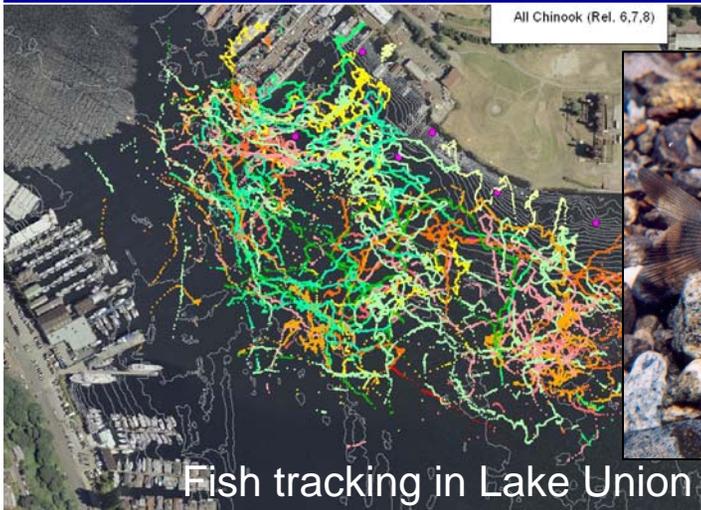
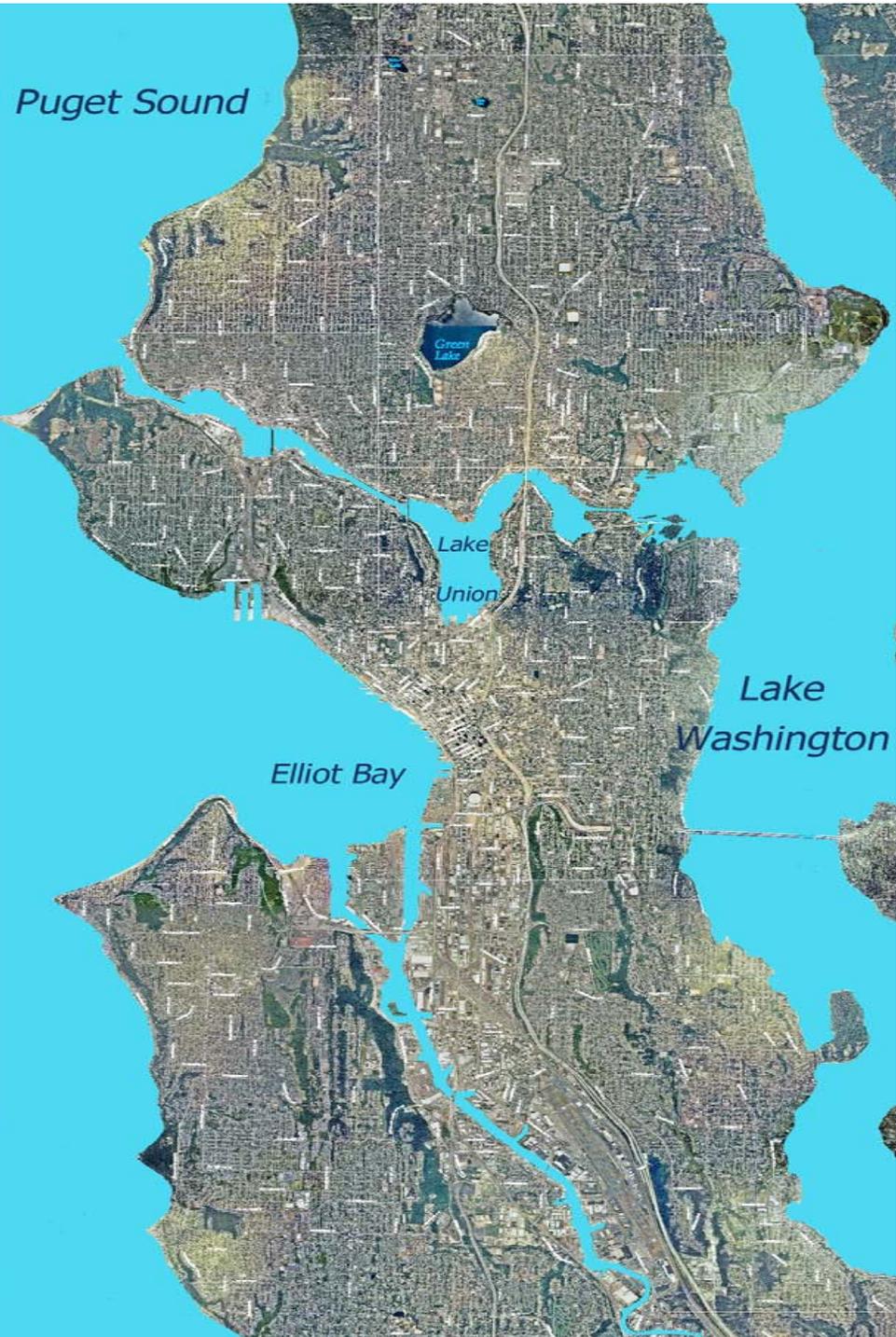


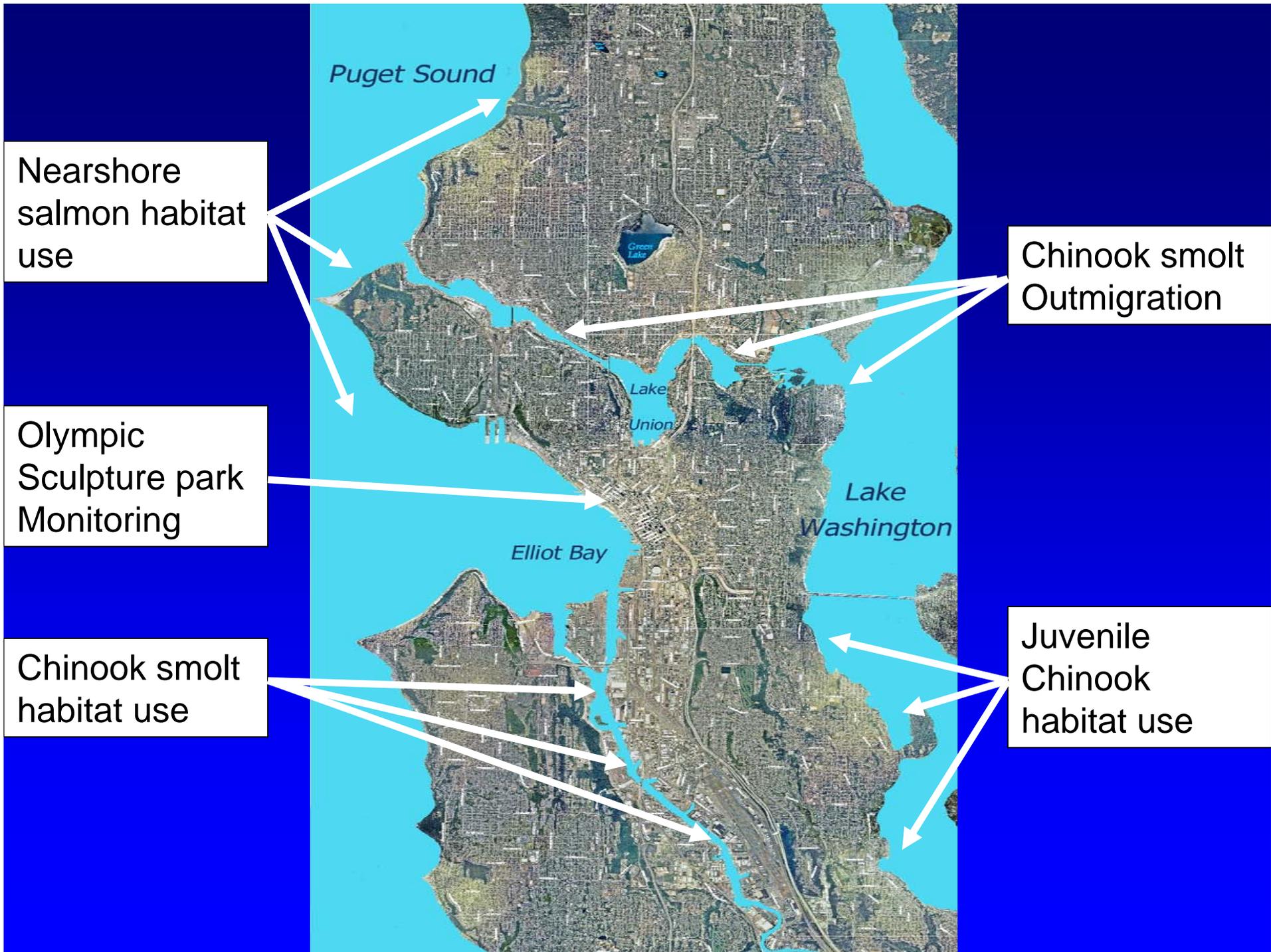
Aquatic Science in Seattle



An Overview of Research on Salmon and Aquatic Habitat

Julie Hall, Seattle Public Utilities
julie.hall@seattle.gov





Lake Washington Juvenile Chinook Habitat Use

Most Chinook come from the Cedar River, entering as fry

Lake Washington is a rearing and migration area for these fish



- Fry enter lake January – April, length is ~40mm (1.6 inches)
- Fingerlings enter lake May-June, length is 80-120mm (3-5 inches)

To Cedar River



Lake Washington Research: Conducted by USFWS

- 2000 - 2006
- Snorkel surveys
- Woody debris and overhead cover experiments
- Dock observations
- Microacoustic tracking



Scientist Roger Tabor conducts a snorkeling survey along the Lake Washington shoreline

(Also restoration site monitoring)

Chinook fry need rearing habitat and “rest stops” for the 3-5 months they inhabit Lake Washington

February-May

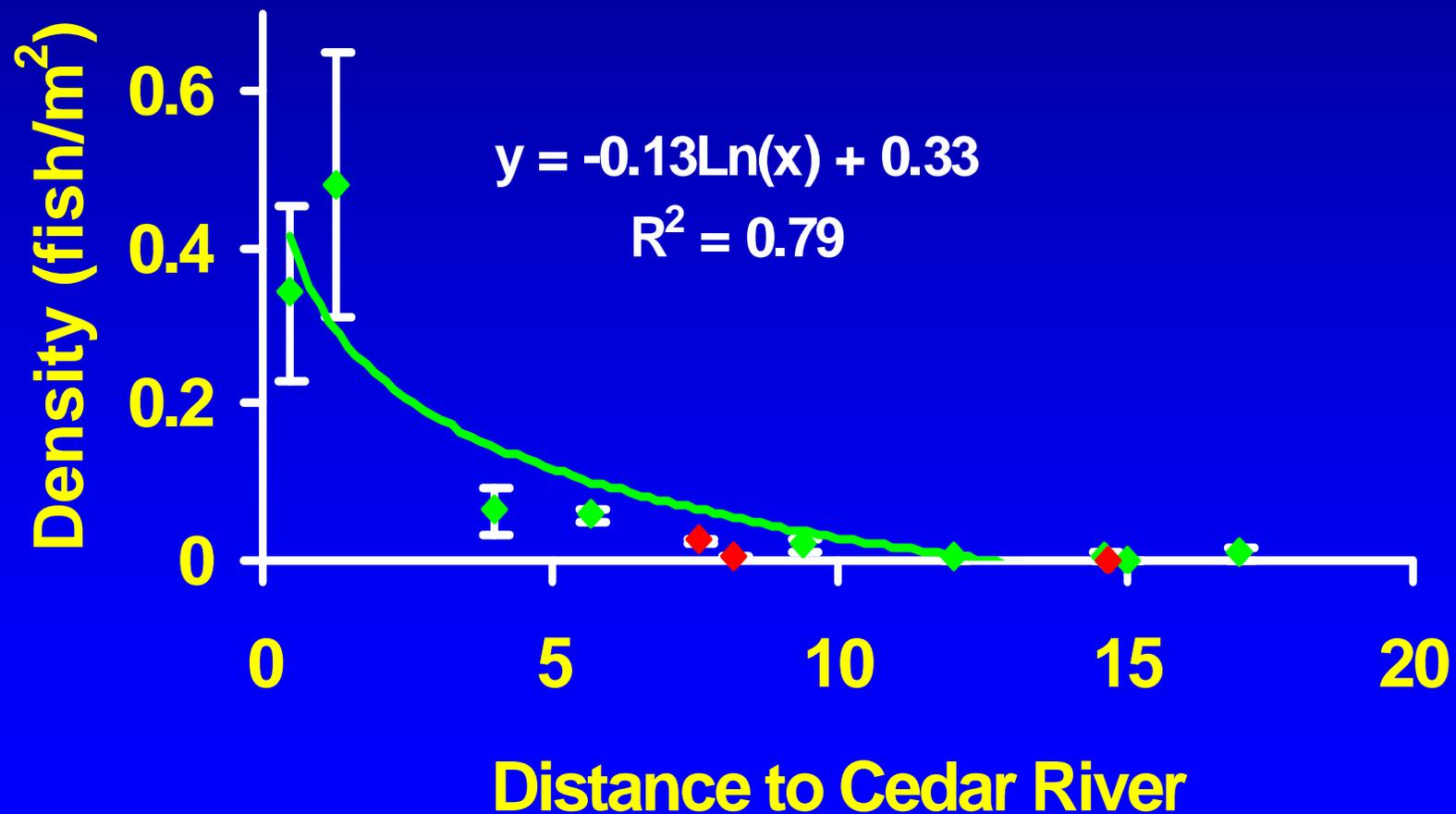


Preferred rearing habitat includes:

- Shoreline areas with shallow depths (>1 m) and gentle slopes
- Fine substrates
- Overhanging vegetation/small woody debris
- Small creeks: mouths and shallow, low gradient, upstream portions

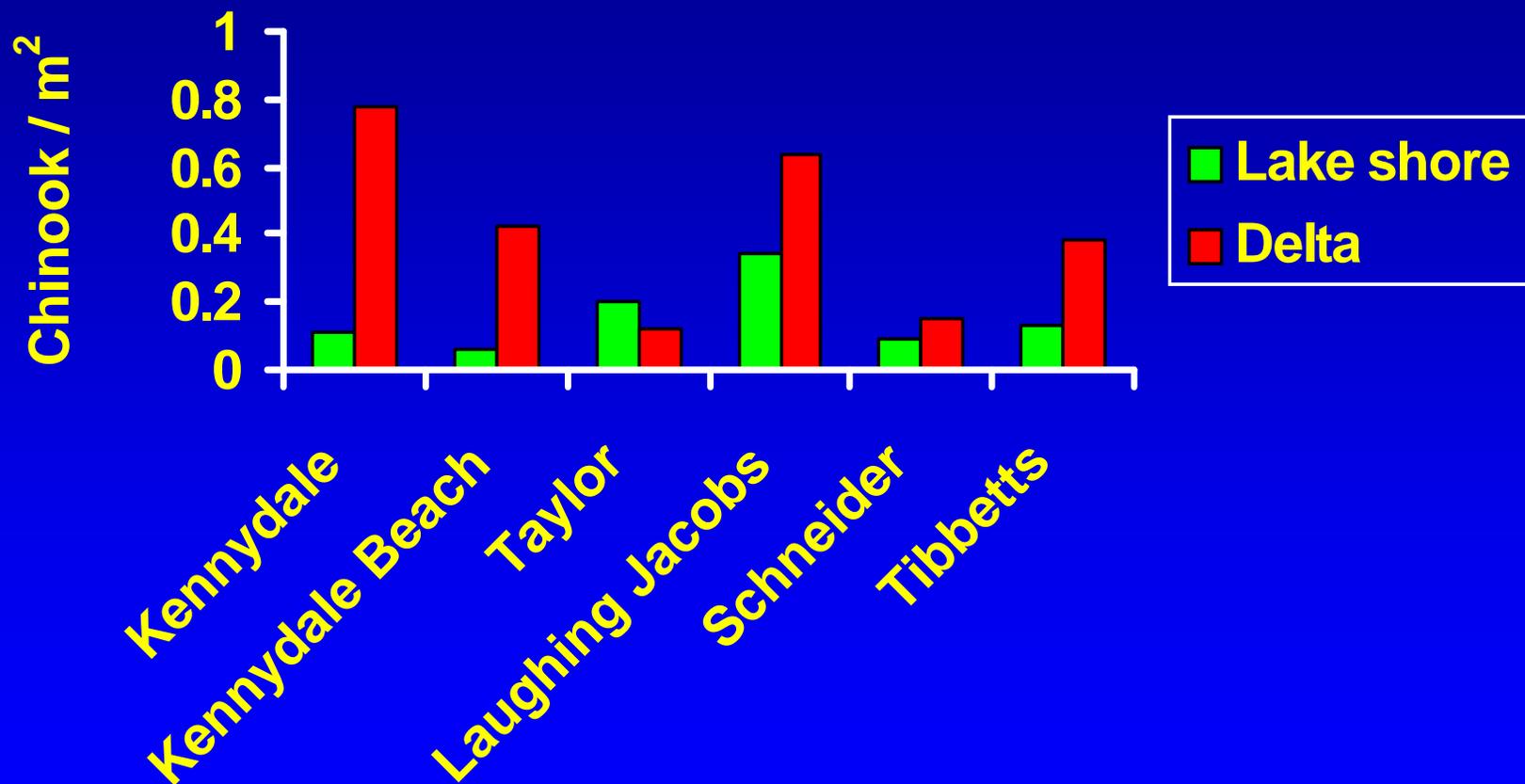
Density of juvenile Chinook, relative to distance from the Cedar River

March – June



Small creek mouths = highly used

Comparison of Deltas and Lake Shore
(South L. Washington and L. Sammamish)



From "Nearshore Habitat Use by Juvenile Chinook Salmon in Lentic Systems of the Lake Washington Basin".
Annual Report, 2002 by Roger Tabor, US Fish and Wildlife Service

Small Creeks



To Avoid Predators, Juvenile Chinook:

Avoid areas with little light,
like under docks

Avoid shorelines without shallow water
areas due to bank armoring



Over-water structures cause
juveniles to detour to deeper
water

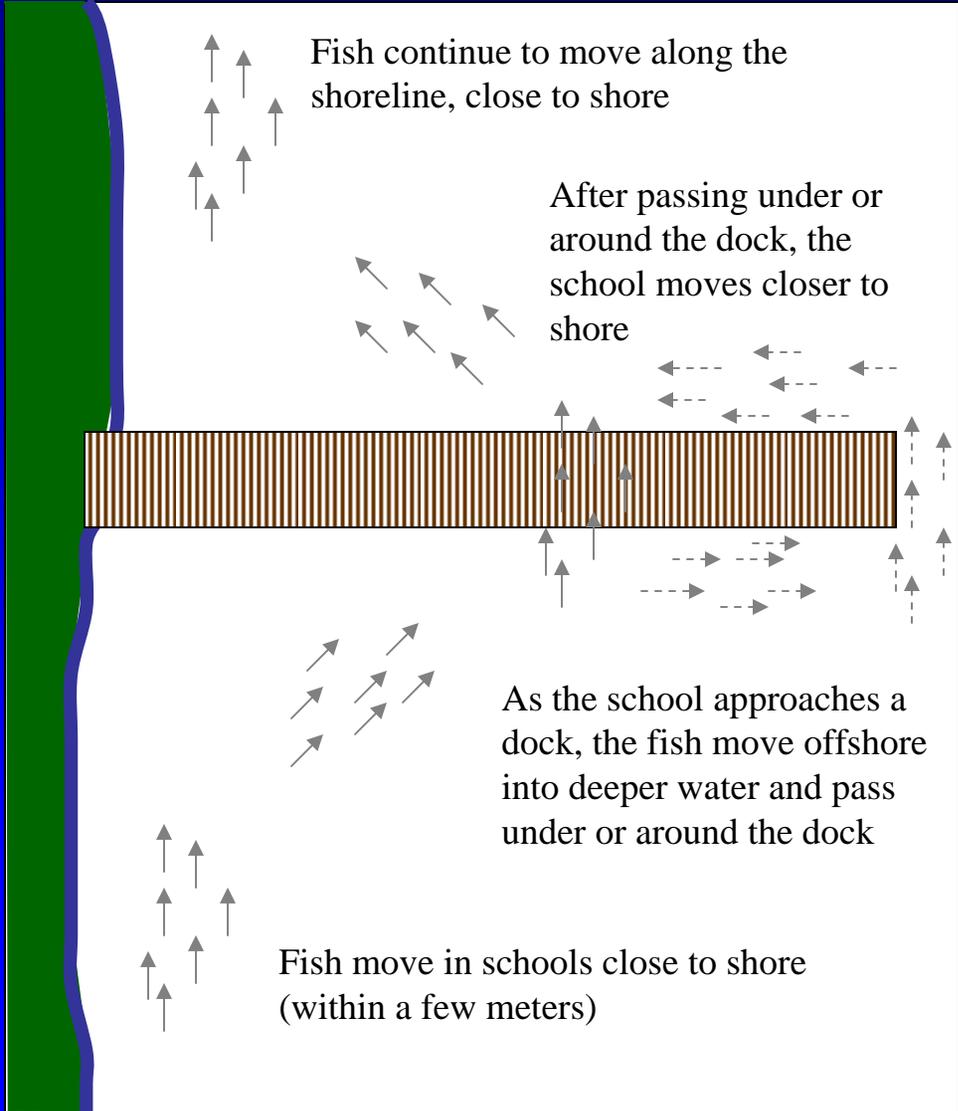


Bulk heading and rip rap
provide a refuge for
predators, reduce shallow
water areas, and prevent
bank sloughing (which
supplies fine sediment)



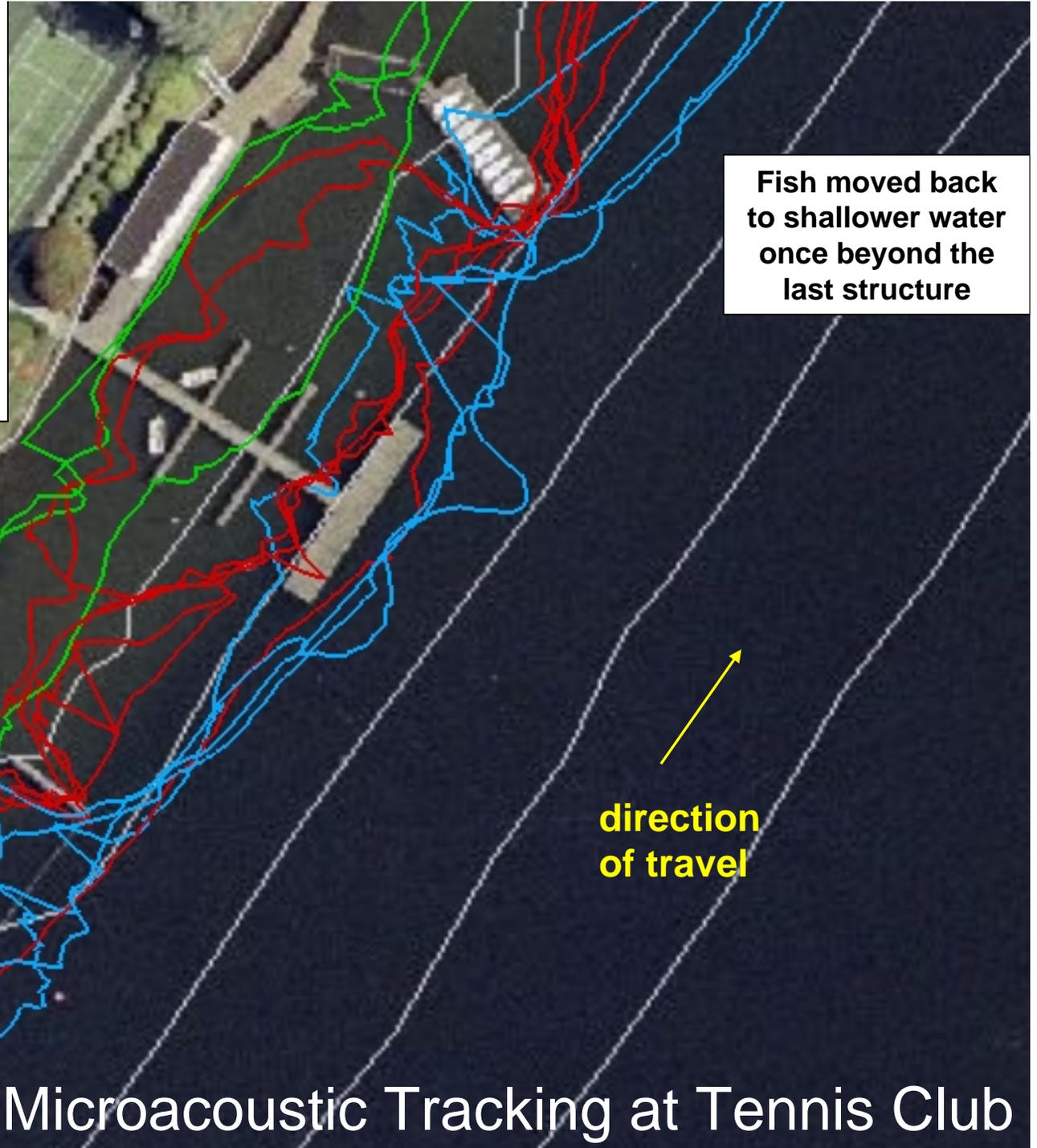
Docks affect how fish move along the shoreline

May-June



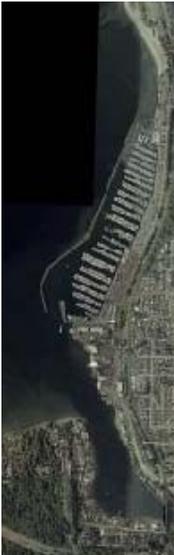
Effect of structures:

- Increase distance traveled
- Force migrating smolts into deeper water (increase predation risk?)

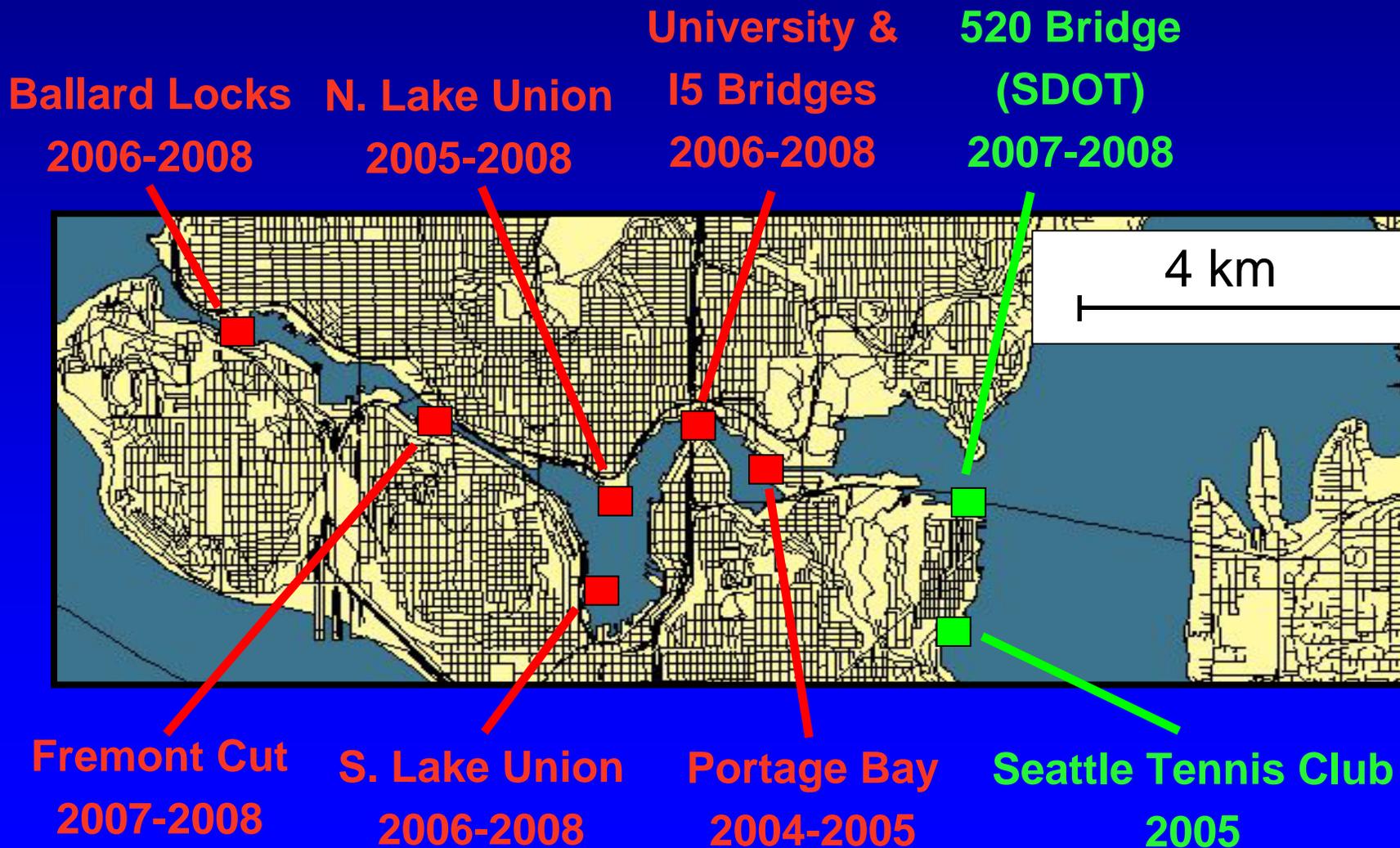


Moving toward Puget Sound...

- Juvenile Chinook seem to migrate into slightly deeper areas of the lake as they become larger. But they still seem to stay near shore.
- They are thought to spend a few days to up to two weeks passing through the Ship Canal. Water in Ship Canal at this time – very warm!
- They exit through the Locks from the first week of June to mid-July
- From 2004-2008, focused on microacoustic tracking of juveniles

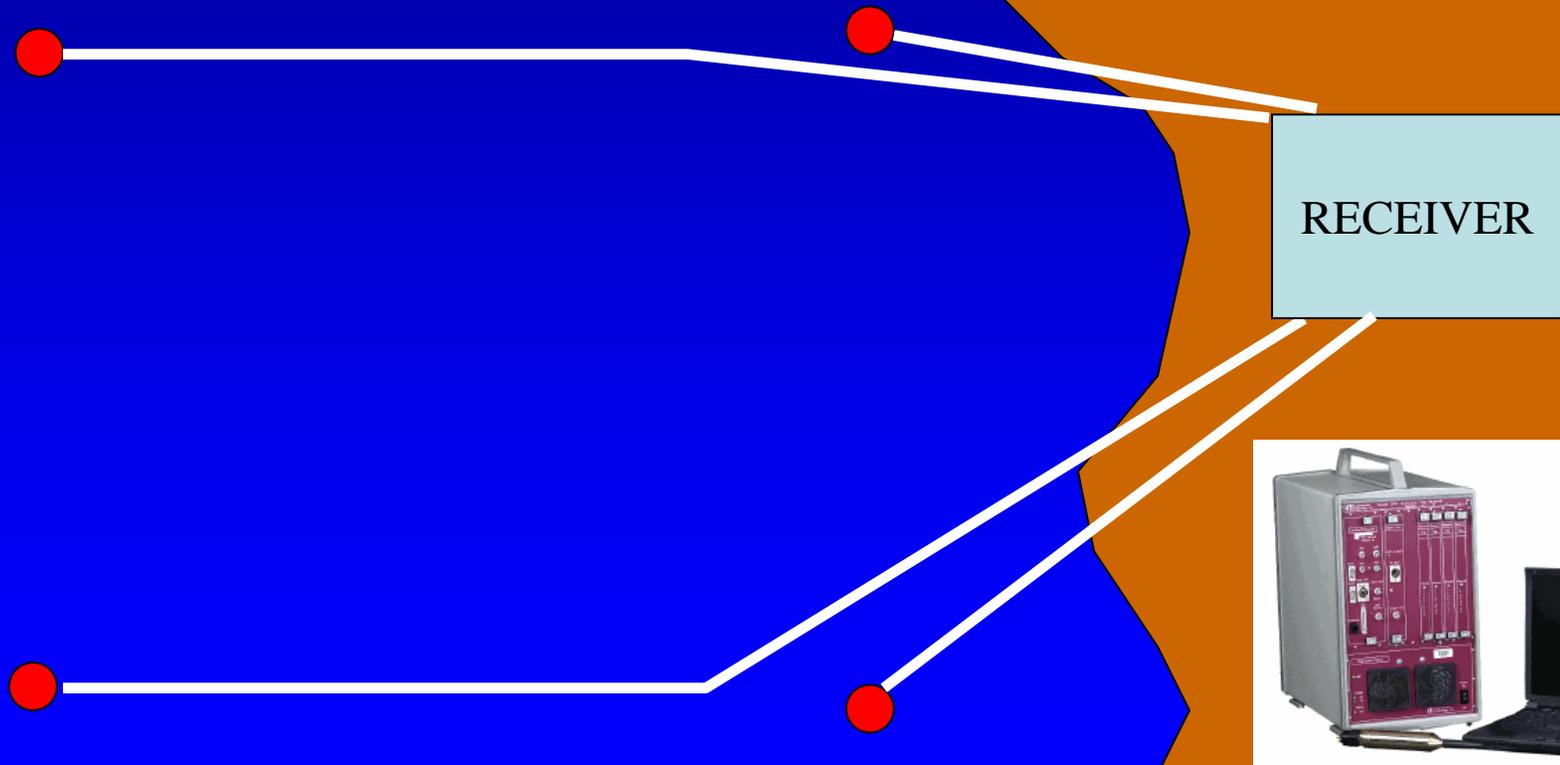


Microacoustic Tracking 2004 - 2008 Study Sites



Tracking System

1. "Listening station"



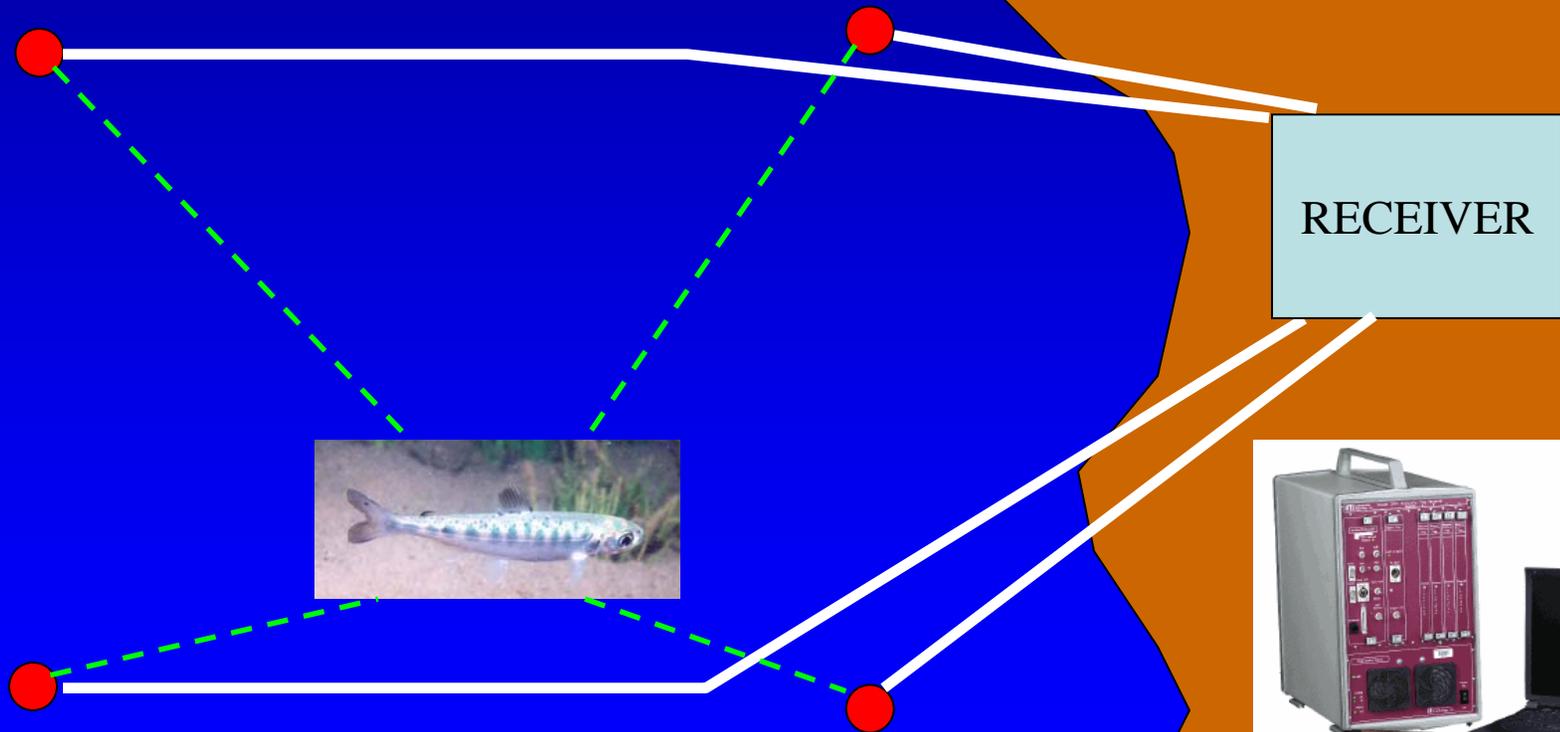
Tracking System

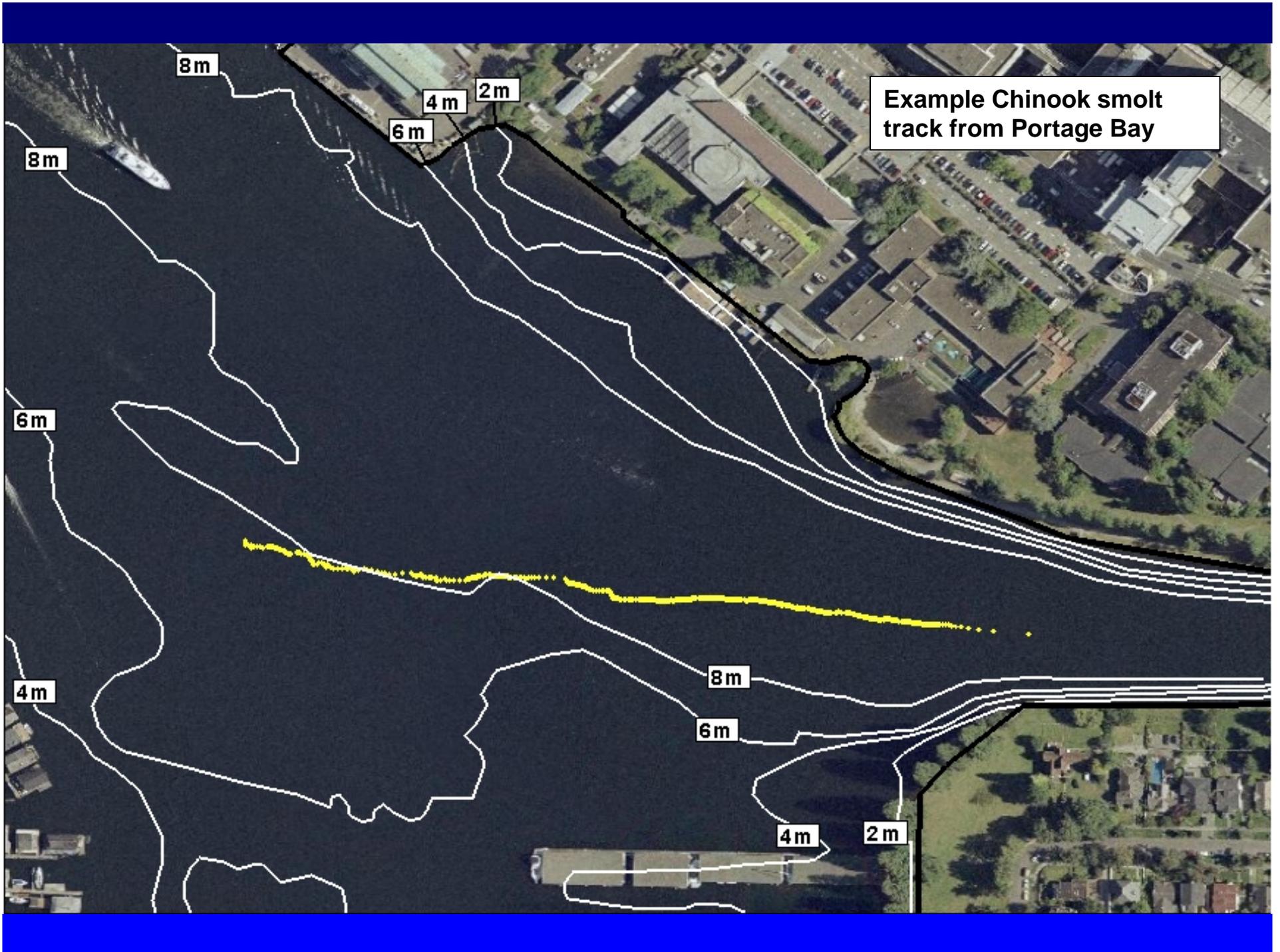
2. Get a fish and a tag



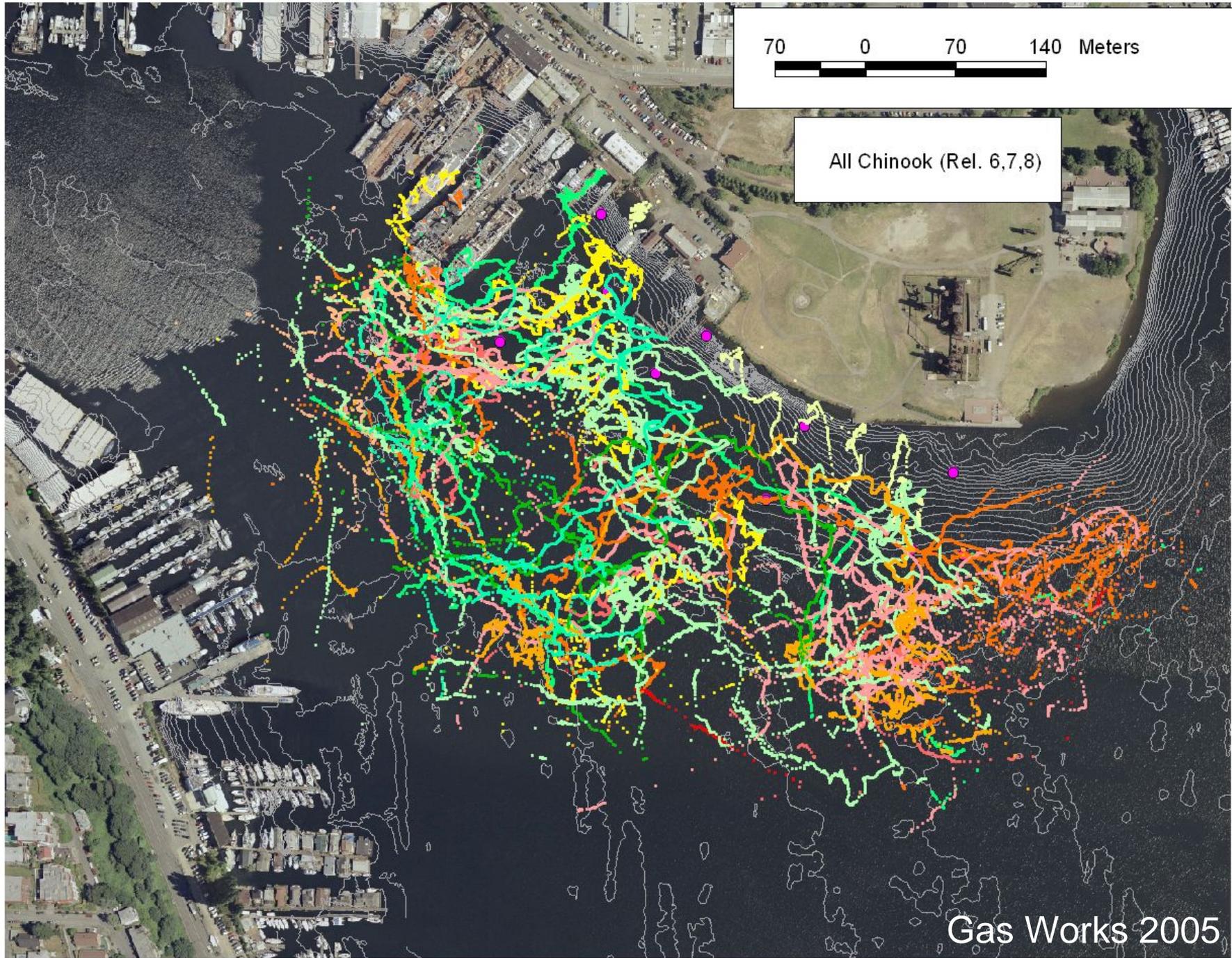
Tracking System

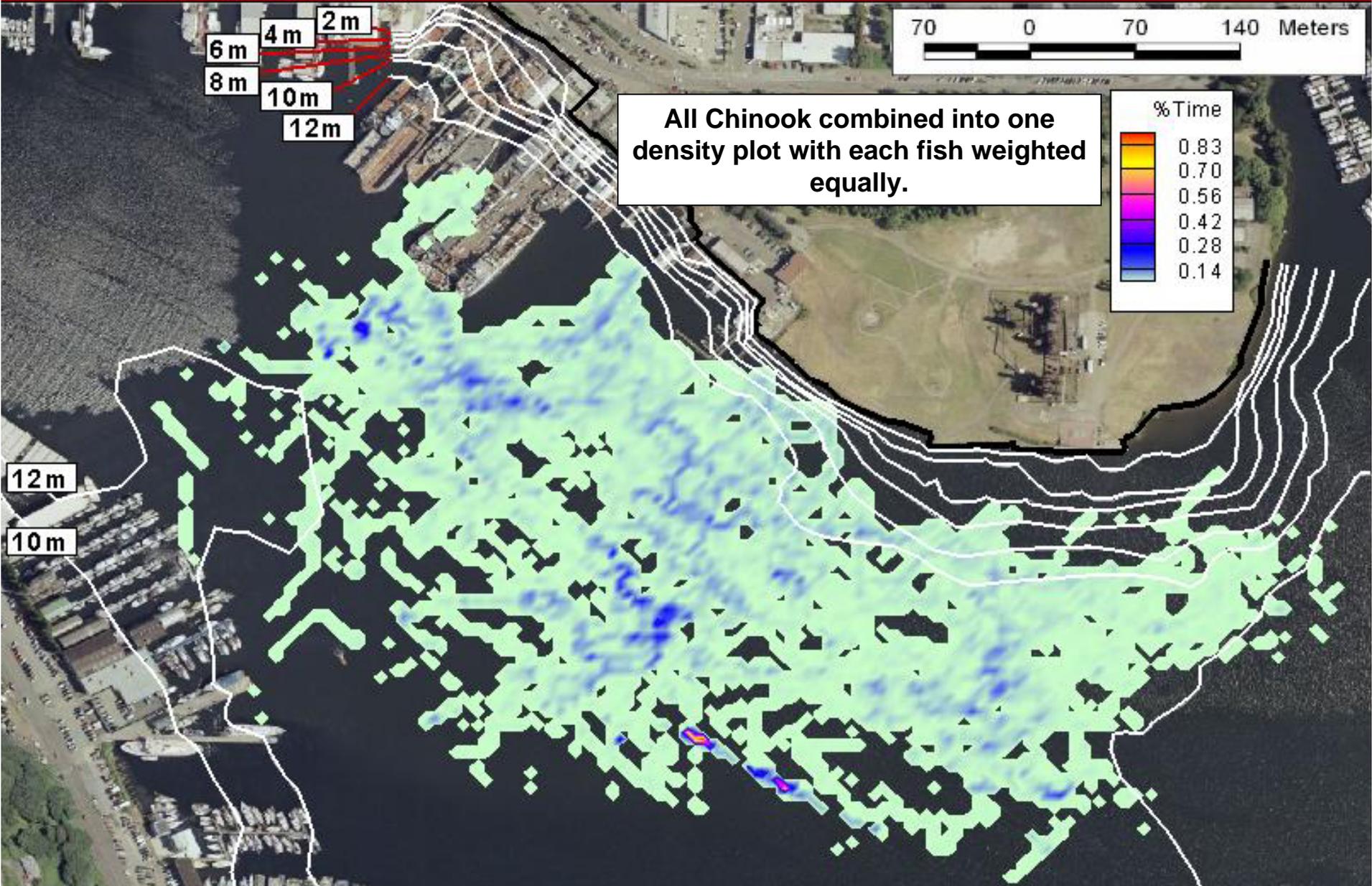
3. Track your fish





Example Chinook smolt track from Portage Bay





Acoustic Results

- Behavior very different between Lake Washington and the Ship Canal/Lake Union
- In Ship Canal, fish are widely distributed and not just along shoreline
- Chinook smolts use south Lake Union!
- Fish appear to spend longer periods of time in Lake Union (several days)
- Fish appear to hold/delay in Union Bay
- Predators associated with overwater structures, steep sloping shorelines, and edge of aquatic vegetation

Puget Sound Juvenile Chinook Habitat Use

Salmon come from the Duwamish, Lake WA, and other areas of Puget Sound

The Sound is used for rearing and migration



- Enter the Sound – May-July

Puget Sound Research: Conducted by UW Wetland Ecosystem Team

- Evaluate habitat use at different shoreline types
- Monitoring at the Olympic Sculpture Park



WET capturing fish

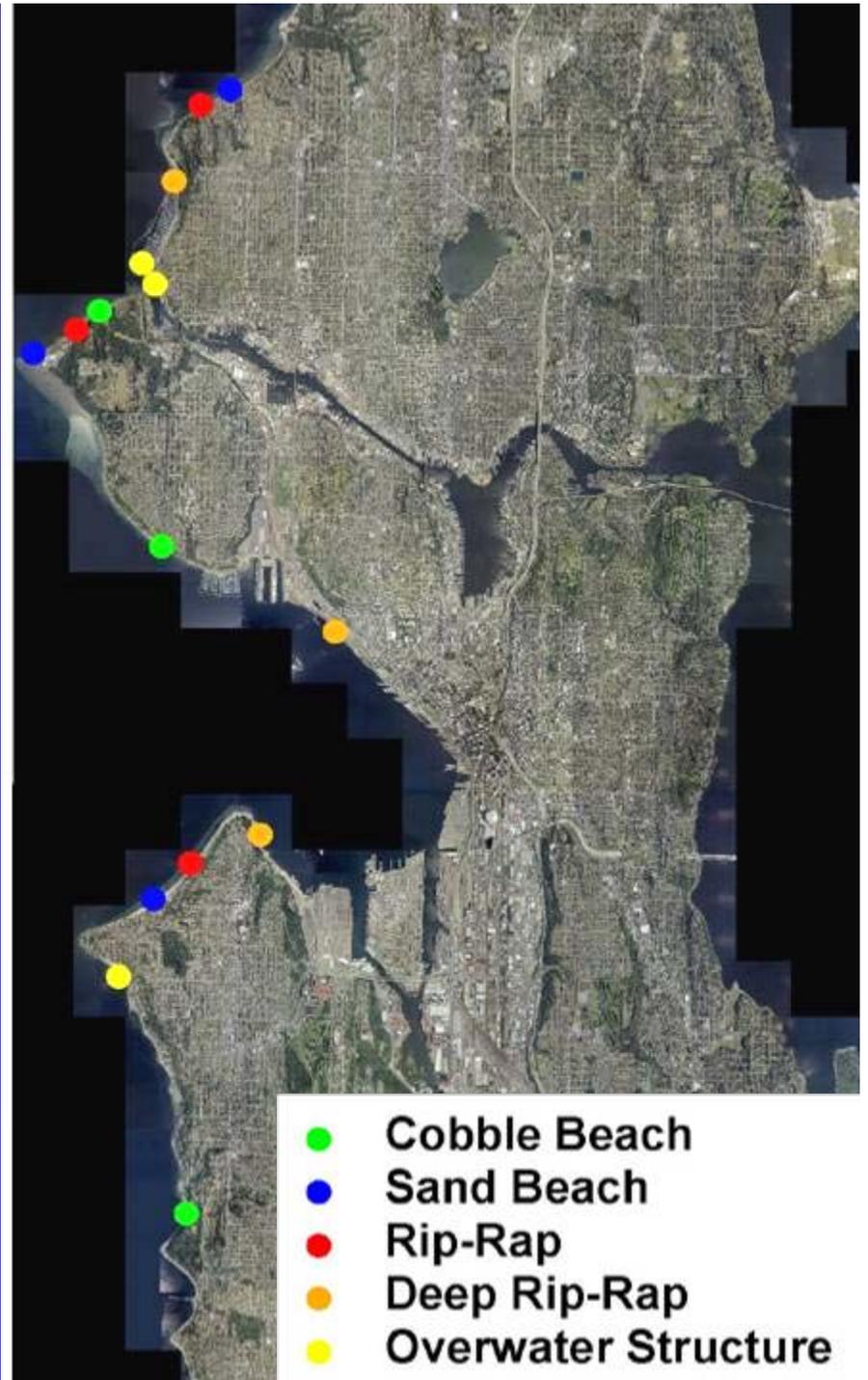


Jason Toft, UW WET

Quantify the abundance and behavior of juvenile salmon and other fish along shoreline habitats.



Courtesy J.
Toft, UW



Sampling Techniques

Typical beach seines can be problematic

...better for quantifying directly along shore, especially where modified



Enclosure Nets

- Sample entire water column
- Minimal problems with underwater obstacles
- Hold fish for a few hours, good for diet analysis

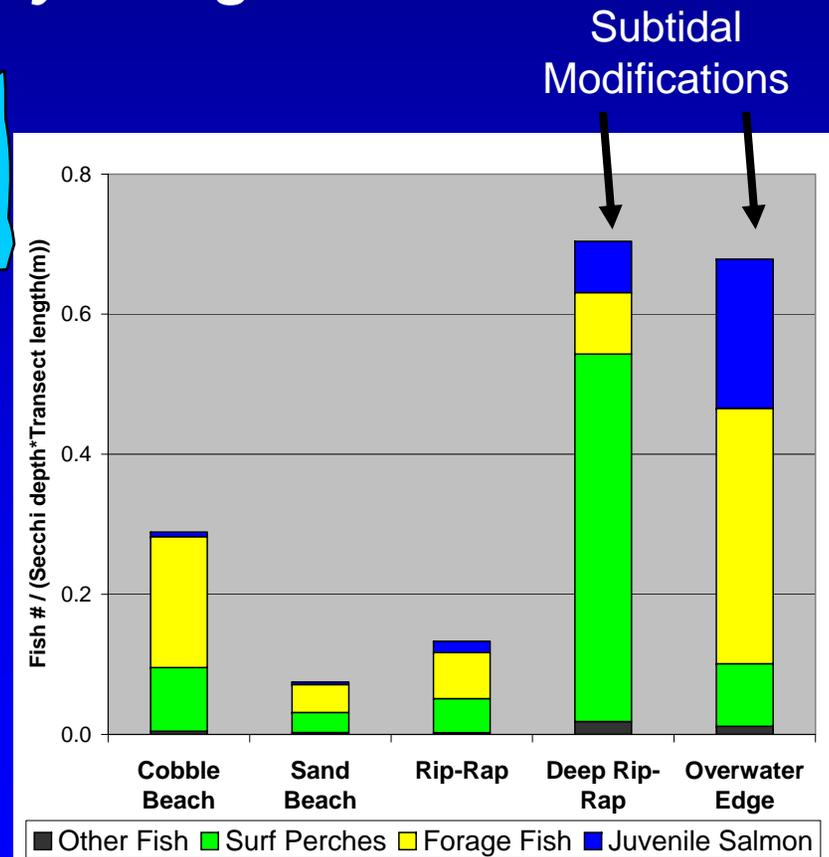
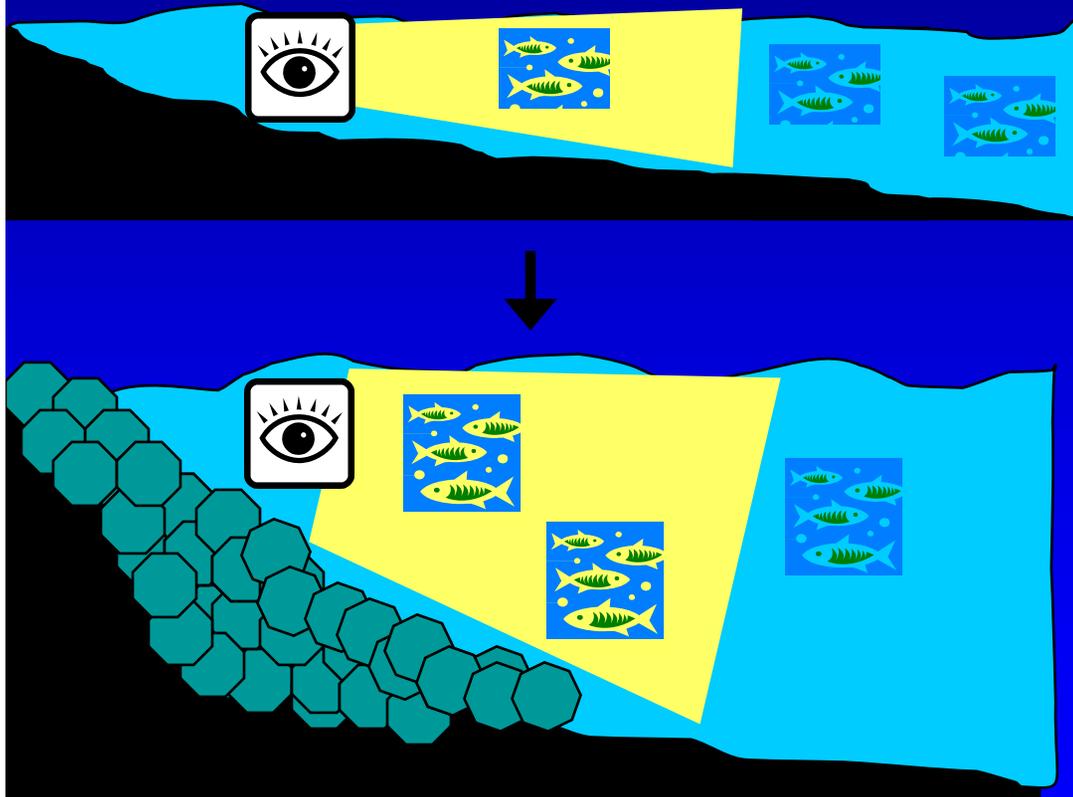


Snorkel Surveys

- Density, behavior, and location
- Fish not harmed
- Sample larval fish too small for nets

Shoreline modifications that extend into the intertidal zone make a large difference in fish distribution.

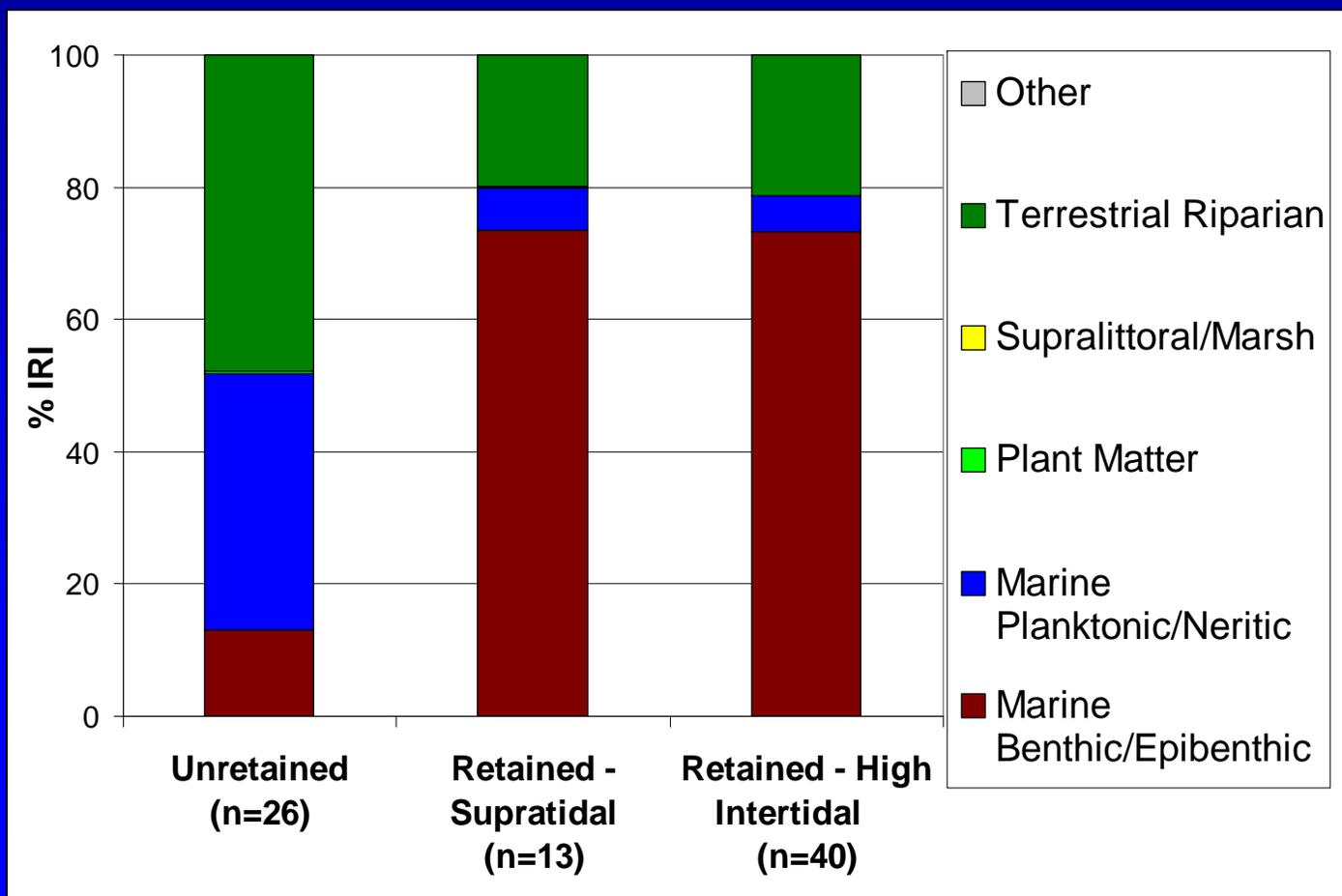
The modifications truncate shallow water habitat and force fish into deep waters directly along shore.



Toft et al. 2007. Fish distribution, abundance, and behavior along city shoreline types in Puget Sound. North American Journal of Fisheries Management 27:465-480.

Presence of any shoreline modification affects types of prey available for fish.

Juvenile Chinook diets shows less terrestrial/riparian input (insects) at modified sites.



Olympic Sculpture Park

Removal of shoreline modifications and enhancement of intertidal zone, with linkages to riparian habitat.



Before – 2005



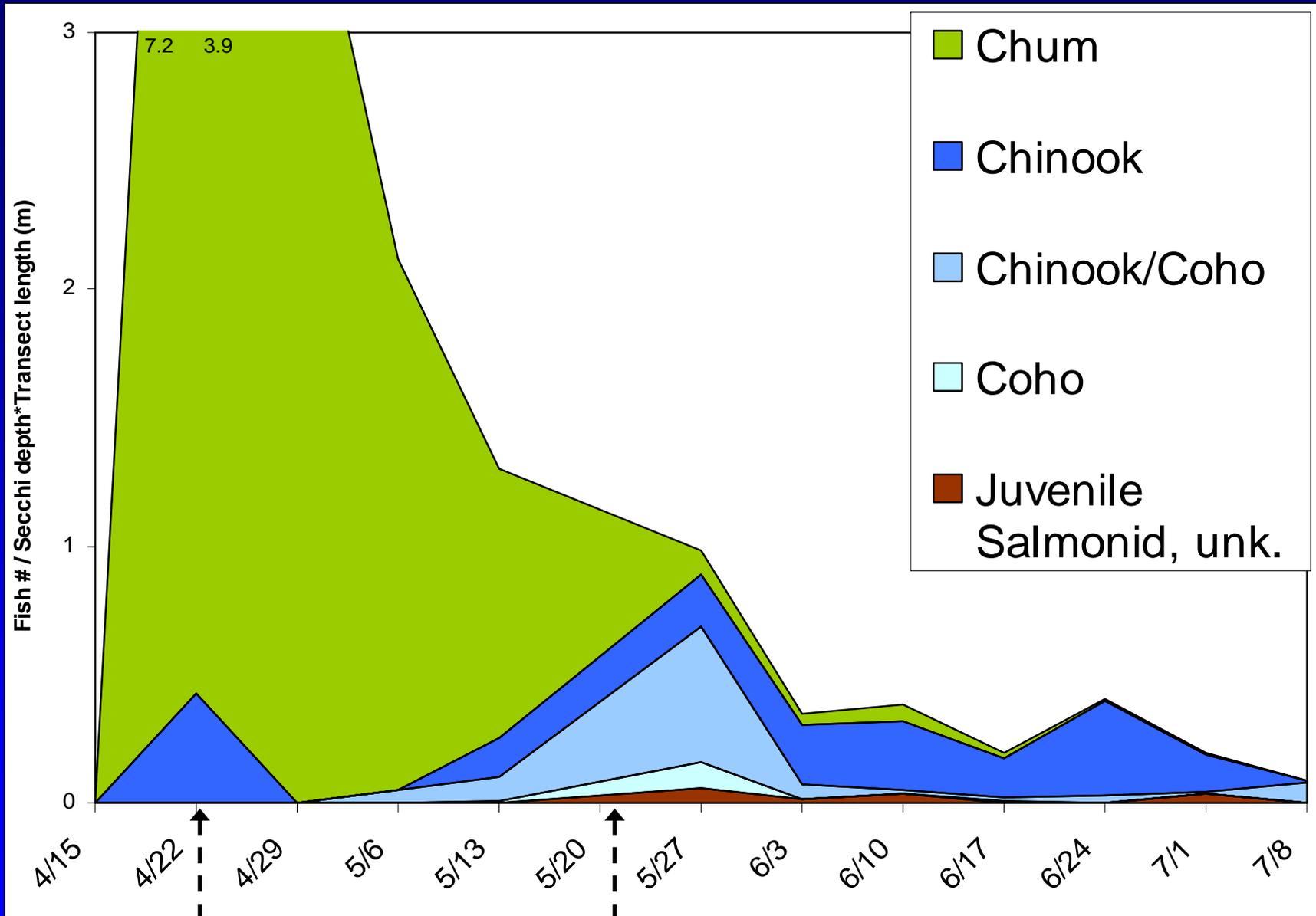
After – 2007

Pre and Post-Construction Monitoring:

1. Fish sampling with snorkel surveys.
2. Aquatic invertebrates.
3. Terrestrial insects.
4. Added in 2007: Vegetation, Fish netting, Beach.

Toft, J., J. Cordell, S. Heerhartz, E. Armbrust, A. Ogston, and E. Flemer. 2008. Olympic Sculpture Park: Results from Year 1 Post-construction Monitoring of Shoreline Habitats. Technical Report SAFS-UW-0801.

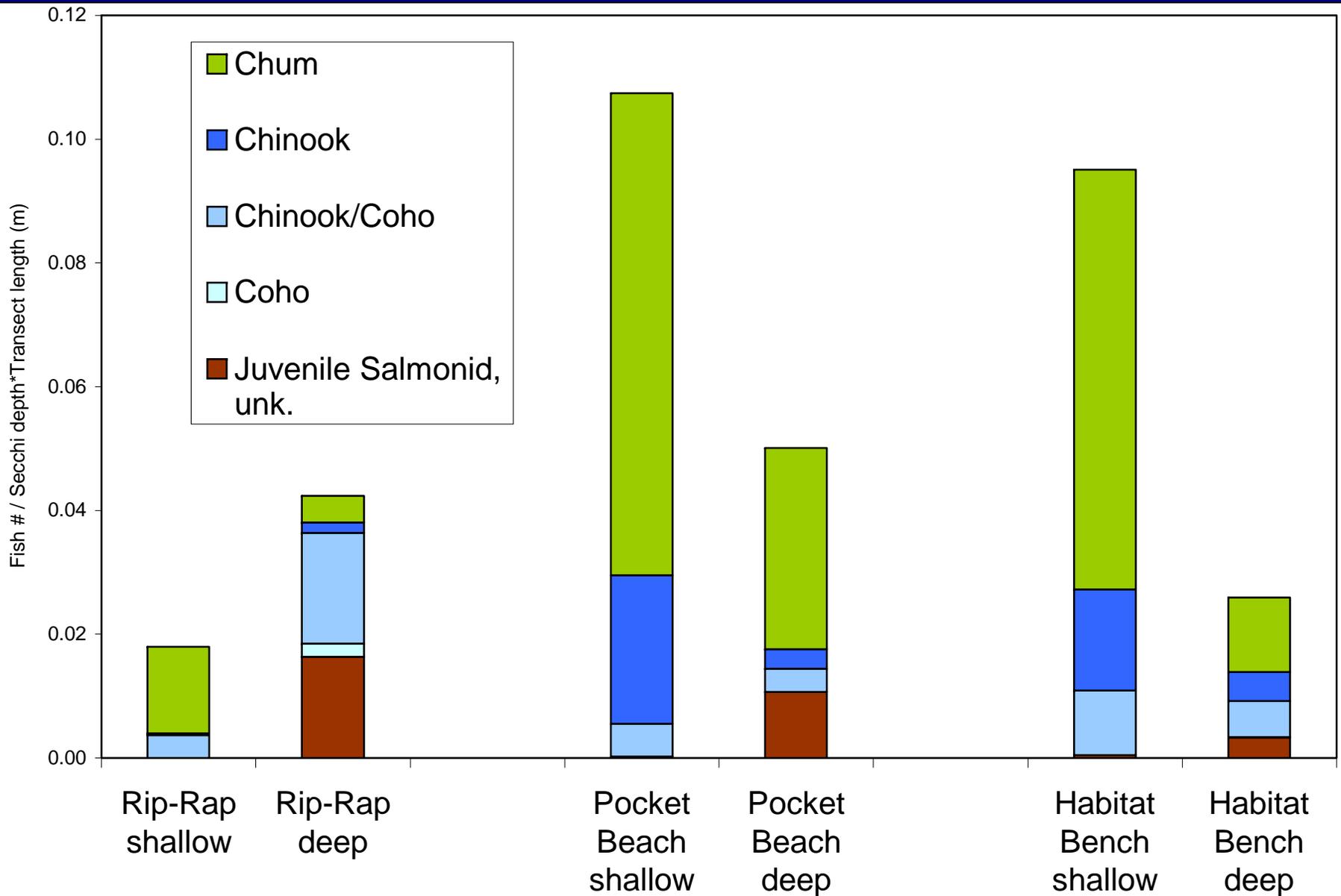
Juvenile Salmon Densities over time



Wild Chinook Fry

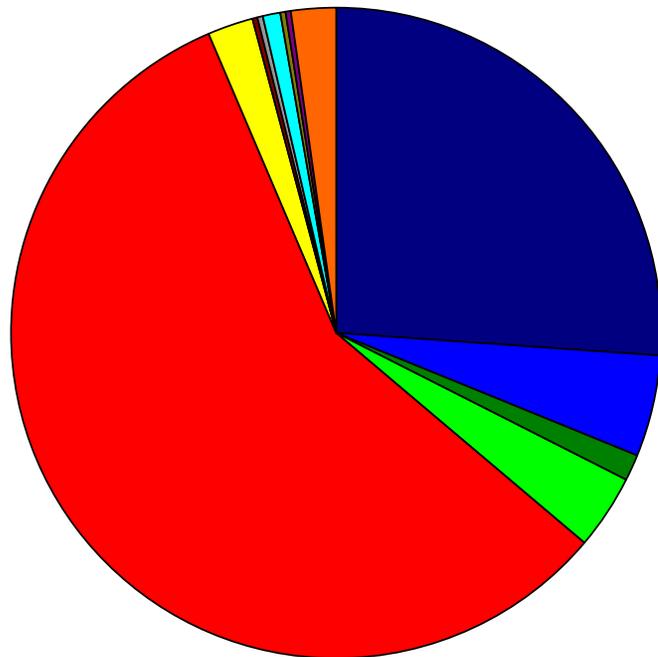
Soos Creek Hatchery Chinook Release

Juvenile salmon were more abundant in shallow water depths at Pocket Beach and Habitat Bench.



Fish Assemblage (2007)

**2007 Olympic Sculpture Park:
Fish % Composition at Pocket Beach
(n = 5; average 53 juvenile salmon)**

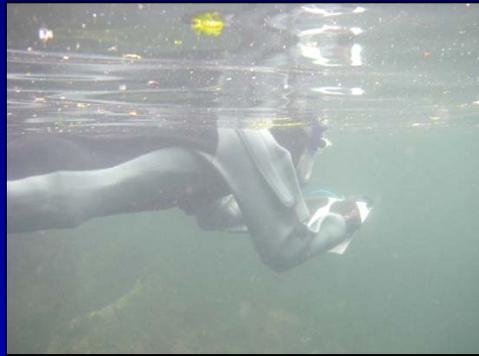


- Chinook (marked)
- Chinook (unmarked)
- Coho (marked)
- Coho (unmarked)
- Chum
- Shiner Perch
- Staghorn Sculpin
- Starry Flounder
- Pacific Sand Lance
- Sculpin, juv.
- Red Rock Crab
- Tidepool Sculpin



Sampling: More diversity, greater densities, available habitat?

Fish



Aquatic Invertebrates living on bottom substrates and algae



Invertebrates living within beach gravel



Sampling: Beach and vegetation development.

Terrestrial Insects



Aquatic Algae



Vegetation



A few overall conclusions...

- Shoreline modifications – armoring and overwater structures – affect fish behavior and distribution and prey availability
- Increases vulnerability to predation and reduces feeding success – lower survival
- Reduce impacts: reduce overwater structures, allow more light underneath, keep armoring above the intertidal zone

A photograph of a small, slender fish with a yellowish-gold body and a dark lateral stripe, swimming against a black background. The fish is positioned horizontally, facing left. Above its head, a series of three white circles of increasing size lead to a large, white, cloud-shaped thought bubble. Inside the bubble, the text "I could have sworn that pocket beach was around here somewhere" is written in a simple, black, sans-serif font.

I could have sworn
that pocket beach was
around here somewhere