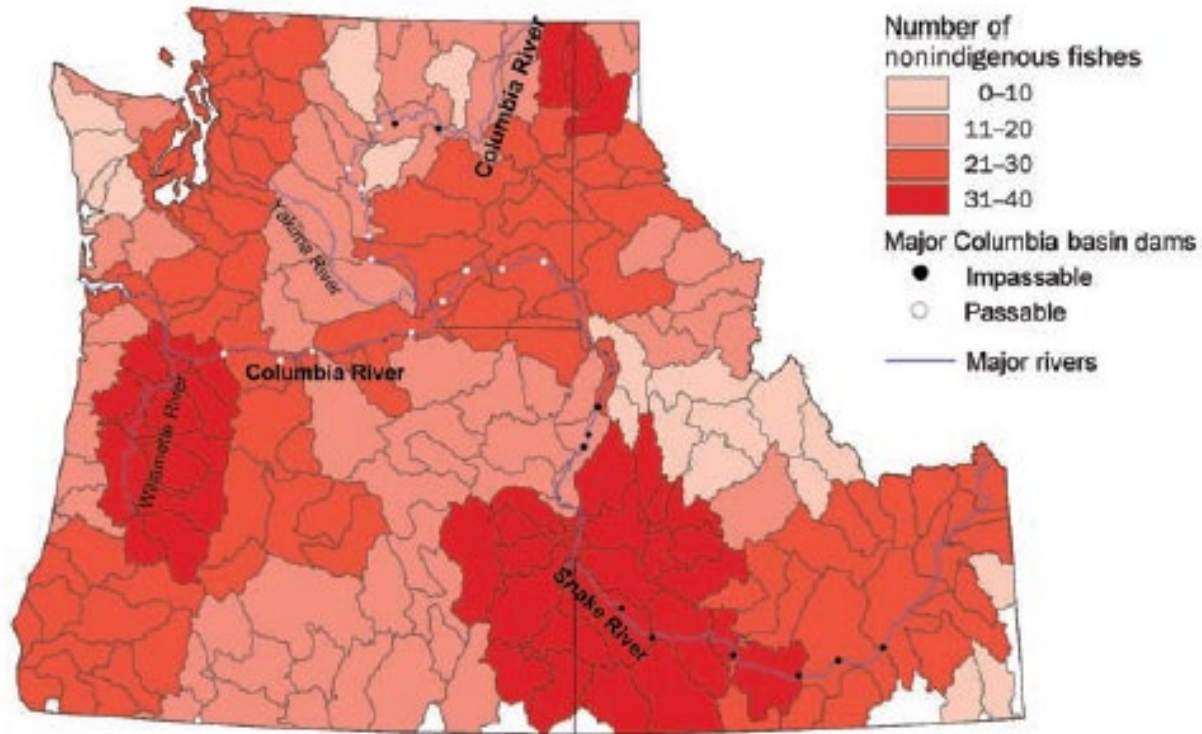
Predator Impacts

- Studies focus on key outmigration corridors
- 1990s, 2000s
  - Native Northern Pikeminnow the majority salmon predator
  - Channel Catfish consumed next most salmonids, but had lowest abundances
  - Smallmouth Bass consumed most food (fish and other prey)
  - Spatial variation in predation impacts based on habitat
- 2010s
  - Increased diversity, abundance, and size
  - Higher direct consumption rates
  - Decreased prey population sizes

Beamesderfer and Rieman 1991; Poe et al. 1991; Poe et al. 1994; Zimmerman 1999; Fritts and Pearsons 2004, 2006; Hughes and Herlihy 2012; Erhardt et al. 2018

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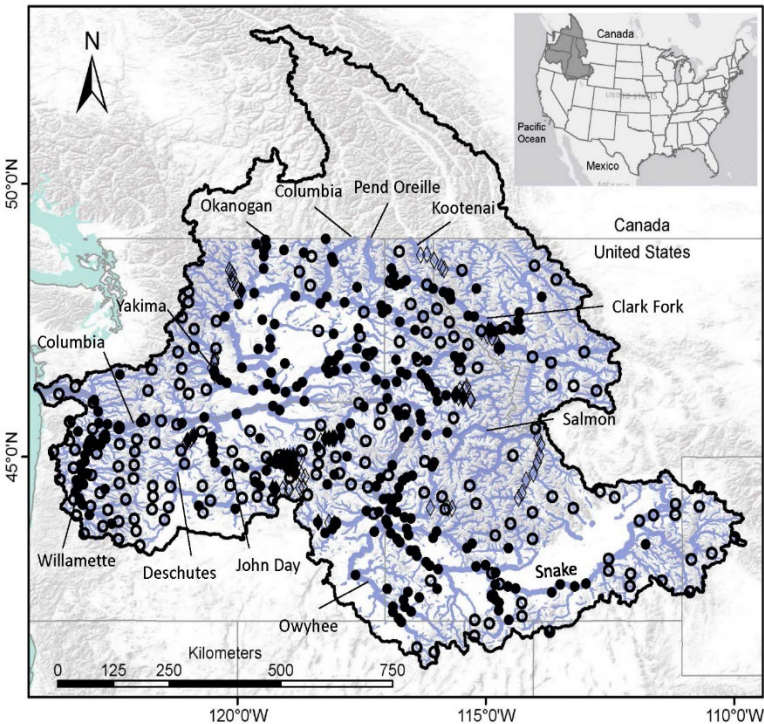Science & Data Solutions

Smallmouth Bass

Objectives

- Predict range boundaries of Smallmouth Bass across disparate rivers

- Determine the potential overlap with rearing salmonids

- Predict future Smallmouth Bass distribution under moderate climate change scenario

Methods

Distribution Data

Environmental Predictors

- Thermal*
- Hydrologic*
- Geomorphic

2080 predictions under A1B climate change scenario

Model

- Multivariate Adaptive Regression Splines (MARS) / Generalized Linear Model (GLM)**

** *Multiple methods, including presence-only MaxEnt gave similar results*

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Elith and Leathwick 2005, 2007; Rubenson and Olden, 2019

Methods

- Used initial prediction to inform eDNA sampling

- Collected eDNA across 14 predicted range boundaries

- Calculated the delta between predicted and observed range boundary

Rubenson and Olden, 2019; Taylor et al. 2018

Methods

- StreamNet.org salmonid distributions
  - Year-round, resident, rearing, spawning

- Threshold - Cutoff for presence locations
  - Maximum sum of sensitivity and specificity > 0.5

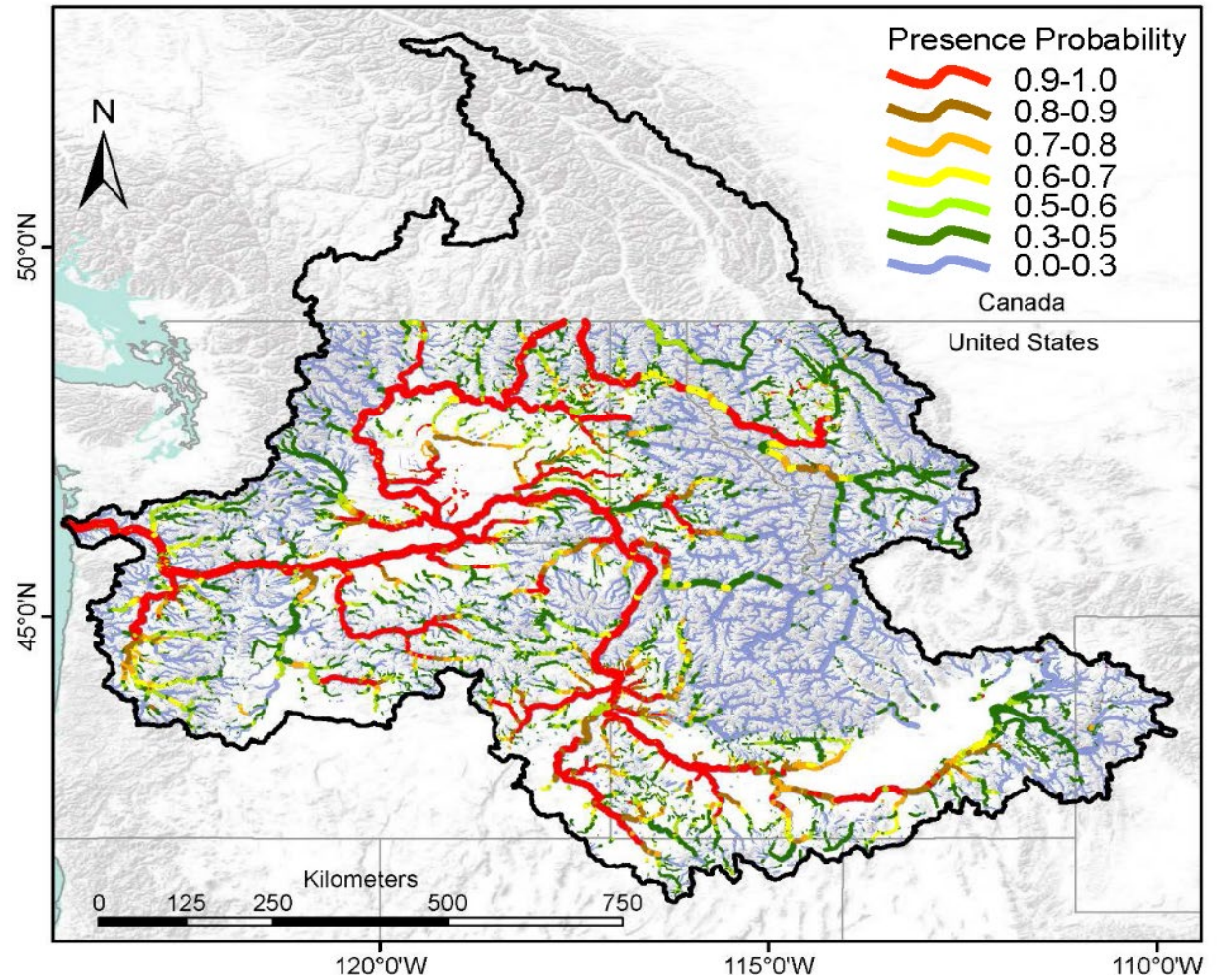- Quantified overlap of Smallmouth Bass in salmonid spawning and rearing habitat

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Results
Current Day

17, 660 km

AUC	0.90
Sensitivity	0.83
Specificity	0.80
TSS	0.62
Kappa	0.62
Accuracy	0.81

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Rubenson and Olden, 2019

Results
2080

29, 818 km

69% more

AUC	0.90
Sensitivity	0.83
Specificity	0.80
TSS	0.62
Kappa	0.62
Accuracy	0.81

Rubenson and Olden, 2019

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Results

Rubenson and Olden, 2019

Results

Species	Run	% of Habitat	RKM
Chinook salmon	Fall	62	2 125
	Spring	22	3 359
	Summer	9	140
Chum salmon	NA	0	0
Coho salmon	NA	19	1 174
Sockeye salmon	NA	39	116
Steelhead	Summer	11	2 606
Steelhead	Winter	15	1 272
Bull Trout	NA	6	1 160
Redband Trout	NA	14	2 810
Westslope Cutthroat Trout	NA	3	1 361
Yellowstone Cutthroat Trout	NA	4	172

**Present day – no future salmon distributions available

Rubenson and Olden, 2019

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Predator Impacts in Headwaters

- Increased predator diversity

  - Coexist with native predators

- Direct predation

  - Decreased abundance of juvenile salmonids

- Resource competition

  - Decreased prey availability

  - Shifts in resource use

  - Decreased growth and survival of juvenile salmonids

Hughes and Herlihy, 2012;
Rubenson and Olden, 2020

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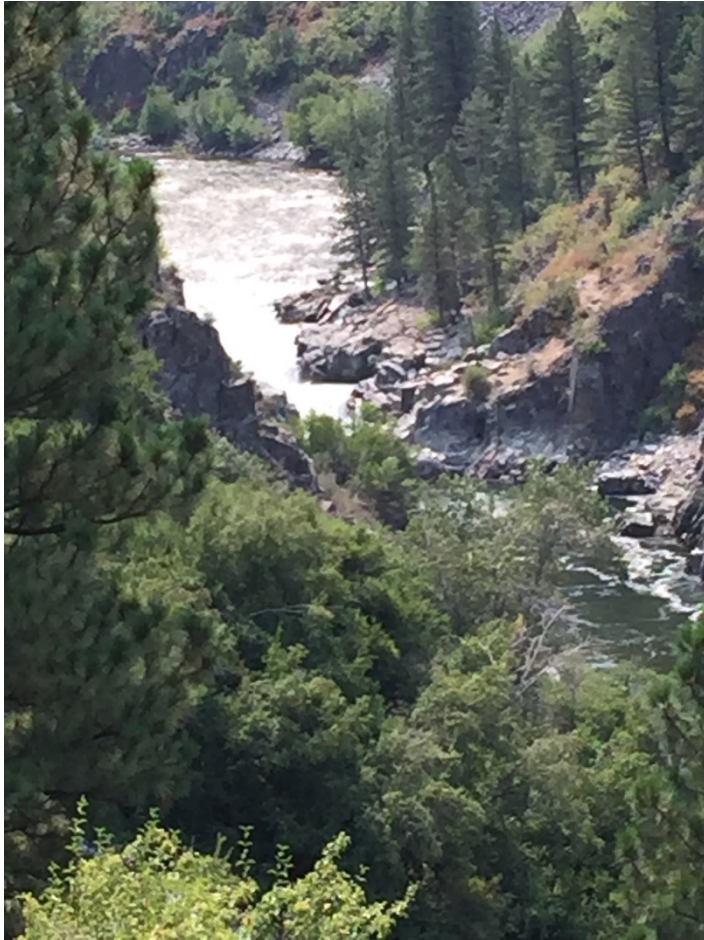ENVIRONMENTAL
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Conclusions

- Year-round threat to rearing juvenile salmonids

- Fall Chinook and Sockeye Salmon highest overlap

- Largely unstudied

- Climate change will benefit nonnative predators

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Implications

- Correlative modeling and eDNA easy to apply to other species

- eDNA provides early warning and identifies range boundaries

- Range boundaries offer unique management opportunities
  - Deterrence
  - Control
  - Eradication

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Questions?

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