May 2nd, 8:30 AM - 10:00 AM

Restoration of the Nisqually River Delta and increased rearing opportunities for salmonids

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Salish Sea Conference
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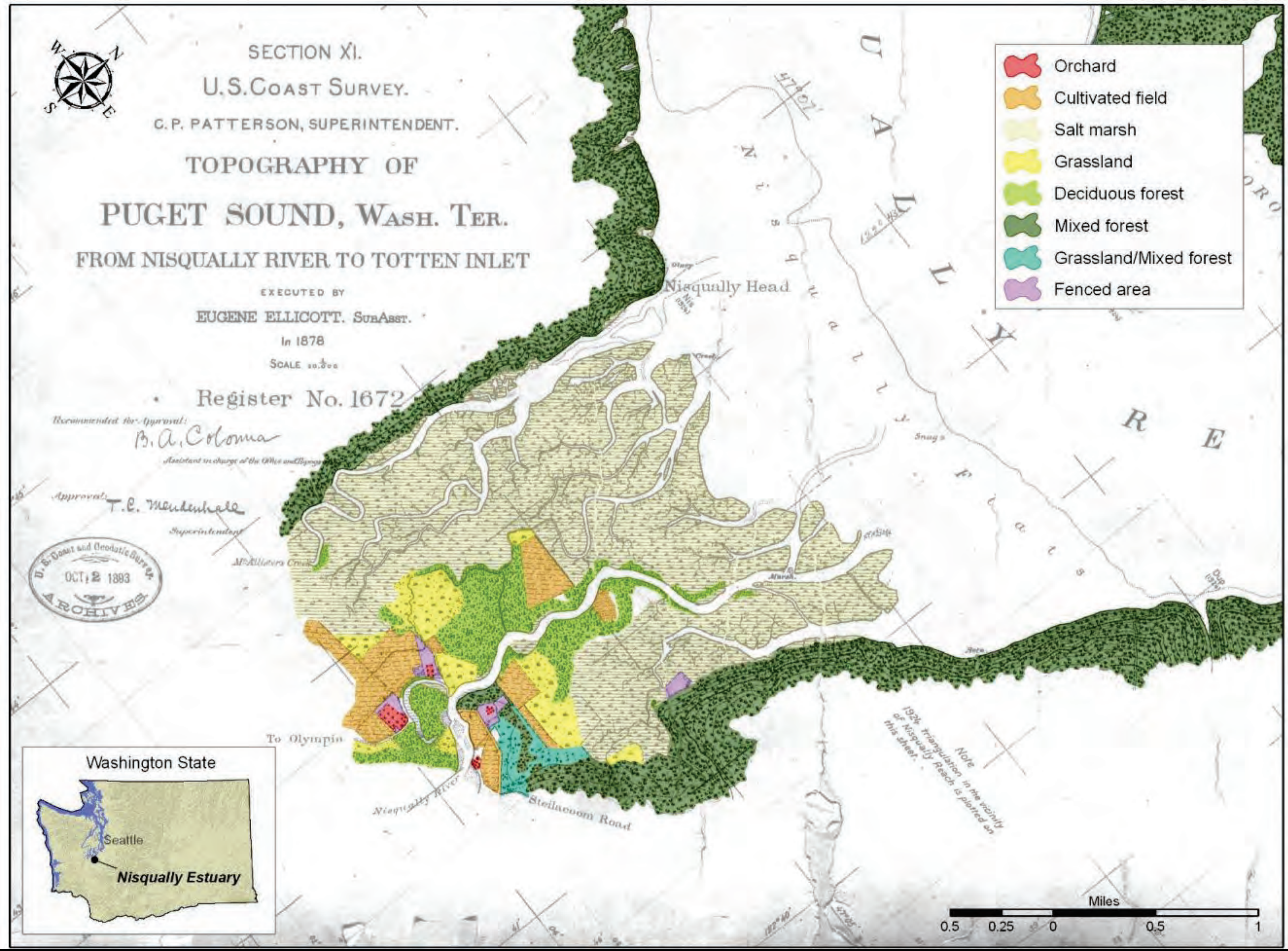
Seattle, Washington

USGS science for a changing world · Nisqually Indian Tribe · U.S. Fish & Wildlife Service · National Wildlife Refuge System · HAMER ENVIRONMENTAL Innovative Solutions to Natural Resource Issues

Historic Condition

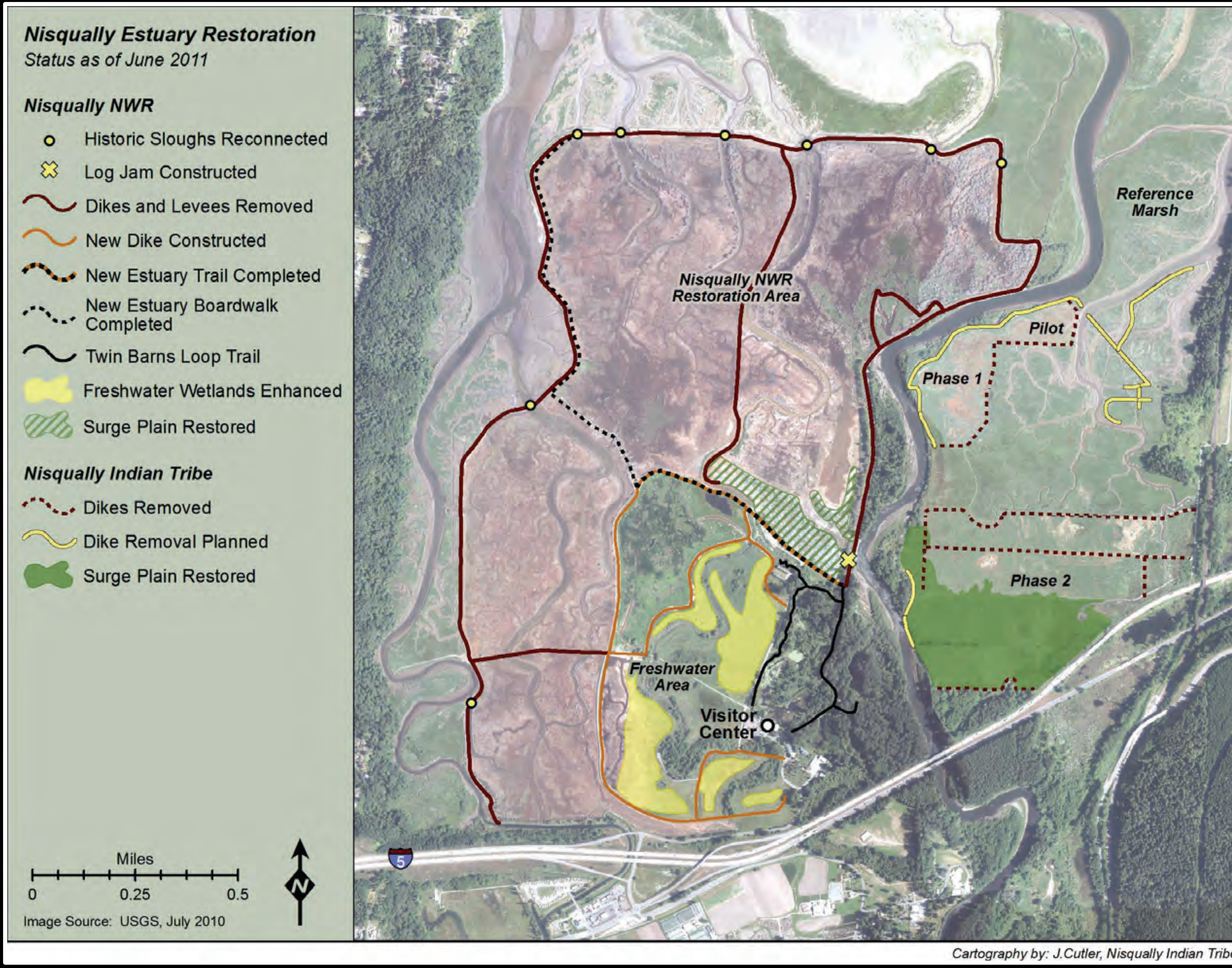


Nisqually Estuary, 1878. Sources: US Coast Survey - Topography of Puget Sound - Nisqually to Totten Inlet, US Geological Survey, Washington State Department of Natural Resources/University of Washington Puget Sound River History Project. Cartography by: J.Cutler, Nisqually Indian Tribe

Development

WA State Historical Society (1904 – 1910)

Salmon Recovery and Conservation Drives Delta Restoration



Chinook Response to Estuary Restoration

Chinook estuary rearing is a critical component of Chinook life history

↓

Opportunity: Chinook are able to access estuarine habitats

↓

Capacity: Estuarine habitats support Chinook rearing functions

↓

Realized Function: Chinook take advantage of estuarine capacity

Opportunity Performance Metrics:
- Delta connectivity
- Full tidal inundation
- Channel development
- Chinook presence

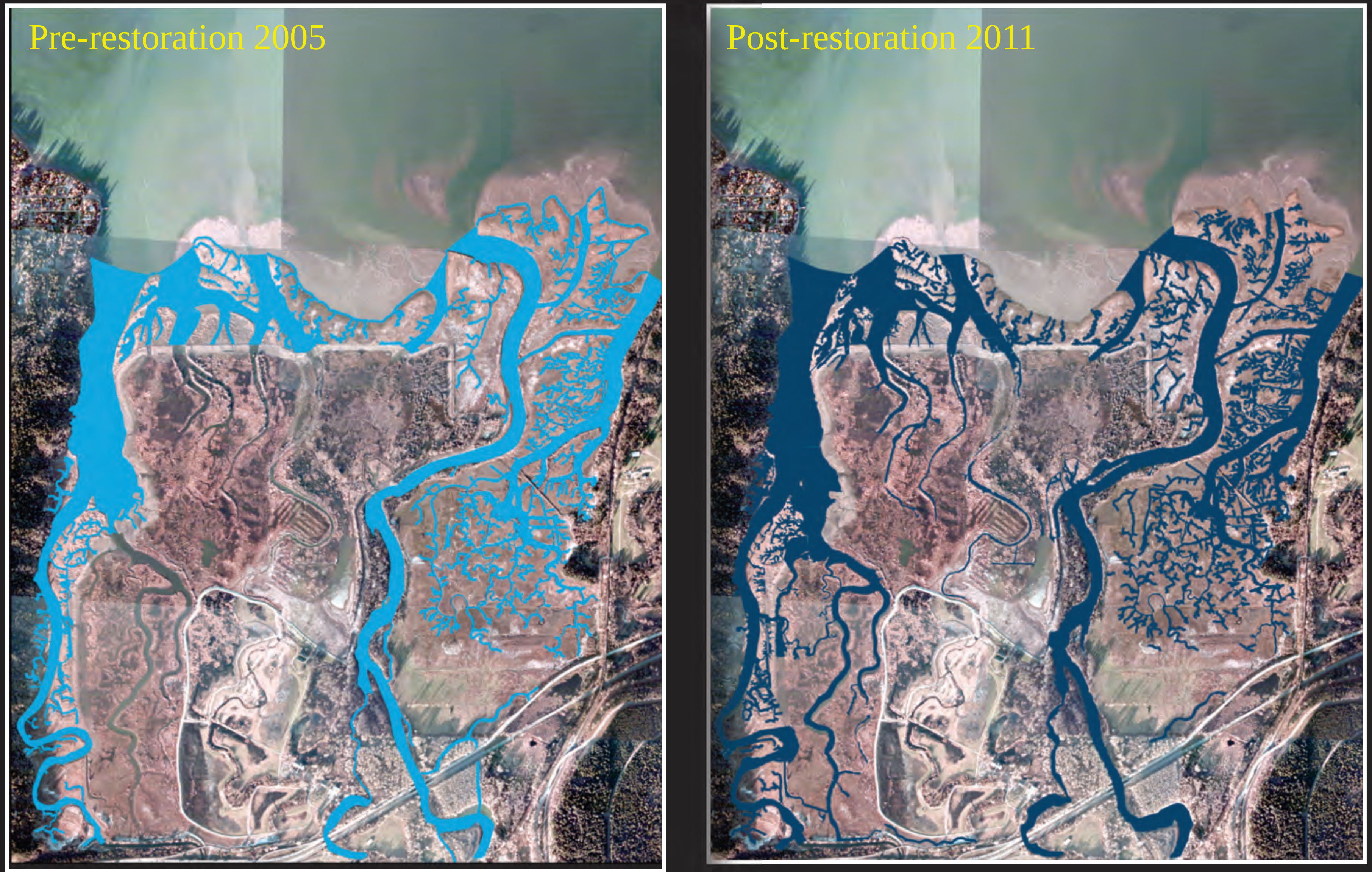
Capacity Performance Metrics:
- Water quality
- Sedimentation
- Elevation
- Vegetation composition and structure
- Invertebrate composition and abundance

Realized Function Performance Metrics:
- Chinook estuary feeding ecology
- Chinook estuary residence time
- Chinook estuary growth
- Chinook life history diversity

Based on Simenstad and Cordell (2000)

Opportunity: Tidal Channels

Tidal channels are the functional interstates of estuaries

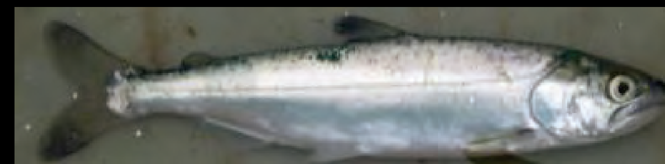


Opportunity: Delta Connectivity

Put physical metrics in terms of juvenile Chinook

- Inundation model to peak outmigration season (March – August)
- Only included tidal depths supporting juvenile Chinook (≥ 0.4 m; Hering et al. 2010)

- Constrained Modeling
  - Continuous water level data
  - Elevation data
    - Aerial and Terrestrial LiDAR
    - Bathymetry



Salmon River estuary, OR (from Hering et al. 2010)

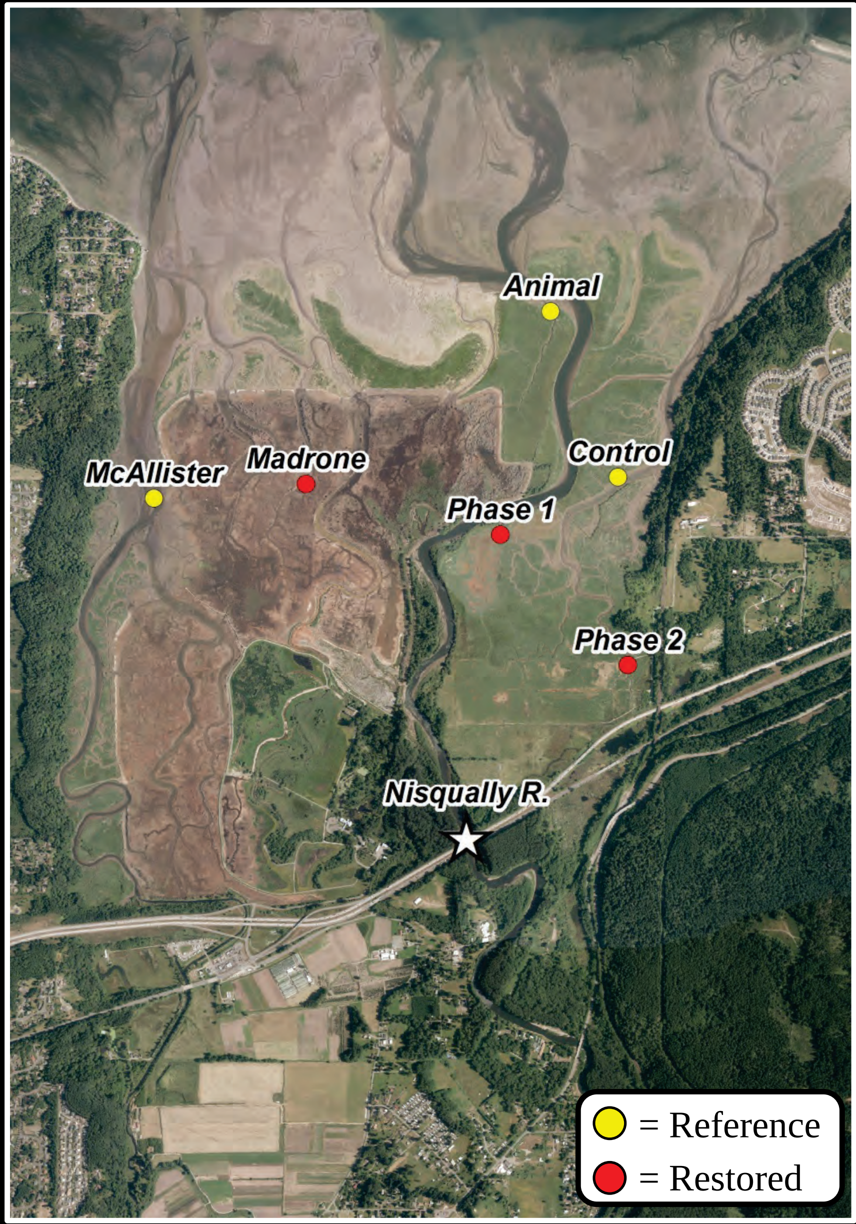
Opportunity: Delta Connectivity

Measurements

For each tidal datum :

- Number of pathways
- Complexity
- Length of time

Verified results with Chinook presence



Opportunity: Delta Connectivity

Pre-restoration Mean Lower Low Water

One reference site accessible:

- McAllister
  - One pathway
  - Complexity using tortuosity ratio:
    - straight line/traveled path
      - 2.5 km/ 10 km = 0.25

Opportunity: Delta Connectivity

Post-restoration Mean Lower Low Water

One reference site accessible:

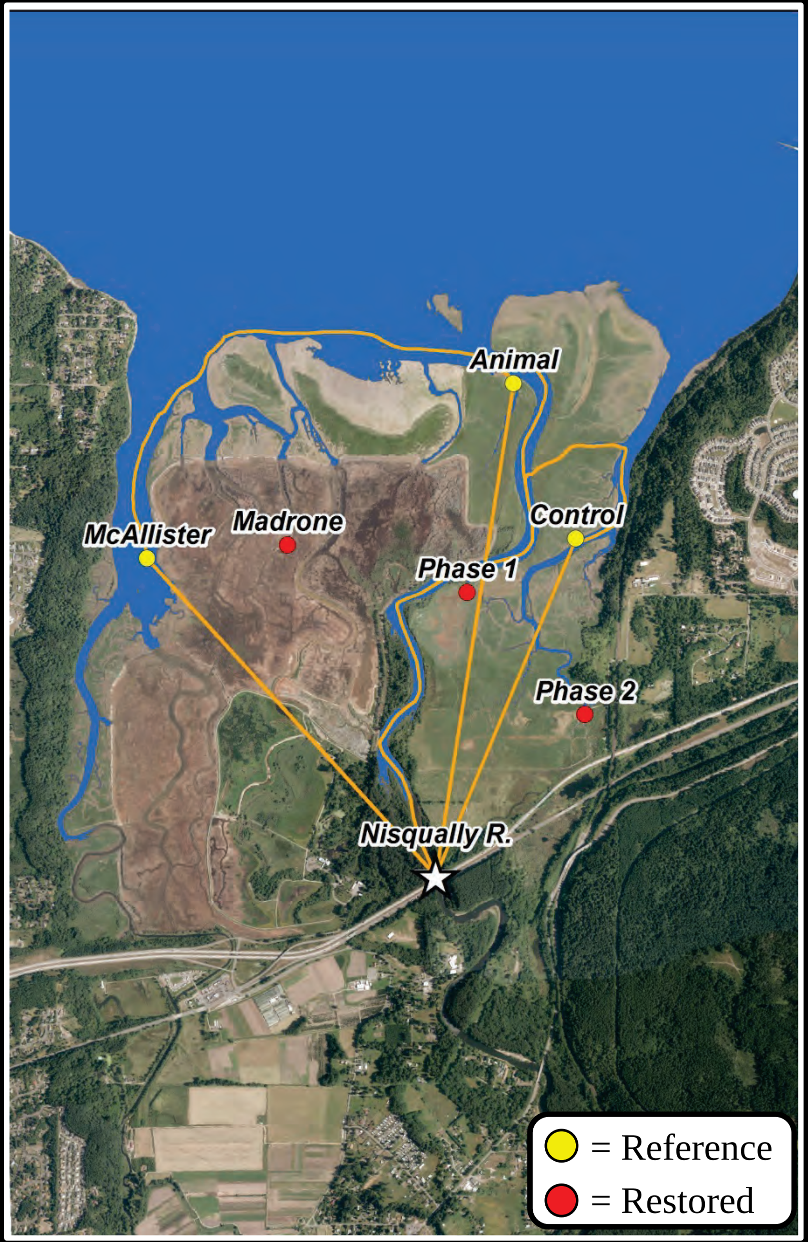
- McAllister
  - One pathway
  - Complexity using tortuosity ratio:
    - straight line/traveled path
      - 2.5 km/ 10 km = 0.25

Opportunity: Delta Connectivity

Pre-restoration Mean Tide Level

Three reference sites accessible:

- McAllister
  - One pathway
  - Complexity = 0.35
- Control
  - One pathway
  - Complexity = 0.48
- Animal
  - One pathway
  - Complexity = 0.70



Opportunity: Delta Connectivity

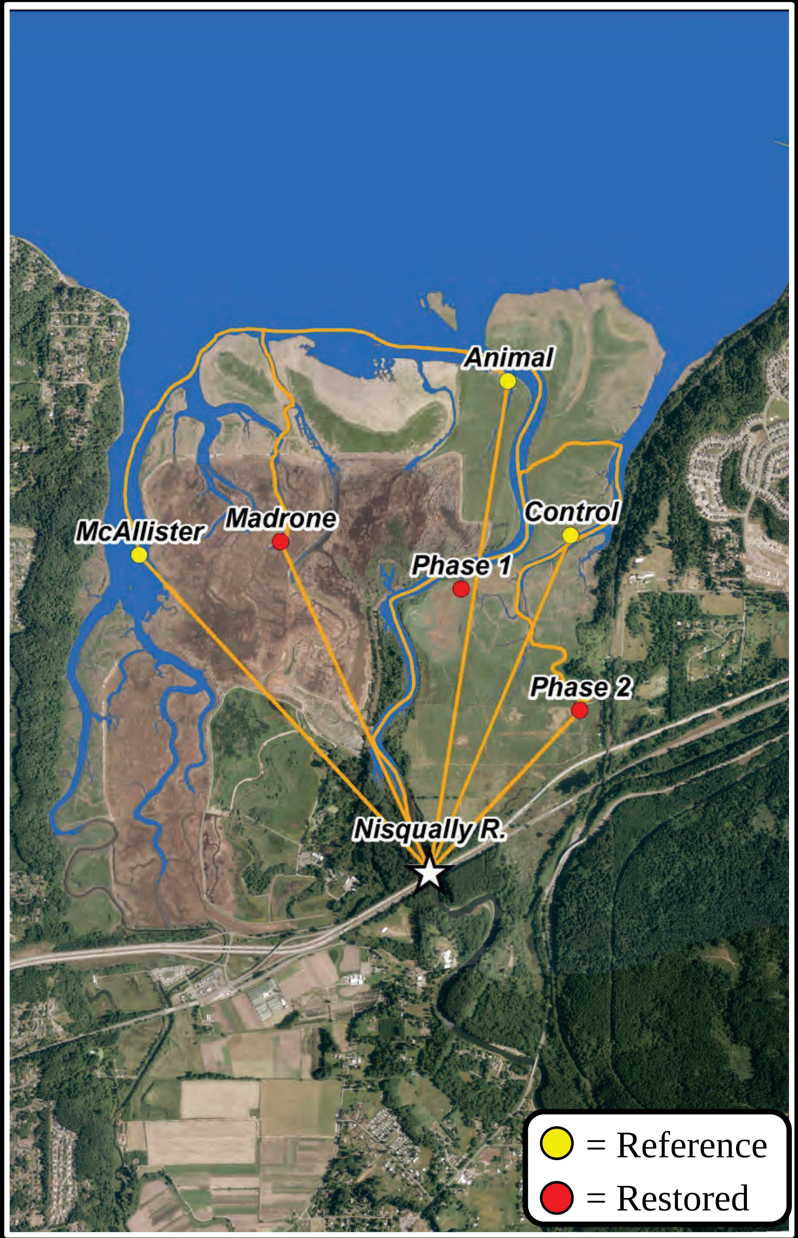
Post-restoration Mean Tide Level

Two reference sites accessible:

- McAllister
  - One pathway
  - Complexity = 0.32
- Control
  - One pathway
  - Complexity 0.48

Three restoration sites accessible:

- Phase 2
  - One pathway
  - Complexity = 0.25
- Madrone
  - One pathway
  - Complexity = 0.32
- Animal
  - One pathway
  - Complexity = 0.70



Opportunity: Delta Connectivity

Pre-restoration Mean Higher High Water

Three reference sites accessible:

- McAllister
  - One pathway
  - Complexity = 0.35
- Control
  - One pathway
  - Complexity = 0.49
- Animal
  - One pathway
  - Complexity = 0.78

Opportunity: Delta Connectivity

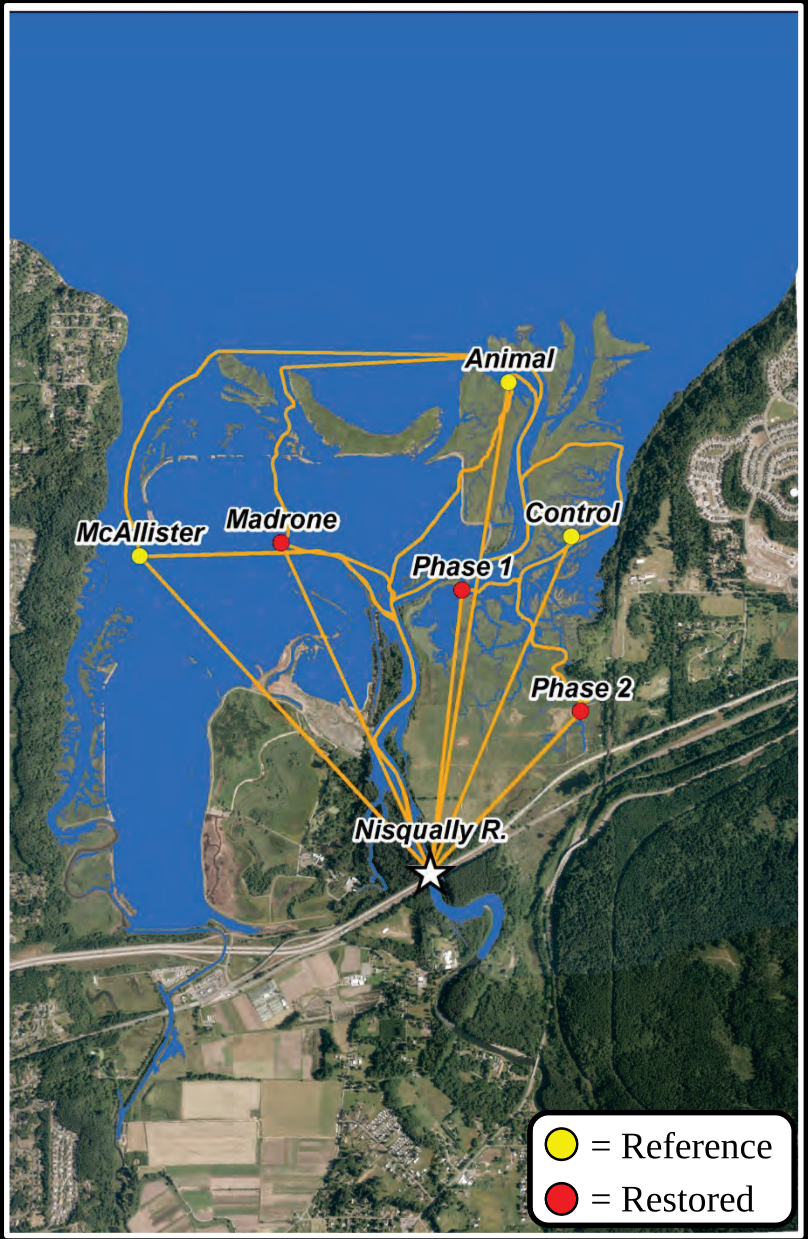
Post-restoration Mean Higher High Water

Three restored sites accessible:

- Phase 1
  - One pathway
  - Complexity = 0.31
- Phase 2
  - One pathway
  - Complexity = 0.22
- Madrone
  - Two pathways
  - Complexity
    - Path 1 = 0.32
    - Path 2 = 0.84

Three reference sites accessible:

- McAllister
  - Three pathways
  - Complexity
    - Path 1 = 0.36
    - Path 2 = 0.74
    - Path 3 = 0.76
- Control
  - One pathway
  - Complexity = 0.49
- Animal
  - Two pathways
  - Complexity
    - Path 1 = 0.78
    - Path 2 = 0.89



Opportunity: Delta Connectivity

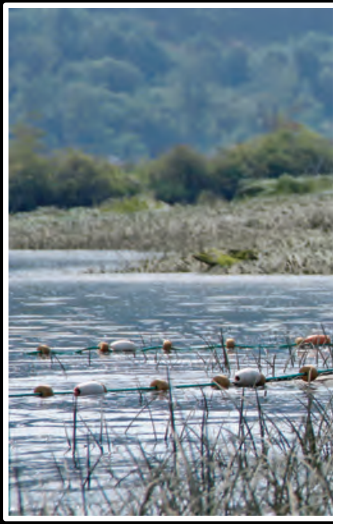
Fish Presence: Methods

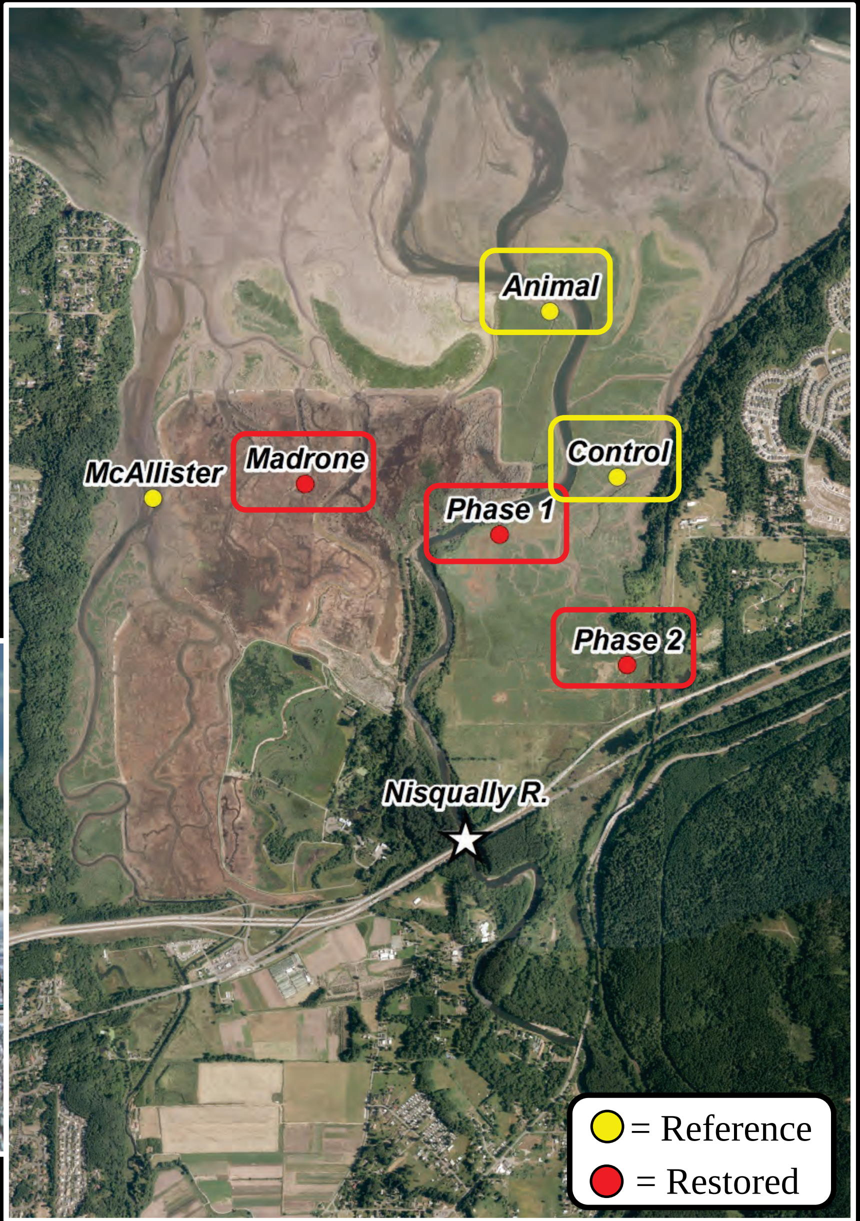
Fyke Trap Surveys

- Tidal channels
  - 3 Restored
  - 2 Reference
- Set on high tide, removed low tide
- Post-restoration

Beach Seine Surveys

- 30 sites
- Mid to high tide
- Pre and post-restoration

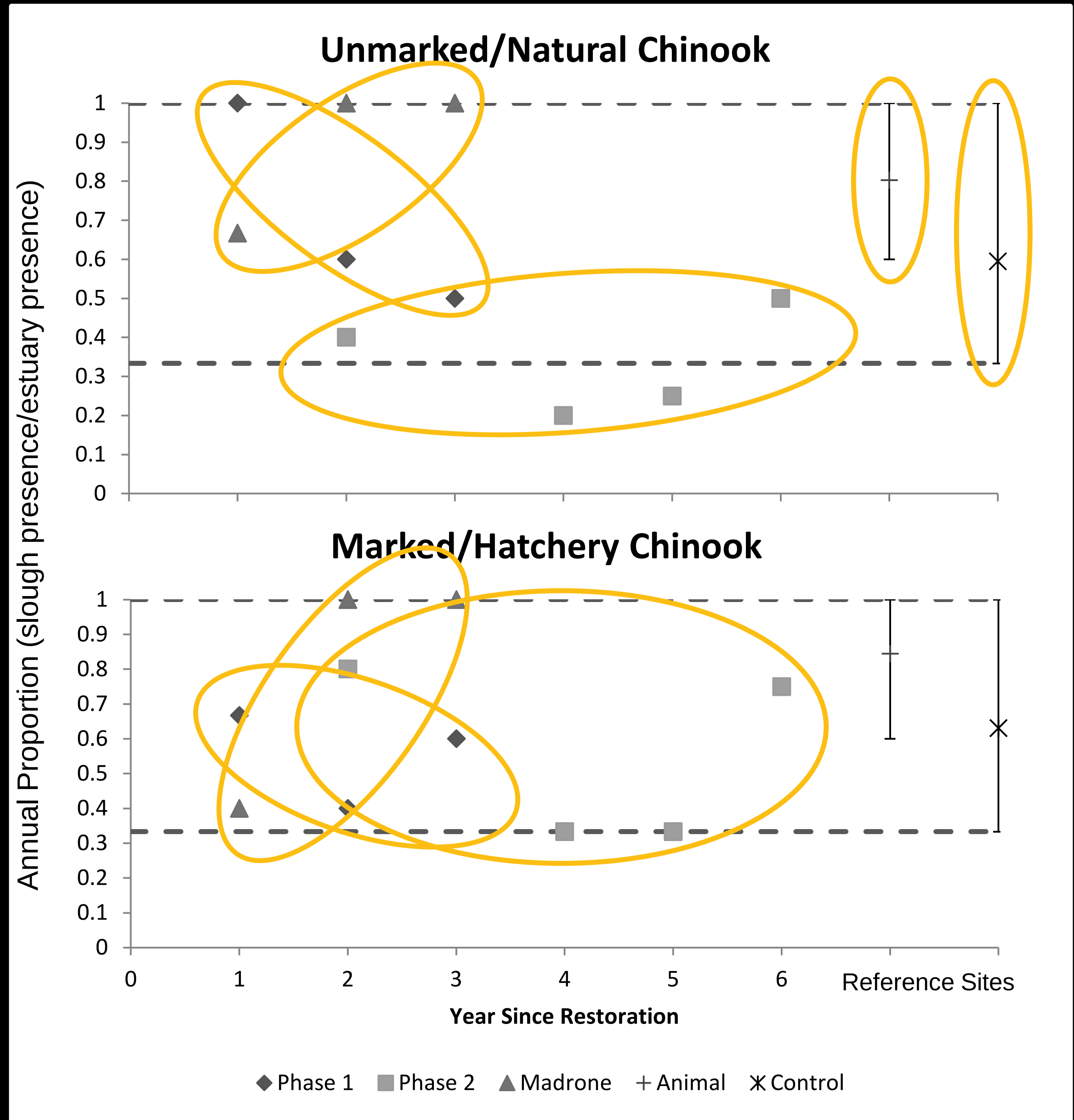




Opportunity: Delta Connectivity

Fish Presence: Results

Annual proportion of months when juvenile Chinook were detected in both a tidal slough (fyke trap) and Nisqually estuary (beach seine)

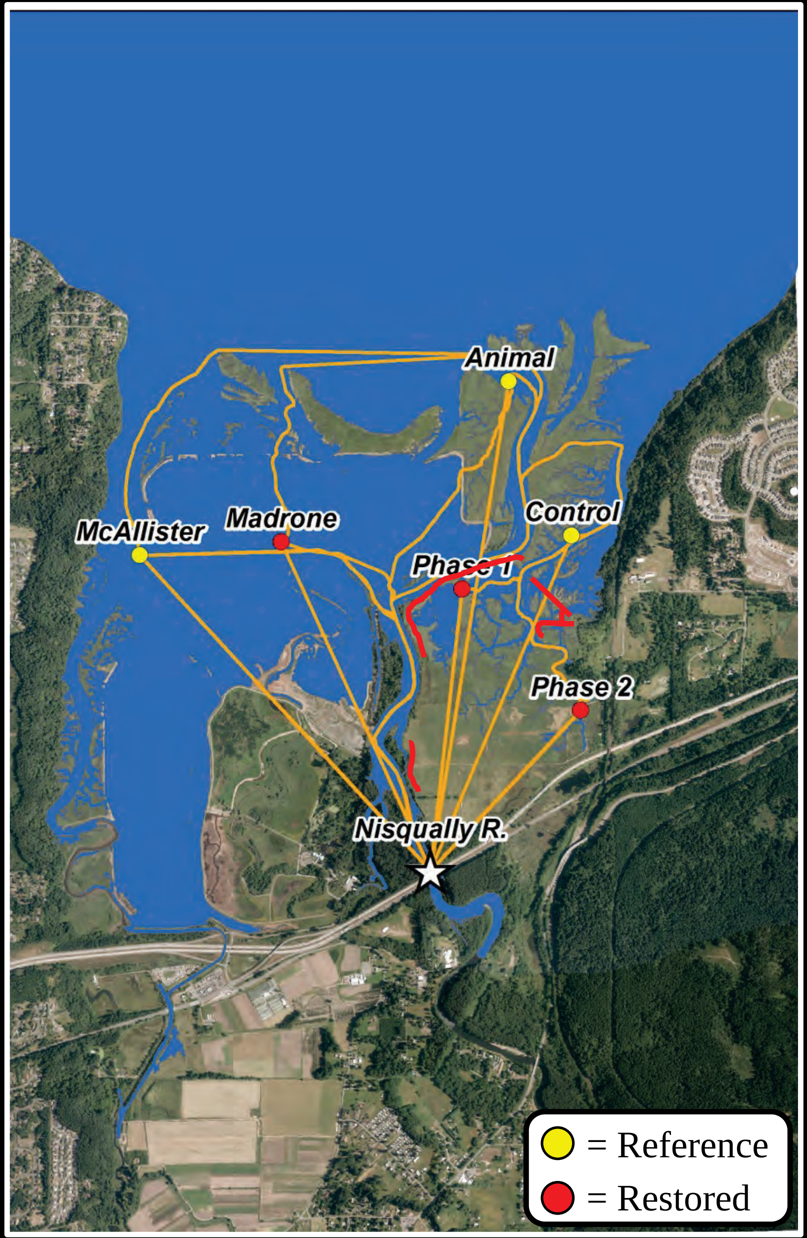


Opportunity: Delta Connectivity

Fish Presence: Results

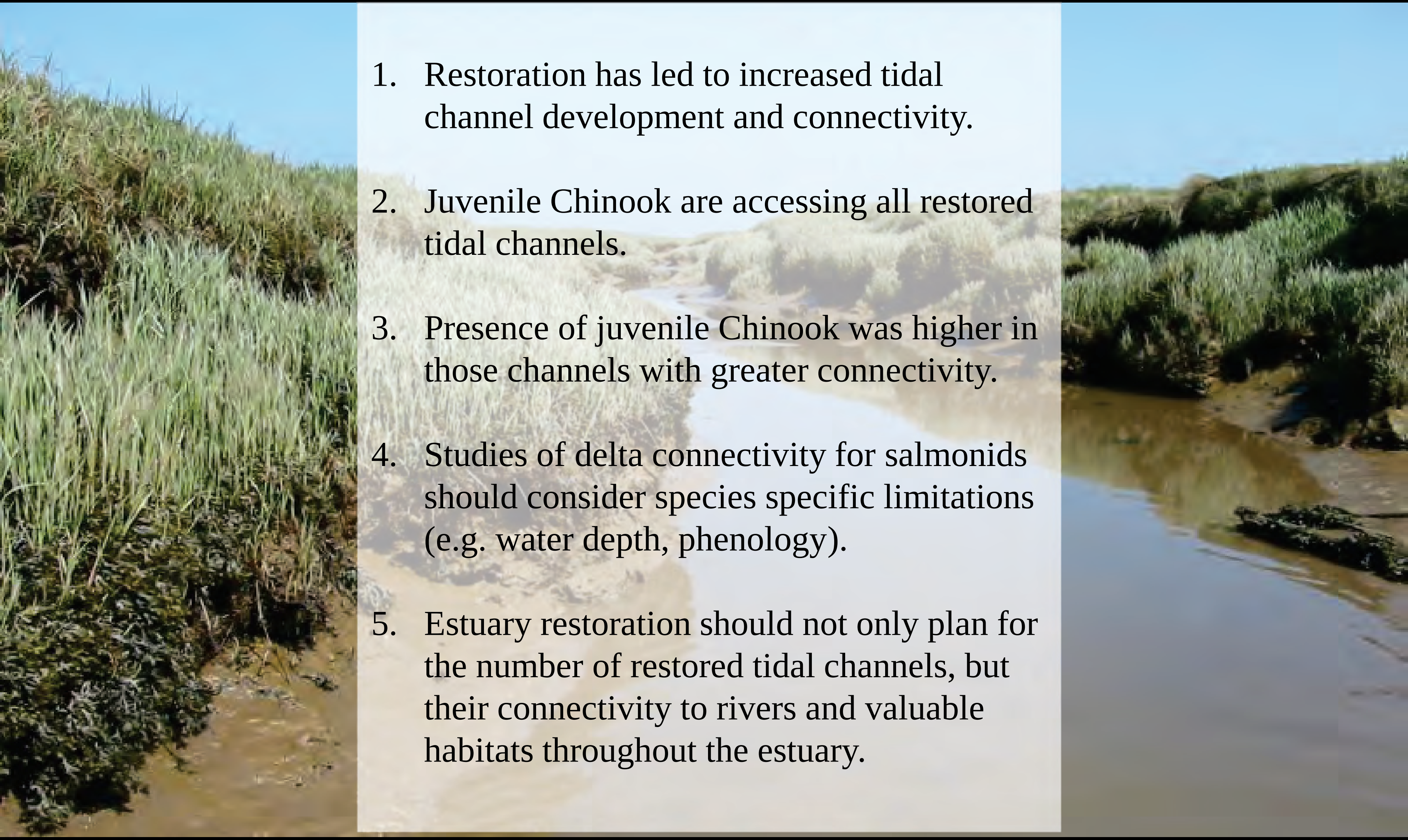
Restored channels:

- Least complex path:
  - Madrone - Phase 1 – Phase 2
- Highest number of paths:
  - Madrone
- Path accessible longest:
  - Madrone and Phase 2



Opportunity: Delta Connectivity

Summary



1. Restoration has led to increased tidal channel development and connectivity.

2. Juvenile Chinook are accessing all restored tidal channels.

3. Presence of juvenile Chinook was higher in those channels with greater connectivity.

4. Studies of delta connectivity for salmonids should consider species specific limitations (e.g. water depth, phenology).

5. Estuary restoration should not only plan for the number of restored tidal channels, but their connectivity to rivers and valuable habitats throughout the estuary.

Nisqually Delta Restoration

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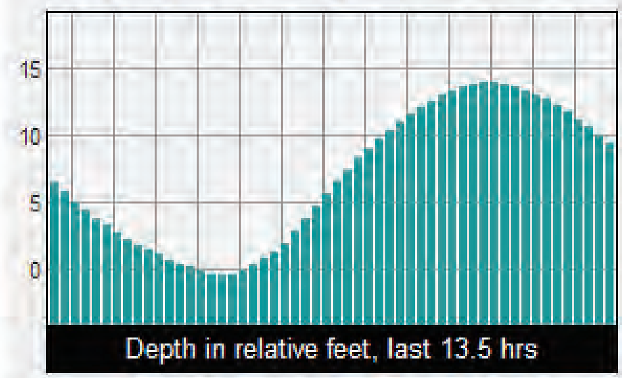
About the Project

After a century of diking off tidal flow, the Brown Farm Dike was removed to inundate 308 ha of the Nisqually National Wildlife Refuge (Refuge) in October 2009. Along with 57 ha wetlands restored by the Nisqually Indian Tribe, the Nisqually Delta represents the largest tidal marsh restoration project in the Pacific Northwest to assist in recovery of Puget Sound salmon and wildlife populations. Over the past decade, the Refuge and close partners, including the Tribe and Ducks Unlimited, have restored more than 35 km of the historic tidal slough systems and re-connected historic floodplains to Puget Sound, increasing potential salt marsh habitat in the southern reach of Puget Sound by 50%. More »

Restoration News

Restoration of the Nisqually Estuary: Tracking the Changes. The Flyway, Spring 2010. September 24, 2010. The restoration of the tides to 762 acres of the Nisqually Estuary in the fall of 2009 initiated many changes at the Refuge. As a mixture of fresh and

Nisqually Monitoring



Depth | Salinity | Temperature

Recent Updates

- Reflections on the Water: Conversations About the Salish Sea
- Rivers and Tides: Restoring the Nisqually Estuary Video

Project Partners and Collaborators

Funding includes: EPA, ESRP, FWS (SSP and CCS), NFWF, and USGS YIF and SISNAR Internships

- Nisqually National Wildlife Refuge
- Nisqually Indian Tribe
- USGS Western Ecological Research Center
- USGS Pacific Coastal and Marine Geology
- USGS Western Fisheries Research Center
- USGS Washington Water Science Center
- Nisqually River Foundation
- Ducks Unlimited
- Nisqually Reach Nature Center
- Avian Design
- USGS Patuxent Wildlife Research Center
- Washington Department of Fish and Wildlife