



# A DECADE OF POST-RESTORATION MONITORING IN THE NISQUALLY RIVER DELTA

Structure, Function, and Benefits for Juvenile Salmon

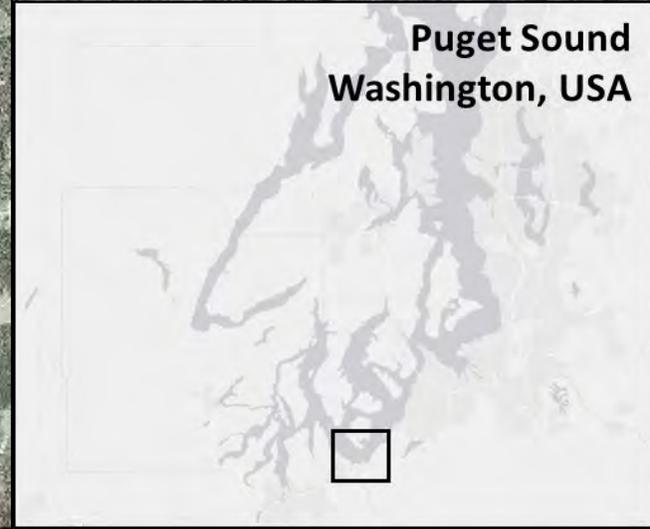
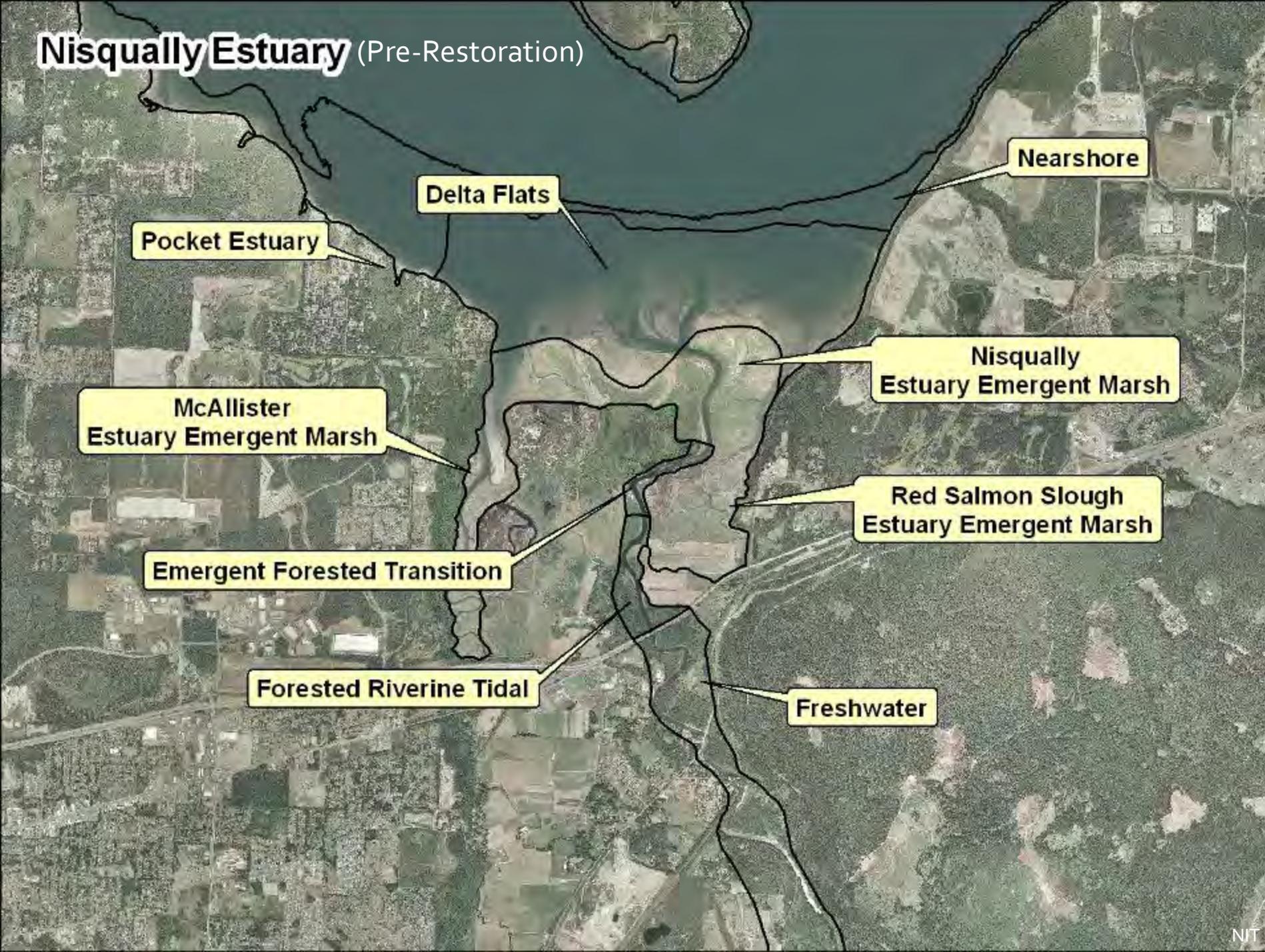
*Melanie Davis, Isa Woo, Susan De La Cruz: USGS Western Ecological Research Center*

*Chris Ellings, Sayre Hodgson: Nisqually Tribe DNR*

*Glynnis Nakai: Nisqually National Wildlife Refuge*

# Nisqually Estuary (Pre-Restoration)

ca. 1904-1910

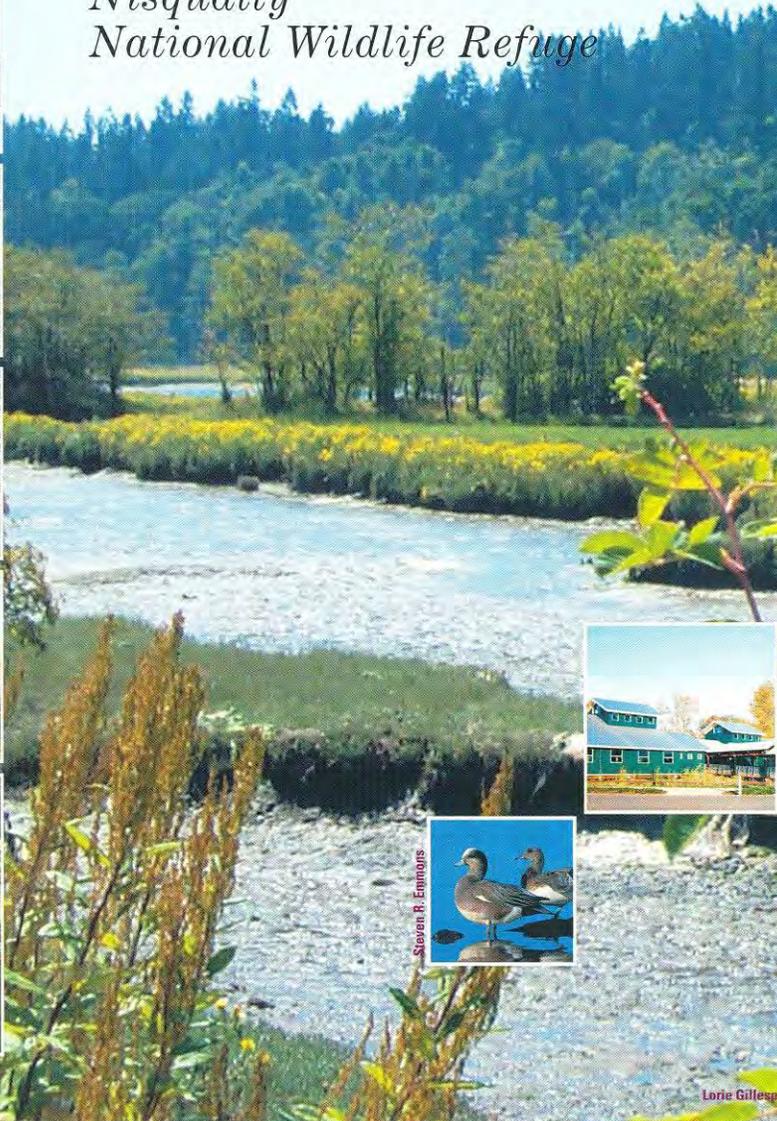


# Summary of the Comprehensive Conservation Plan

*Nisqually National Wildlife Refuge*



Lorie Gillespie



Sharon R. Emmons

Lorie Gillespie

# Comprehensive Conservation Plan Completed - November 2004

Summer 2005

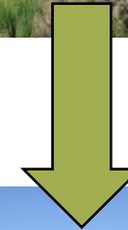


November 2009

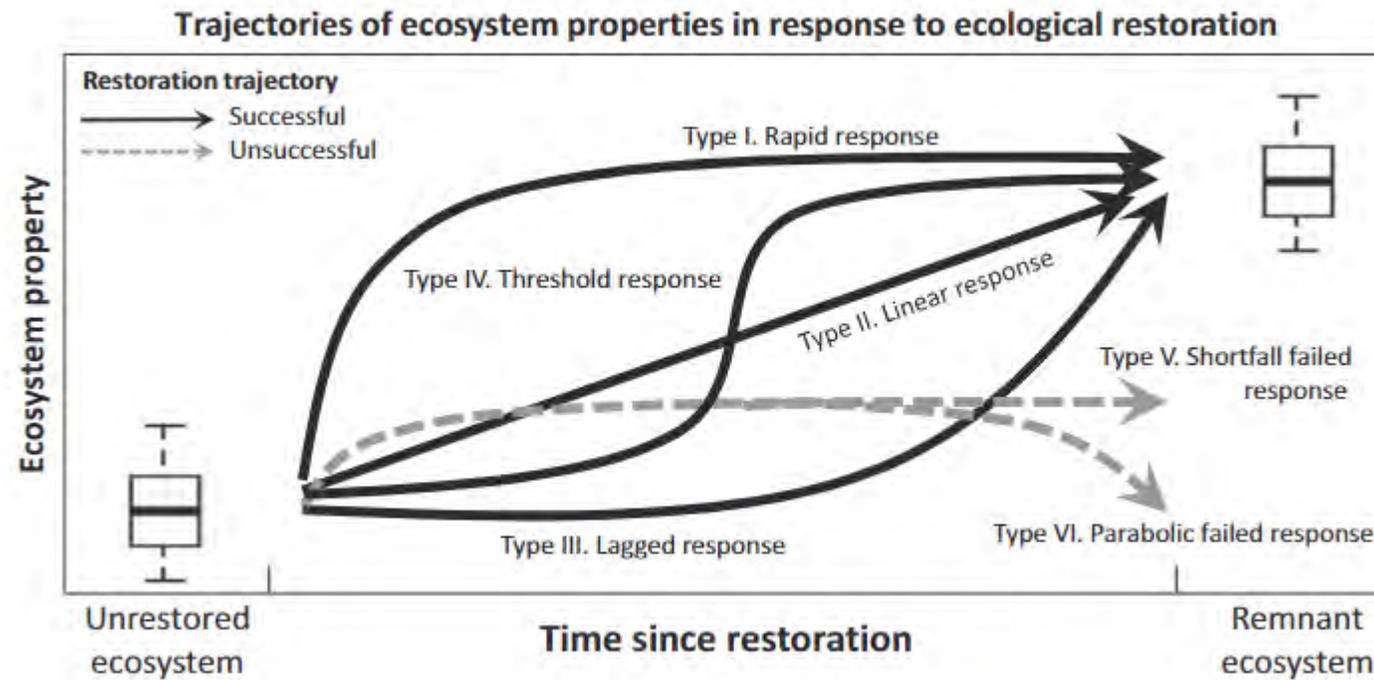


June 2006

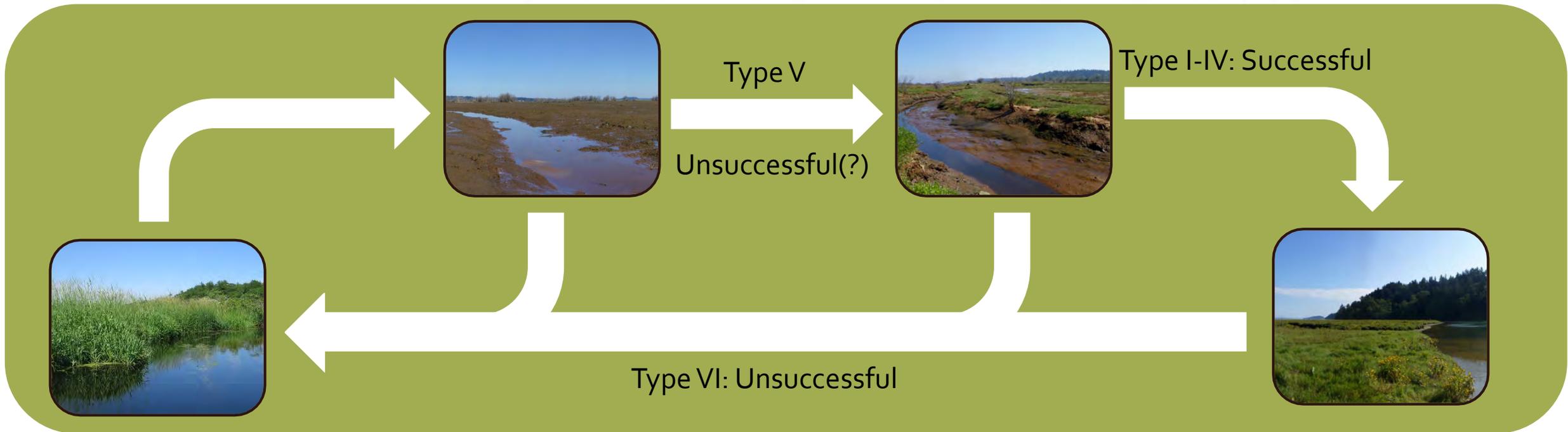
# Habitat Change Through Time



# Restoration-mediated disturbance leads to alternative functional states

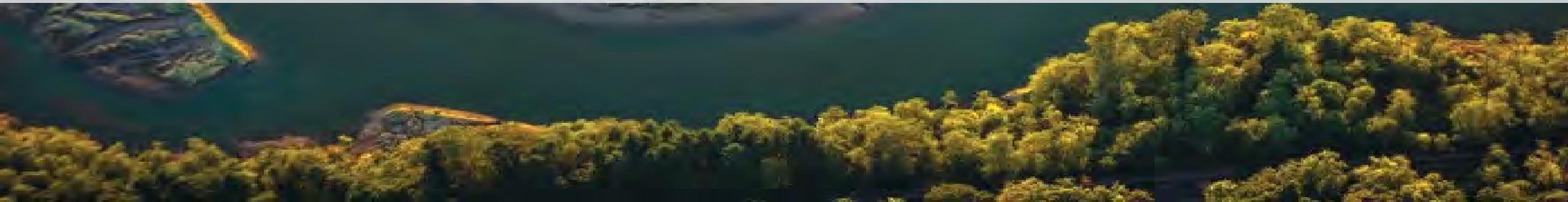


Wallace et al. 2017  
 Hobbs and Norton 1996  
 Hobbs and Harris 2001  
 Suding et al 2004

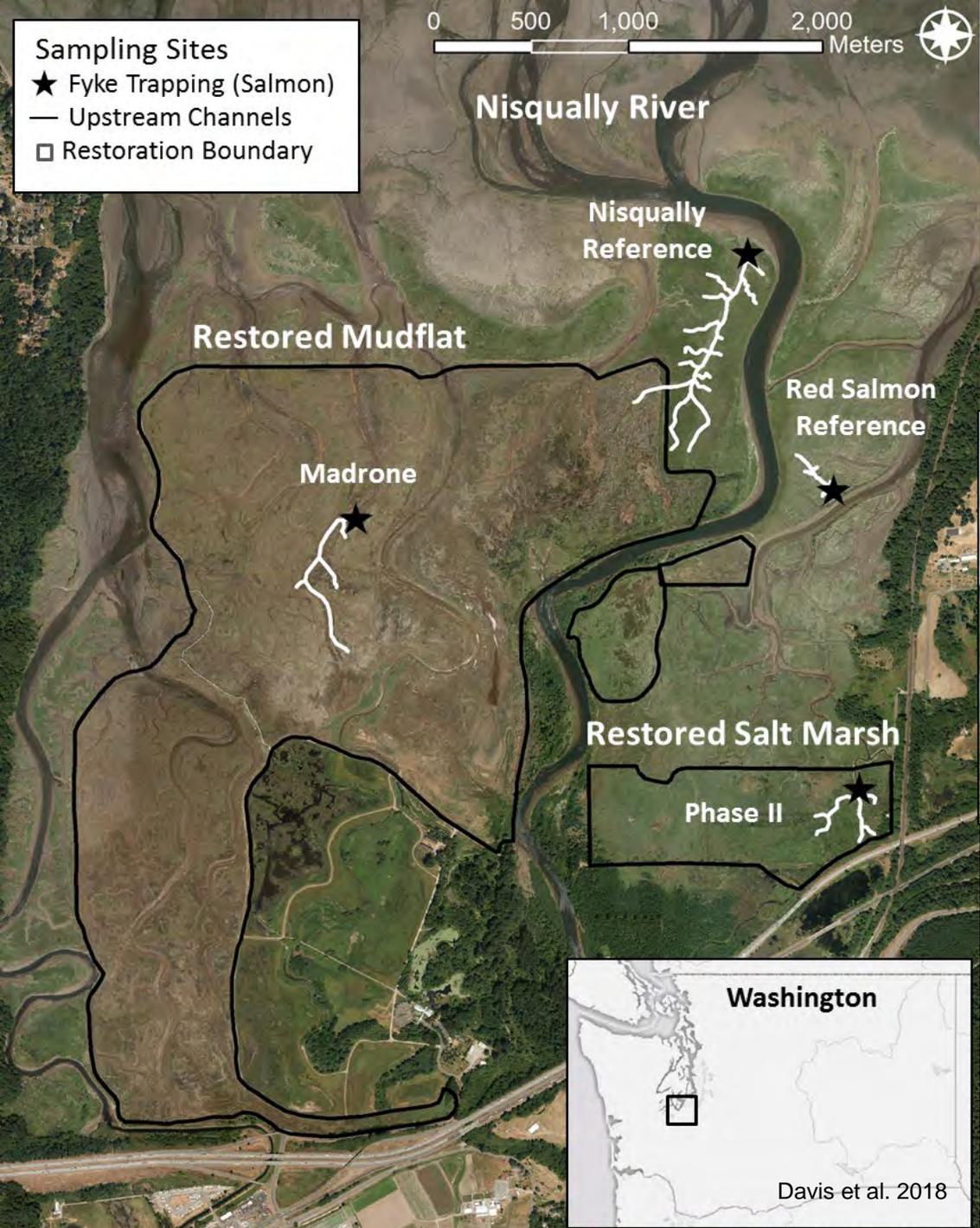
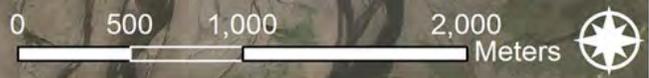




## Success Criteria (Simenstad & Cordell 2000)

- Opportunity Potential
    - i.e., How much habitat is available?
  - Foraging Capacity
    - i.e., Are there sufficient prey resources there?
  - Realized Function
    - i.e., Are individuals using newly-available habitat?
- 

**Sampling Sites**  
 ★ Fyke Trapping (Salmon)  
 — Upstream Channels  
 □ Restoration Boundary



# Opportunity



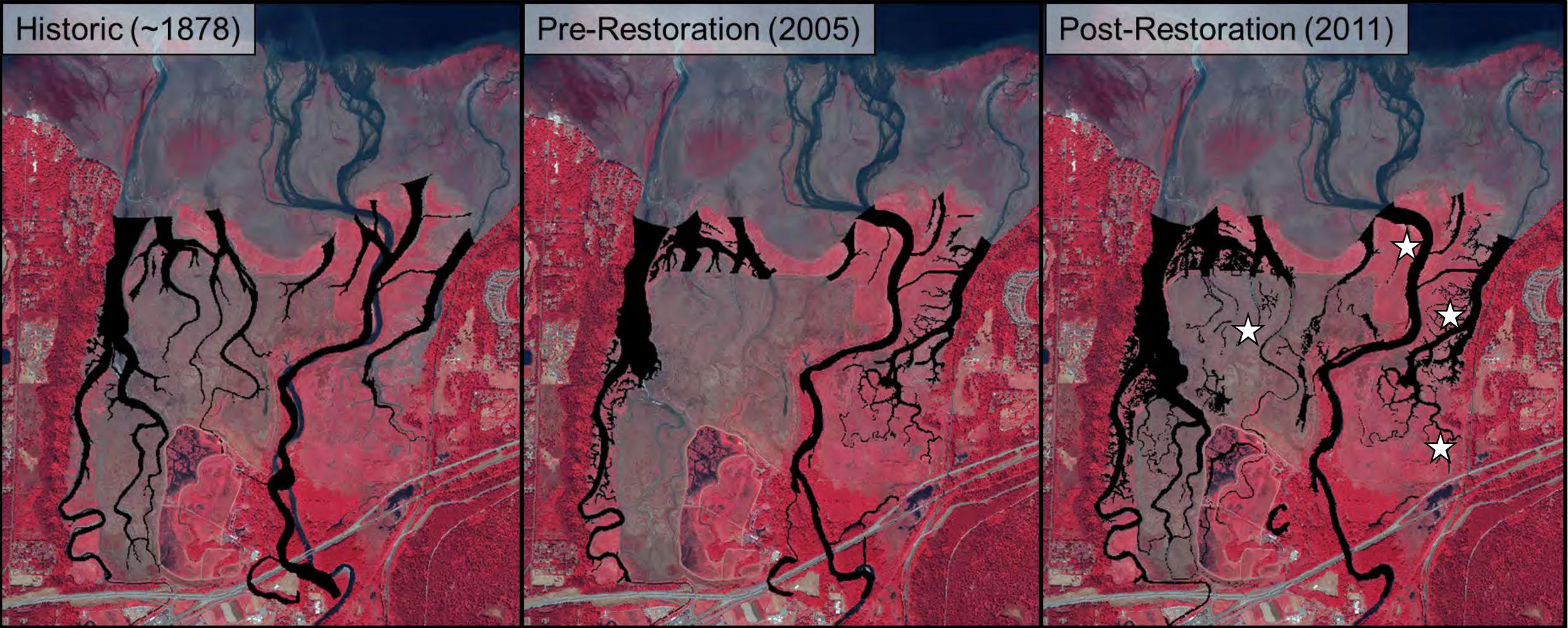
# Capacity



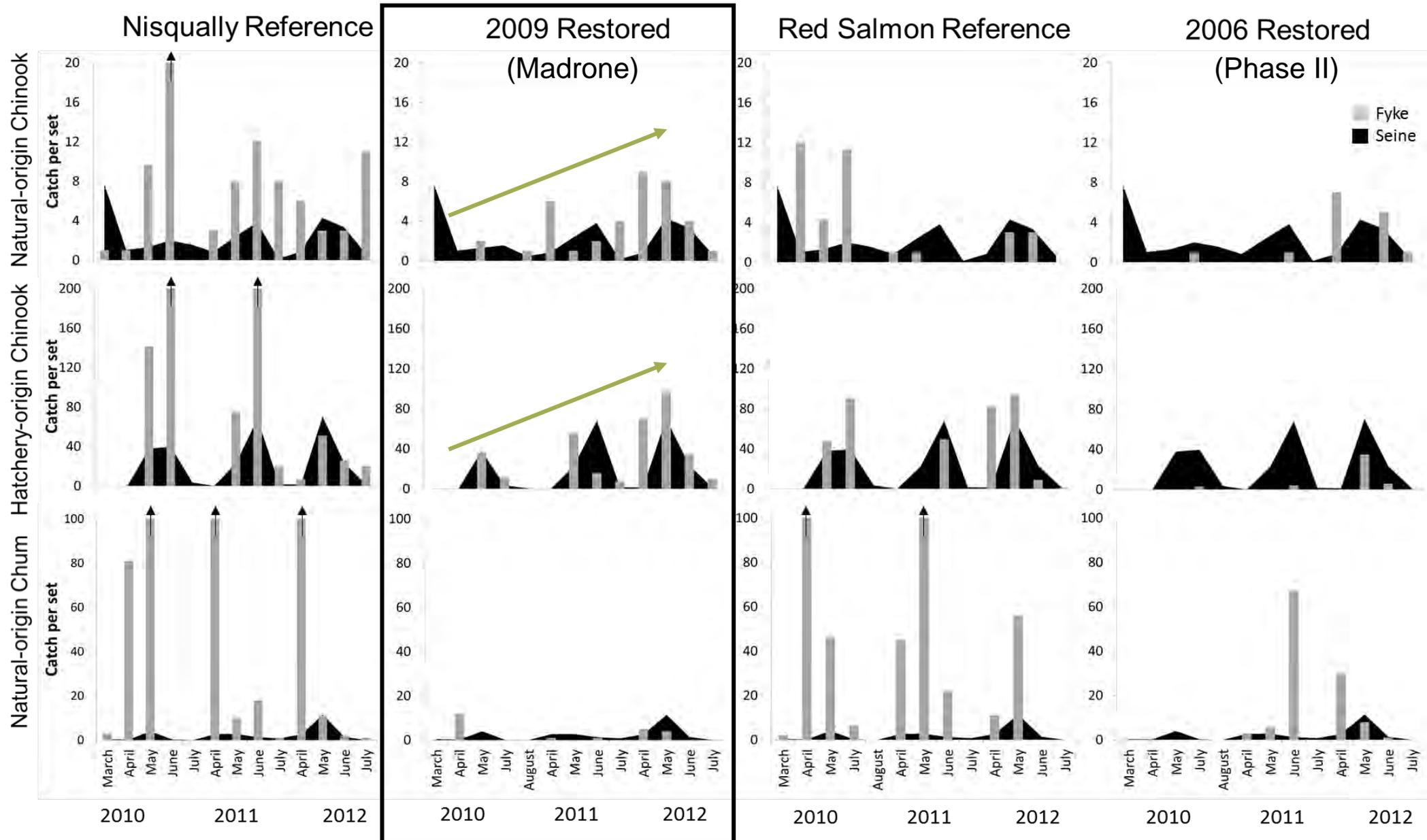
# Realized Function



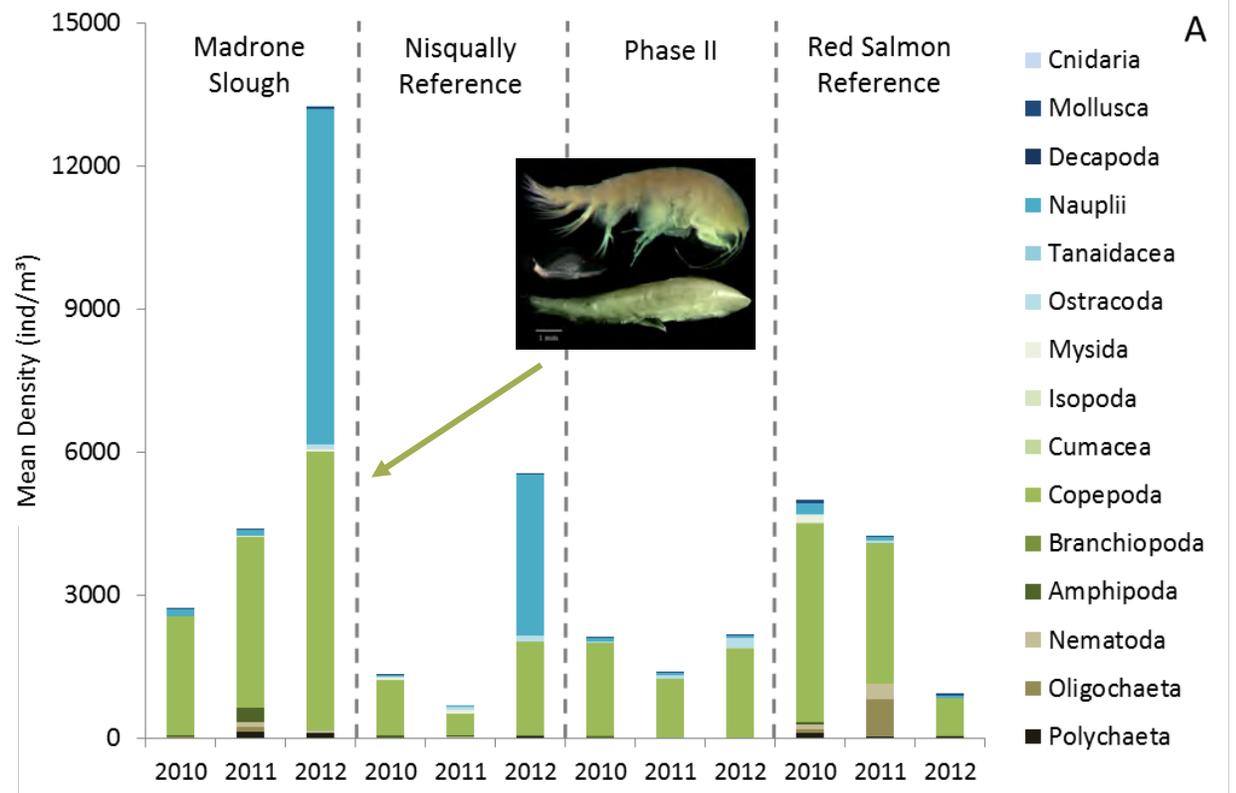
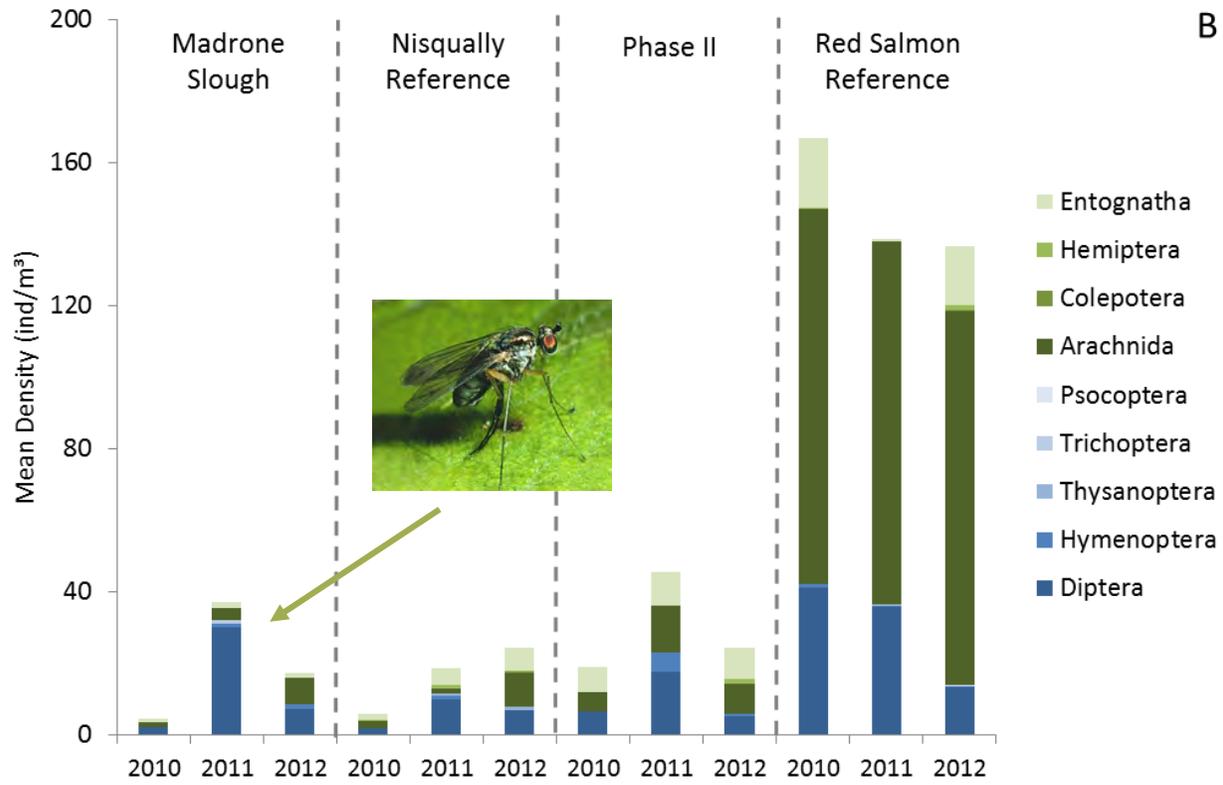
# Opportunity Potential: How much habitat is available and are salmon using it?



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# Foraging Capacity: Are prey resources sufficient?

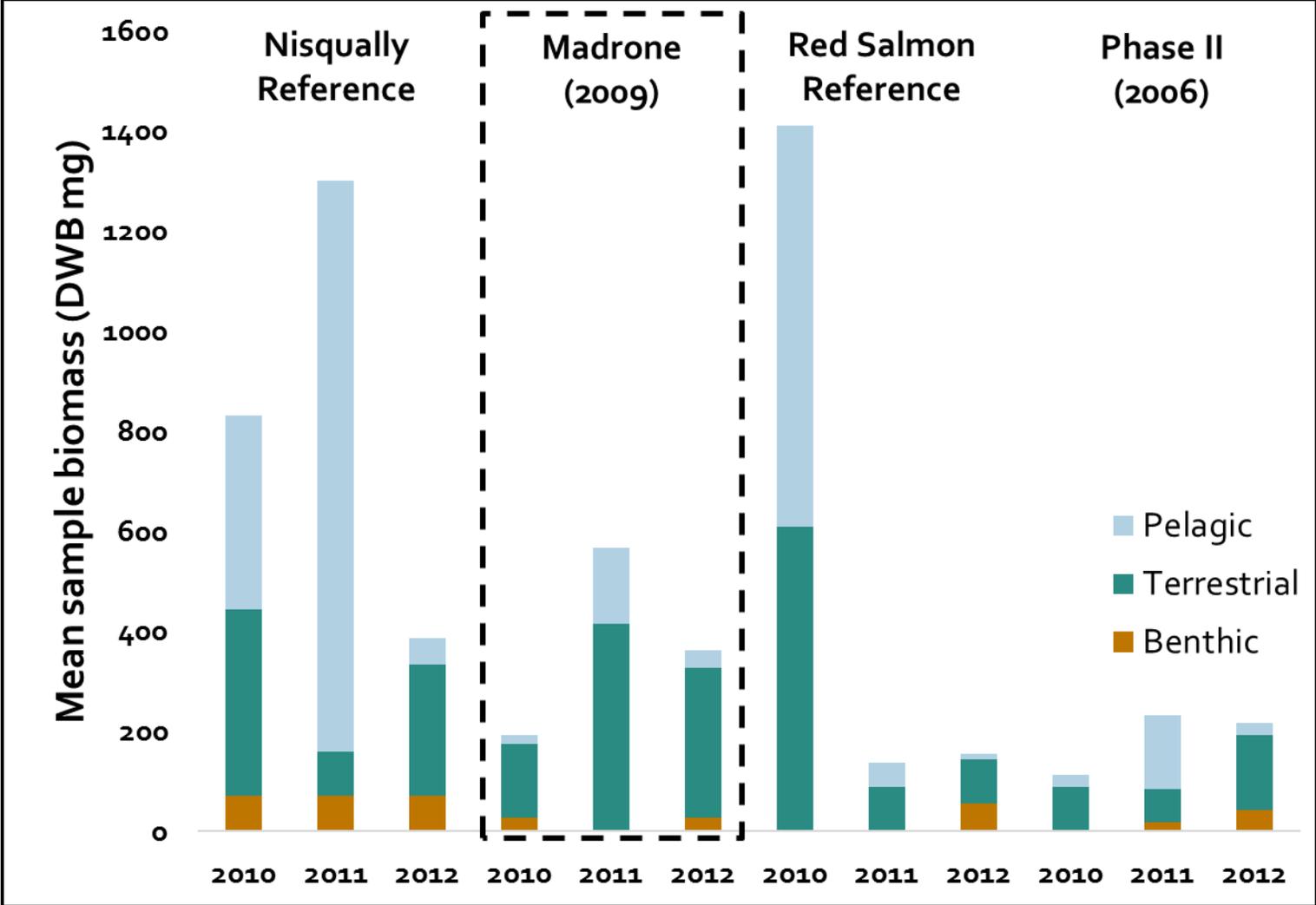


Woo et al. 2018

A

B

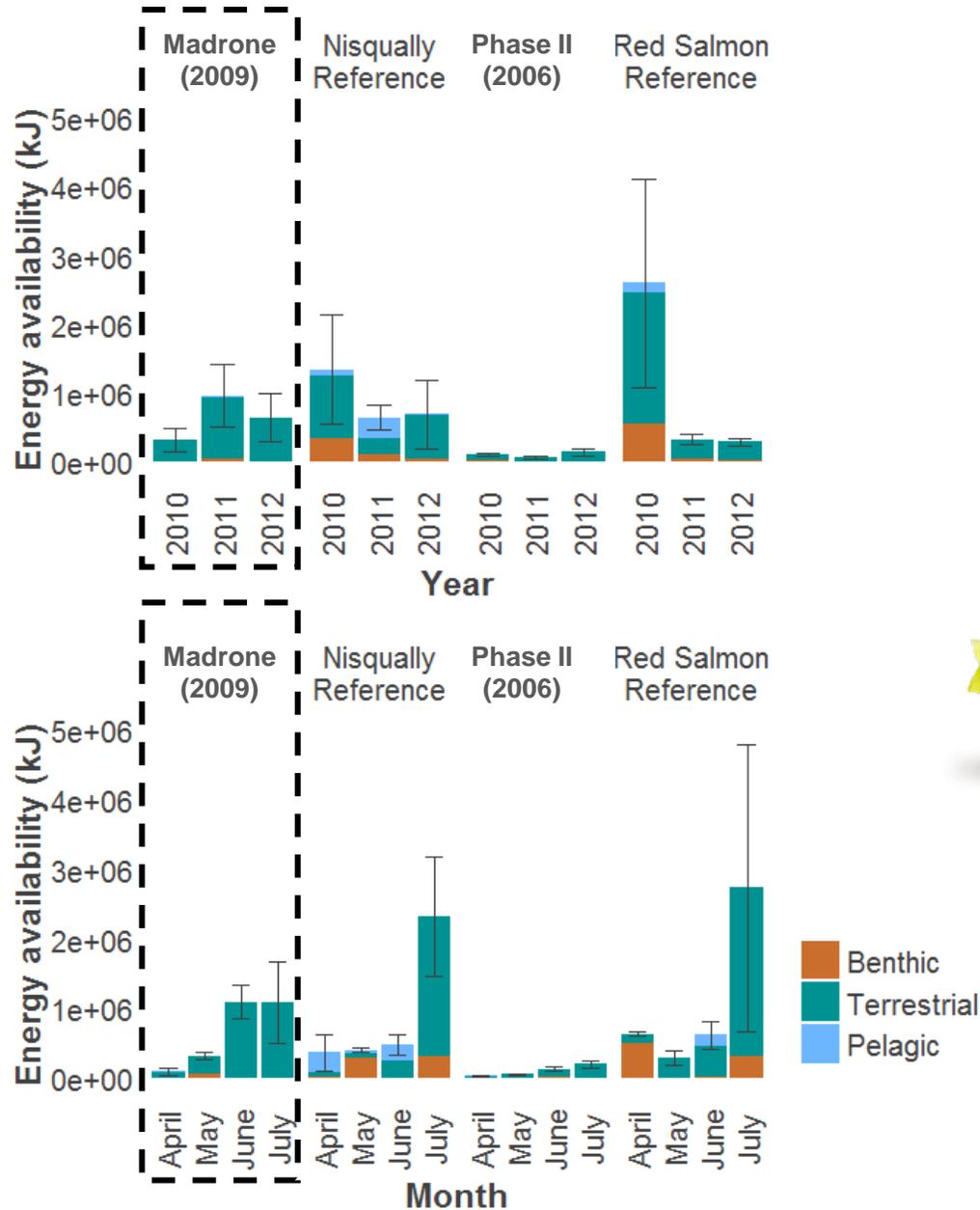
# Foraging Capacity: Are prey resources sufficient?



Woo et al. 2018



# Realized Function: Can salmon access and benefit from newly-available habitat?

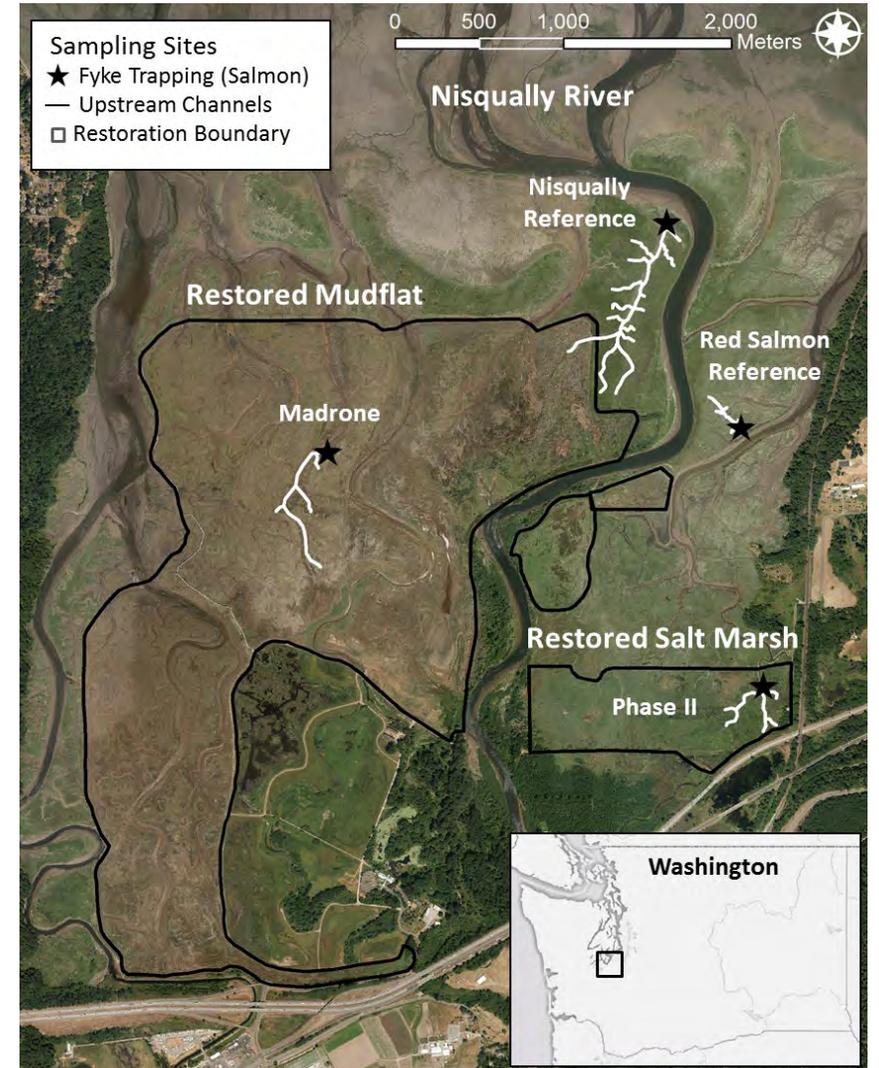
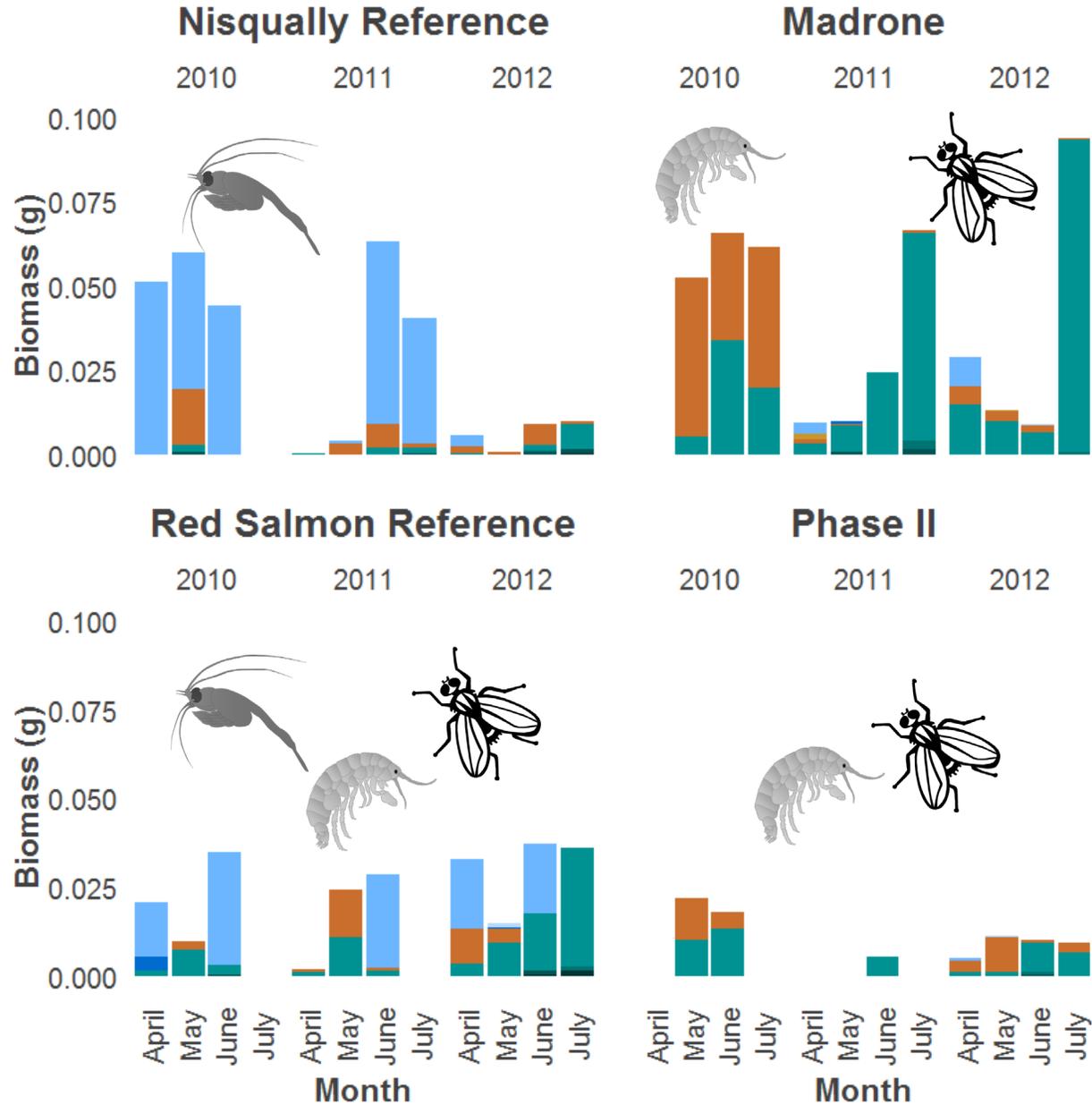


$$\text{Prey Energy Density (kJ/g)} \times \text{Biomass (g/m}^2) \times \text{Restoration Area (m}^2) = \text{Energy Availability (kJ/m}^2)$$



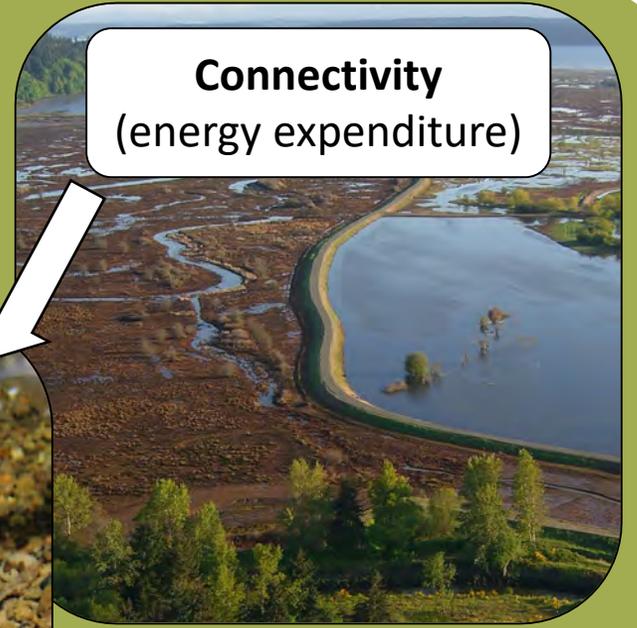
About 3,585 hamburgers worth of energy at any given time in the restoration area by 2012

# Realized Function: Can salmon access and benefit from newly-available habitat?

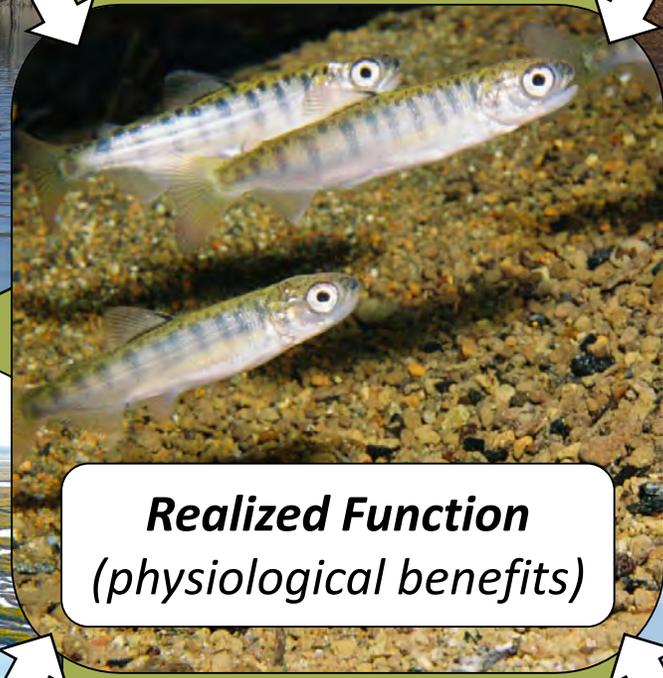




**Inundation Duration**  
(accessibility)



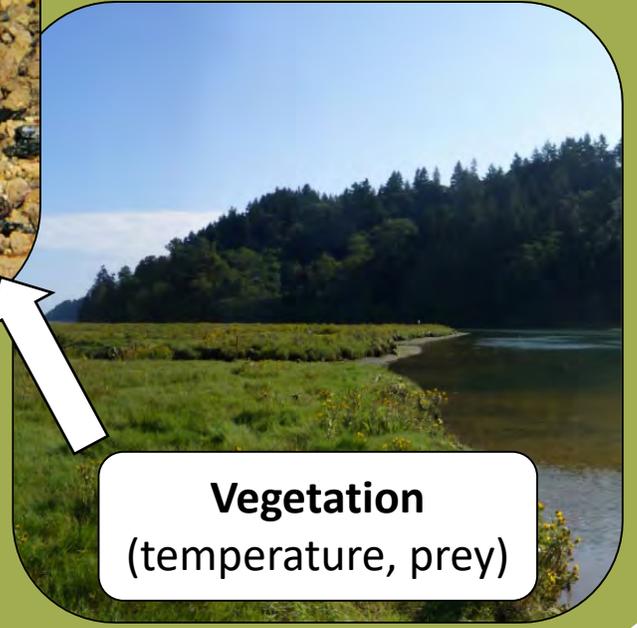
**Connectivity**  
(energy expenditure)



**Realized Function**  
(physiological benefits)

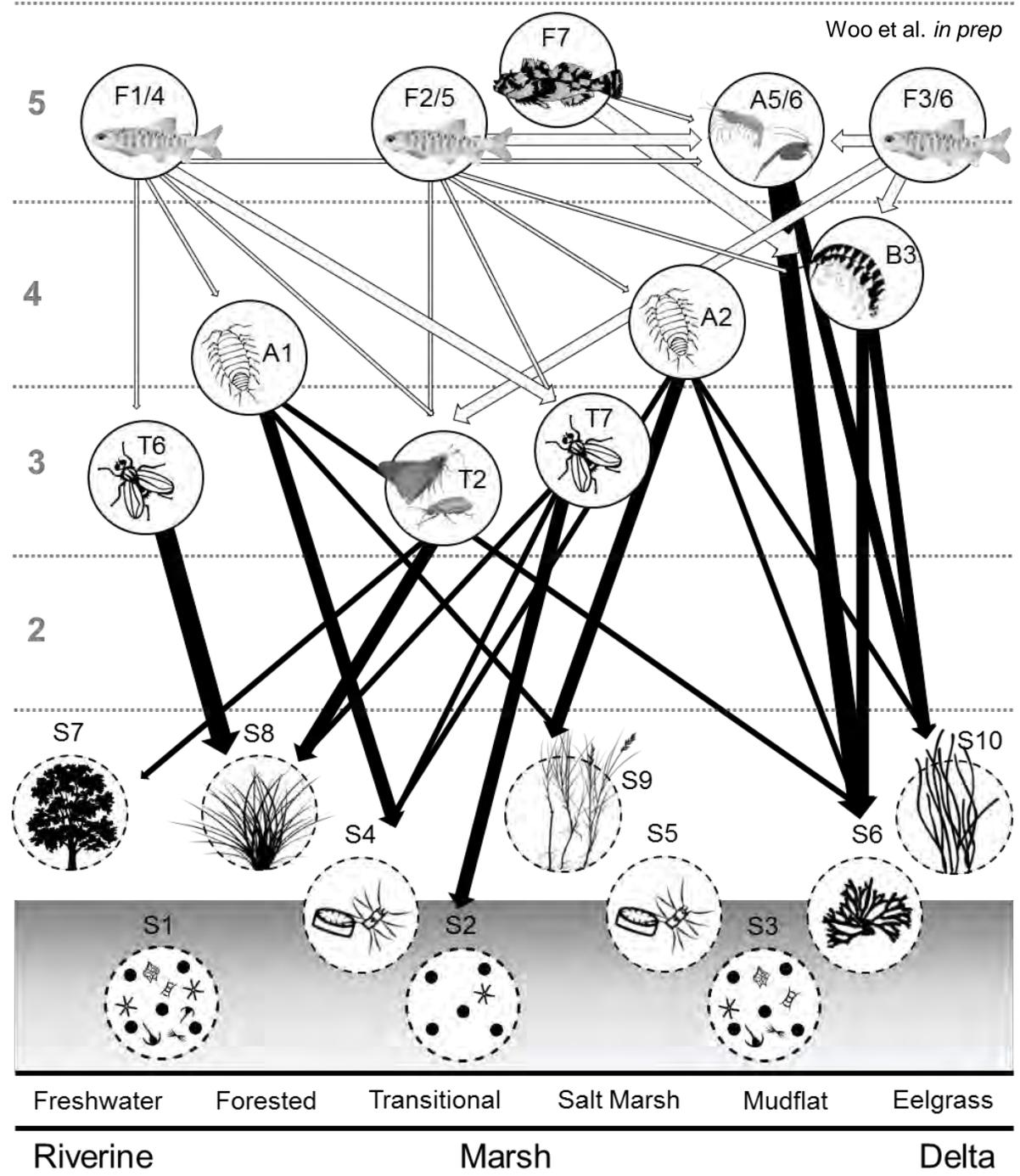
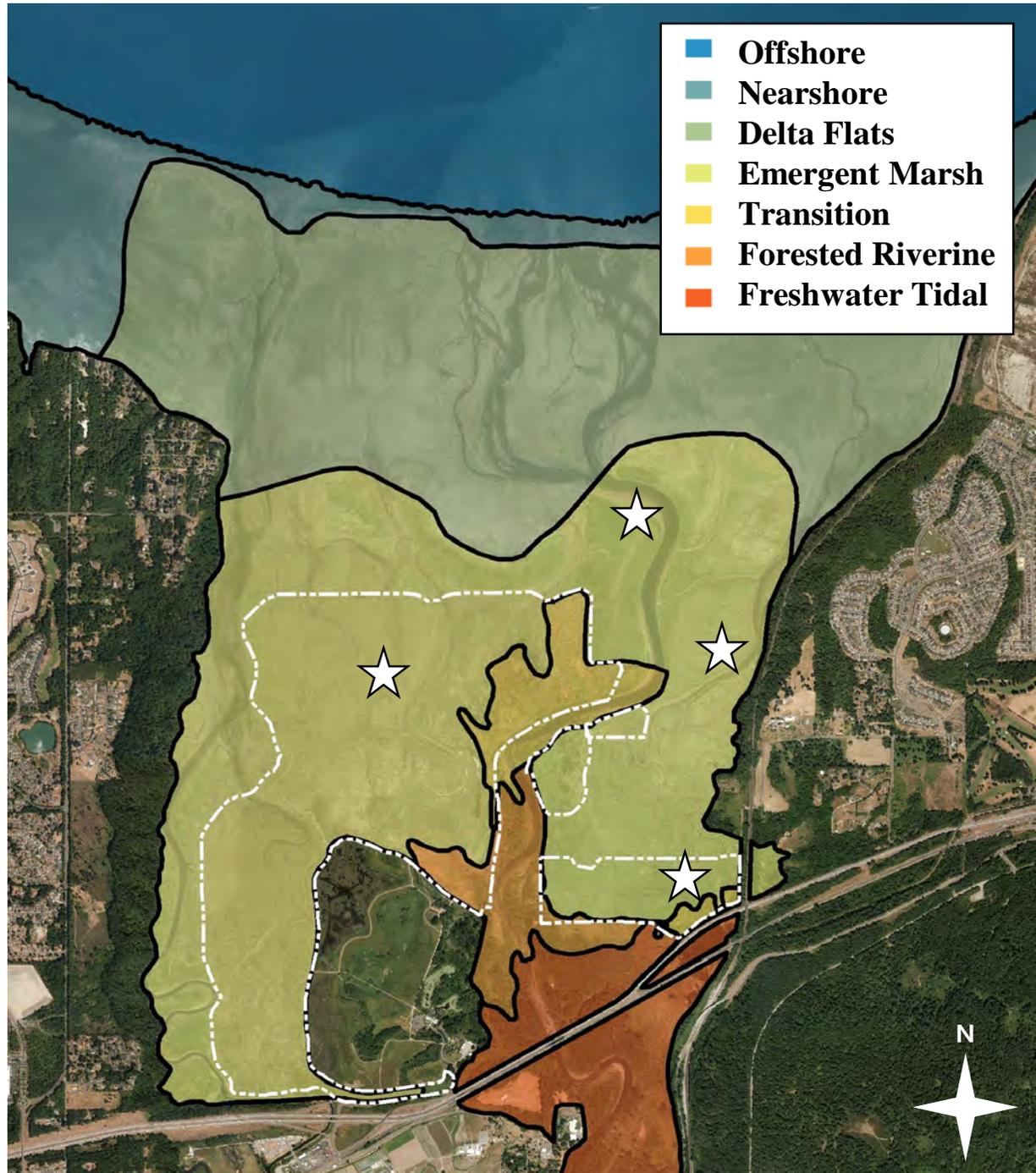


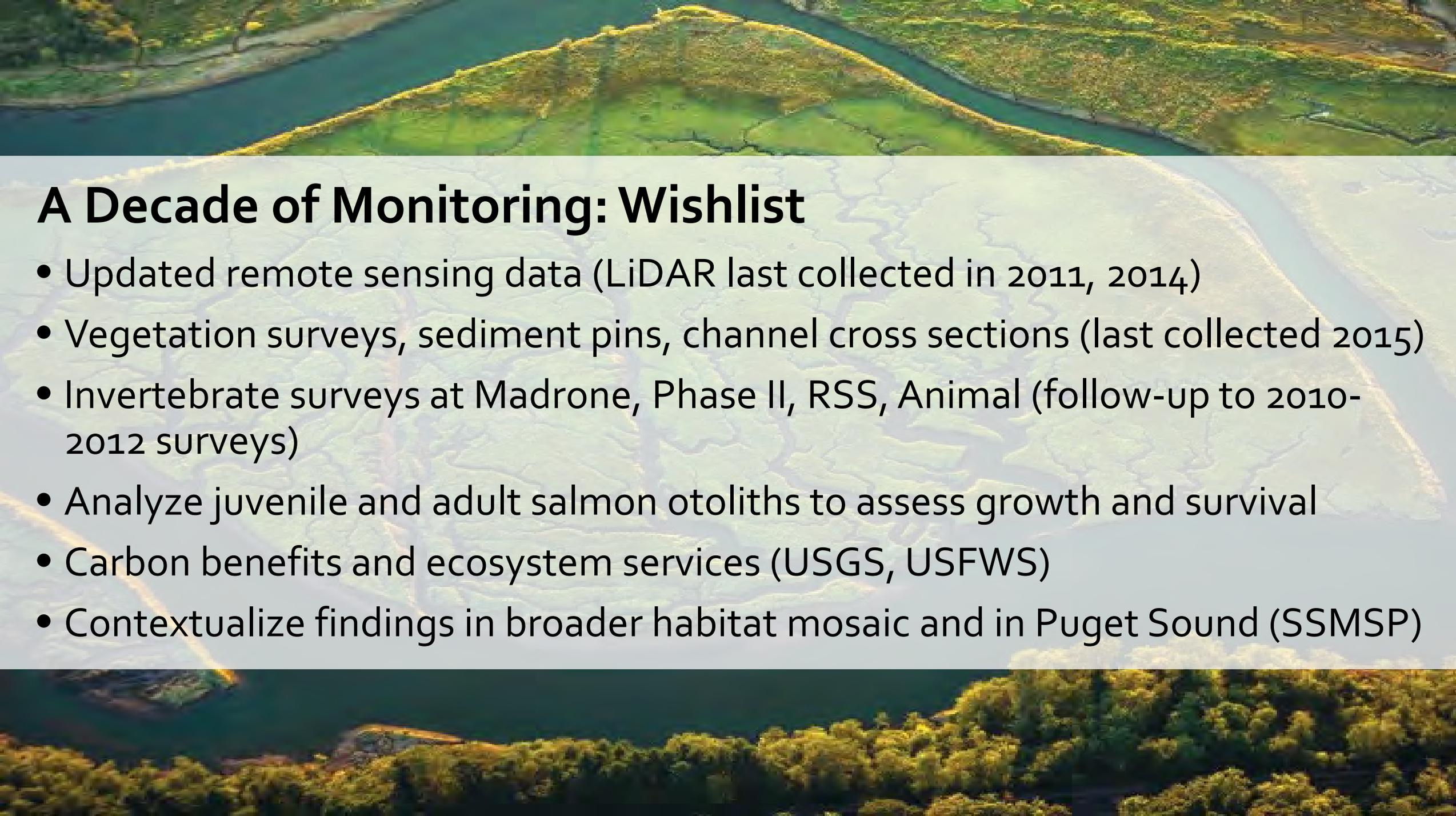
**Complexity**  
(space, refugia)



**Vegetation**  
(temperature, prey)





An aerial photograph showing a winding river through a lush, green landscape. The river is dark blue-green, and the surrounding land is covered in dense vegetation, with some areas appearing more yellowish-green, possibly due to sunlight or specific plant types. The terrain is hilly, and the river flows through a valley.

## A Decade of Monitoring: Wishlist

- Updated remote sensing data (LiDAR last collected in 2011, 2014)
- Vegetation surveys, sediment pins, channel cross sections (last collected 2015)
- Invertebrate surveys at Madrone, Phase II, RSS, Animal (follow-up to 2010-2012 surveys)
- Analyze juvenile and adult salmon otoliths to assess growth and survival
- Carbon benefits and ecosystem services (USGS, USFWS)
- Contextualize findings in broader habitat mosaic and in Puget Sound (SSMSP)

# Supporting Agencies



Nisqually Indian Tribe



WASHINGTON STATE  
Recreation and  
Conservation Office



SCHOOL OF  
AQUATIC  
and  
FISHERY  
SCIENCES

