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Salmon Recovery Conference 04/09/2019

NOAA

Effect of multiple pressures on early marine survival of juvenile salmon in Puget Sound

Hem Nalini Morzaria-Luna[1]

Isaac Kaplan[2], Raphael Girardin[3], Chris Harvey[2], Michael Schmidt[1], Elizabeth A. Fulton[4], and Parker MacCready[5]

1. Long Live the Kings; 2. NOAA Northwest Fisheries Science Center; 3. IFREMER, Boulogne-sur-mer, France. 4. CSIRO Marine and Atmospheric Research. 5. University of Washington

Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Data LDEO-Columbia, NSF, NOAA

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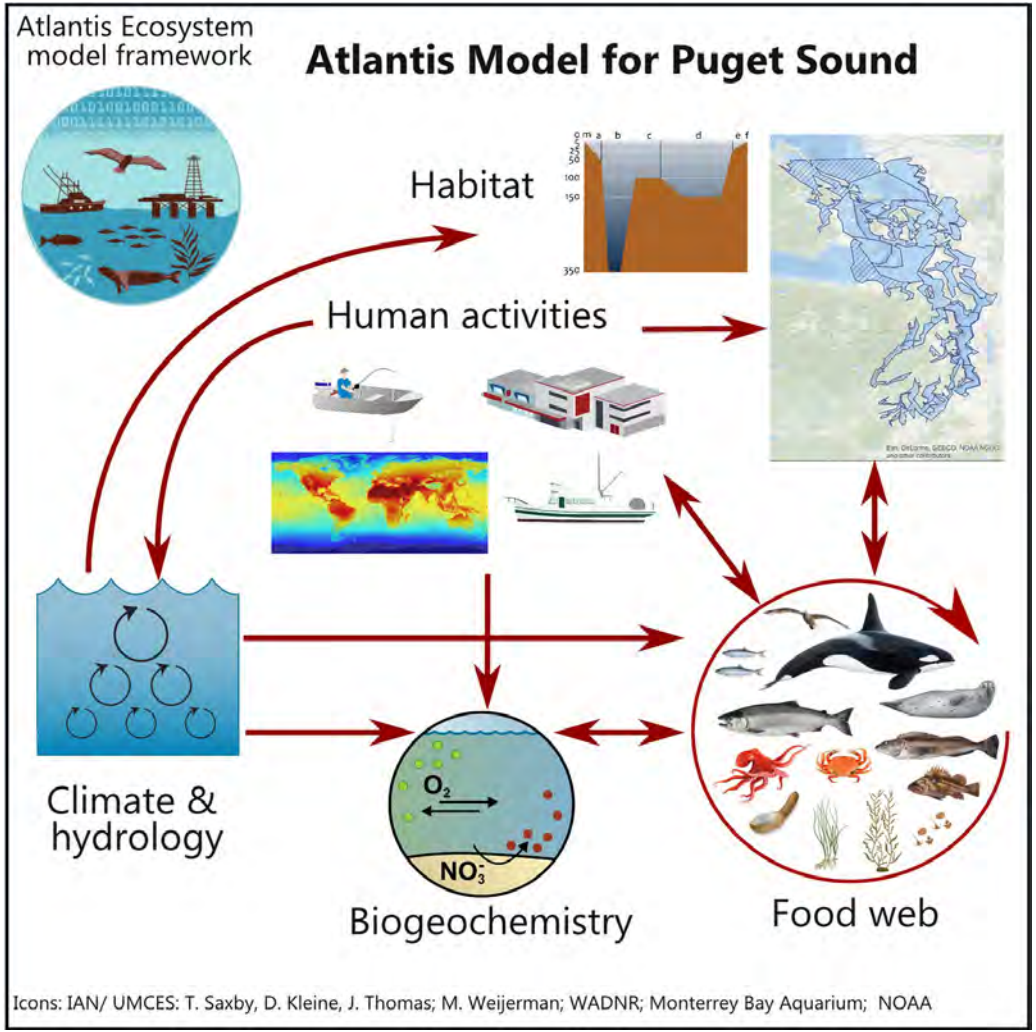

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Strategic Role of Atlantis

Weijerman et al. (2016)

Atlantis is a "sandbox" for understanding:

- Trophic interactions
- Cumulative impacts (Climate change, nutrient loading, toxics, fishing pressure…)
- Trade-offs between management objectives
- Socio-economics and human behavior

NOT intended for:

Tactical management decisions

Replacing fisheries stock assessments

Studying local small-scale perturbations (i.e. stream-scale)

NOT fast enough for intensive parameter estimation

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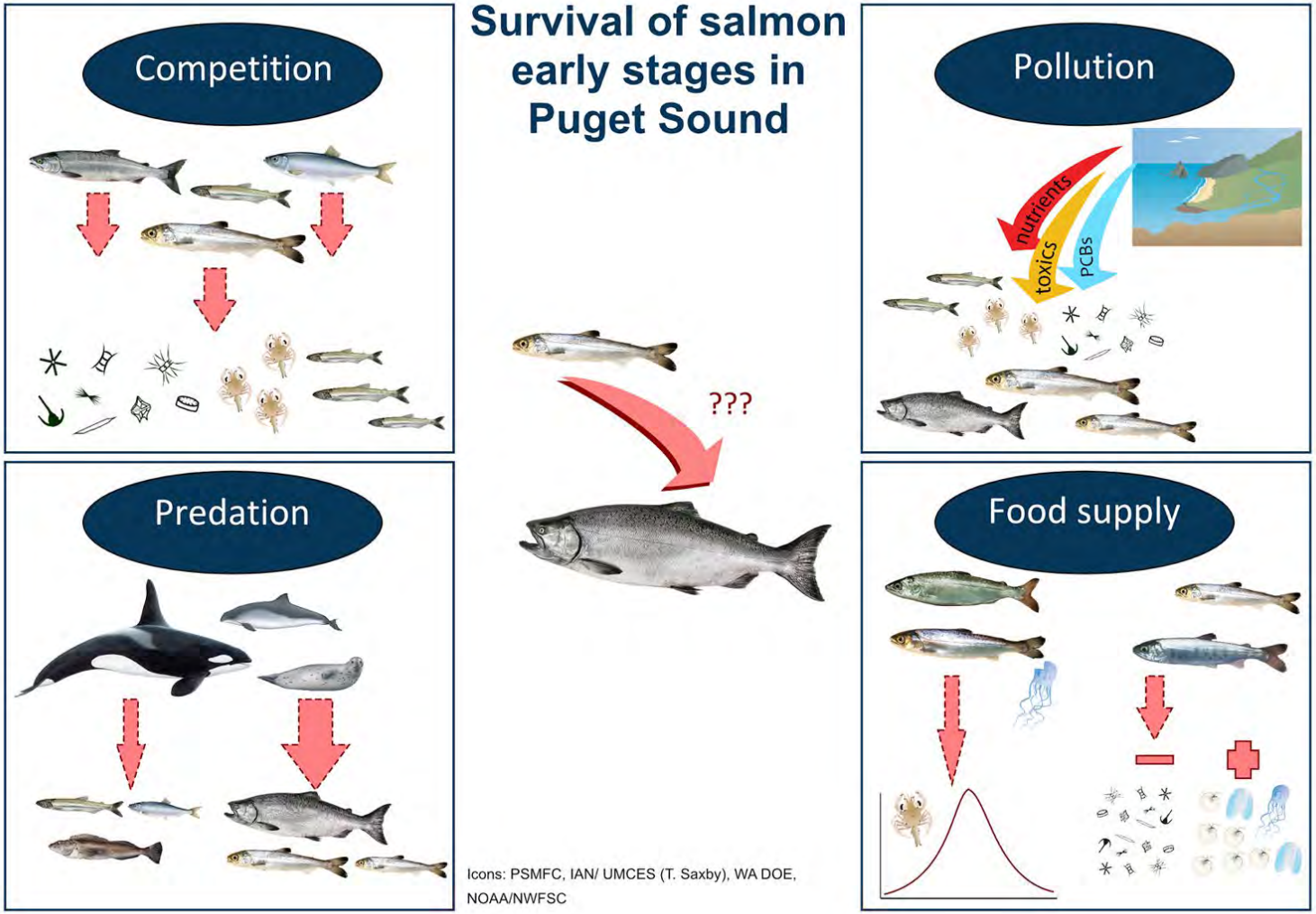
Main goal: evaluate drivers of early marine survival for Chinook and coho salmon



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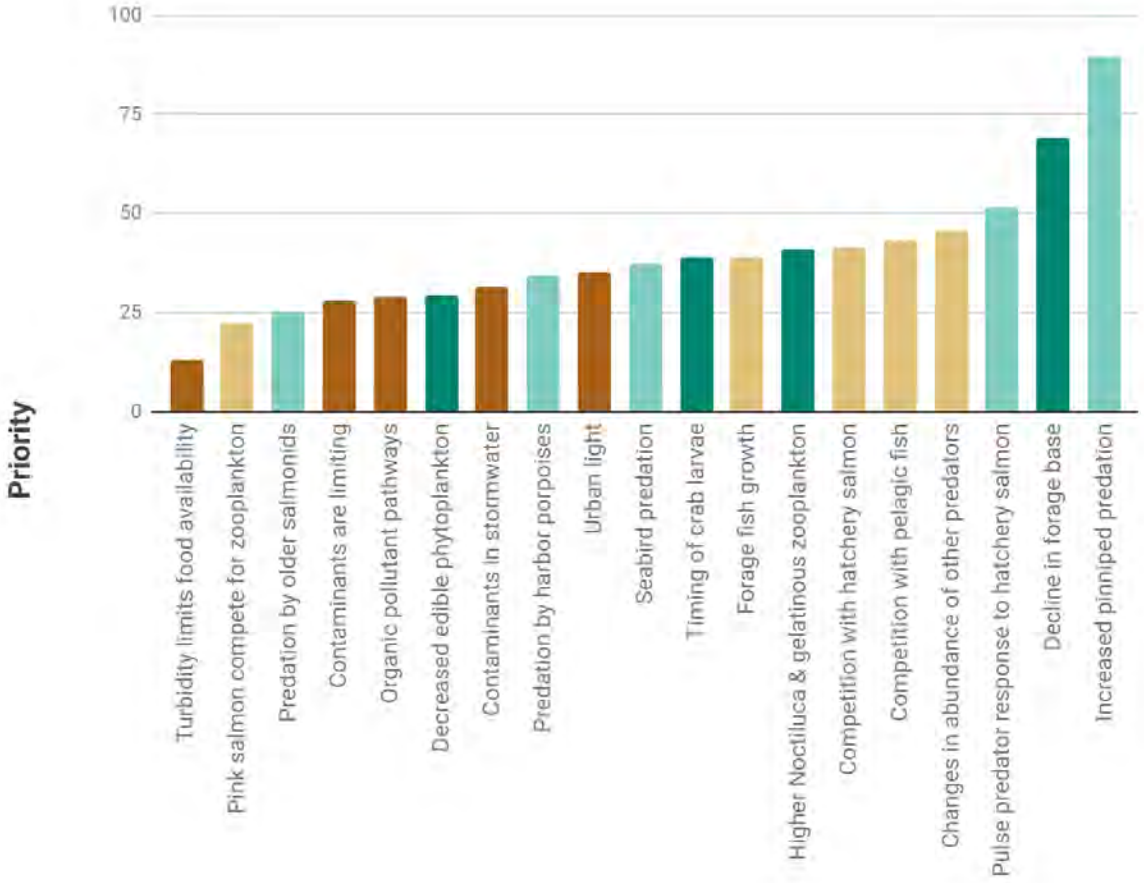
Competition

Predation

Pollution

Food supply



Drivers of increased mortality on juvenile salmon

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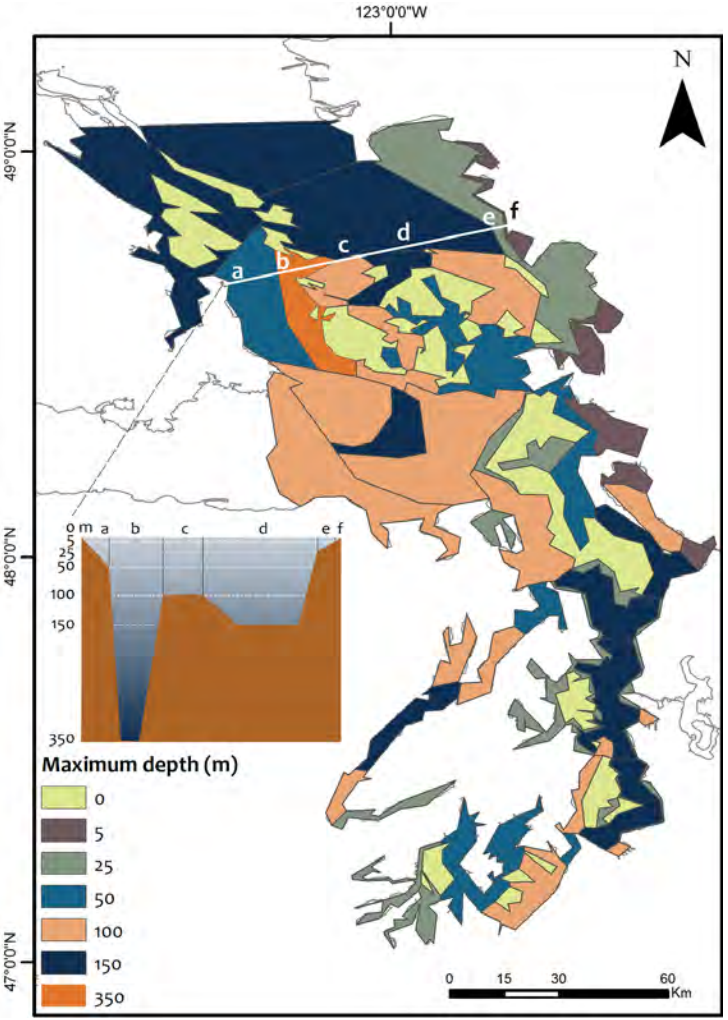
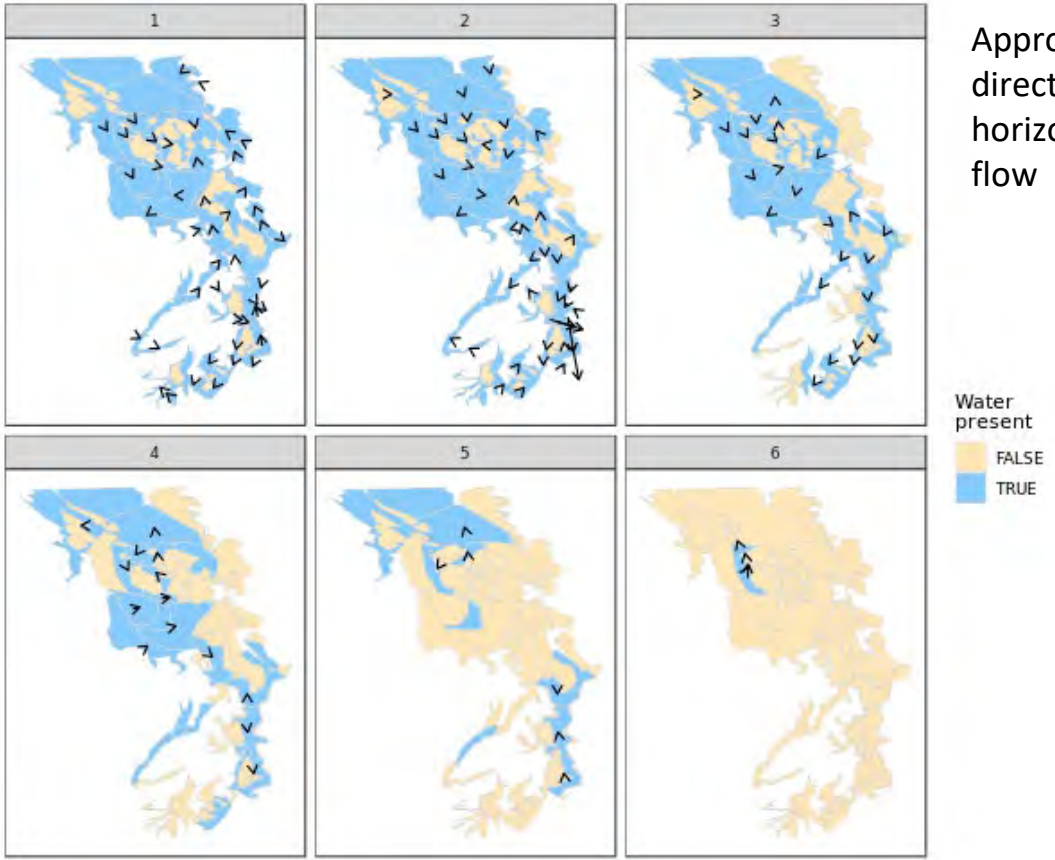


Oceanographic forcing

Data: Parker MacCready. University of Washington

ROMS 2005-2006
Spatial scale: 280 m - 3.1 km; 20 layers



Approximate directions of horizontal flow

Sutherland, D. A., P. MacCready, N. S. Banas, and L. F. Smedstad, 2011: A Model Study of the Salish Sea Estuarine Circulation. J. Phys. Oceanogr., 41, 1125–1143

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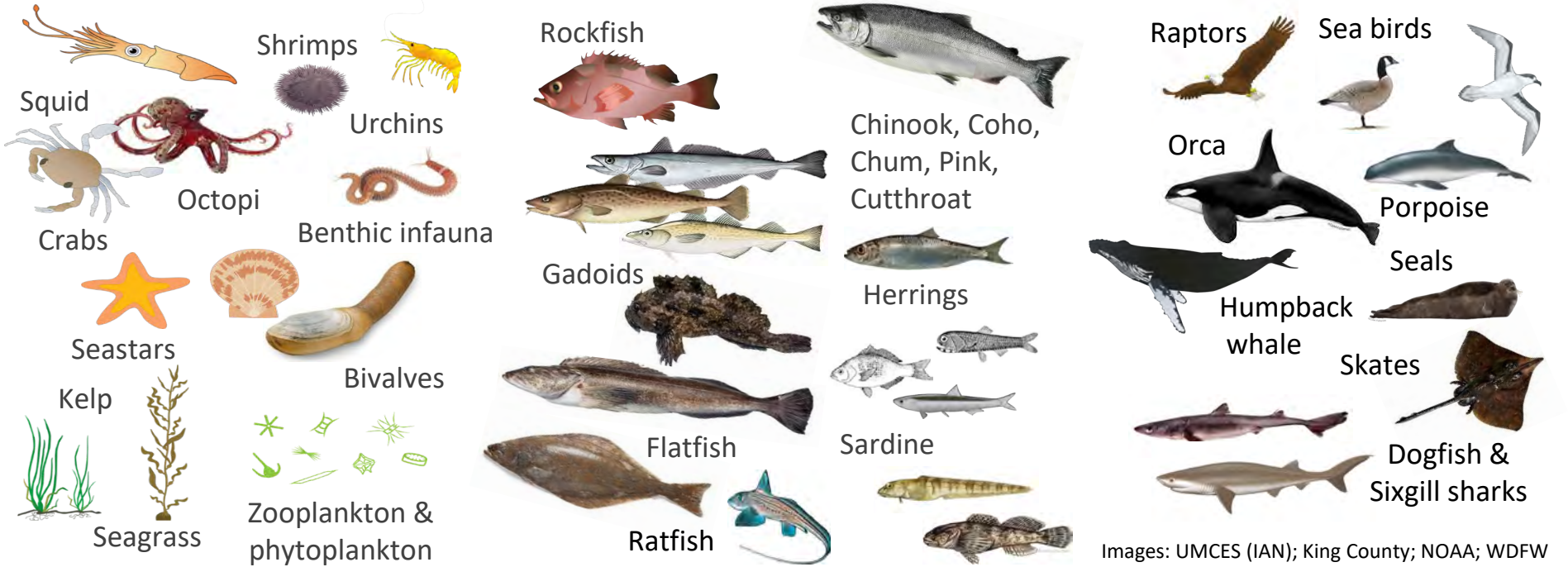
Atlantis functional groups

74 groups (2 bacteria, 3 detritus groups)

4 primary producers, 6 zooplankton, 11 invertebrates

35 fish: 21 salmon, 7 demersal, 5 pelagic, 2 forage

3 birds, 3 shark & rays, 7 marine mammals



Images: UMCES (IAN); King County; NOAA; WDFW

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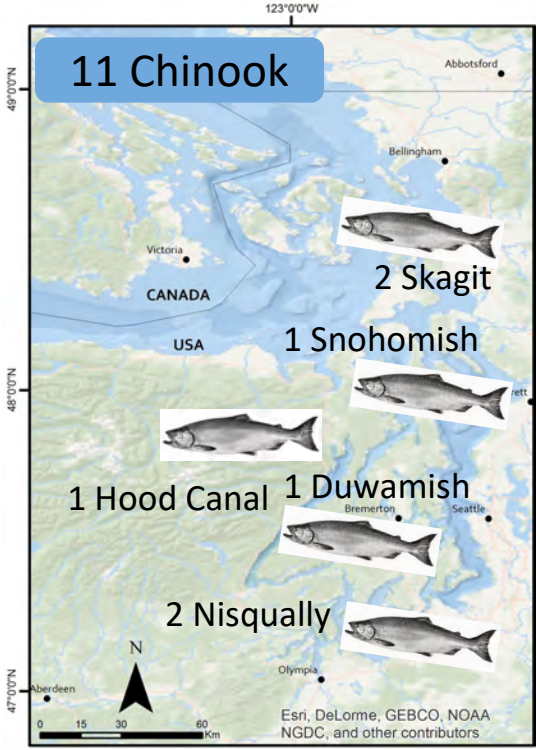
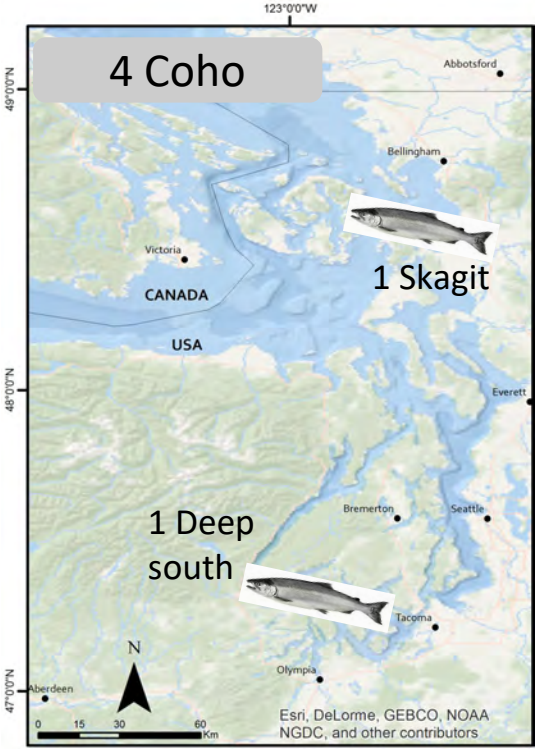
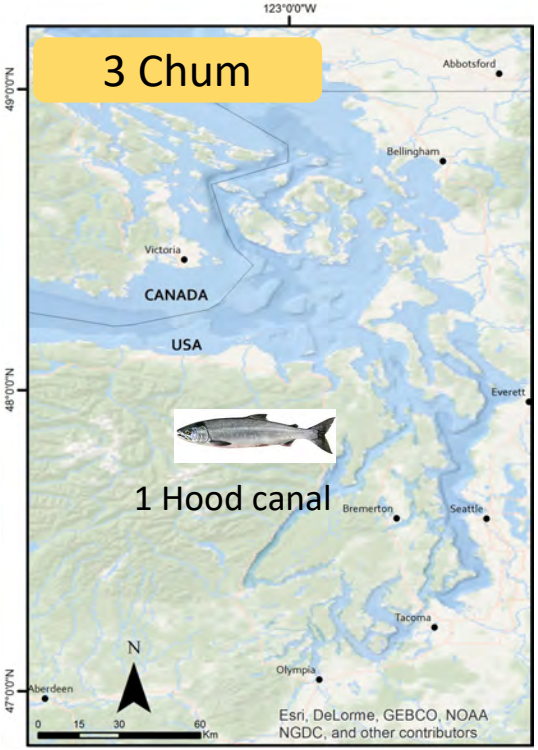
Salmon functional groups



2 Hatchery groups
2 'Other' groups



1 Hatchery groups
1 'Other' groups



1 Hatchery groups
1 'Other' groups

1 Pink

1 Sockeye

1 Canadian salmonids

Fraser River chinook

Images: WDFW

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Salmon life history parameters

- Capturing life history parameters accurately lets us simulate competition between salmon species and populations.
- Life history: age at maturity, lifespan, natural mortality, growth and consumption, reproductive rates, spawning period. Run timing, outmigrant timing, size and growth, residence, additional movement patterns, smolt:adult
- Spatial distributions during migrations; diets

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Spatial abundance

Geostatistical modelling approach VAST to estimate biomass indices and spatial distribution

Thorson et al. 2015, Thorson and Barnett 2017

- RV Ricker trawl surveys.
- Benthic fauna surveys provided by Valerie Partridge et al. WA Dept of Ecology's Puget Sound Assessment and Monitoring Program (PSAMP).
- WDFW bottom trawl surveys. April--June, 1989-2007.

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Salmon spatial abundance

Stock-level assessment based on tagged hatchery fish. Origin determined using RMIS.

11 Chinook	4 Coho	3 Chum	Pink	Sockeye	Canadian Fraser River Chinook
Nisqually yearling Other yearling	Other yearling	Hood canal Hatchery group 'Other' group			
⬇	⬇	⬇		⬇	
Gen. model	**Gen. model**	**Gen. model**		**No data**	

Assume wild distribution = hatchery

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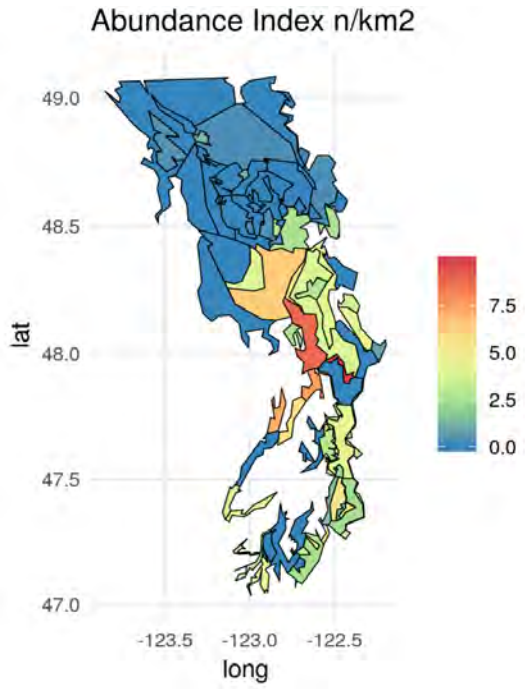
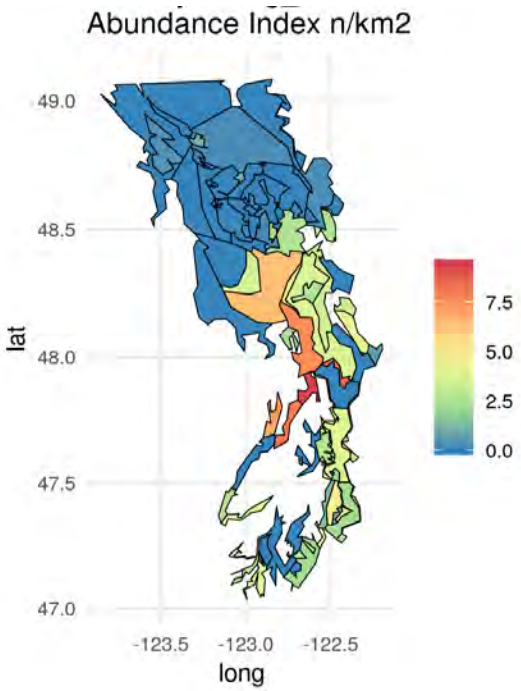
Salmon spatial abundance

Models expanded to monthly patterns: Published information and expert knowledge

Chinook subyearling Snohomish. Summer abundance



Chinook subyearling Snohomish. Fall



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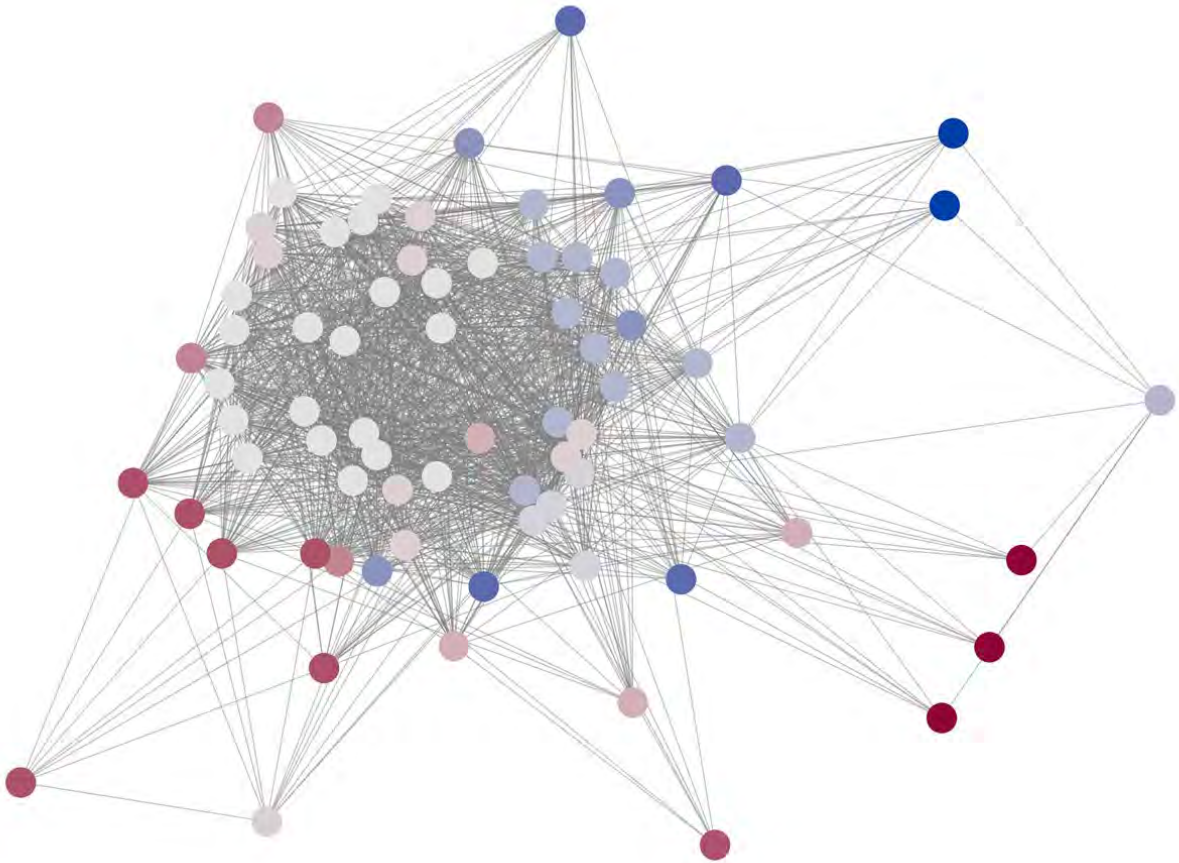
Food web



Guild

- Detritus
- Bacteria
- Primary producers
- Zooplankton
- Invertebrates
- Forage fish
- Salmon
- Demersal fish
- Elasmobranchs
- Birds
- Marine mammals

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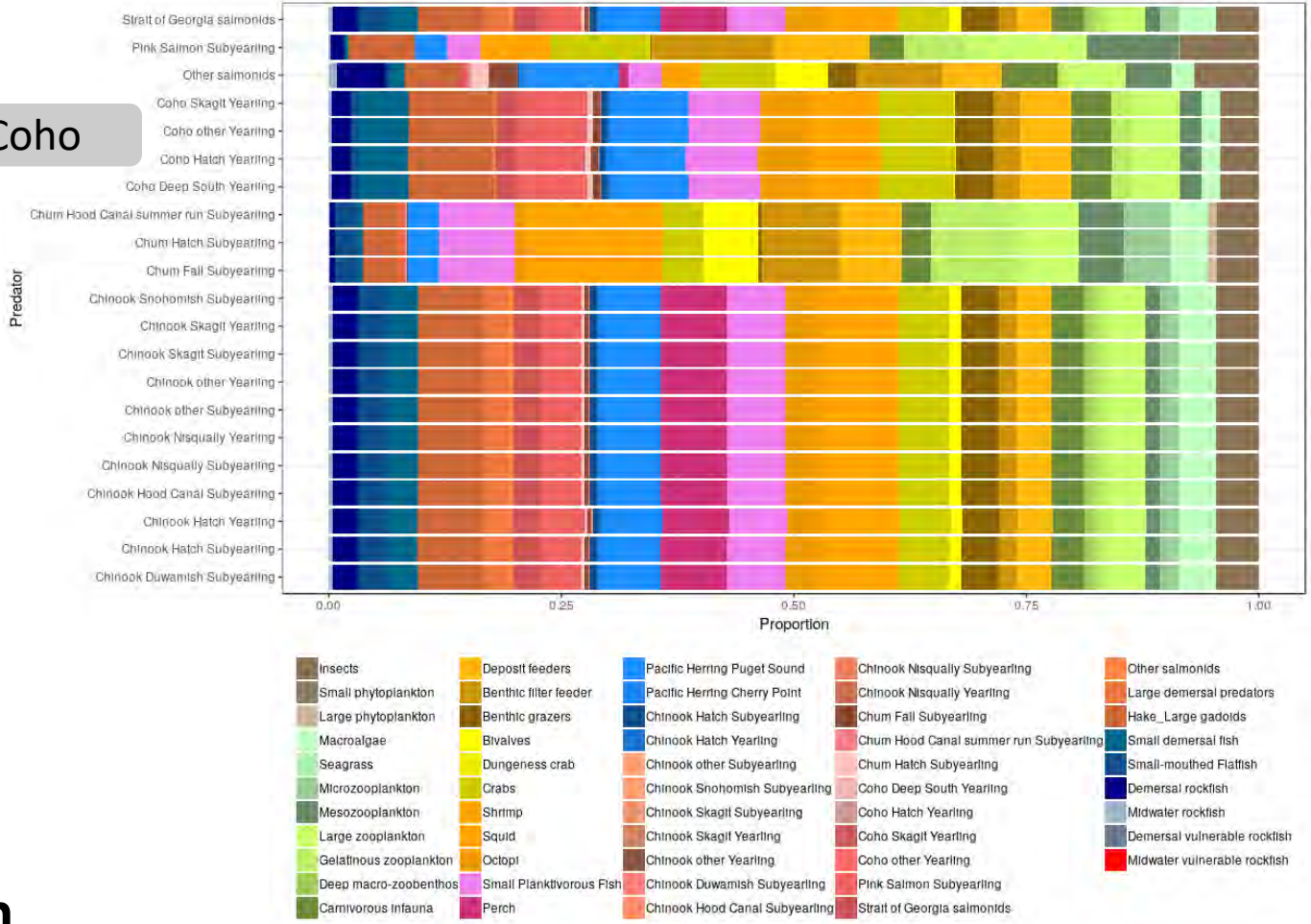
Coho

Chum

Chinook



Juvenile salmon diet composition

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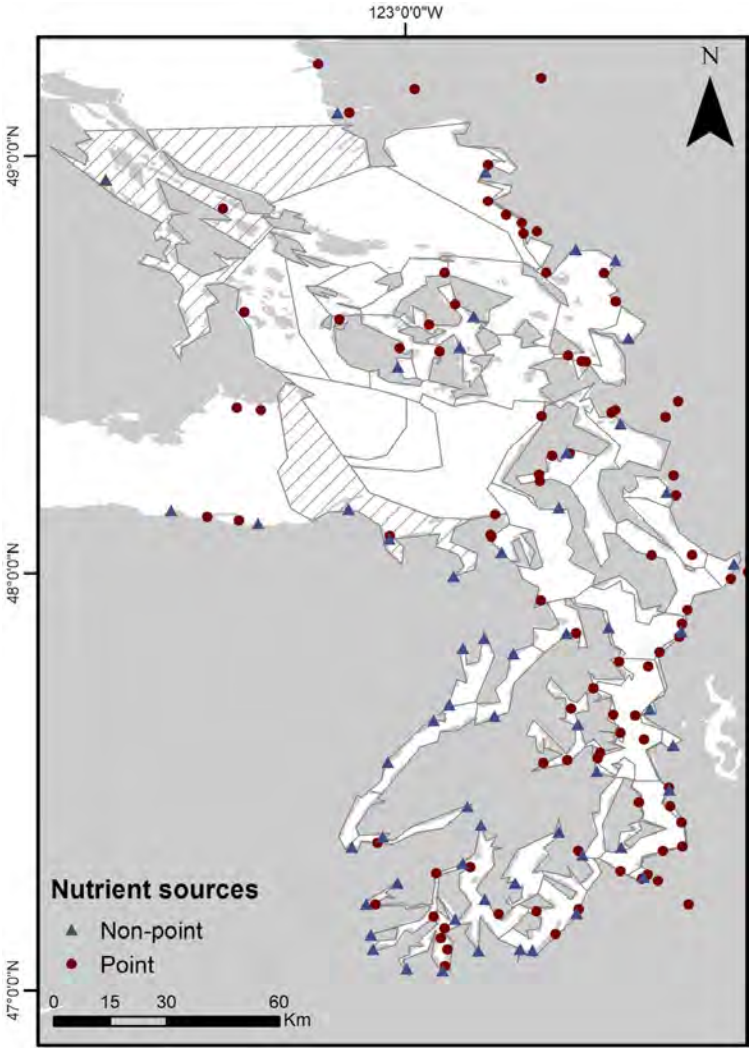
Nutrient forcing

- Point and non-point sources
- Mohamedali et al. (2011) Publication No. *11-03-057,Washington State Department of Ecology*.
- 1999-2008 and 2009-2014
- Assigned to Atlantis polygons



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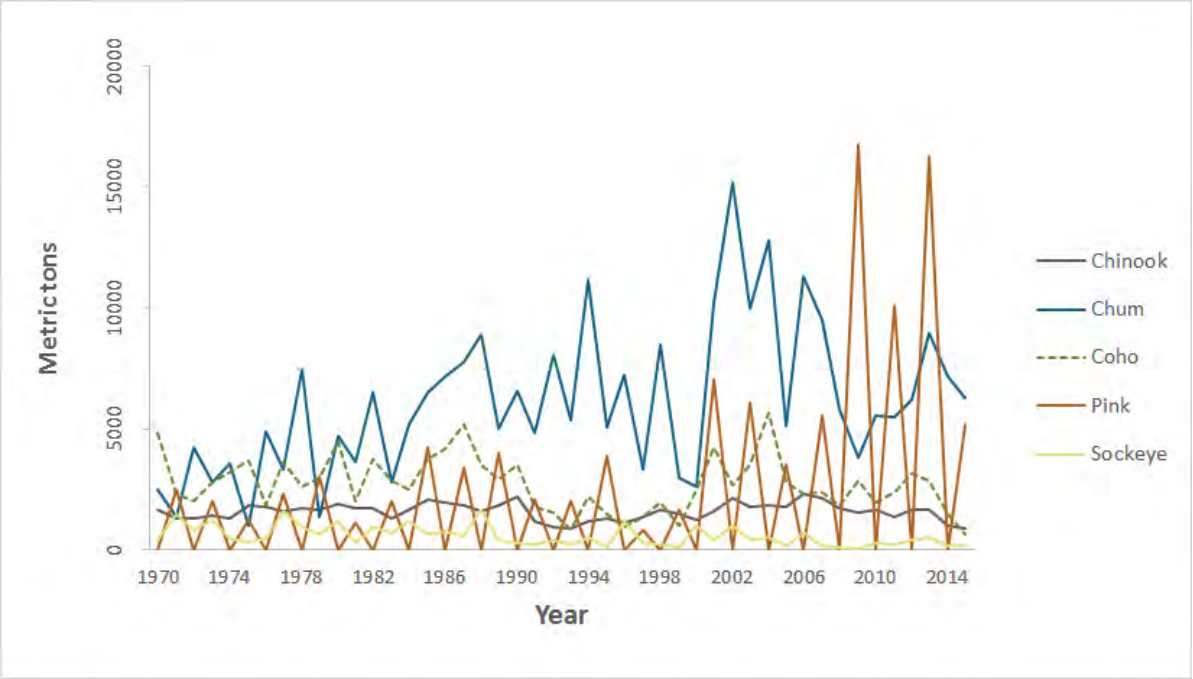
Calibration/ validation

- Historical model 1970 - 2011
- Next steps (calibration)
  - Historical period ~1970 through 2011
  - Skill assessment: 2011-2017



Reconstructed salmon time series (J. Losee, WDFW)

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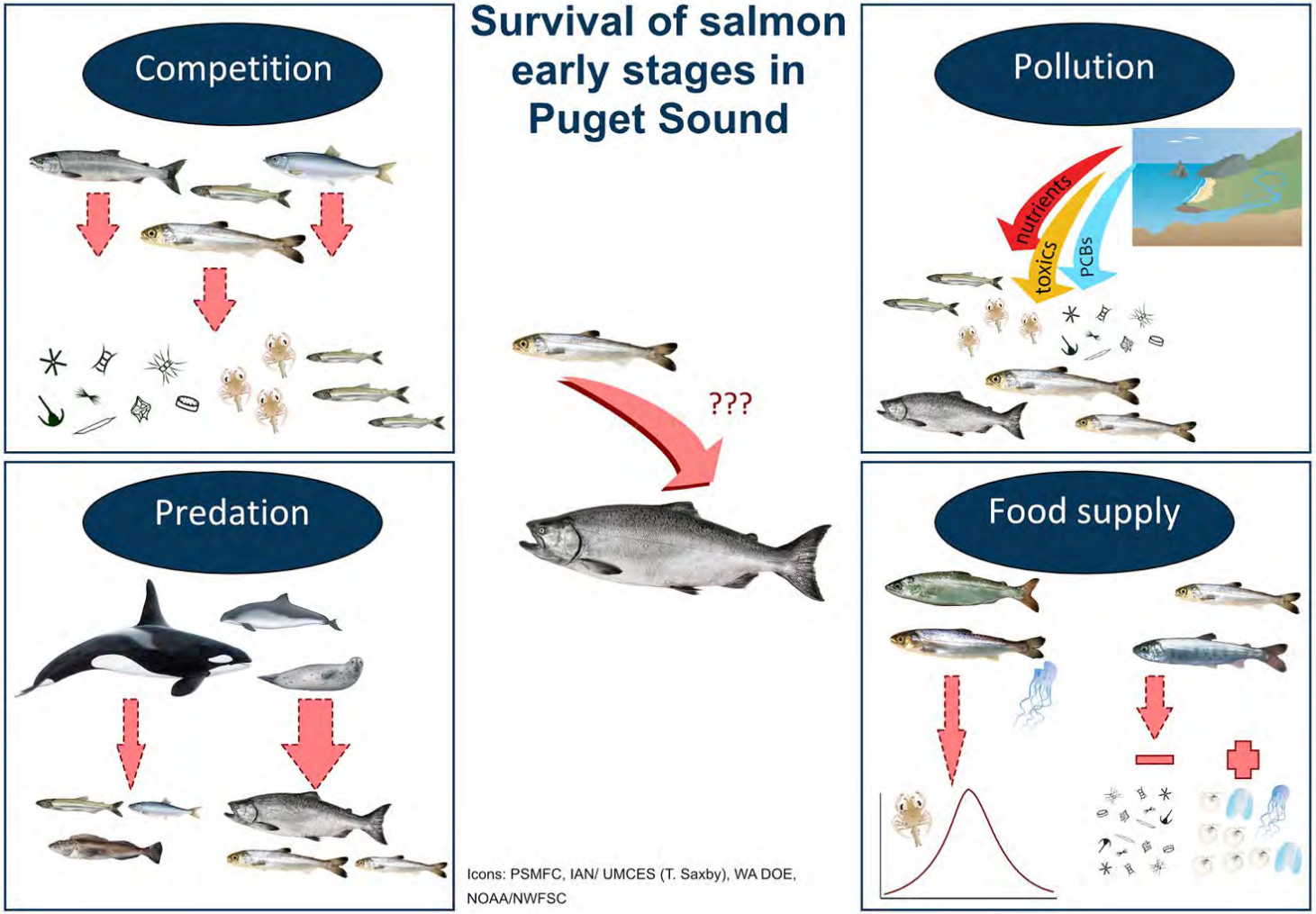

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Competition

Food supply

Predation

Pollution

Bottom-up

1) Competition from hatchery salmon
2) Competition from wild pink and chum salmon
3) Shift to low-quality plankton (gelatinous zooplankton)
4) Decline in herring biomass
5) Decline in availability of crab larvae
6) Shift in release timing of hatchery Chinook
7) Size/growth of early salmon
8) Harvest of forage fish and subsequent effects on jellyfish and forage fish

Top-down

1) Predation by Harbor seals, California Sea lions, and Steller sea lions

2) Predation by Harbor porpoise, dogfish, and birds (separately).

Contaminants in stormwater; Contaminants PCB or PBDE

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Thank you for your attention

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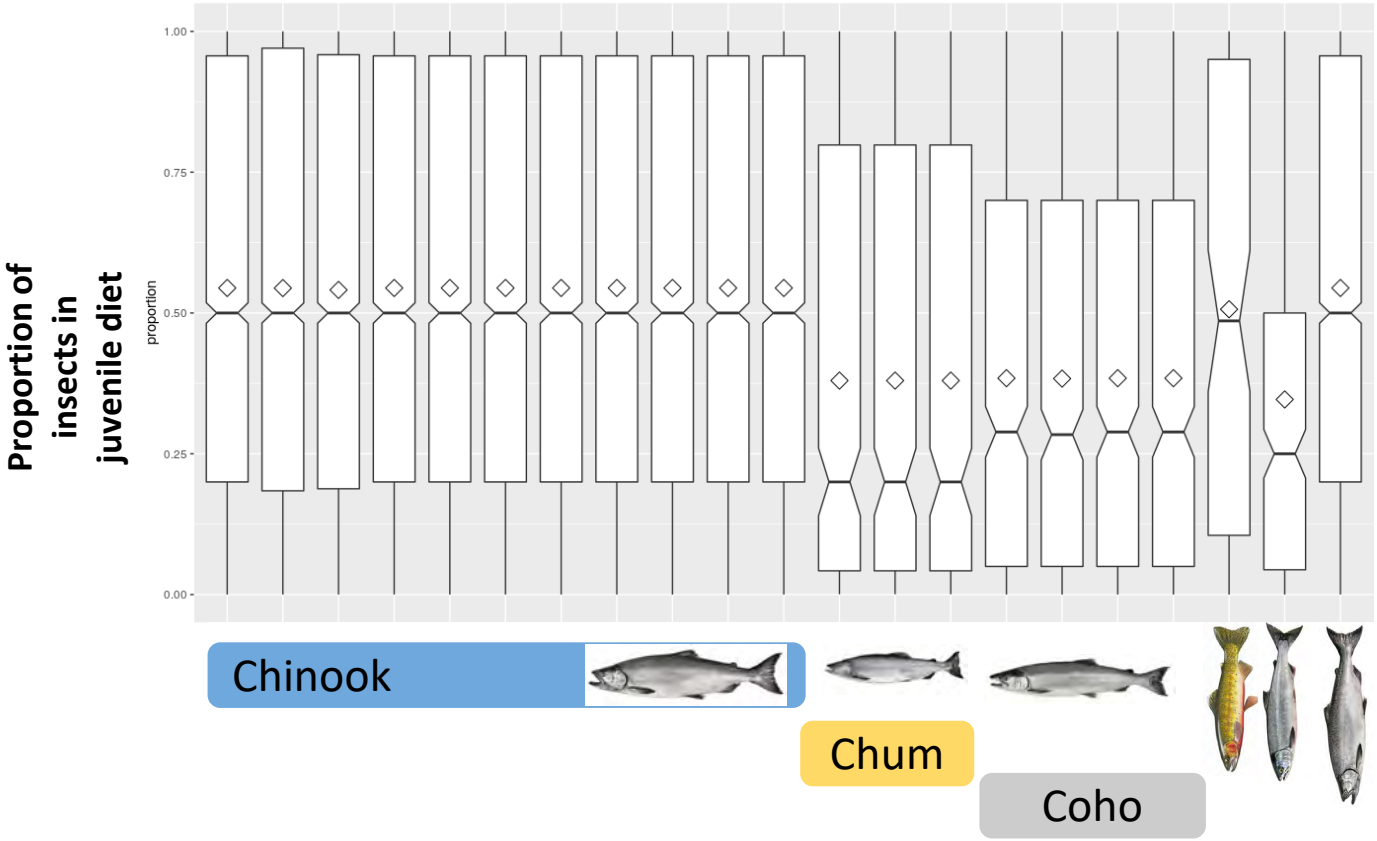
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