




Nurseries of the sea: The value of estuaries for supporting resilient salmon populations

Julian Gan, M.Sc | Nearshore Habitat Restoration Knowledge Exchange Workshop | January 31, 2024



Fisheries and Oceans | Pêches et Océans
Canada | Canada

An aerial photograph of a coastal wetland area at sunset. The sun is low on the horizon, casting a golden glow over the scene. The landscape features a mix of green marshland, brownish water channels, and a large body of water in the foreground. In the distance, a town and mountains are visible under a cloudy sky. A semi-transparent dark green rectangular box is overlaid in the center of the image, containing white text.

I am presenting from the unceded traditional territories of the x̣m̄əθḳw̄əȳəm (Musqueam), Ṣkẉx̣ẉú7mesh (Squamish), and səlilwətał (Tsleil-Waututh) First Nations.



Why are estuaries important for Pacific salmon?

Ocean — Estuary — River

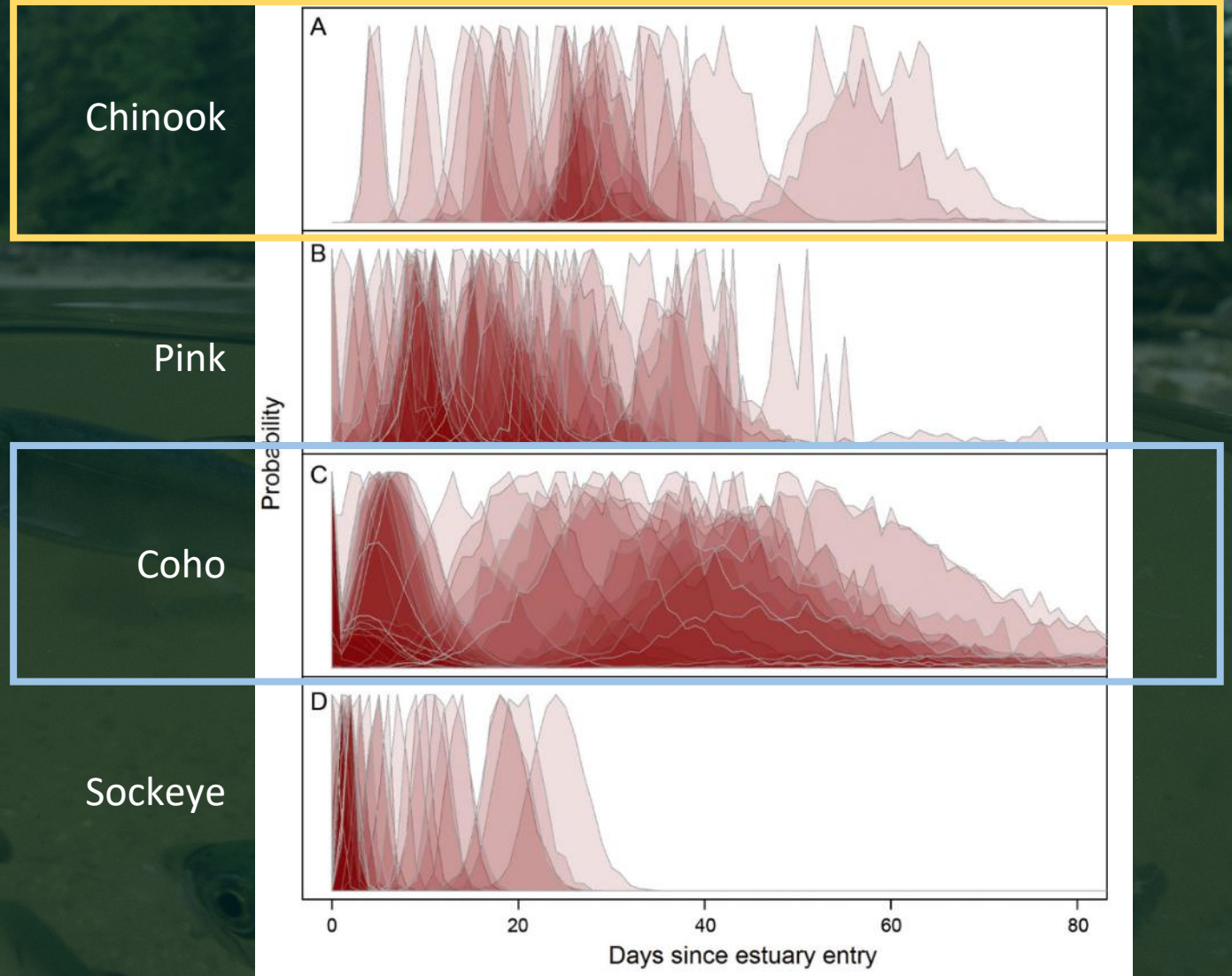


Watershed Watch Salmon Society

Skeena River estuary, BC

Moore et al., 2016

Estuaries can serve as stopover or rearing habitat for multiple species of salmon



An underwater photograph of a stream or estuary. The water is clear, showing green algae and rocks. Several small, striped fish are swimming. Overlaid on the image are four dark teal text boxes connected by yellow arrows pointing downwards. The text boxes contain the following text: 'Long estuary residency time', 'Fast estuary growth rates', 'Increased length prior to ocean entry', and 'Potential increase in marine survival'.

Long estuary residency time

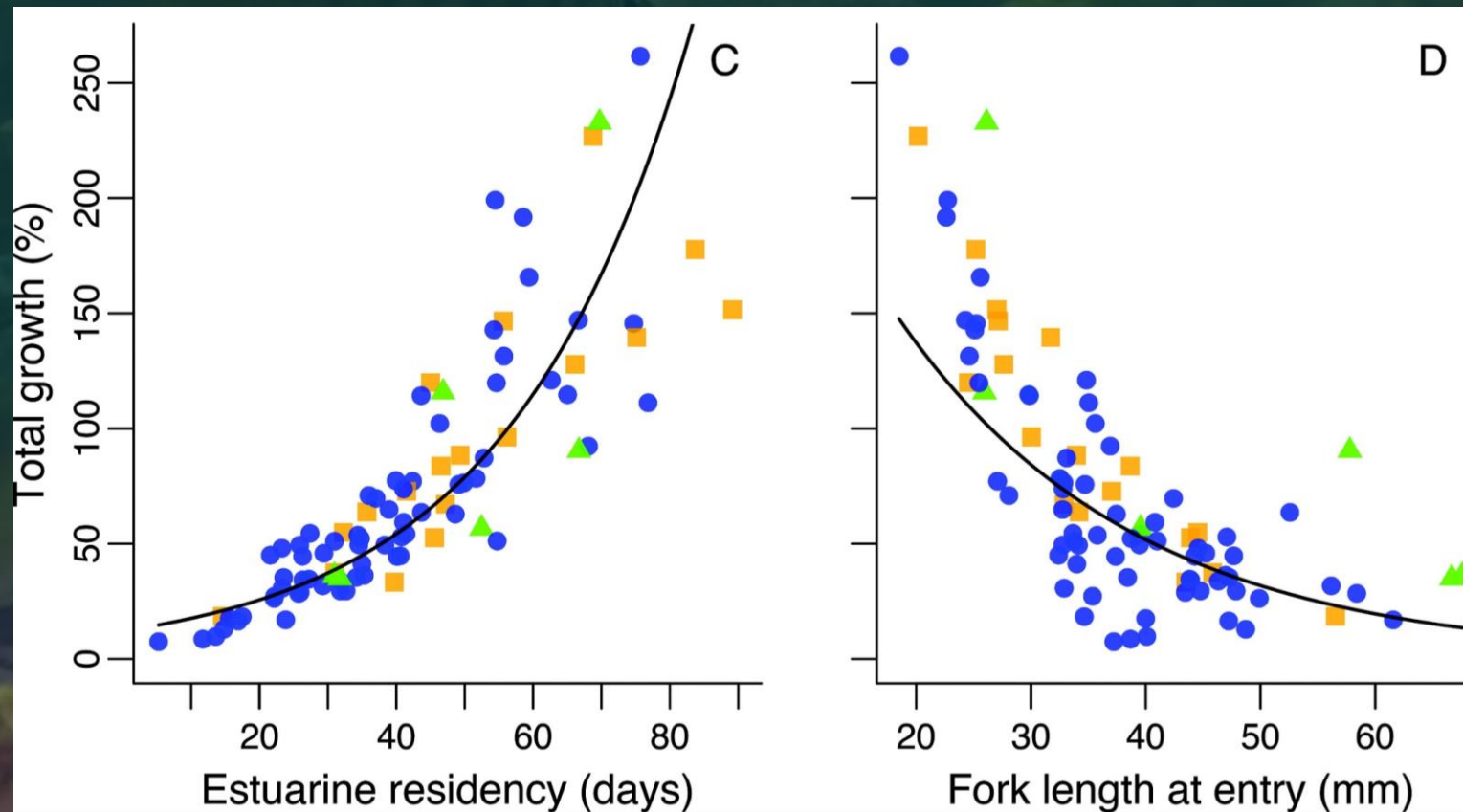
Fast estuary growth rates

Increased length prior to ocean entry

Potential increase in marine survival

Estuary residency can boost growth

Chinook that entered the estuary earlier and smaller resided longer and grew more



Estuary residency can boost growth

Smaller coho
stayed in the
estuary up to
40 days

10 x
estuarine
growth
compared to
freshwater

Avg. 10%
increase in
body length
prior to
ocean entry

25-50%
increase in
marine
survival



Estuary conditions may affect early marine survival

JOURNAL OF **FISH BIOLOGY**



Volume 75, Issue 6
October 2009
Pages 1287-1301

Linking marine and freshwater growth in western Alaska Chinook salmon *Oncorhynchus tshawytscha*

G. T. Ruggerone ✉, J. L. Nielsen, B. A. Agler



Contents lists available at [ScienceDirect](#)

Progress in Oceanography

journal homepage: www.elsevier.com/locate/pocean

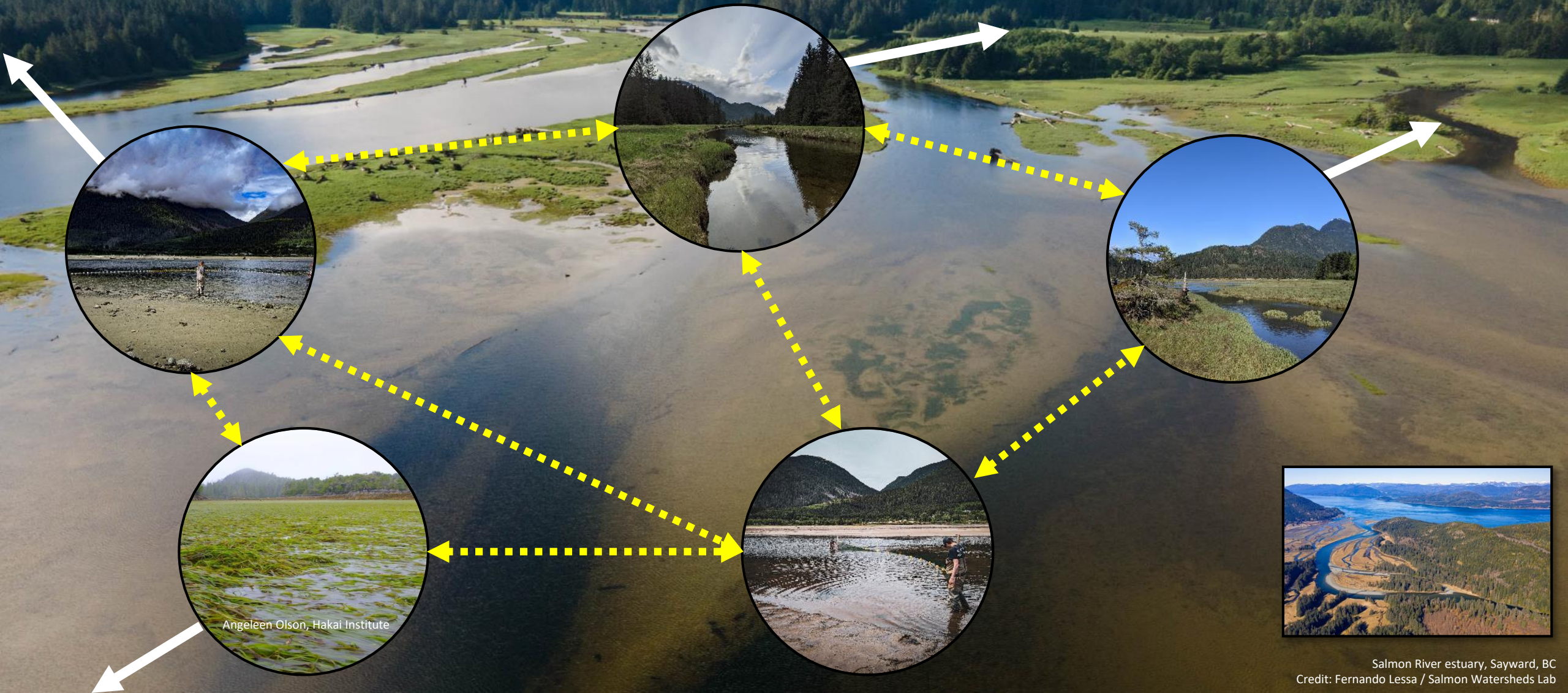


Phenological mismatch, carryover effects, and marine survival in a wild steelhead trout *Oncorhynchus mykiss* population

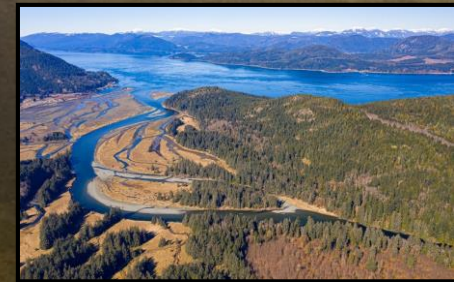
Samantha M. Wilson^{a,*}, Thomas W. Buehrens^b, Jennifer L. Fisher^c, Kyle L. Wilson^a,
Jonathan W. Moore^a



Estuaries contain a mosaic of different habitats used by salmon



Angeleen Olson, Hakai Institute



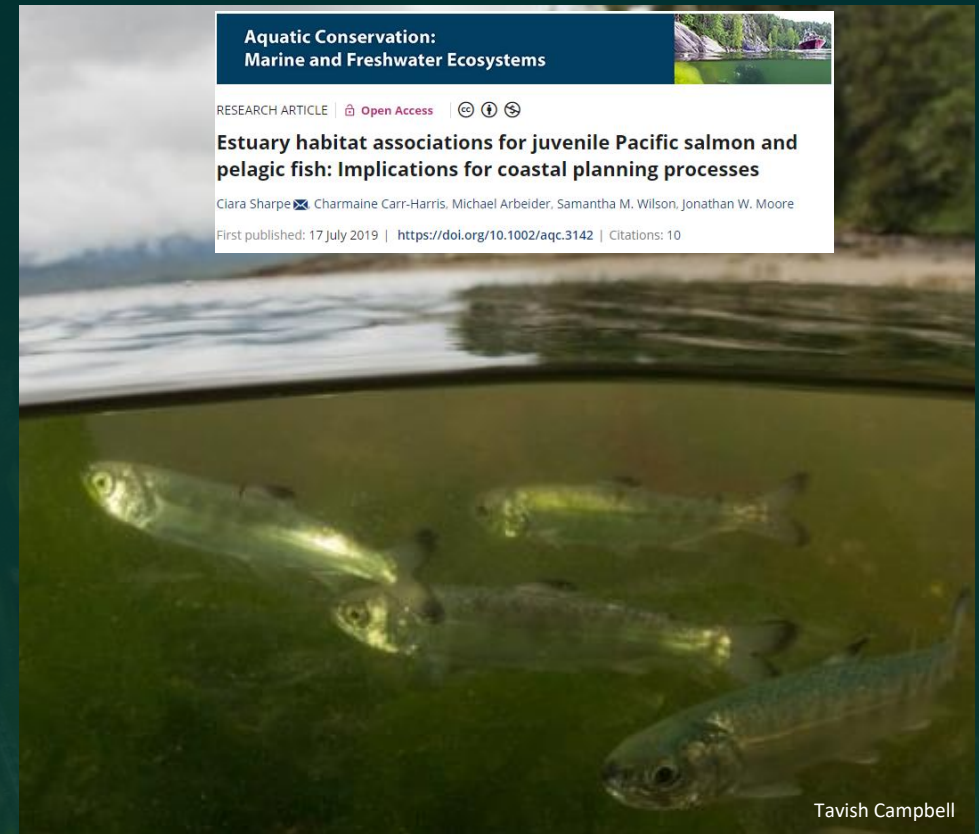
Salmon River estuary, Sayward, BC
Credit: Fernando Lessa / Salmon Watersheds Lab

Fish use different habitats within the estuary



Fraser River estuary, BC

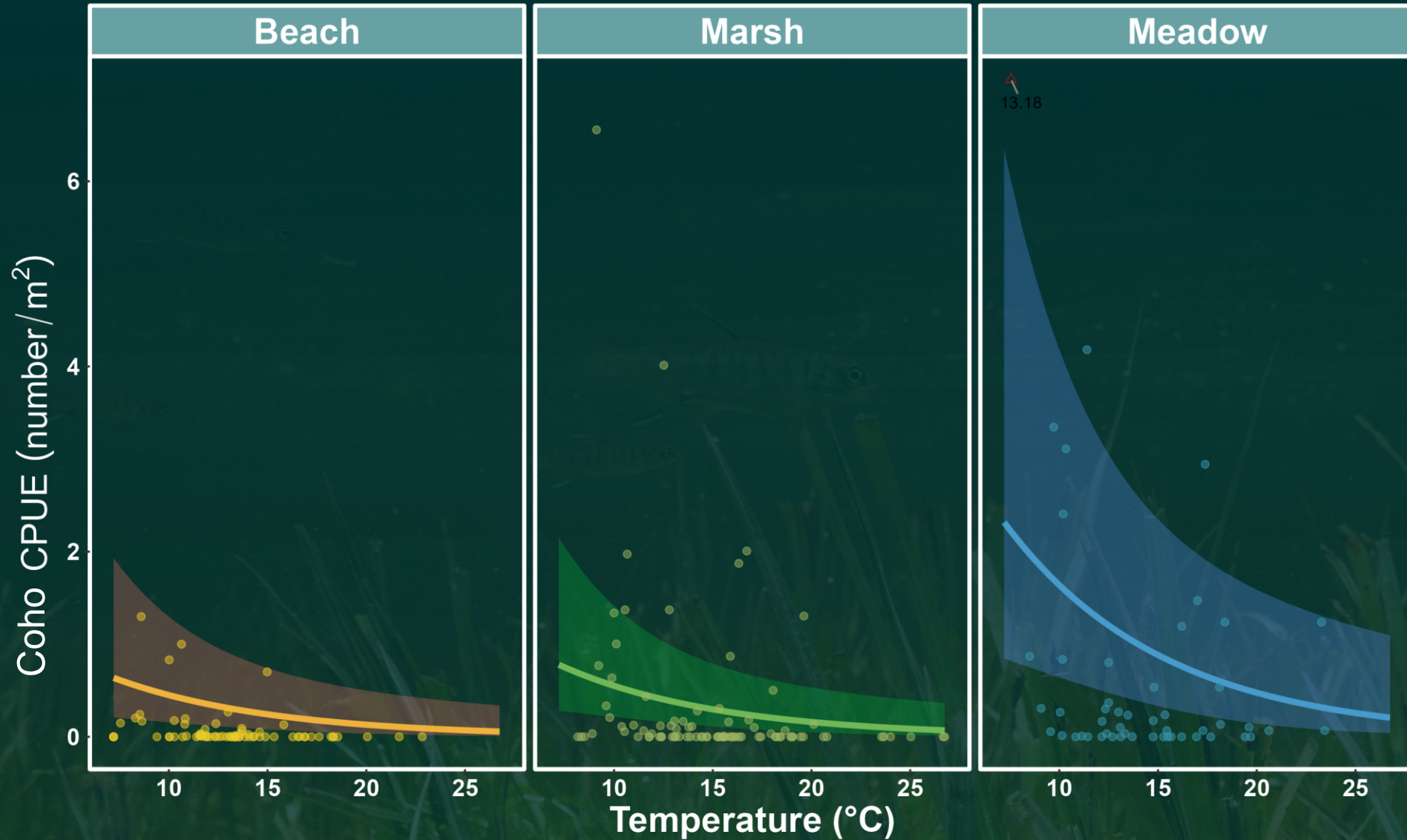
Chalifour et al., 2019



Skeena River estuary, BC

Sharpe et al., 2019

Fish use different habitats within the estuary



Chinook prey quality & foraging patterns vary across different estuary habitats

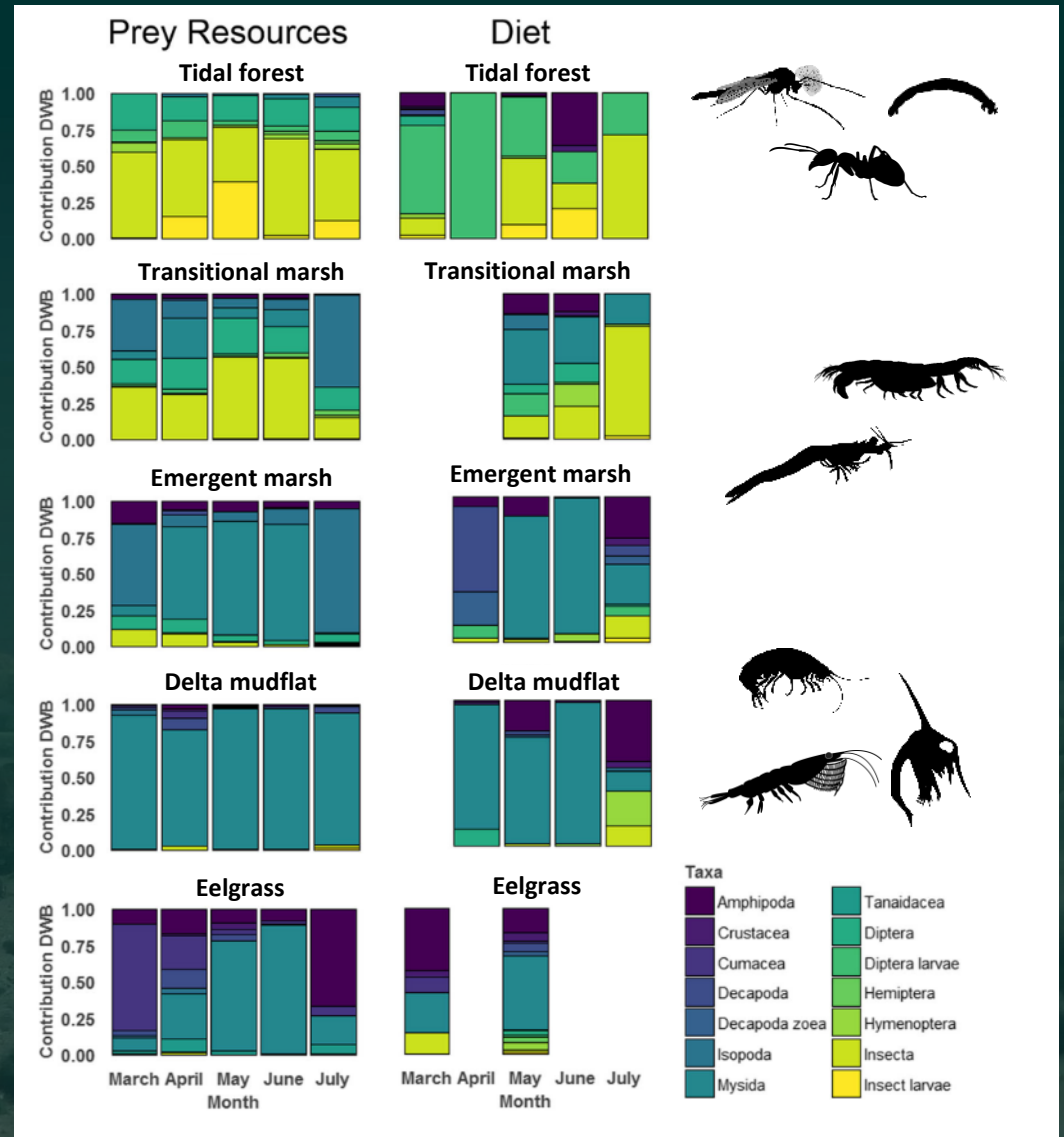


Nisqually River delta, OR

Freshwater



Saltwater



Woo et al., 2019







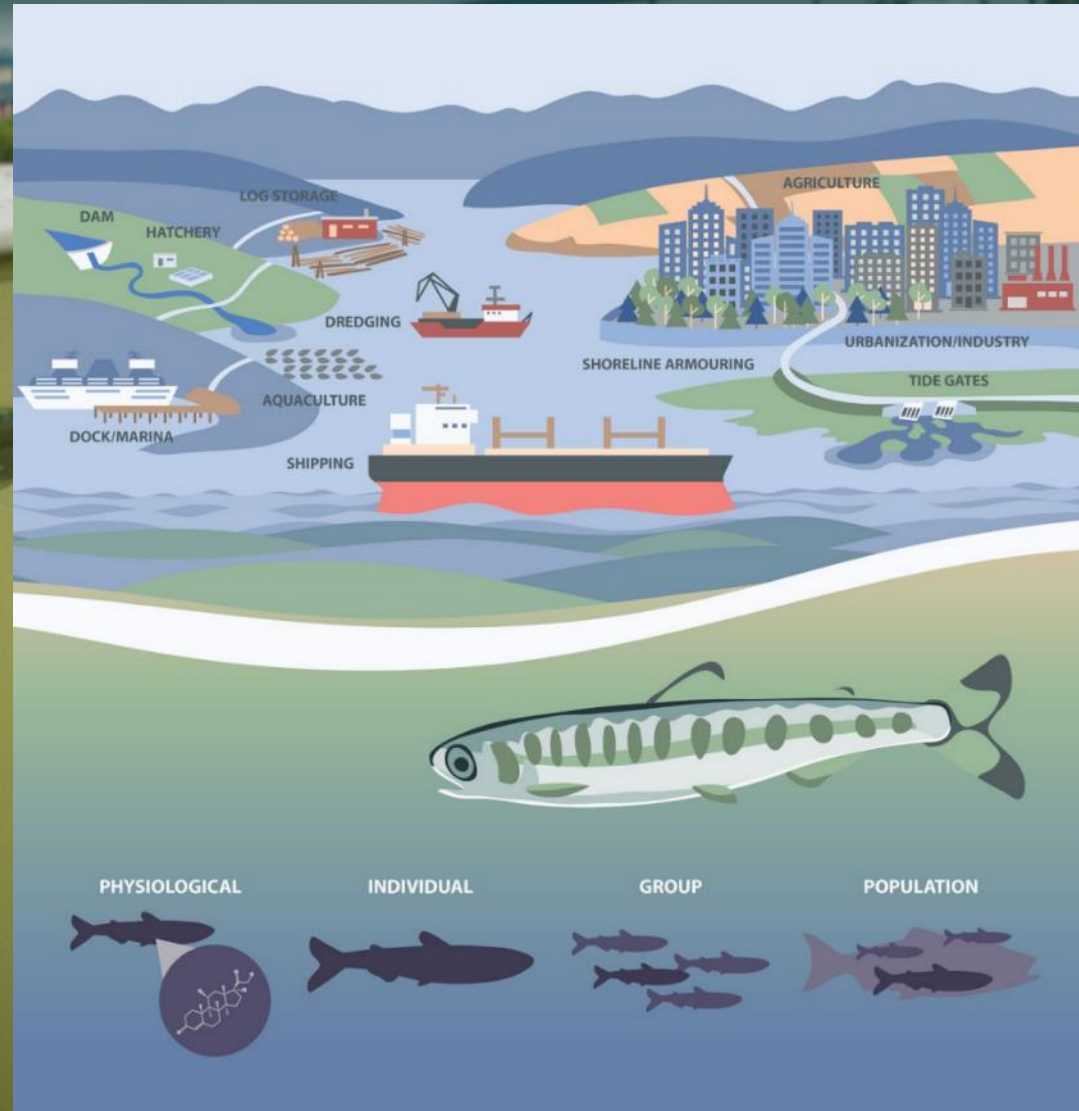
Human activity in estuaries can impact salmon at multiple scales

Estuaries Vol. 26, No. 4B, p. 1094–1103 August 2003

Estuarine Influence on Survival Rates of Coho (*Oncorhynchus kisutch*) and Chinook Salmon (*Oncorhynchus tshawytscha*) Released from Hatcheries on the U.S. Pacific Coast

A. MAGNUSSON* and R. HILBORN

Human activity in estuaries can impact salmon at multiple scales

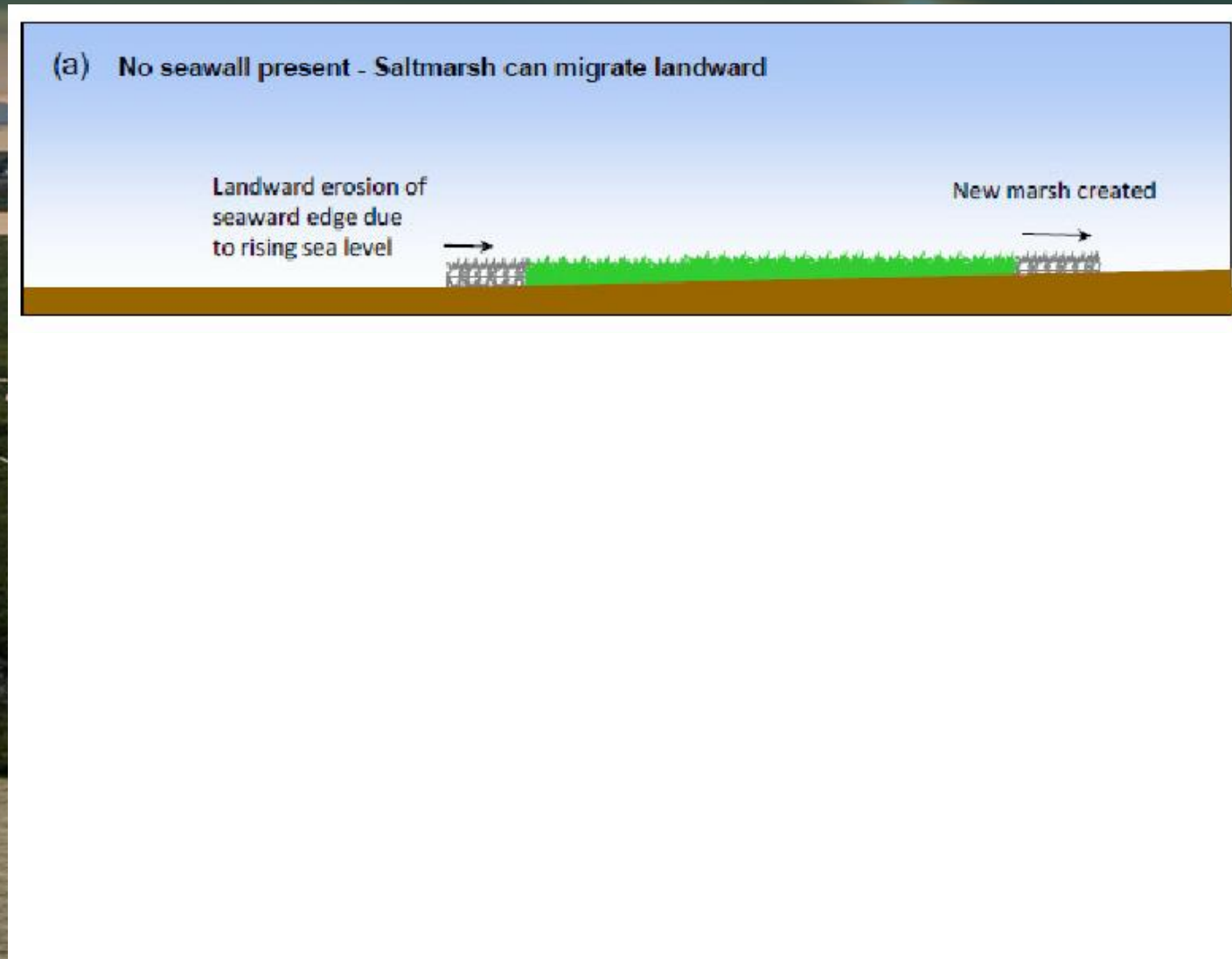


Hodgson et al., 2019

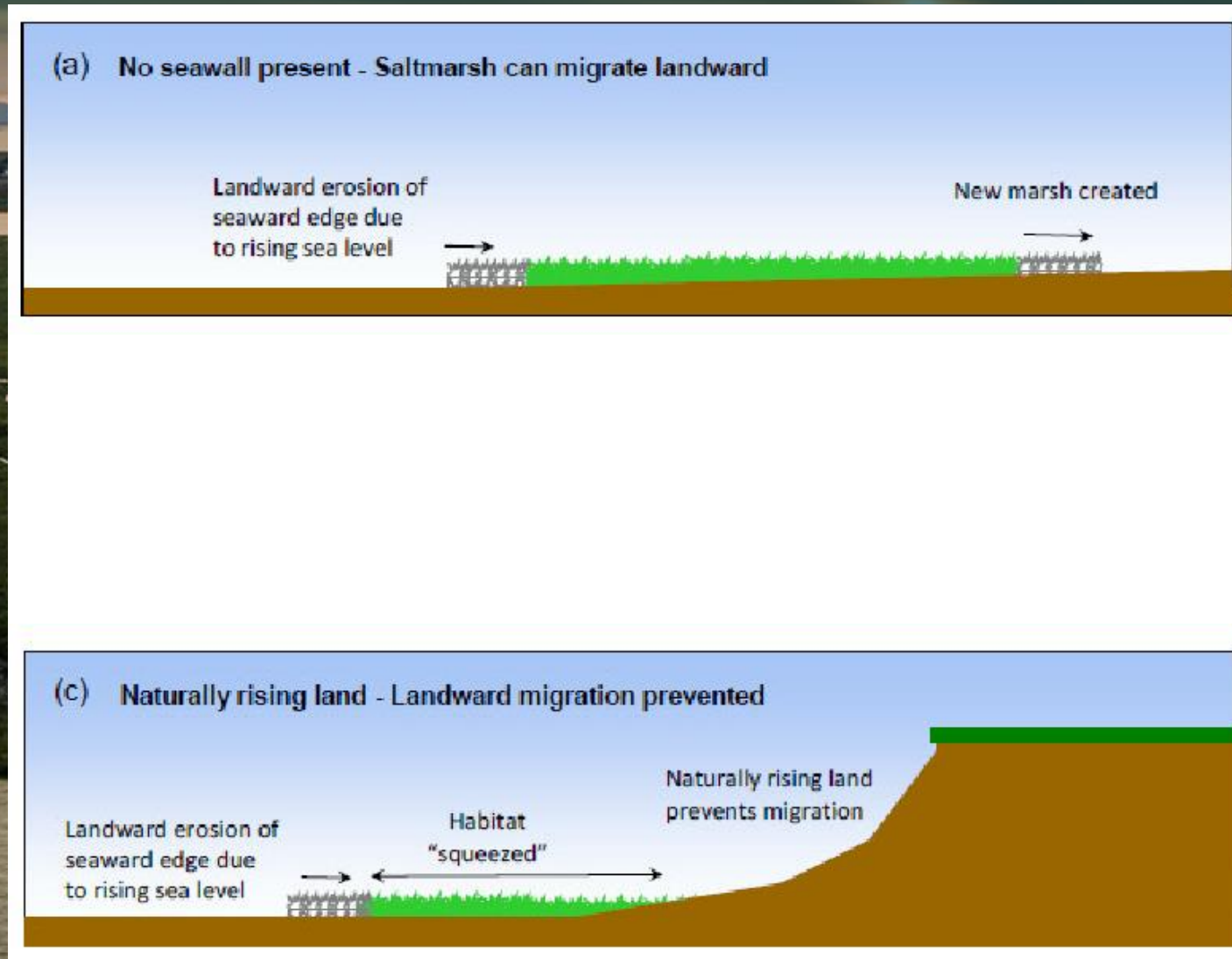
How are salmon in estuaries vulnerable to climate change?



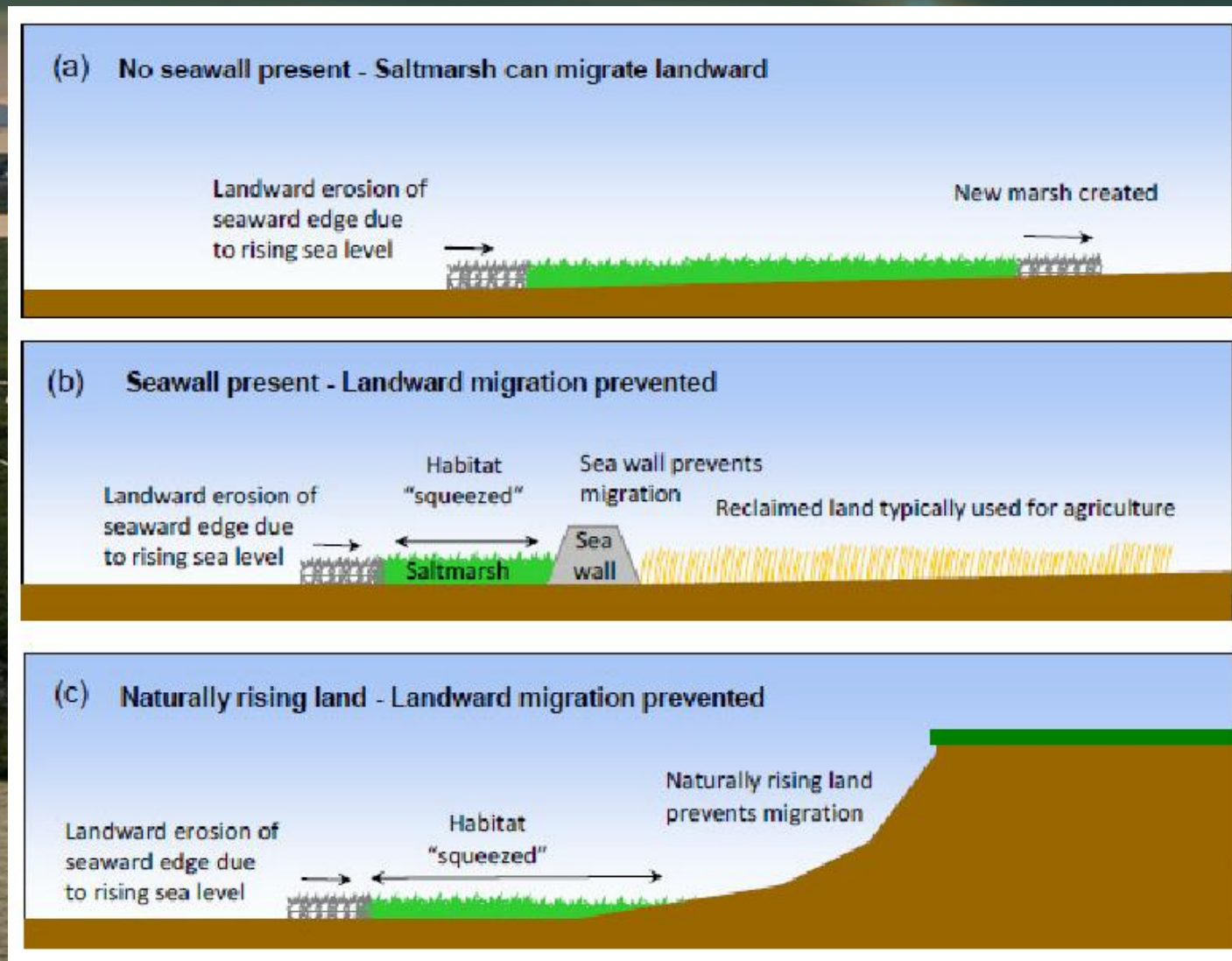
Sea-level rise alone could increase or decrease vegetated habitat



Sea-level rise alone could increase or decrease vegetated habitat



Coastal squeeze constrains possible habitat expansion



Sea-level rise could increase or decrease vegetated habitat

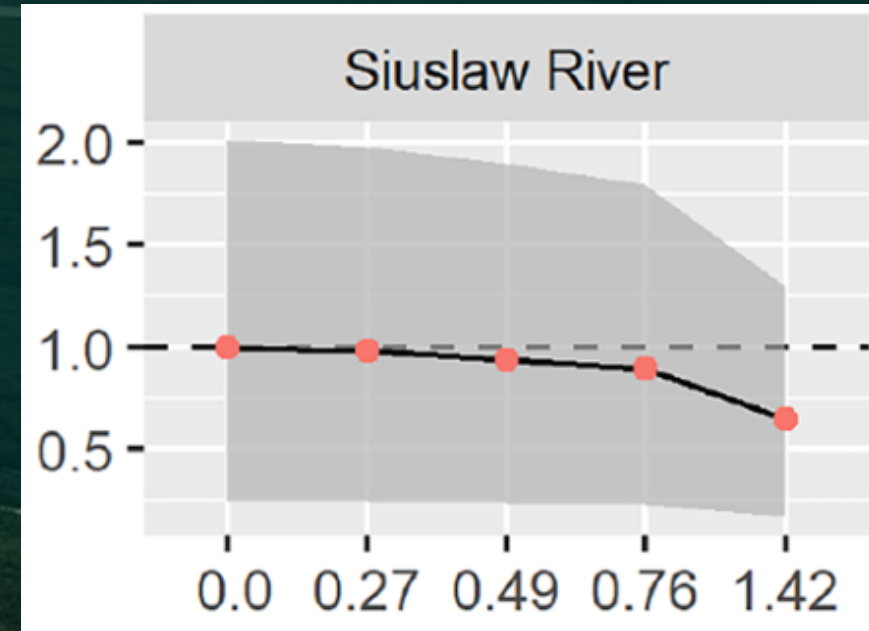
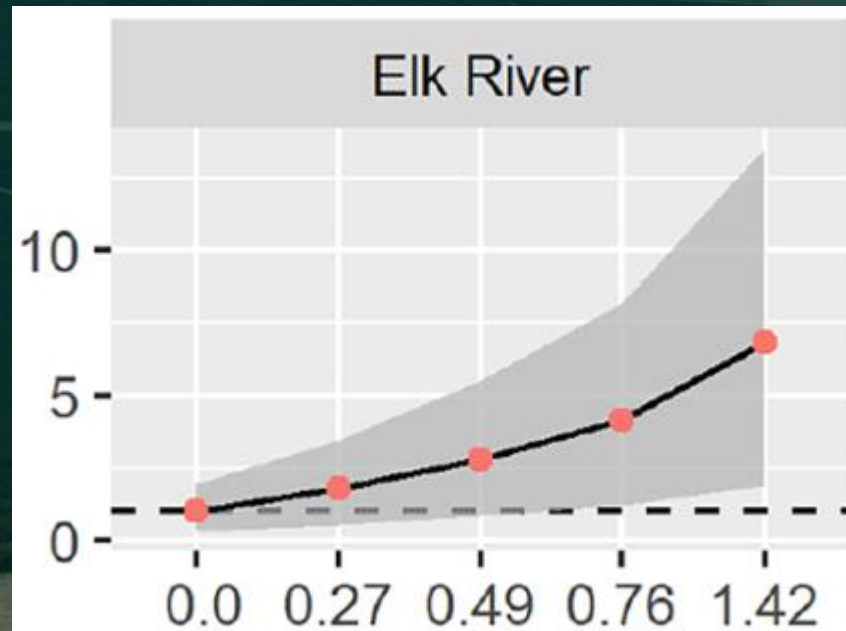
Coastal Oregon

Hall et al., 2023

↑ Up to 5x initial capacity

↓ down to 0.75x initial capacity

Relative capacity change



Sea level rise scenario (m)

Temperature dynamics may shift under climate change

ORIGINAL RESEARCH article

Front. Mar. Sci., 27 November 2023

Sec. Marine Ecosystem Ecology

Volume 10 - 2023 | <https://doi.org/10.3389/fmars.2023.1278810>

This article is part of the Research Topic

Turning with the Tide and Time in the Salish Sea: Change in Estuary and Nearshore Habitats and Species Dependent on Them

[View all 3 Articles >](#)

Complex temperature mosaics across space and time in estuaries: implications for current and future nursery function for Pacific salmon



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Temperature dynamics & growth potential may shift under climate change

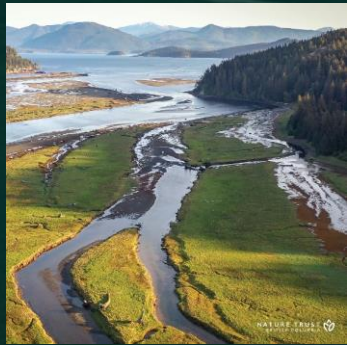
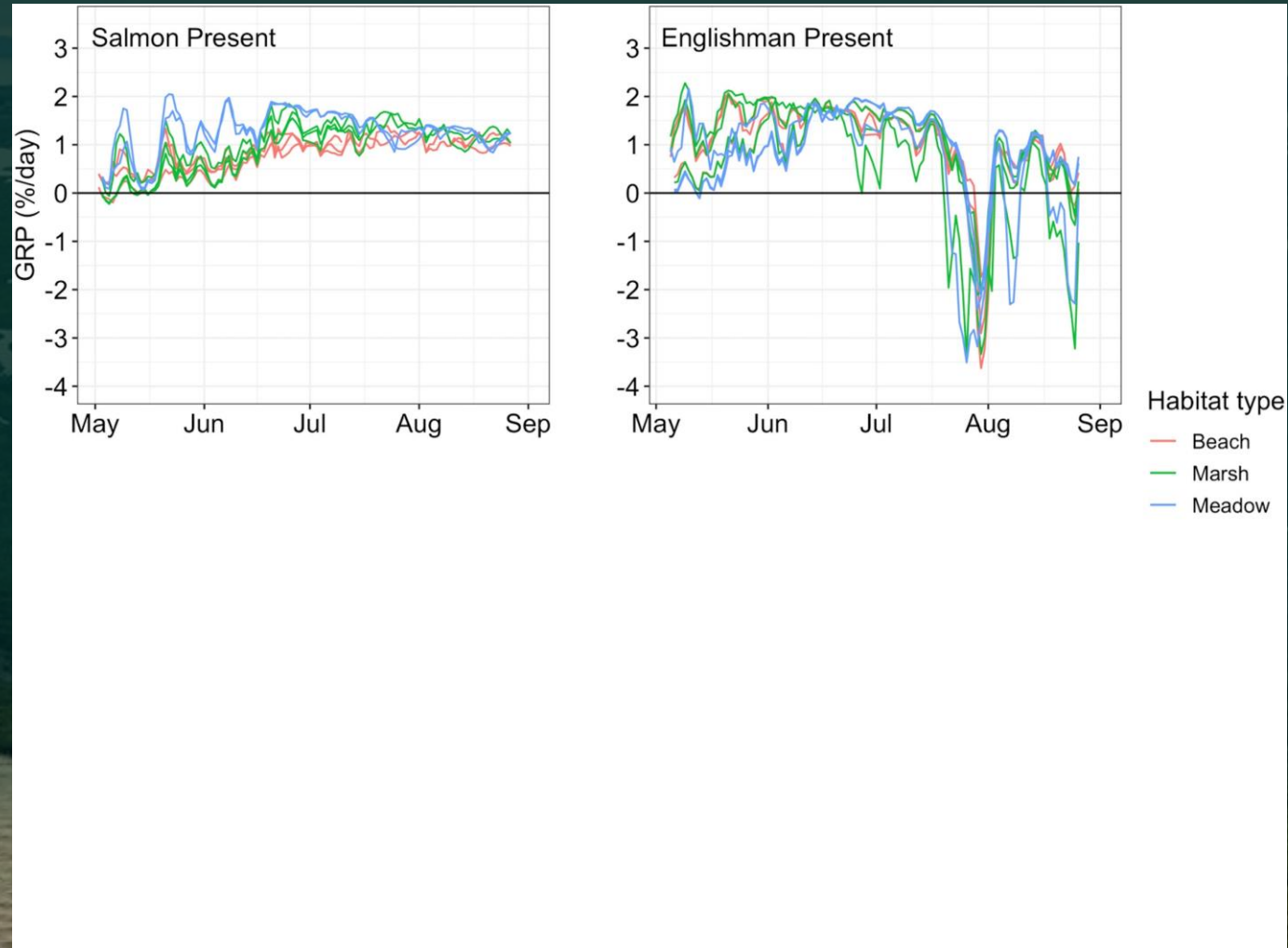


NATURE TRUST
BRITISH COLUMBIA

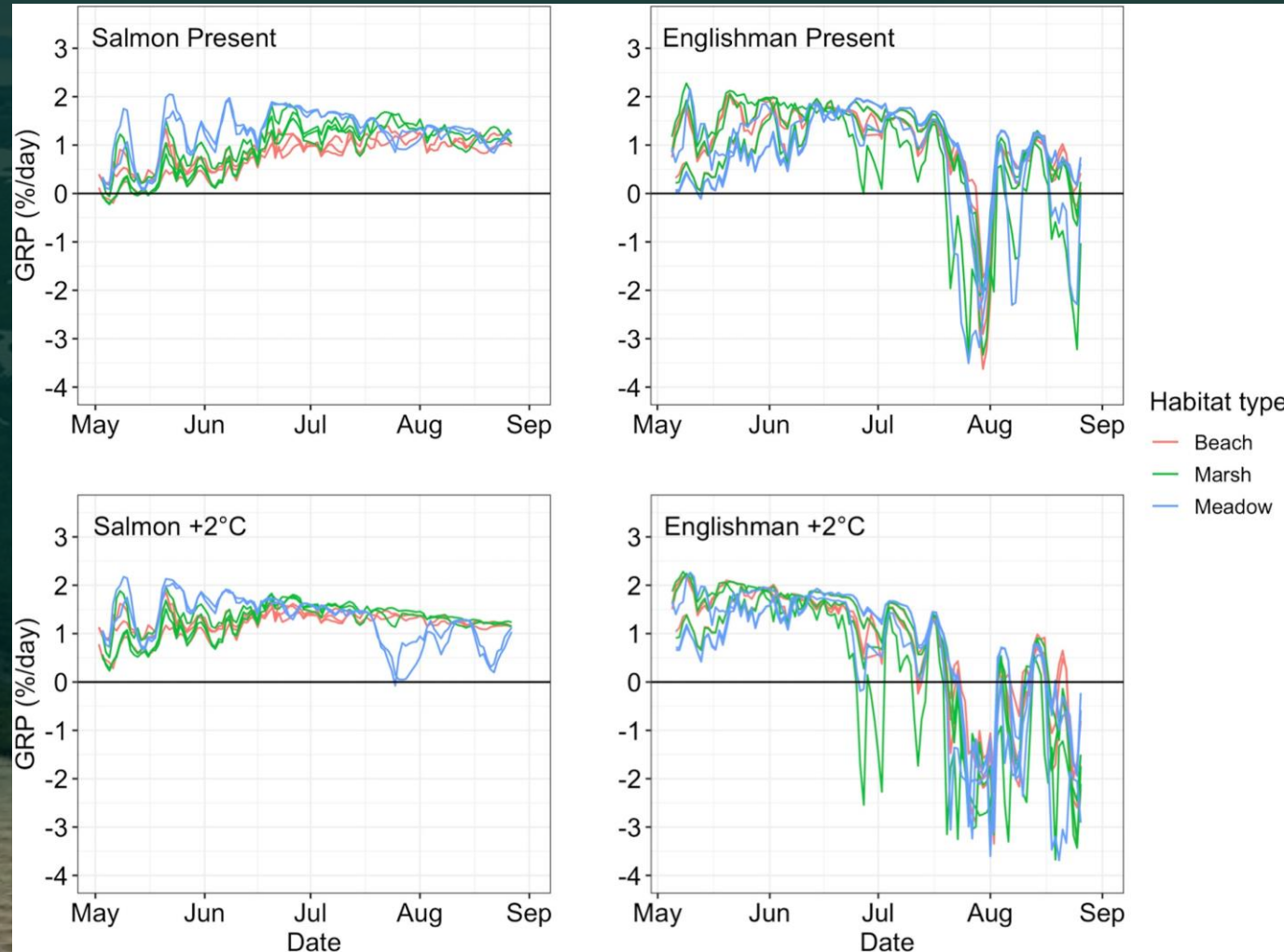
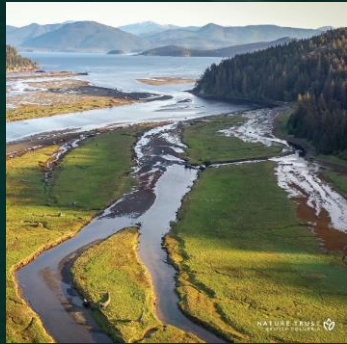


Englishman River estuary, Parksville, BC
Nature Trust British Columbia

Temperature dynamics & growth potential may shift under climate change



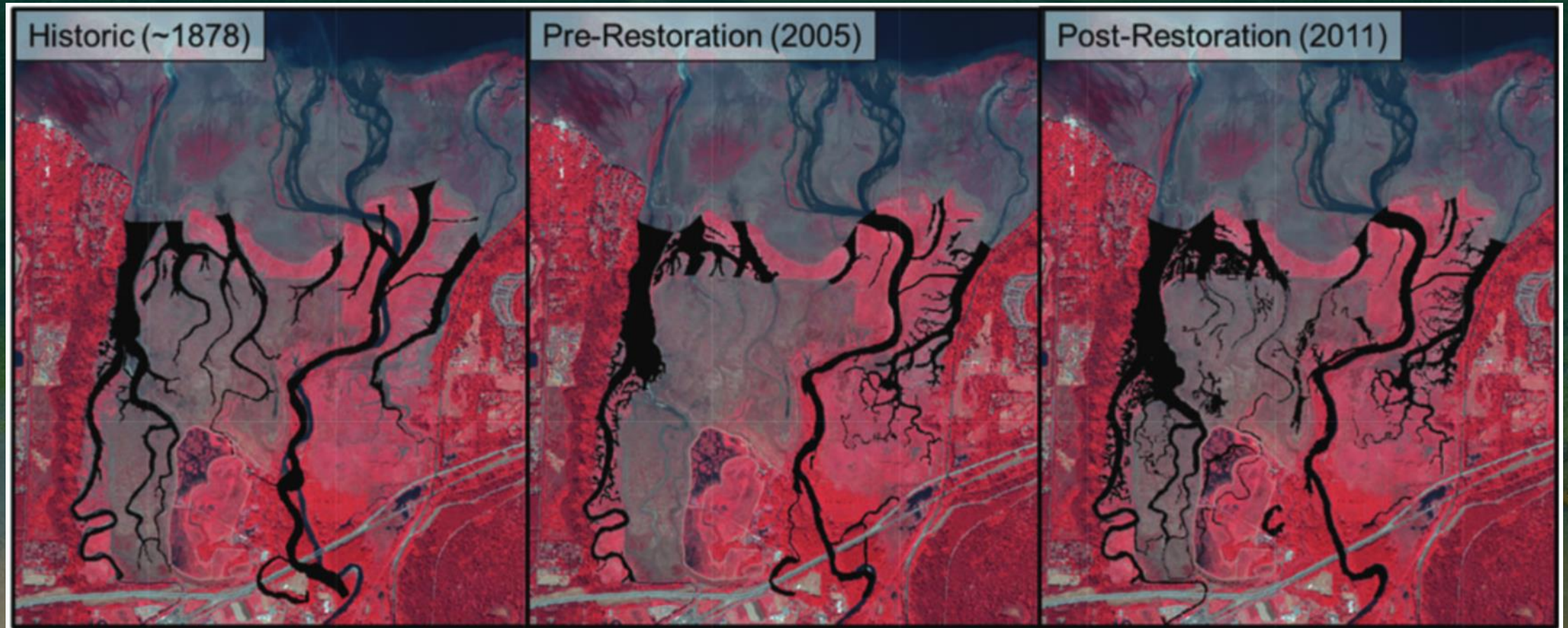
Temperature dynamics & growth potential may shift under climate change



Restoring estuaries by improving habitat connectivity

Nisqually River Delta, OR

Ellings et al., 2016



Restoring habitat connectivity enhances foraging capacity

Woo et al., 2018



- Dipteran & hymenopteran biomass increased 3-fold 1-3 years post-restoration



- Benthic crustacean biomass went from 0 to ~5,000-75,000 individuals/m²

Restoring estuaries can benefit salmon populations

- **Estuaries promote life history diversity & population resilience:** salmon that rear in estuaries grow quicker and enter the ocean bigger
- Different estuary habitats provide **diverse foraging opportunities**
- Systems can have **varying resilience to climate change**
- Restoring connectivity can improve habitat *capacity* and *opportunity*, but need to measure *realized function* to gauge success
(Simenstad & Cordell, 2000)

Thank you

