

# **Behavior of Chinook salmon smolts and smallmouth bass near overwater structures in Lake Washington**

**Presentation to the Summer Shoreline Planners Coordination Meeting, Tukwila Community Center, July 24, 2008**



**Mark Celedonia & Roger Tabor  
U.S. Fish and Wildlife Service**

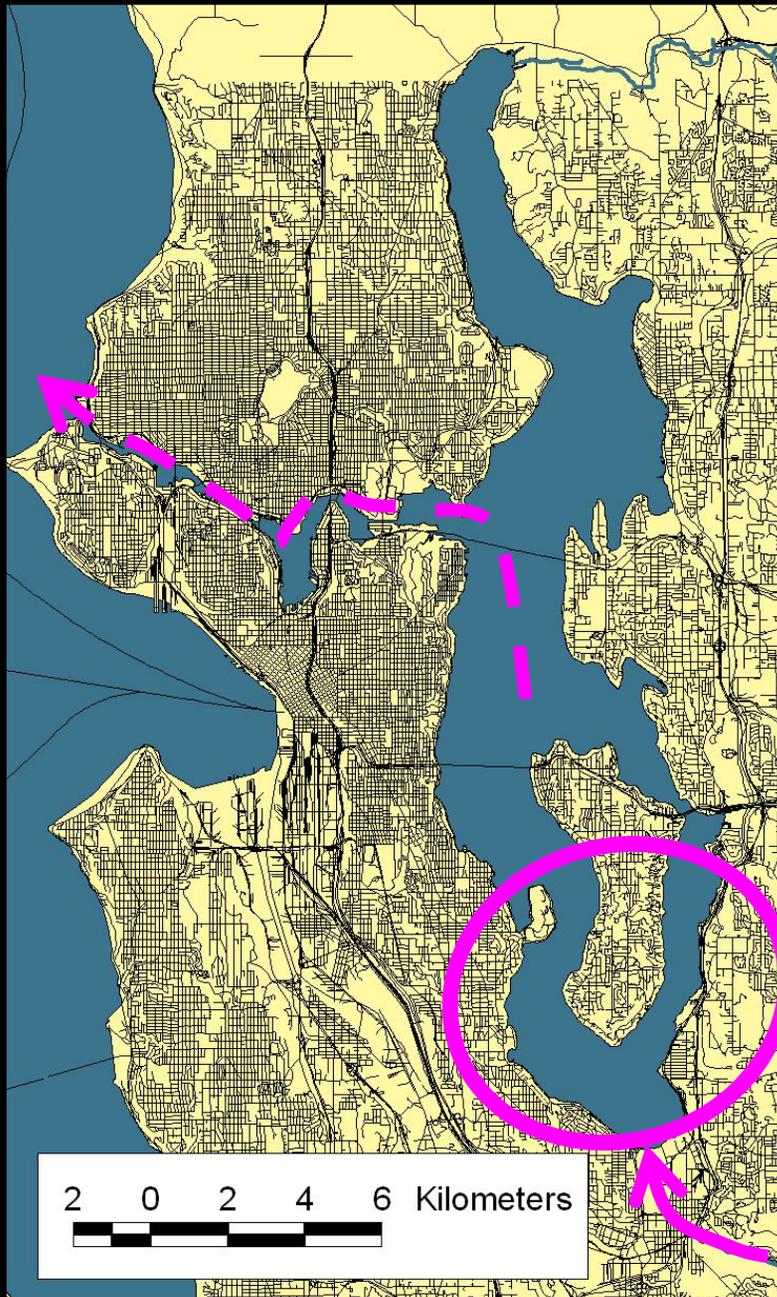
## **2 COMPLIMENTARY METHODS:**

- **VISUAL DOCK OBSERVATIONS**
- **FINE-SCALE ACOUSTIC TRACKING**

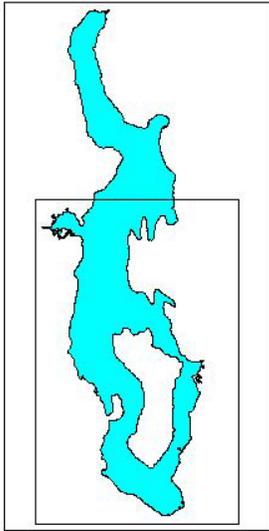
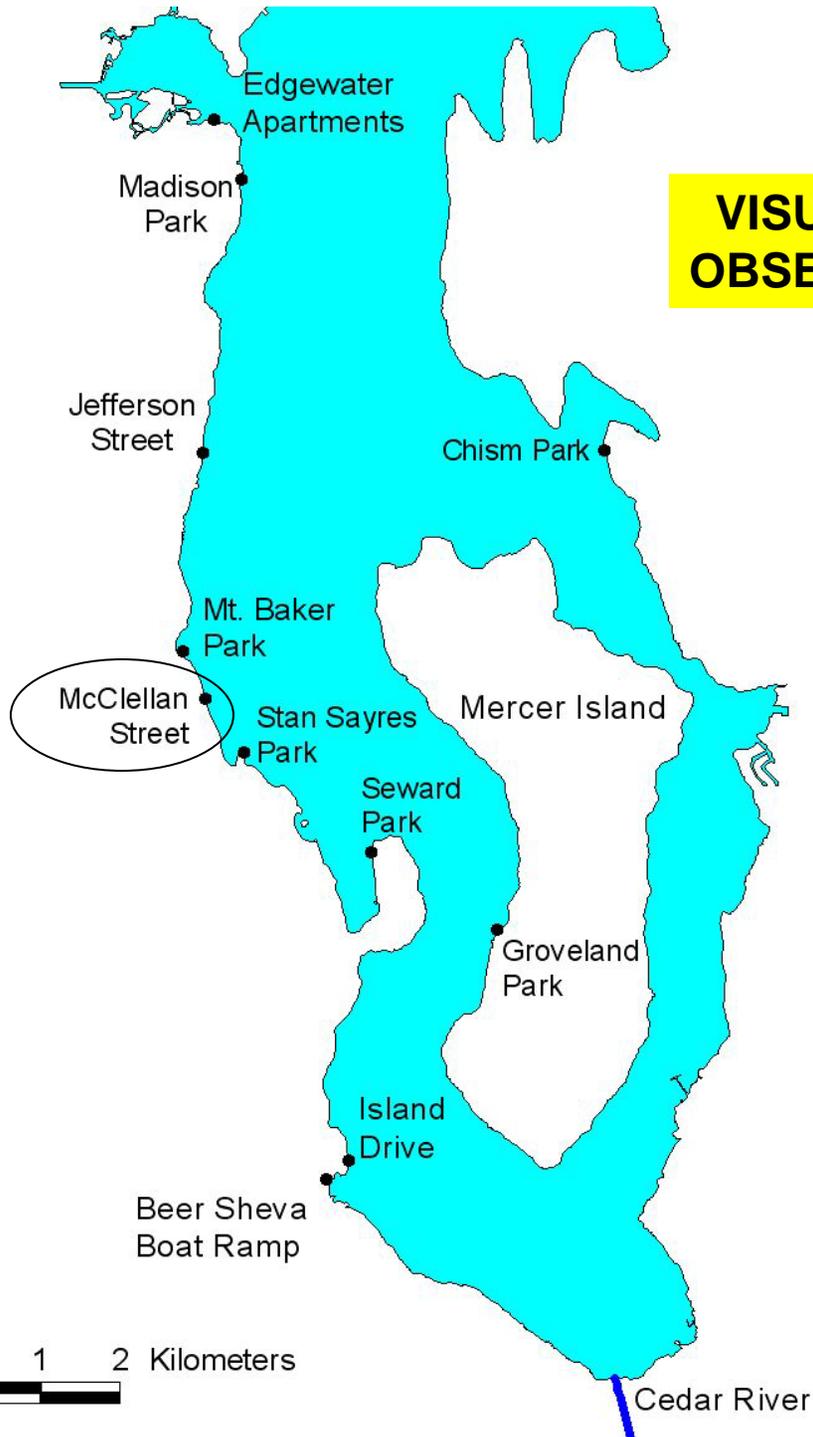
# Background

## Juvenile Chinook

- February: peak outmigration from Cedar R.
- Feb. – mid-May: inhabit nearshore area
  - shallow water (< 1 m)
  - gentle slope
  - small substrate
- mid-May thru June:
  - move into deeper water
  - habitat use???
  - movement patterns???



# VISUAL DOCK OBSERVATIONS

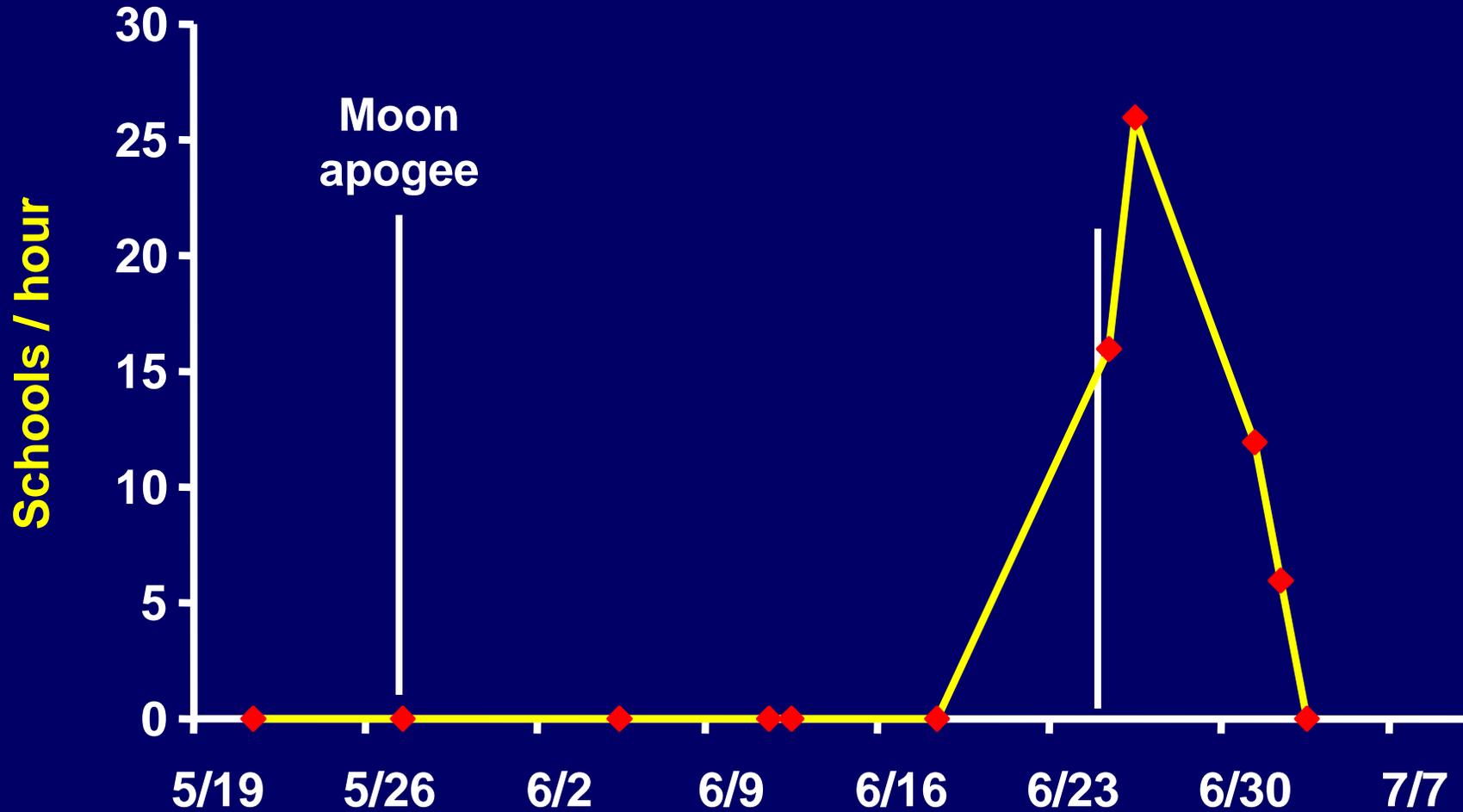


1 0 1 2 Kilometers

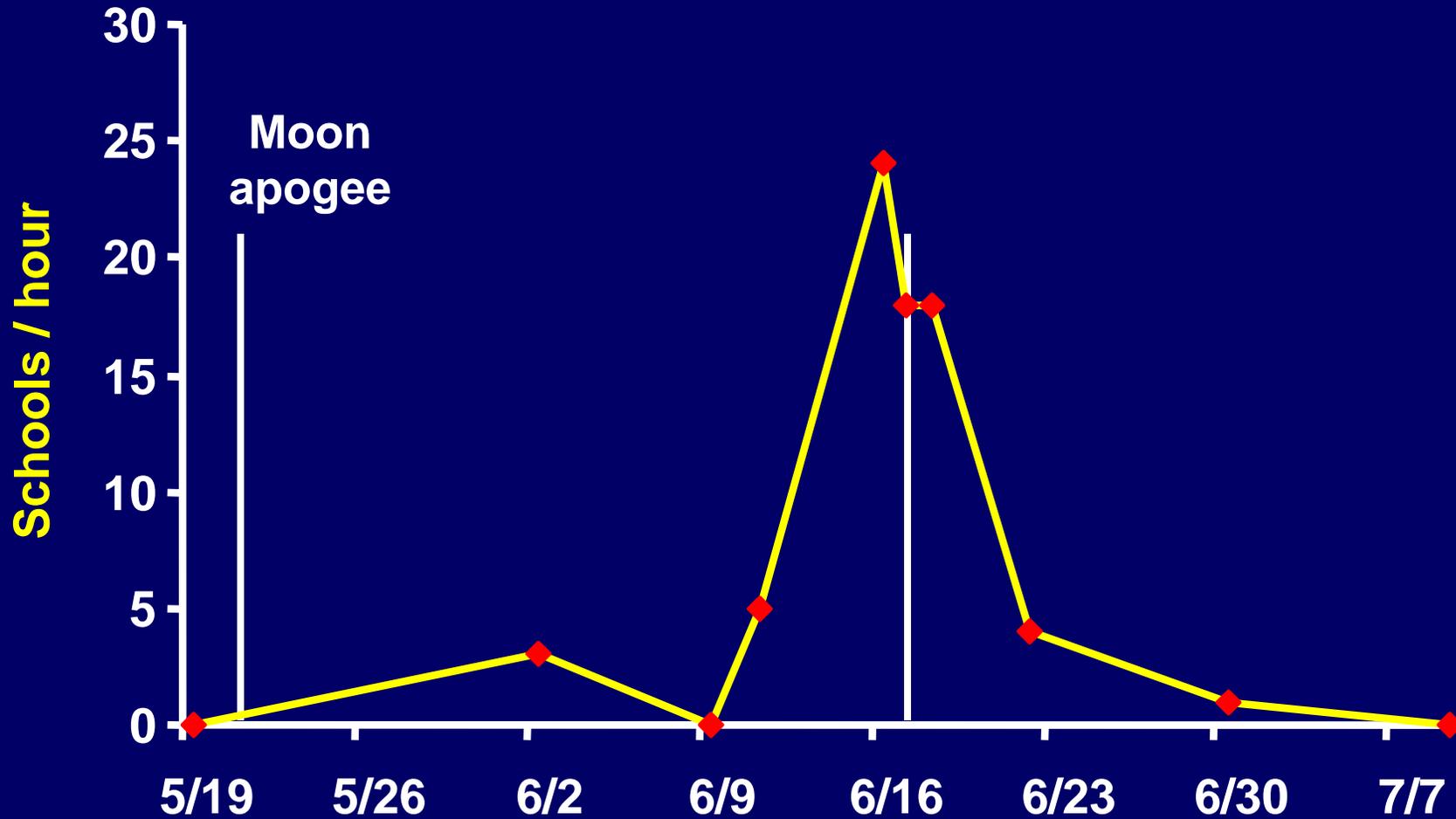
**School of Chinook salmon smolts  
migrating along the western shore of Lake  
Washington as observed from a boat dock**



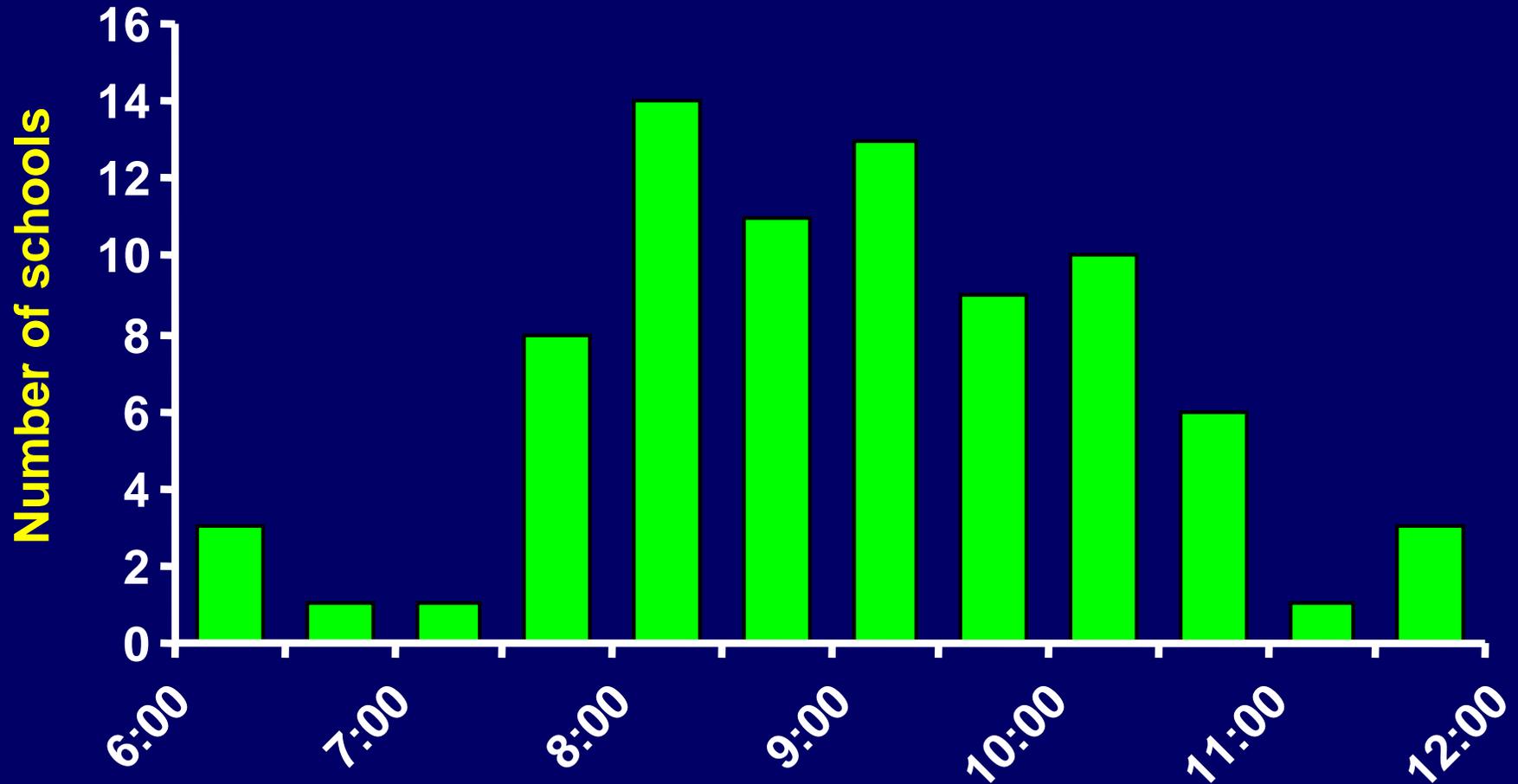
# McClellan Pier, 2003



# McClellan Pier, 2004

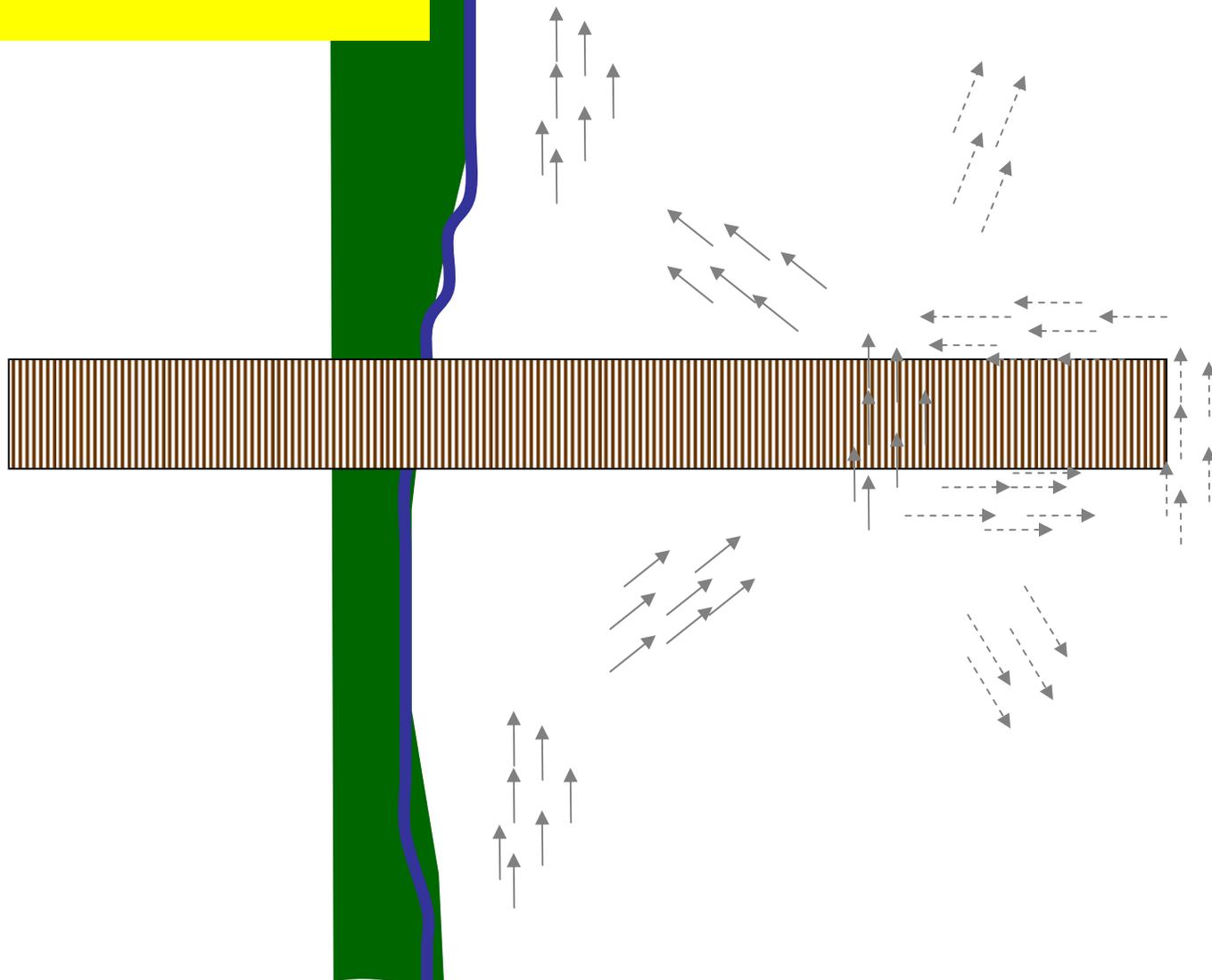


# McClellan Pier – June 16, 2004



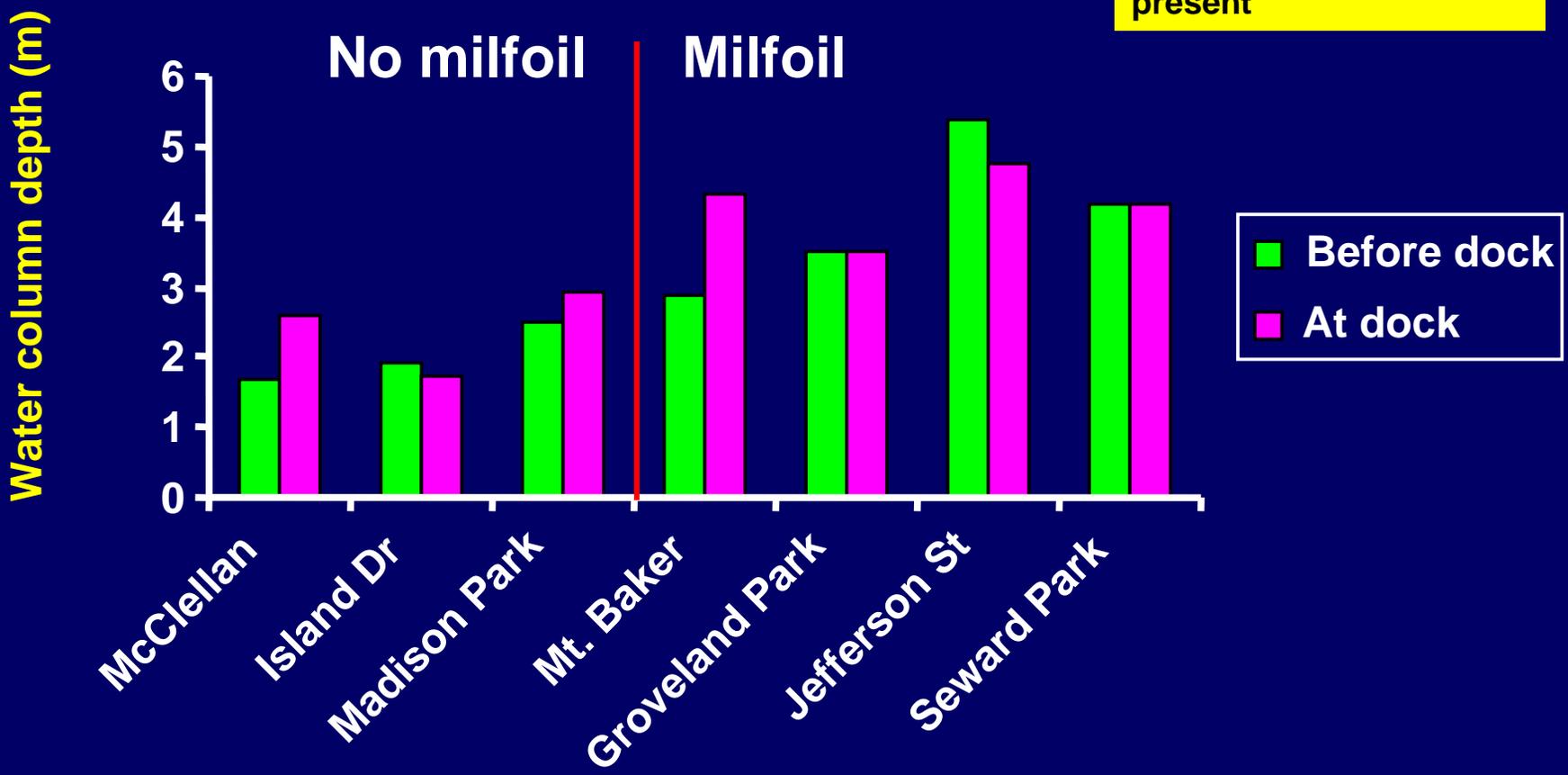
**Commonly observed behaviors of Chinook schools at boat docks:**

- 1. Move to deeper water prior to swimming under structure**
- 2. Swim completely around the perimeter of the structure**
- 3. Return to shallower water once beyond the structure**



# Visual observations, 2003 and 2004

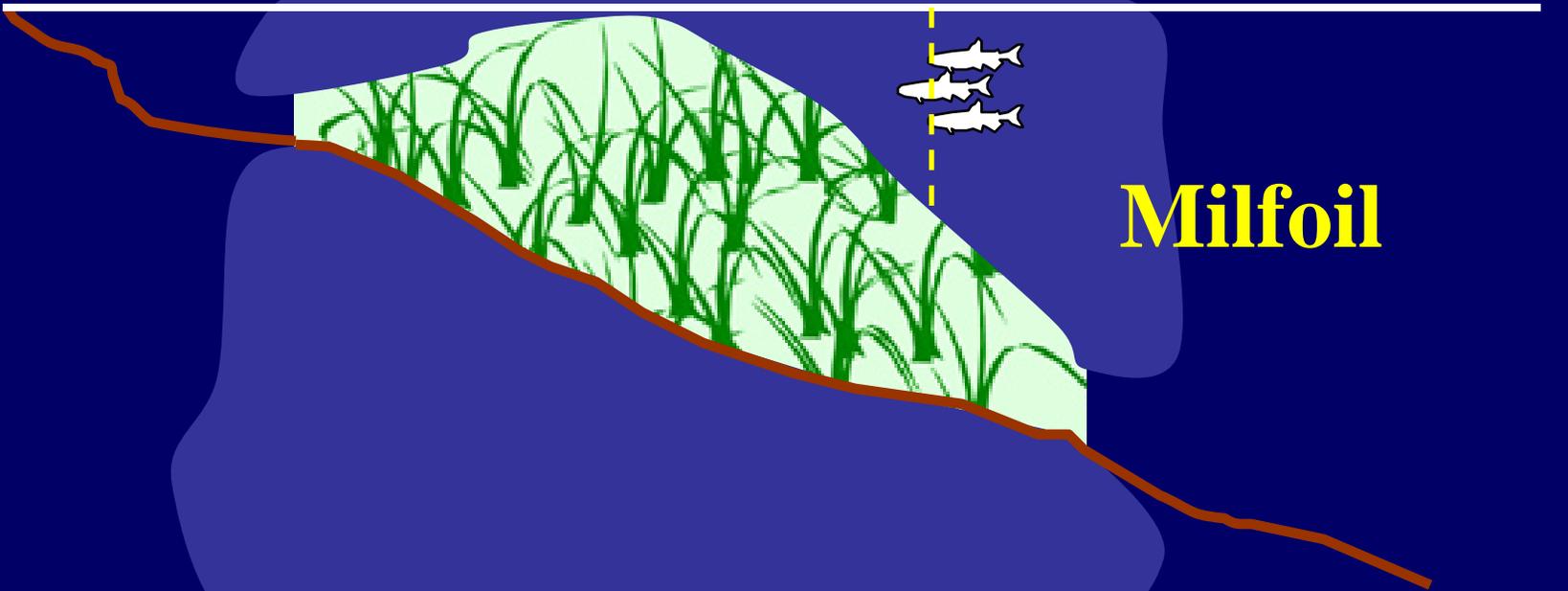
Chinook use deeper water when milfoil is present





**No milfoil**

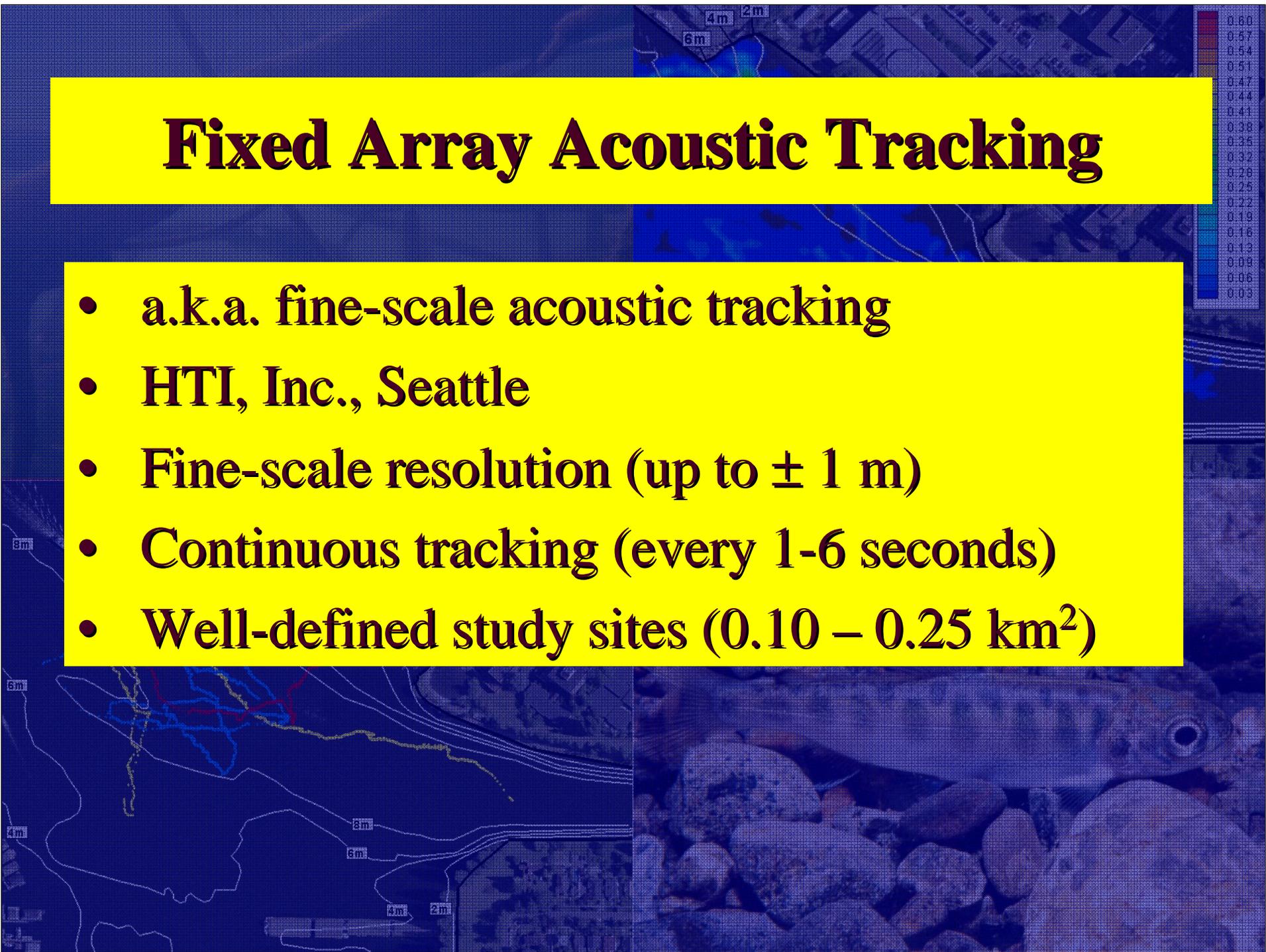
Milfoil functions as a  
false bottom that  
Chinook swim above



**Milfoil**

# Fixed Array Acoustic Tracking

- a.k.a. fine-scale acoustic tracking
- HTI, Inc., Seattle
- Fine-scale resolution (up to  $\pm 1$  m)
- Continuous tracking (every 1-6 seconds)
- Well-defined study sites (0.10 – 0.25 km<sup>2</sup>)

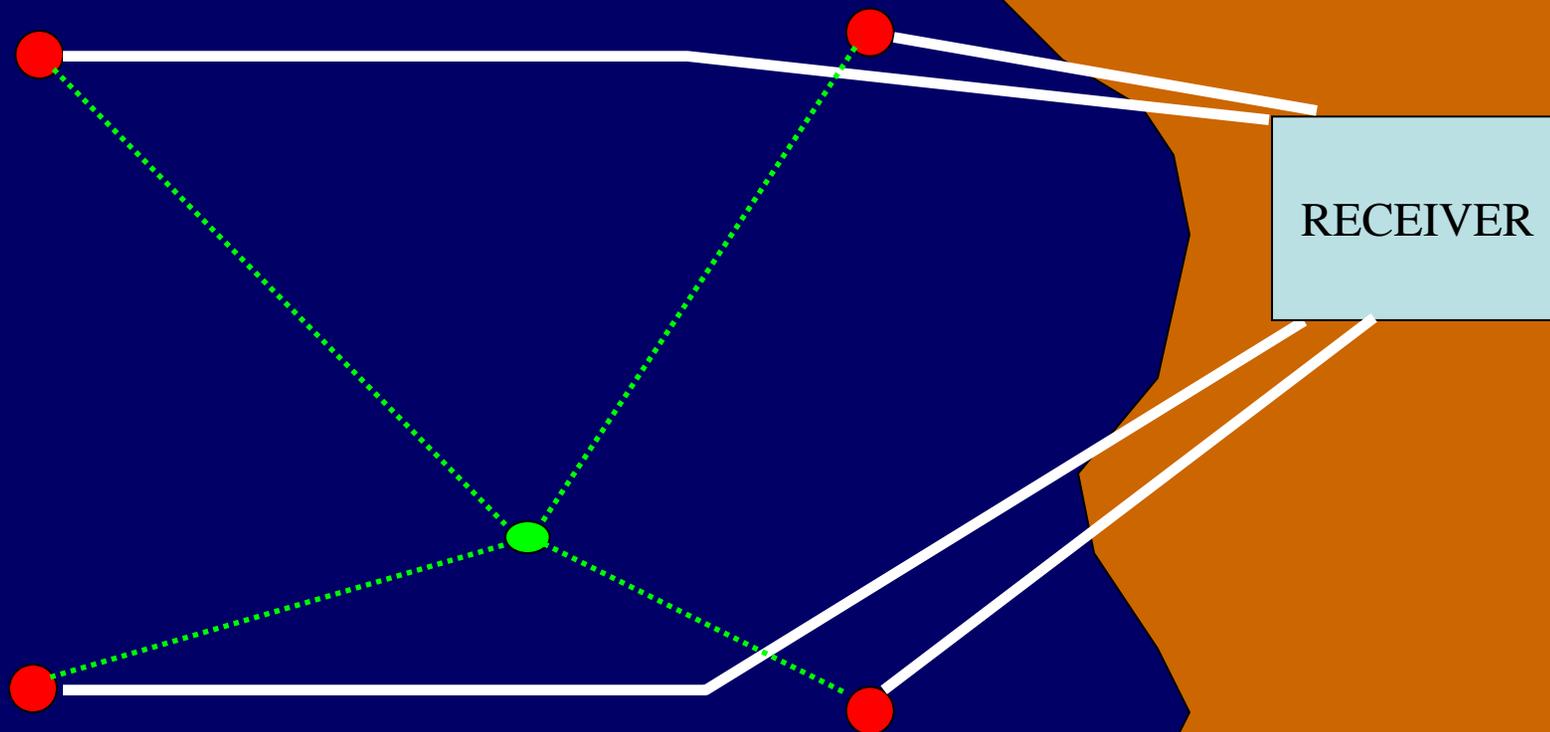


# Simplified System Schematic

“The array”:

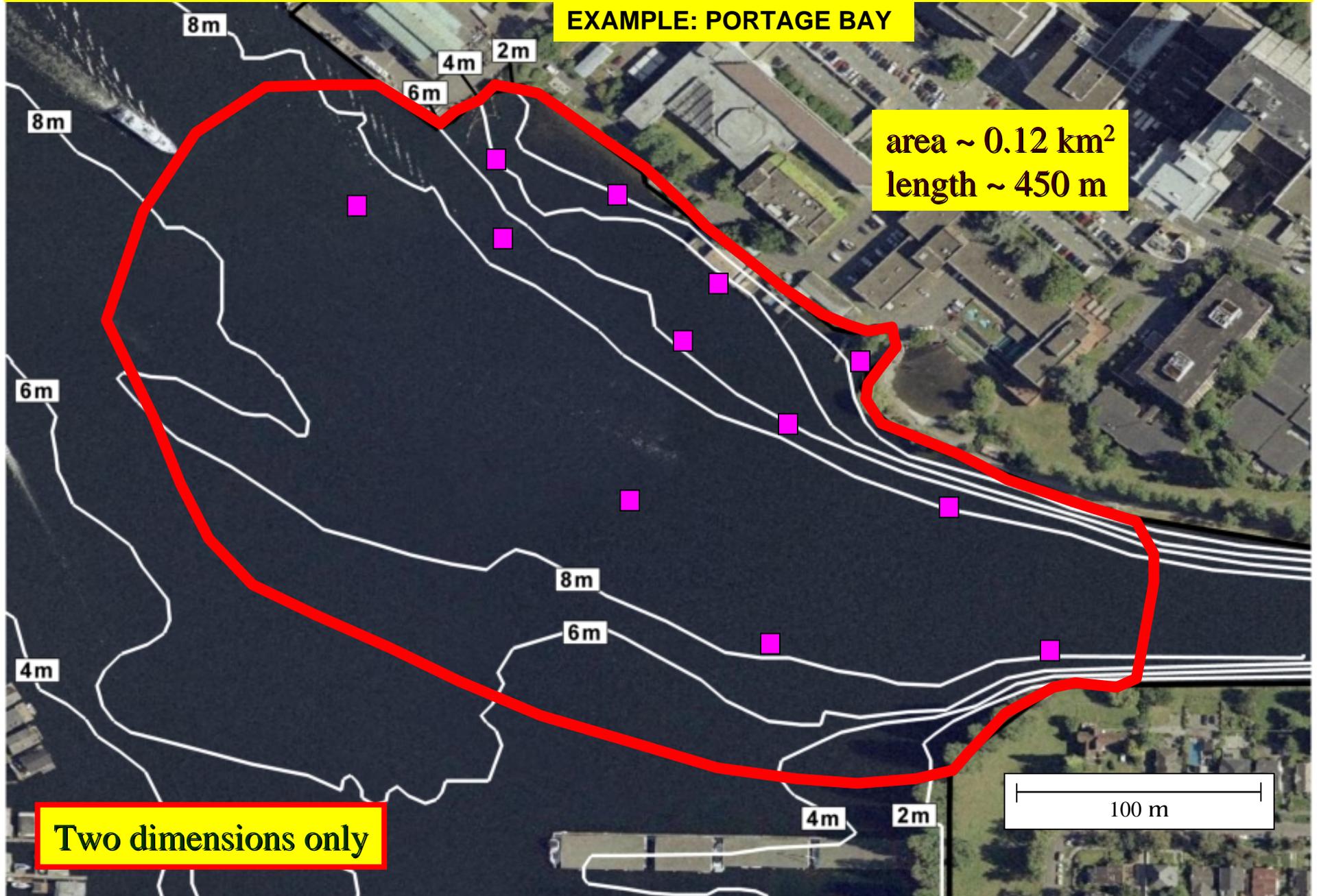
$\geq 4$  hydrophones

$< 100\text{-}150$  m between hydrophones



# Hydrophone Positions & Coverage Area

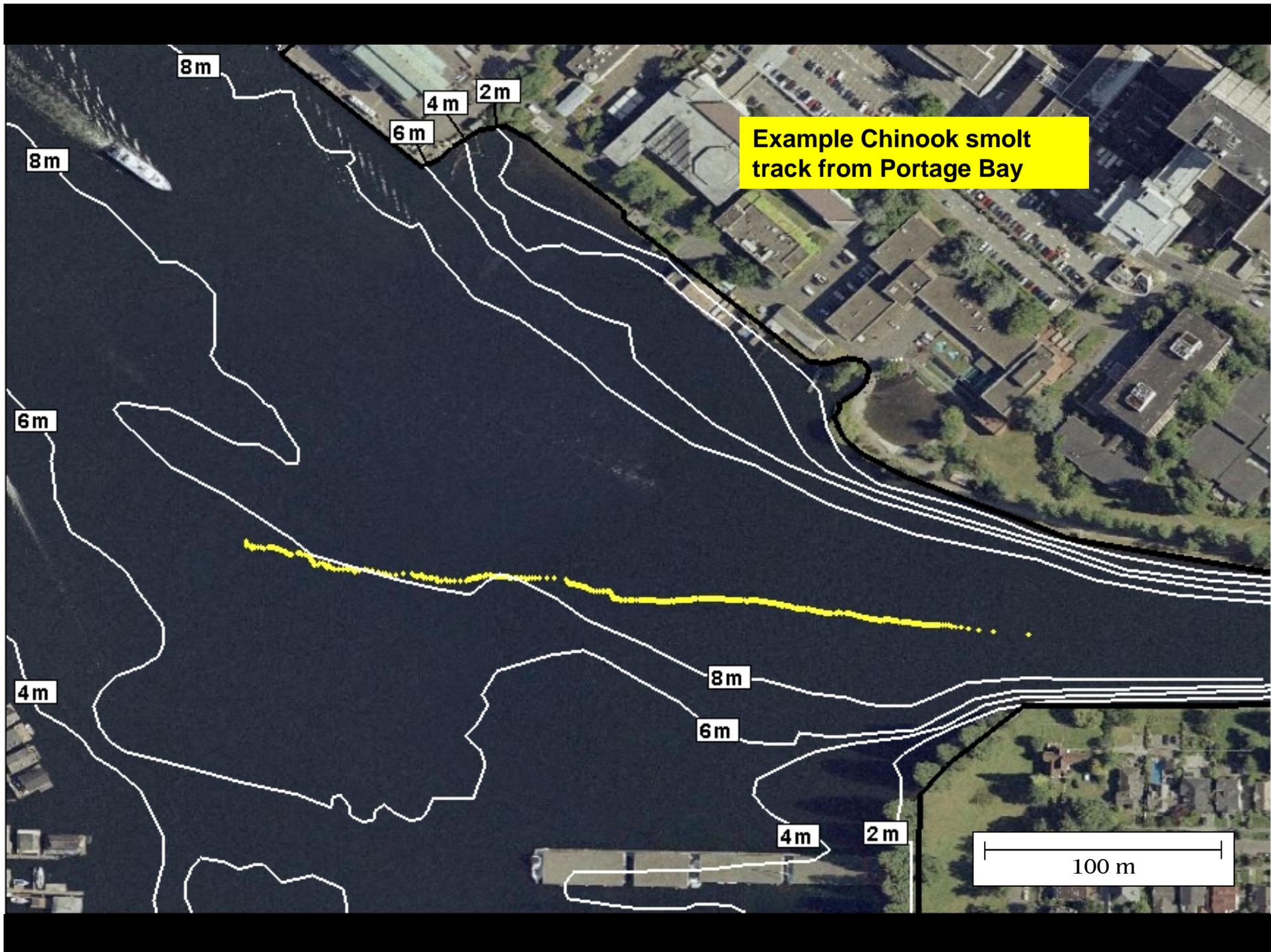
EXAMPLE: PORTAGE BAY



area ~ 0.12 km<sup>2</sup>  
length ~ 450 m

100 m

Two dimensions only



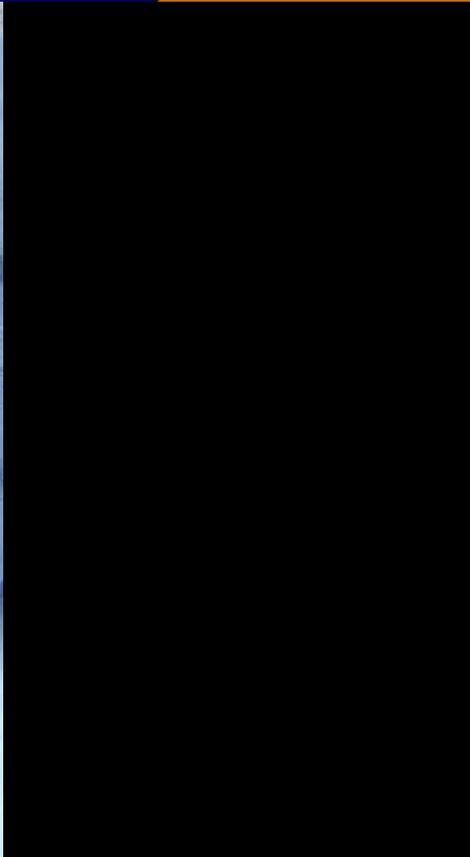
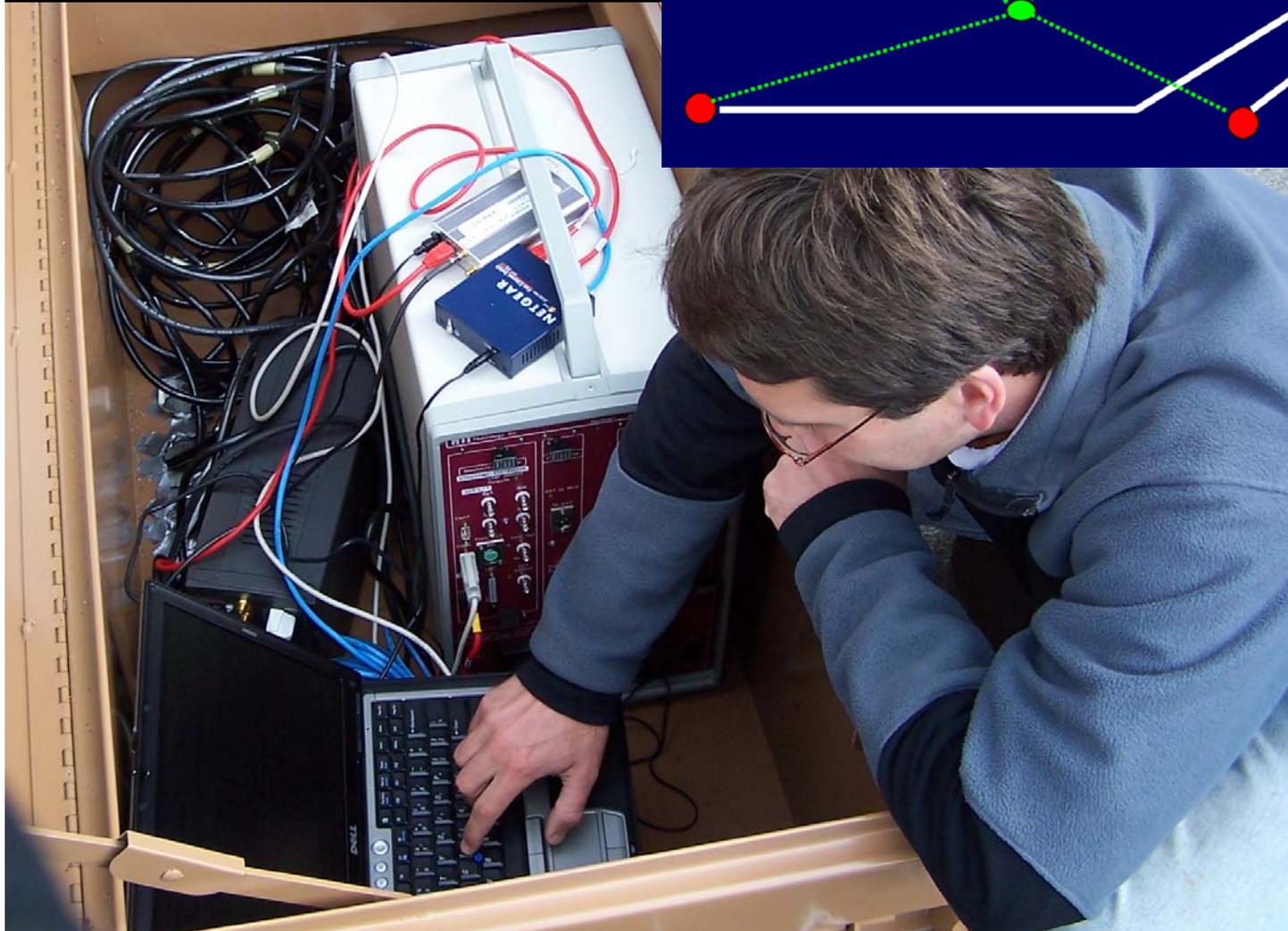
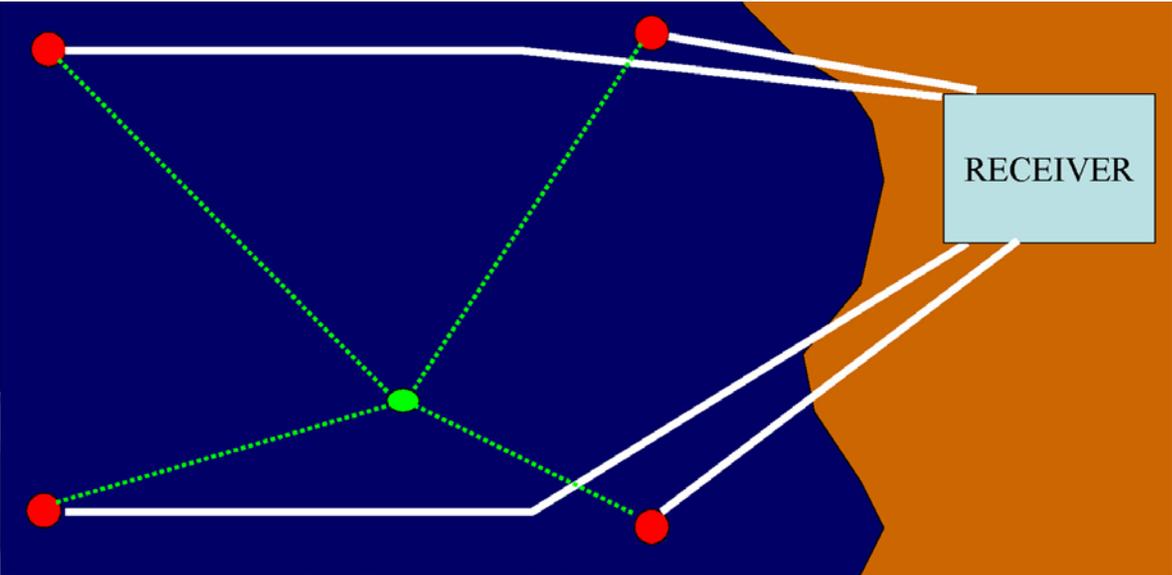
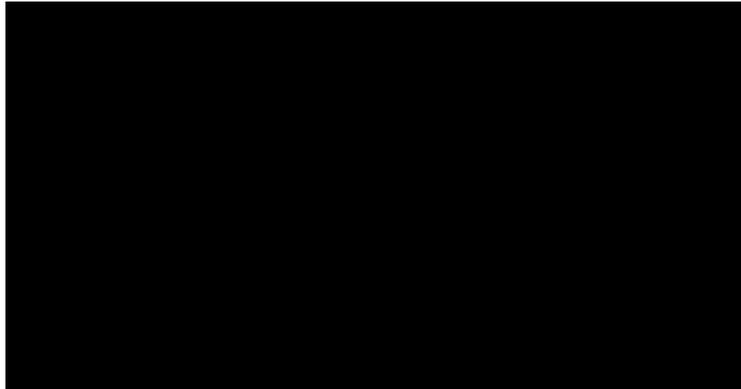
# Micro-Acoustic Tag

- 16.4 mm long x 6.7 mm diameter
- weight = 0.65 g in air
- emits signal every 1-6 seconds
- ~10-14 day tag life
- predator tags larger, last longer
- implant in fish
  - surgical
  - gastric (stomach)



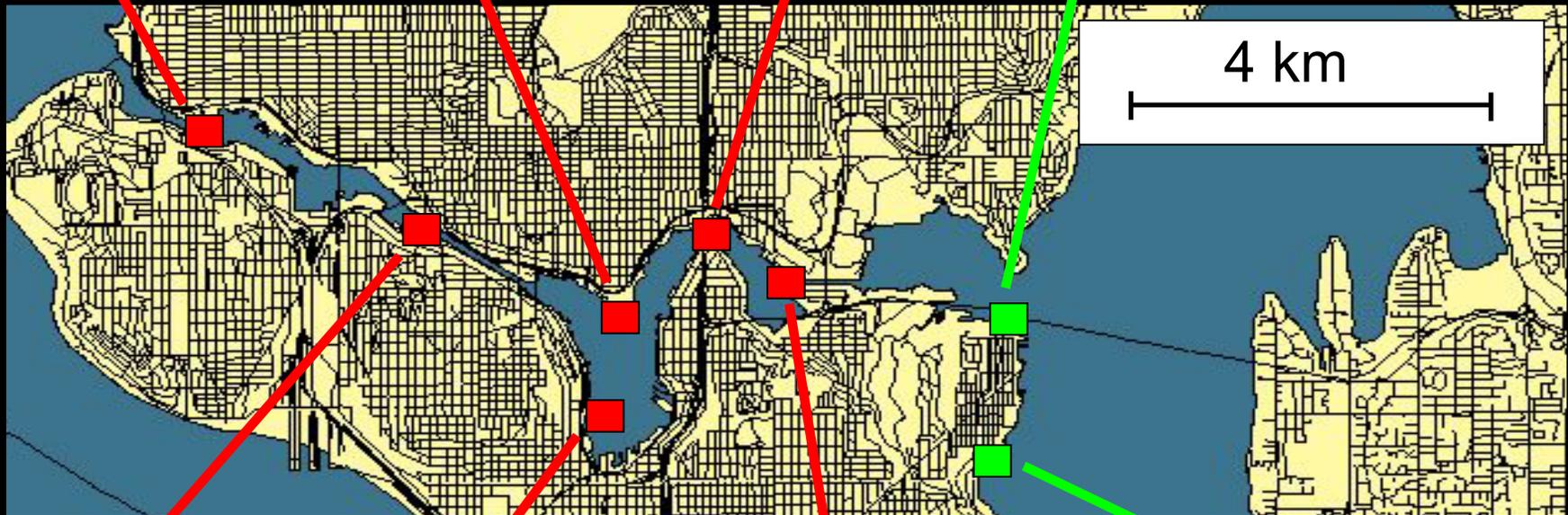
# Inserting the tag





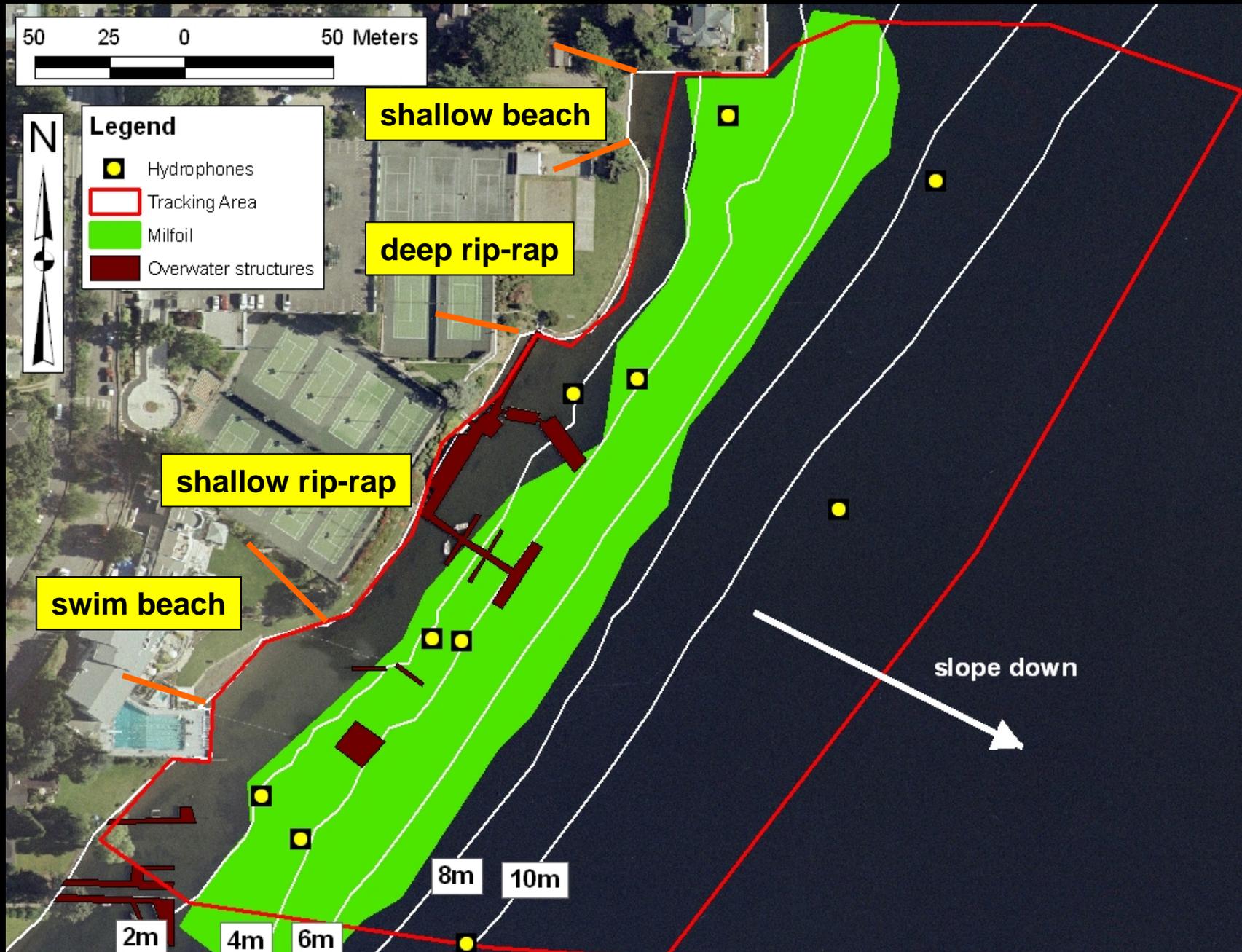
# 2004 - 2008 Study Sites

**Ballard Locks** 2006-2008  
**N. Lake Union** 2005-2008  
**University & 15 Bridges** 2006-2008  
**520 Bridge** 2007-2008



**Fremont Cut** 2007-2008  
**S. Lake Union** 2006-2008  
**Portage Bay** 2004-2005  
**Seattle Tennis Club** 2005

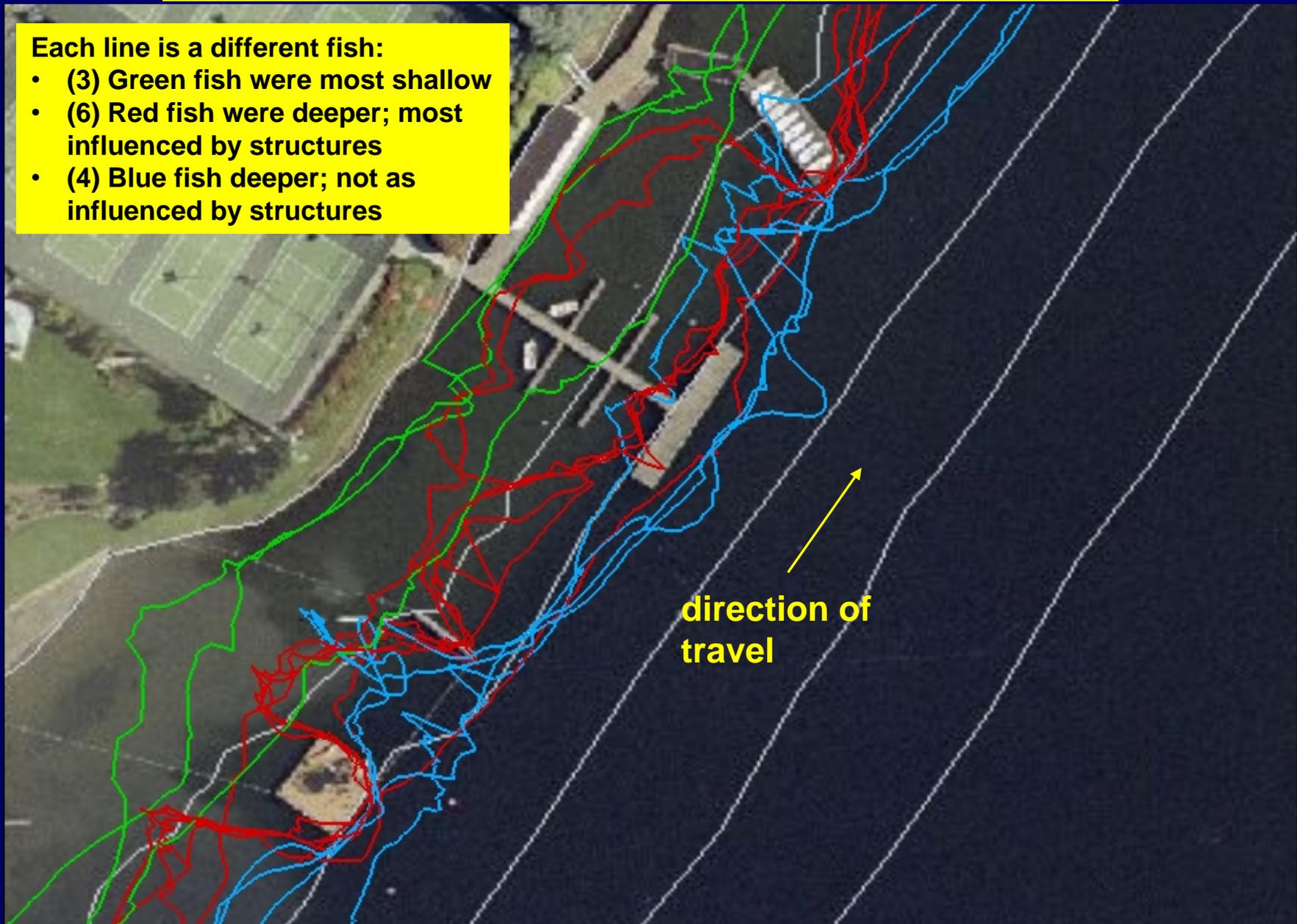
# Seattle Tennis Club (2005)



# Behavior around structures Tennis Club

Each line is a different fish:

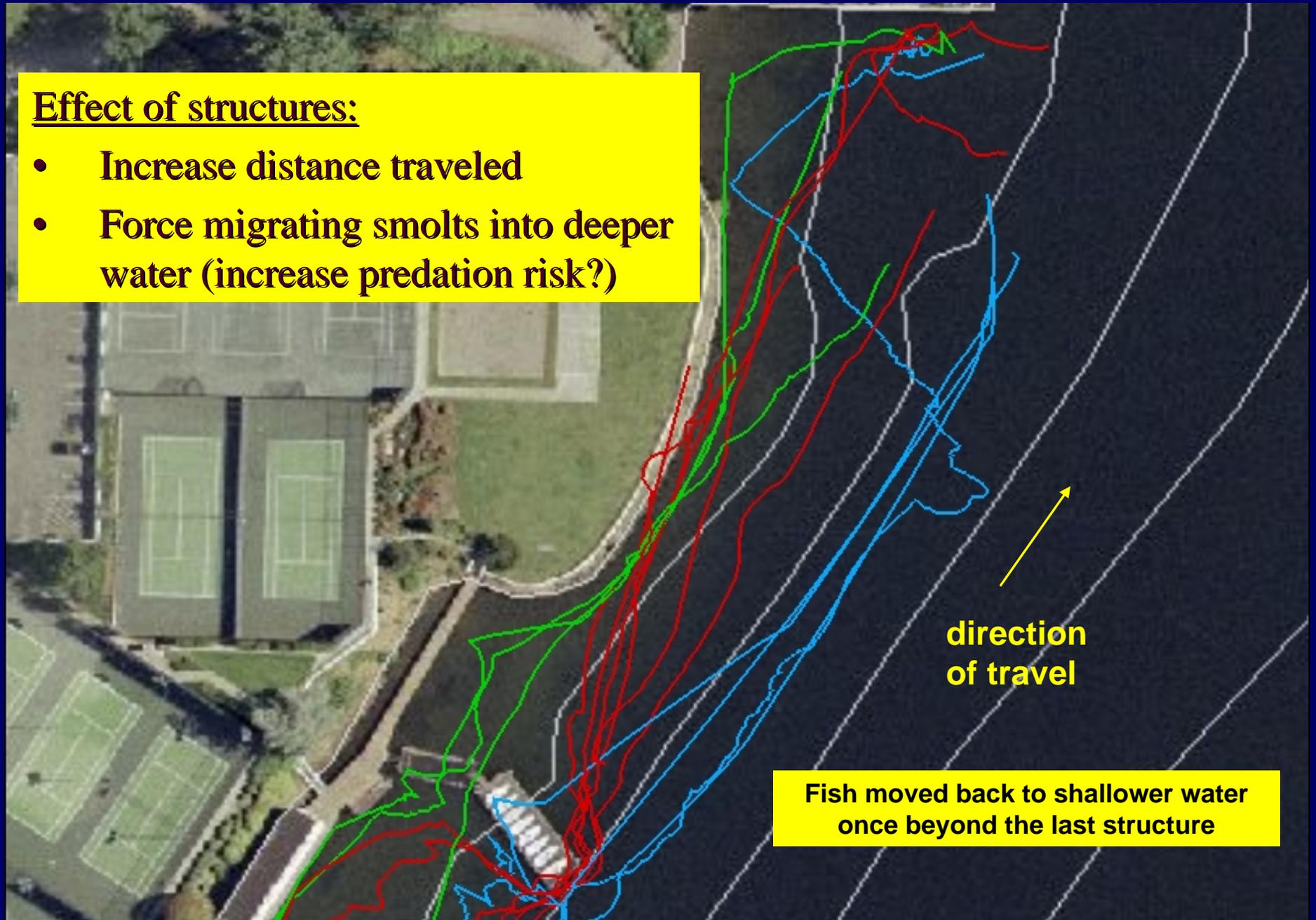
- (3) Green fish were most shallow
- (6) Red fish were deeper; most influenced by structures
- (4) Blue fish deeper; not as influenced by structures



# Tennis Club

## Effect of structures:

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

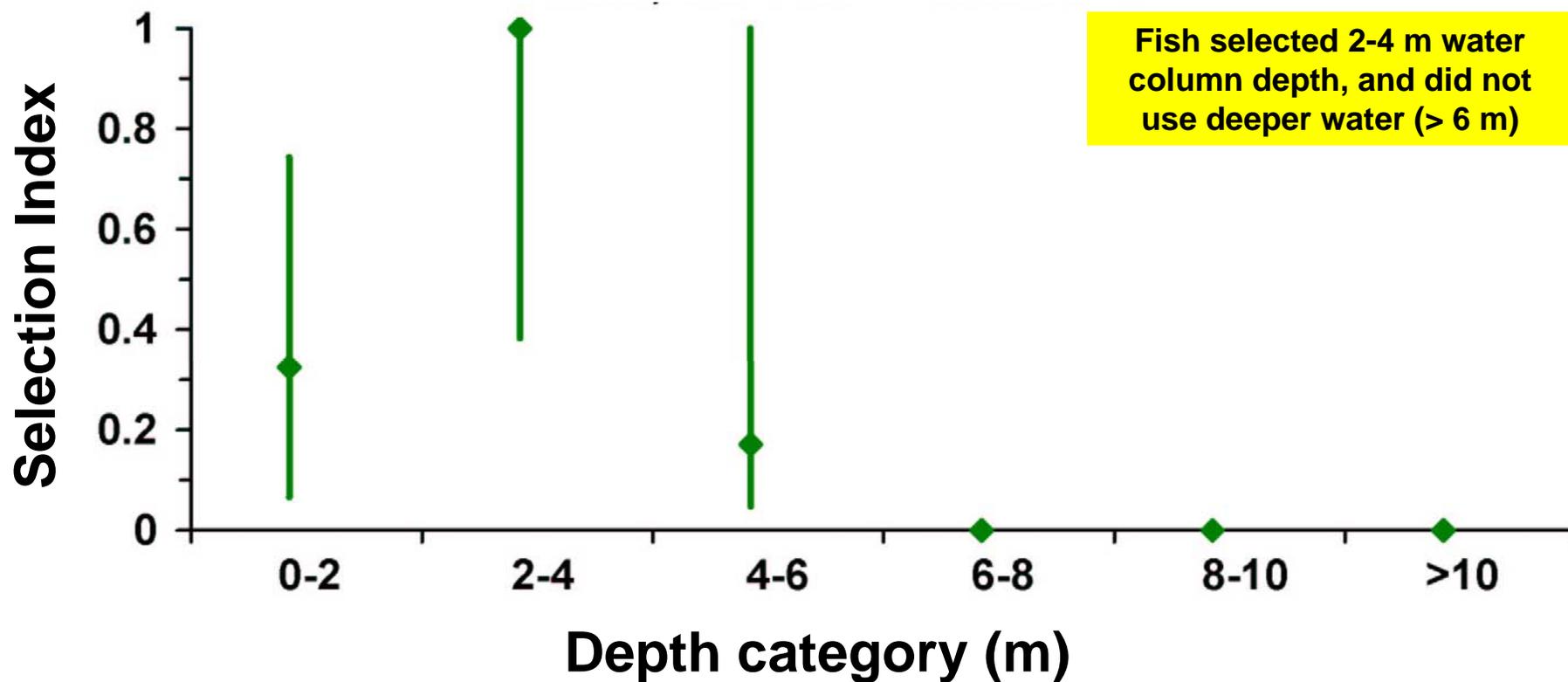


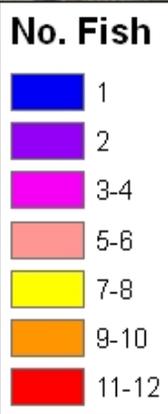
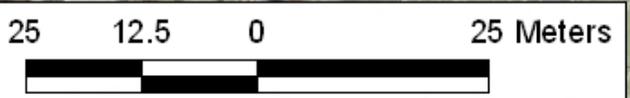
direction  
of travel

Fish moved back to shallower water  
once beyond the last structure

# Tennis Club (2005)

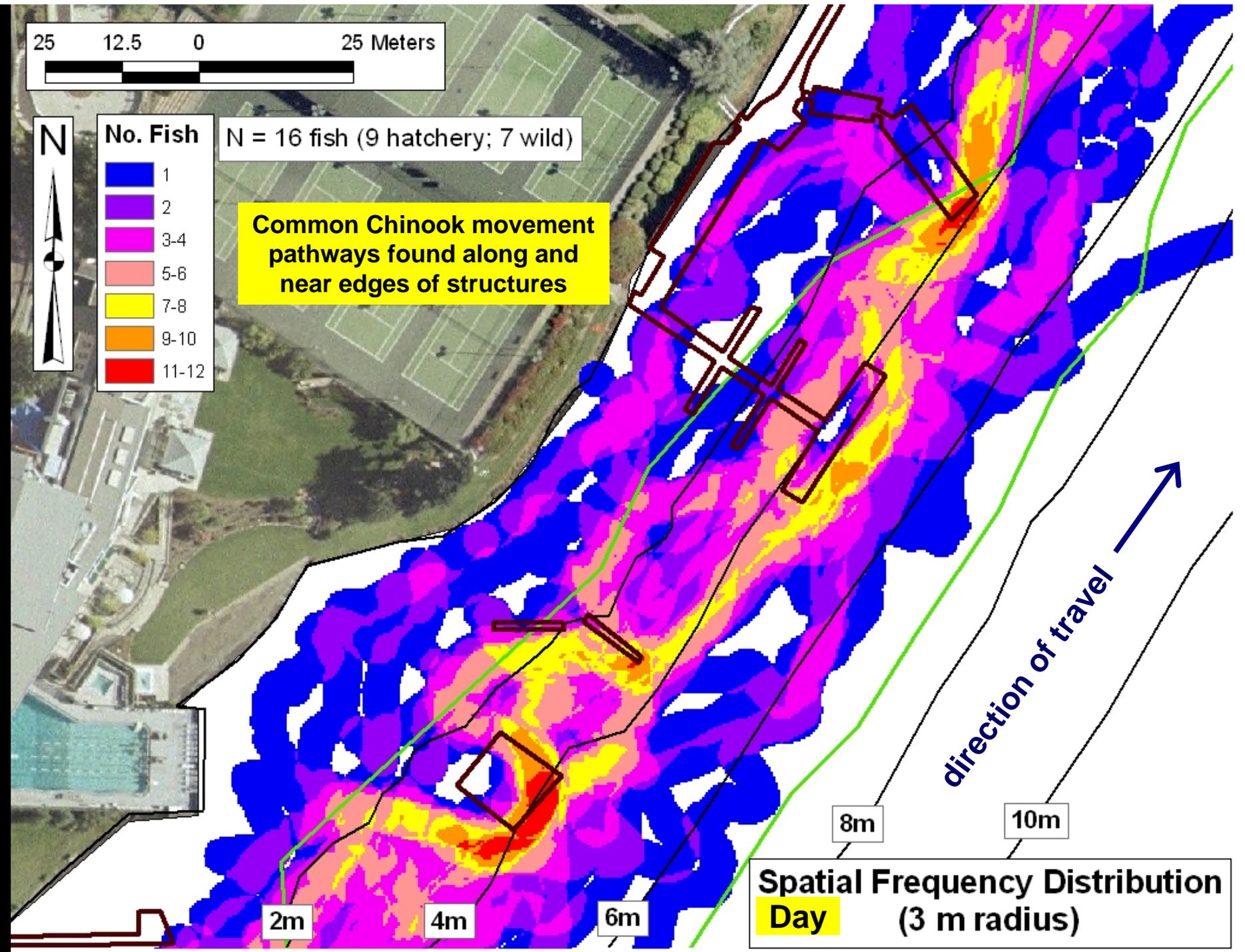
## Median Depth Selection - Day



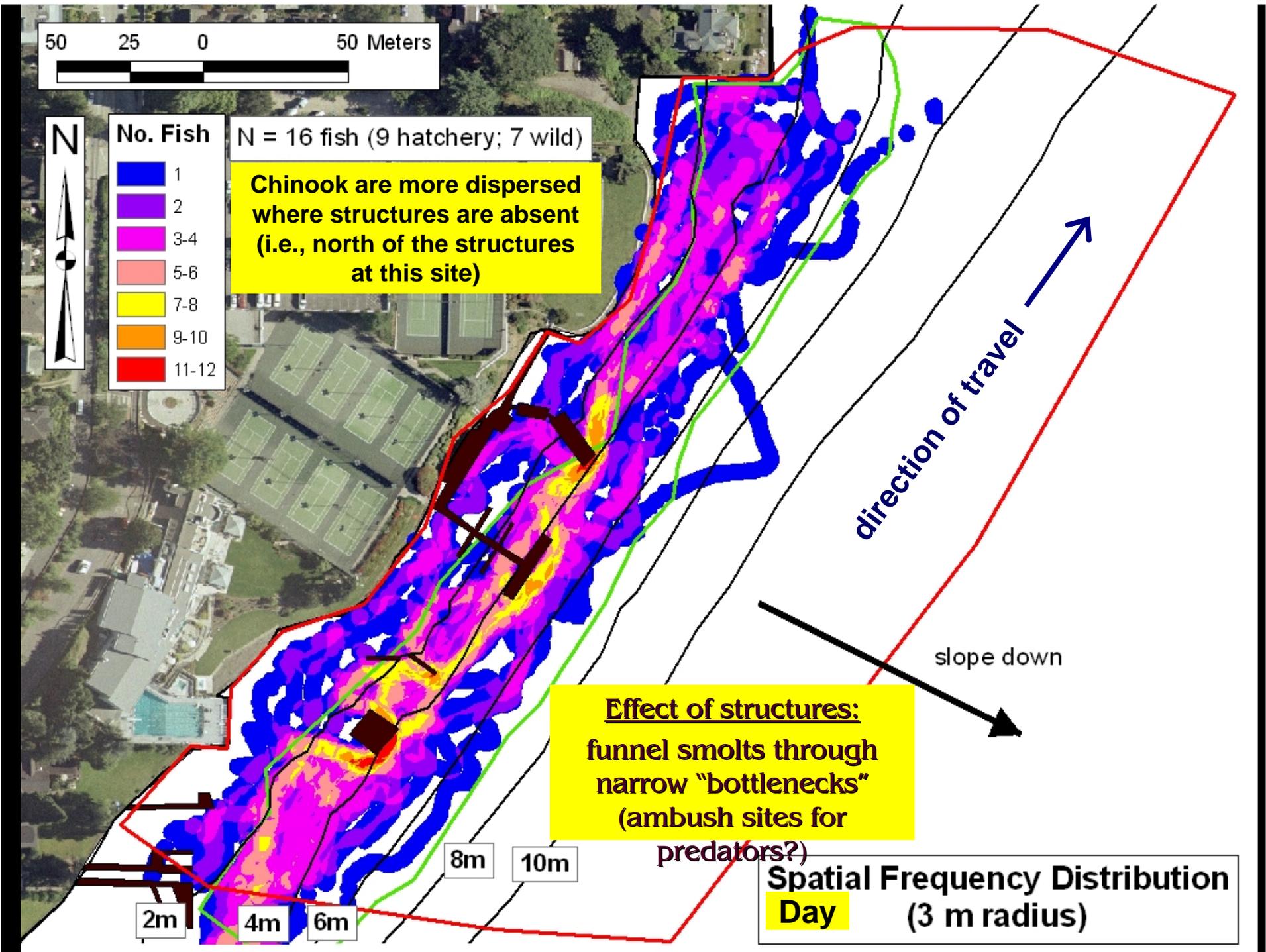


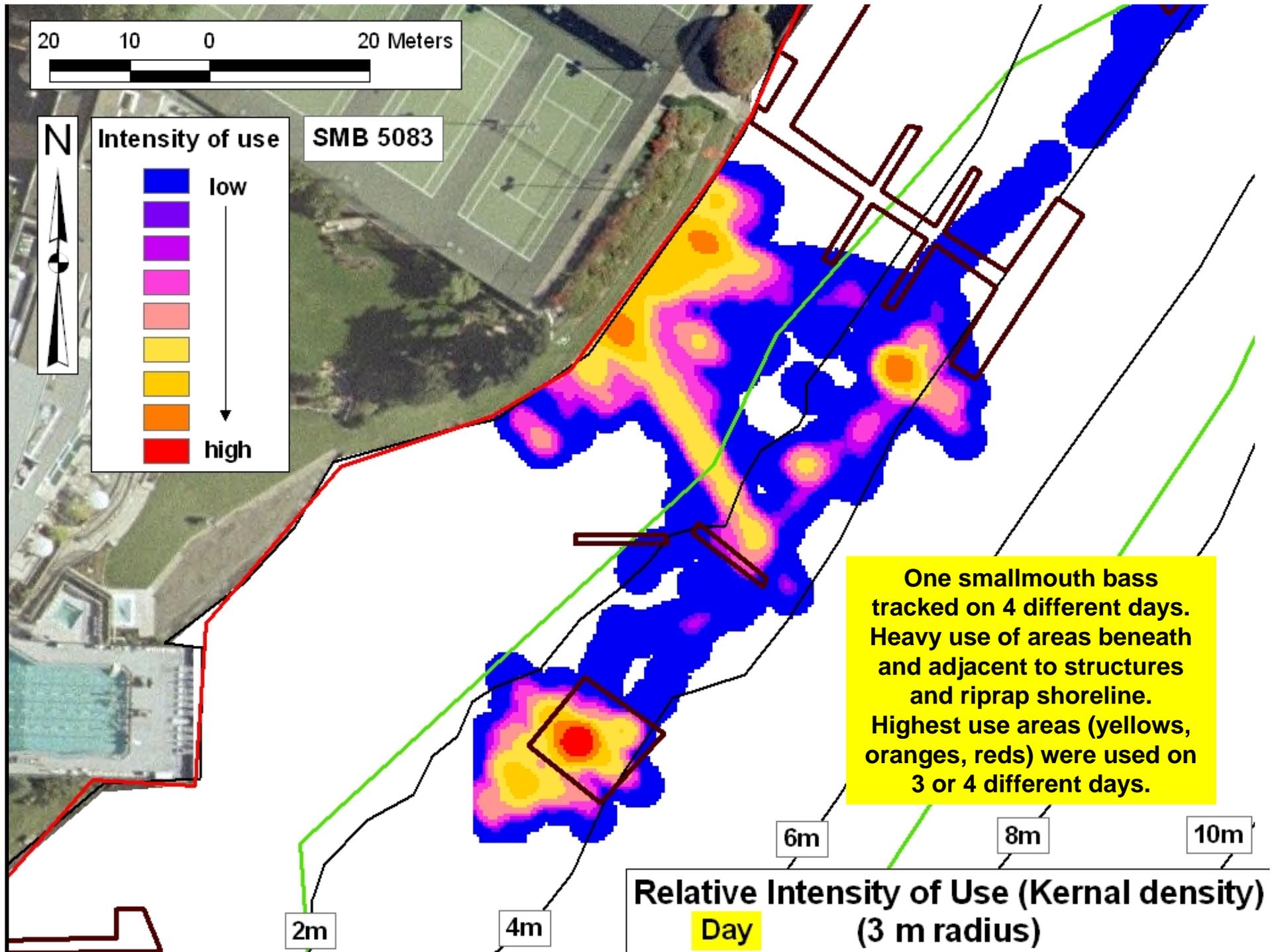
N = 16 fish (9 hatchery; 7 wild)

**Common Chinook movement pathways found along and near edges of structures**

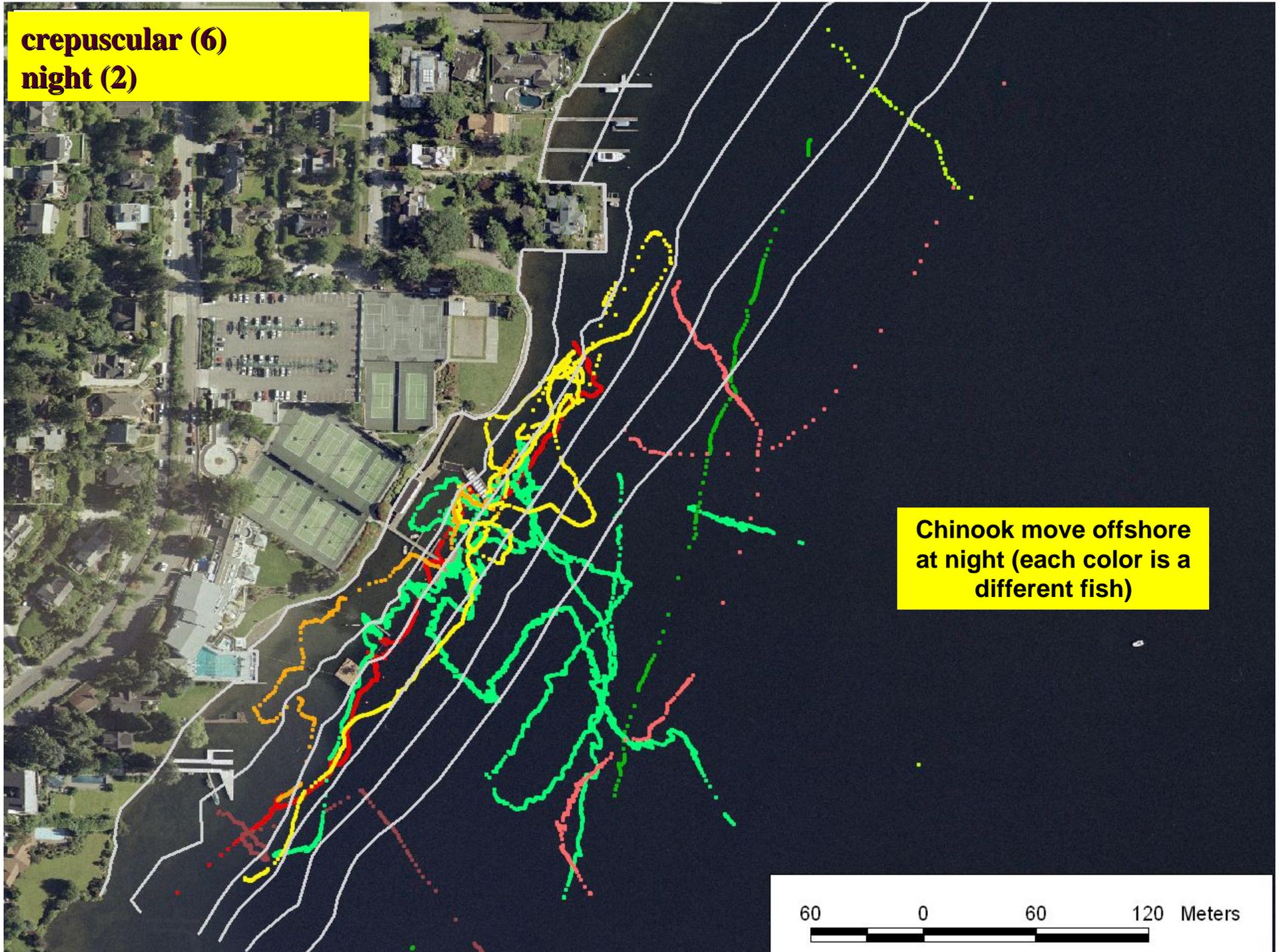


**Spatial Frequency Distribution Day** (3 m radius)





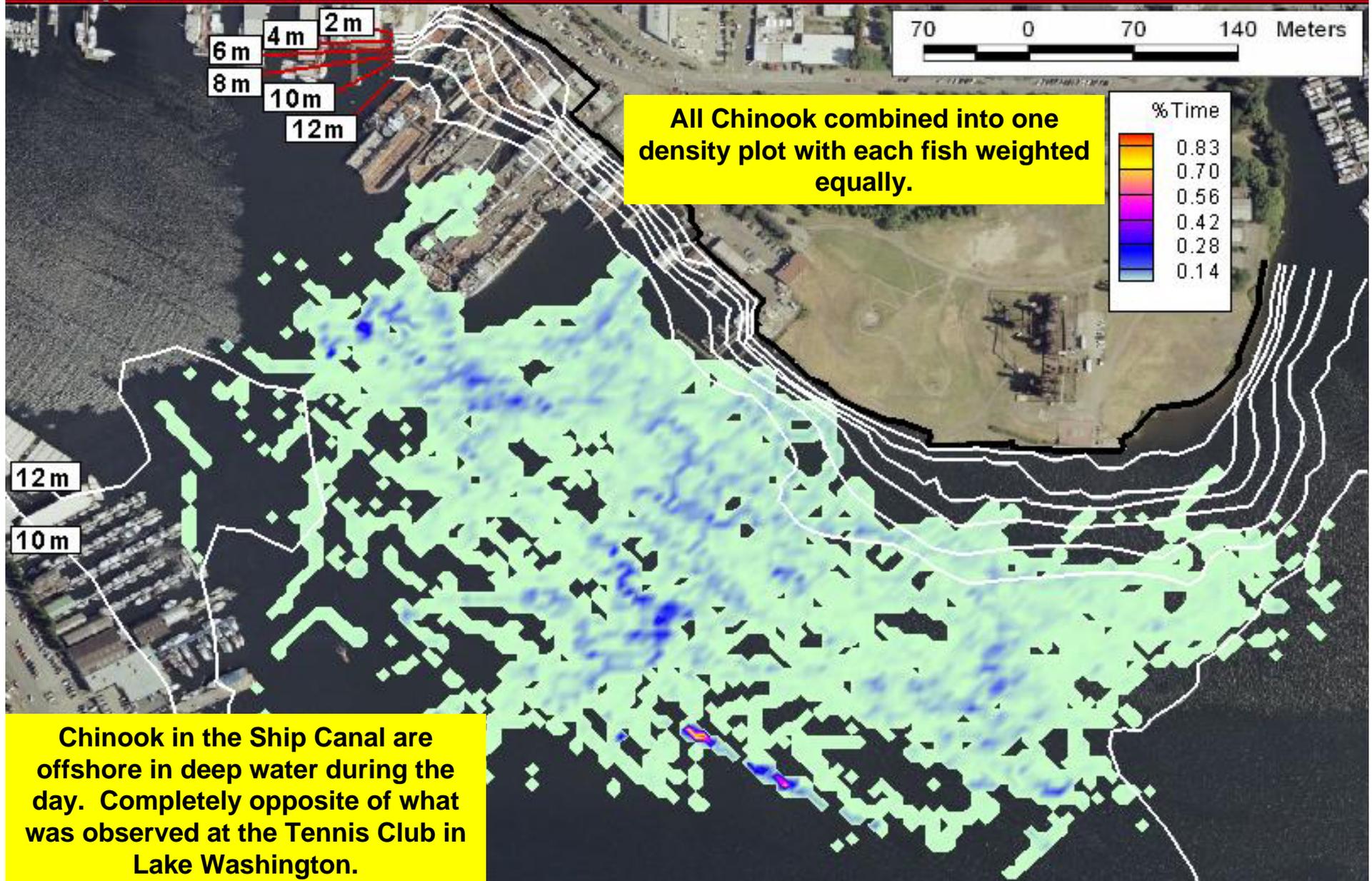
**crepuscular (6)  
night (2)**

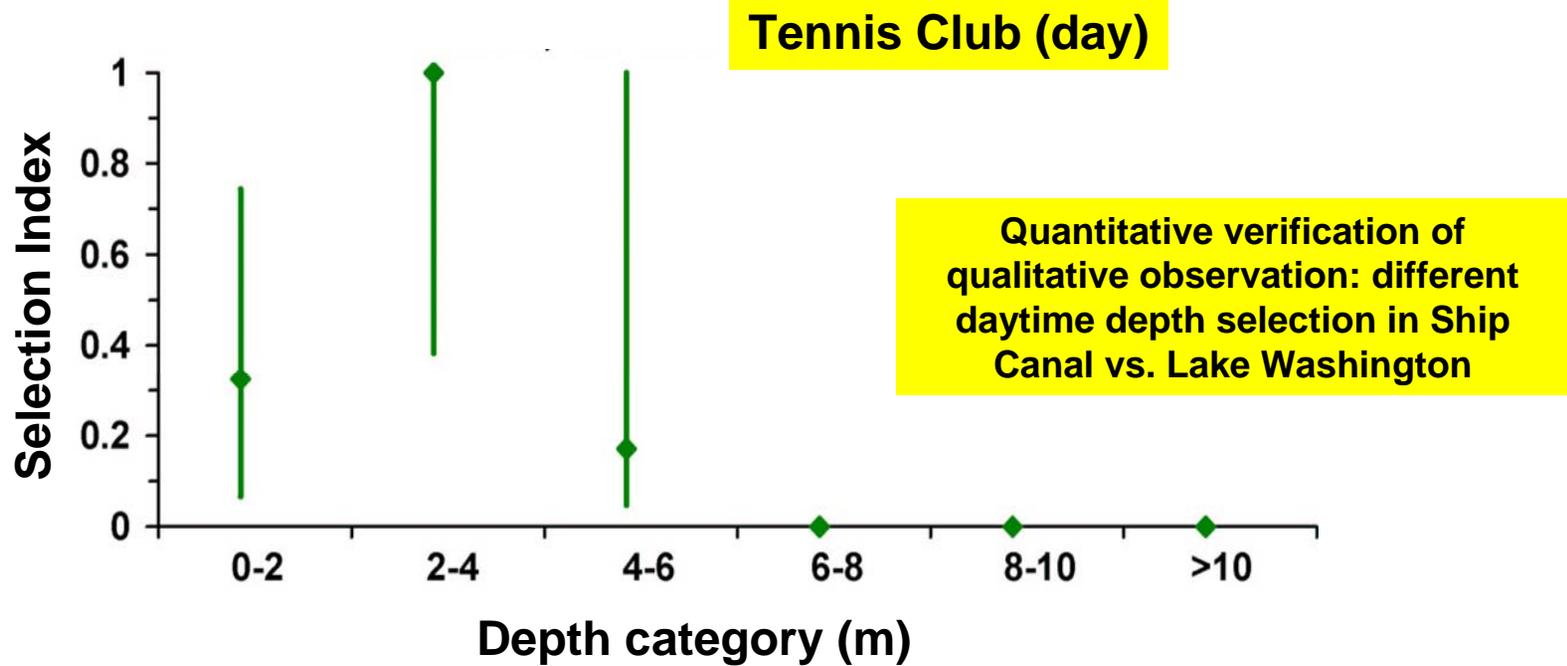
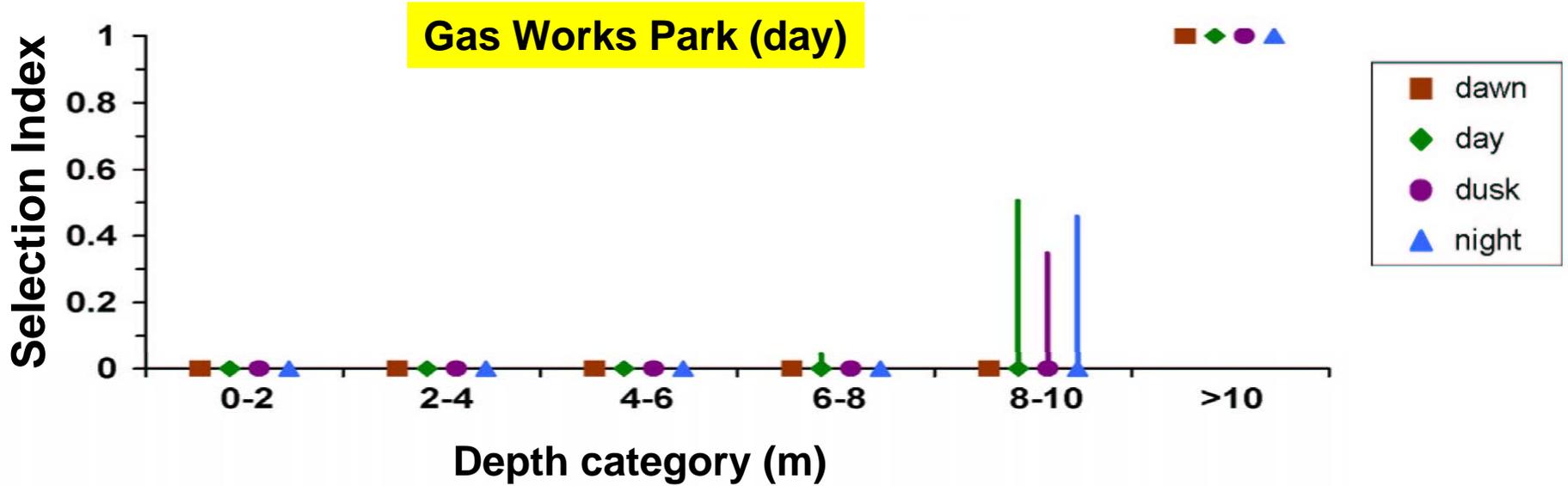


**Chinook move offshore  
at night (each color is a  
different fish)**

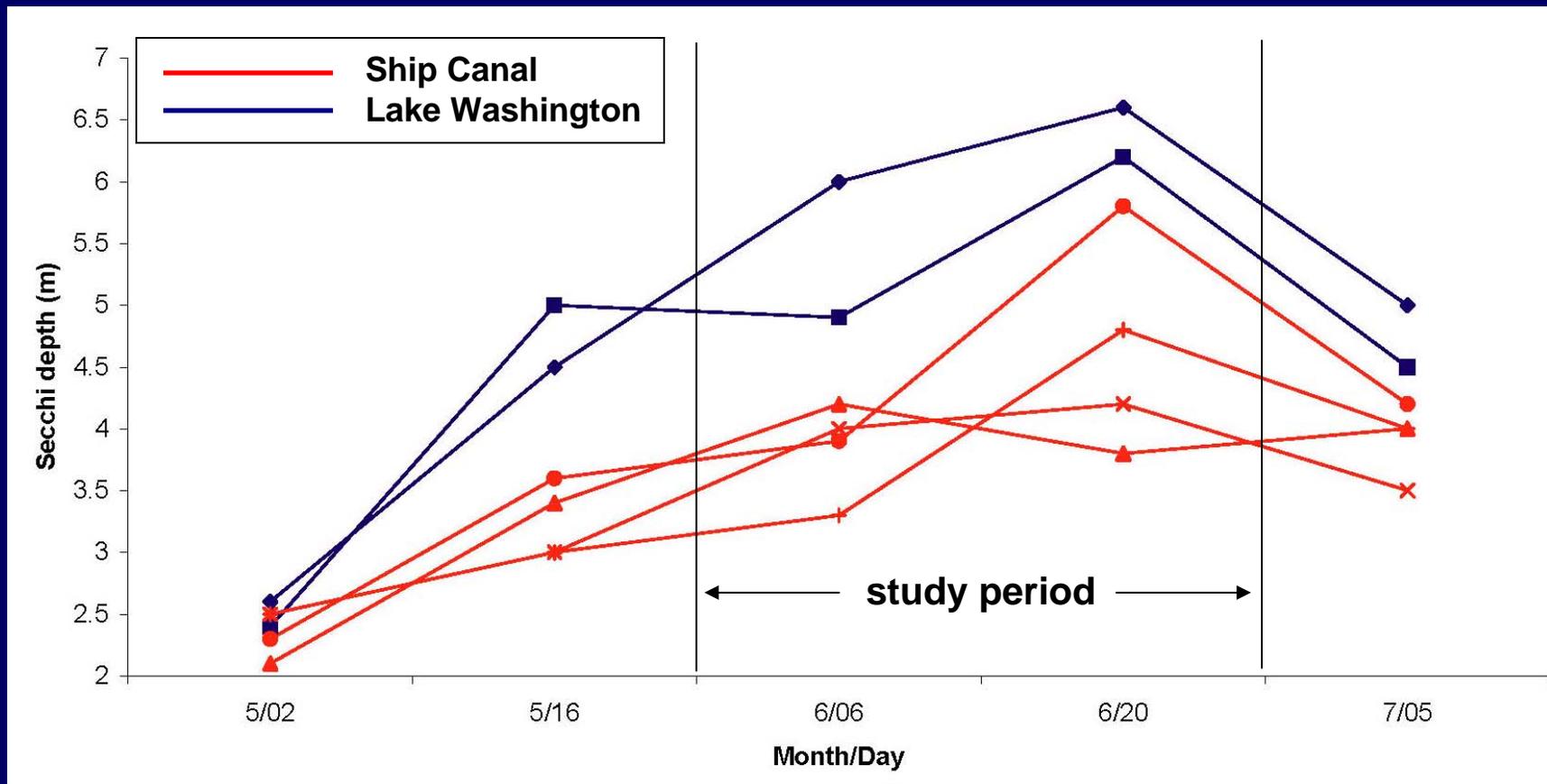
60 0 60 120 Meters

# Gas Works Park, 2005 (day)





# Water Clarity



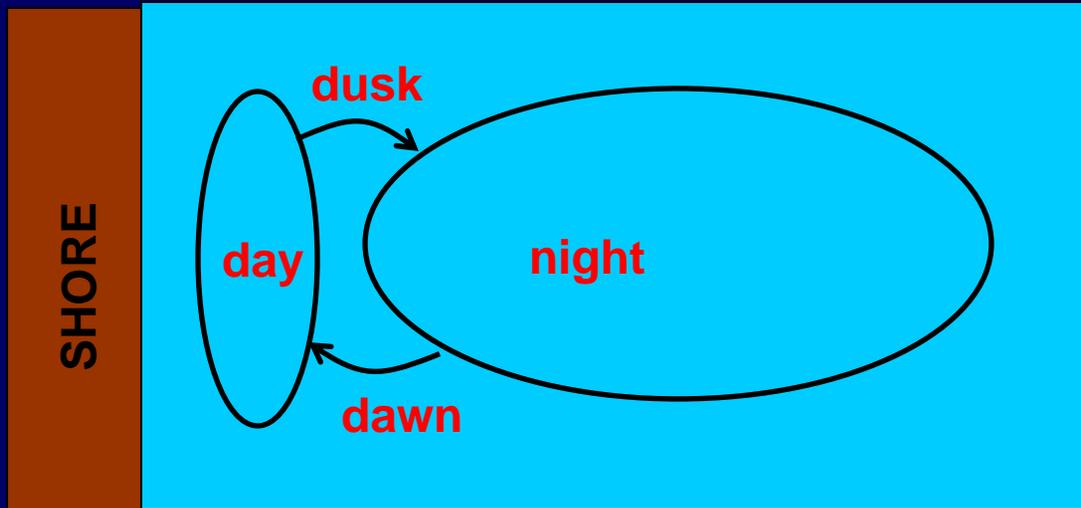
**Site-specific data  
collected in 2007 & 2008**

**Differences in water clarity between  
Ship Canal and lake Washington  
may account for differences in  
daytime daytime depth  
selection/shoreline orientation.**

Source: King County

# Prey distribution models

Water clarity can influence depth selection and shoreline orientation of prey fish.



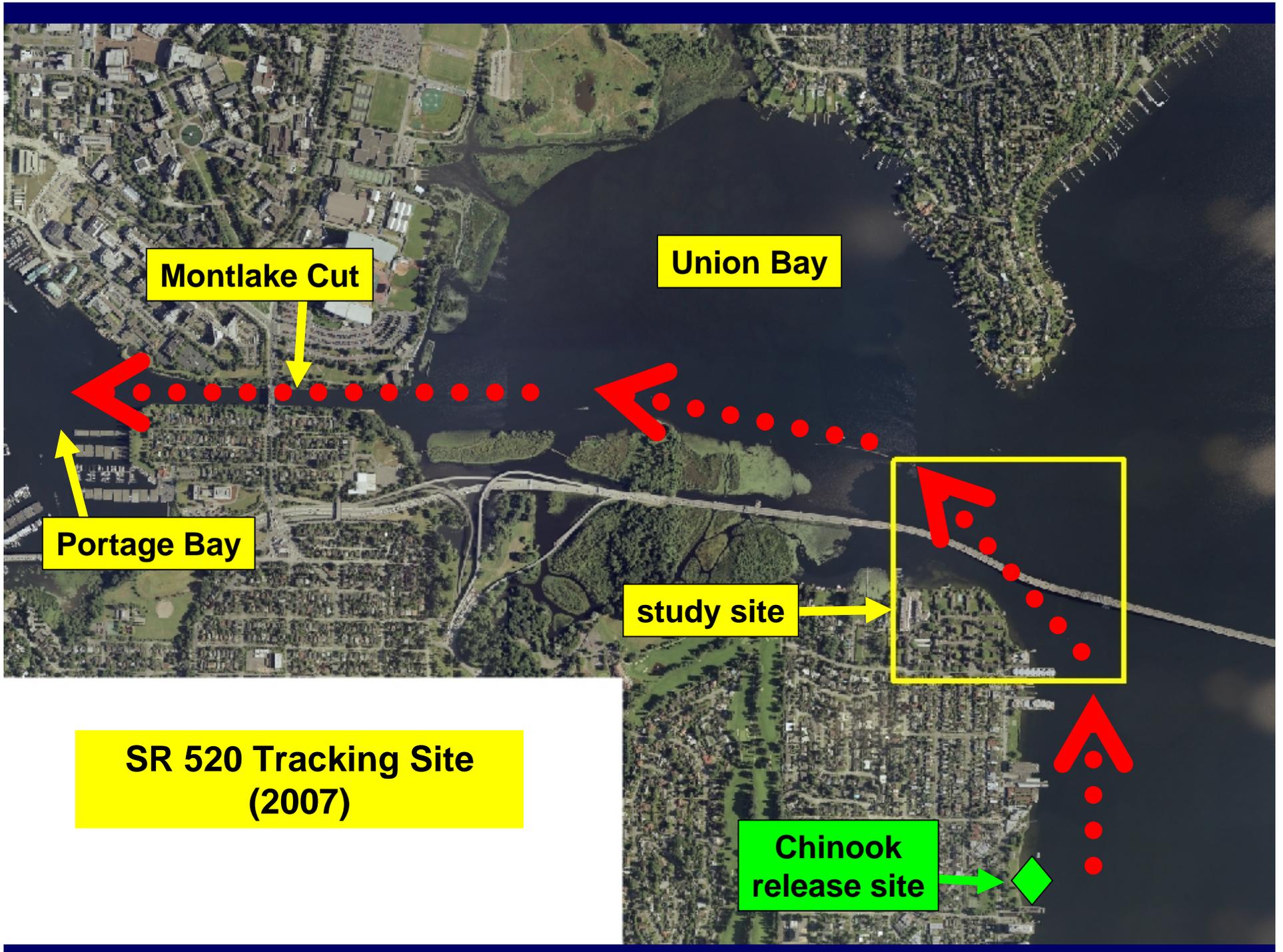
**HIGH PREDATION RISK**  
clear water &/or  
many predators

**Lake Washington  
(Tennis Club)**



**LOW PREDATION RISK**  
turbid water &/or  
few predators

**Ship Canal  
(Portage Bay &  
Gasworks Park)**



Montlake Cut

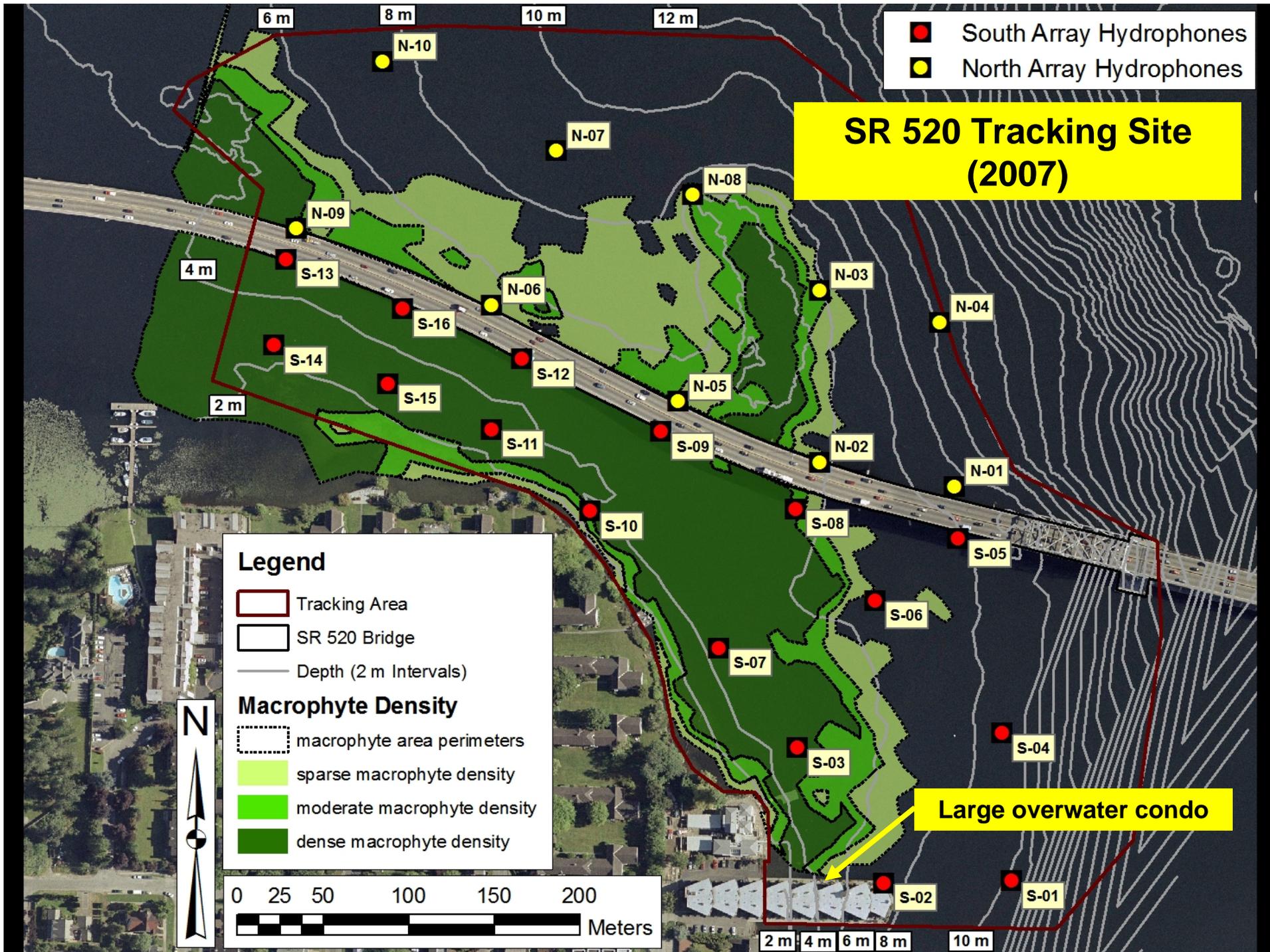
Union Bay

Portage Bay

study site

SR 520 Tracking Site  
(2007)

Chinook  
release site

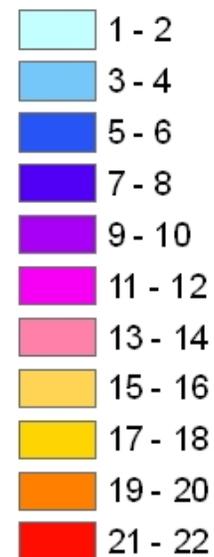


**Spatial frequency distribution for Chinook released on 6/01 and tracked during early day (dawn to 2:00 PM)**

**Note the “bottleneck” evident around the outside perimeter of the condo building and the dispersal north of here where no structures are present. Similar pattern as that observed at the Tennis Club several slides earlier.**

total no. fish tracked during diel period: n = 35

no. fish tracked by area:

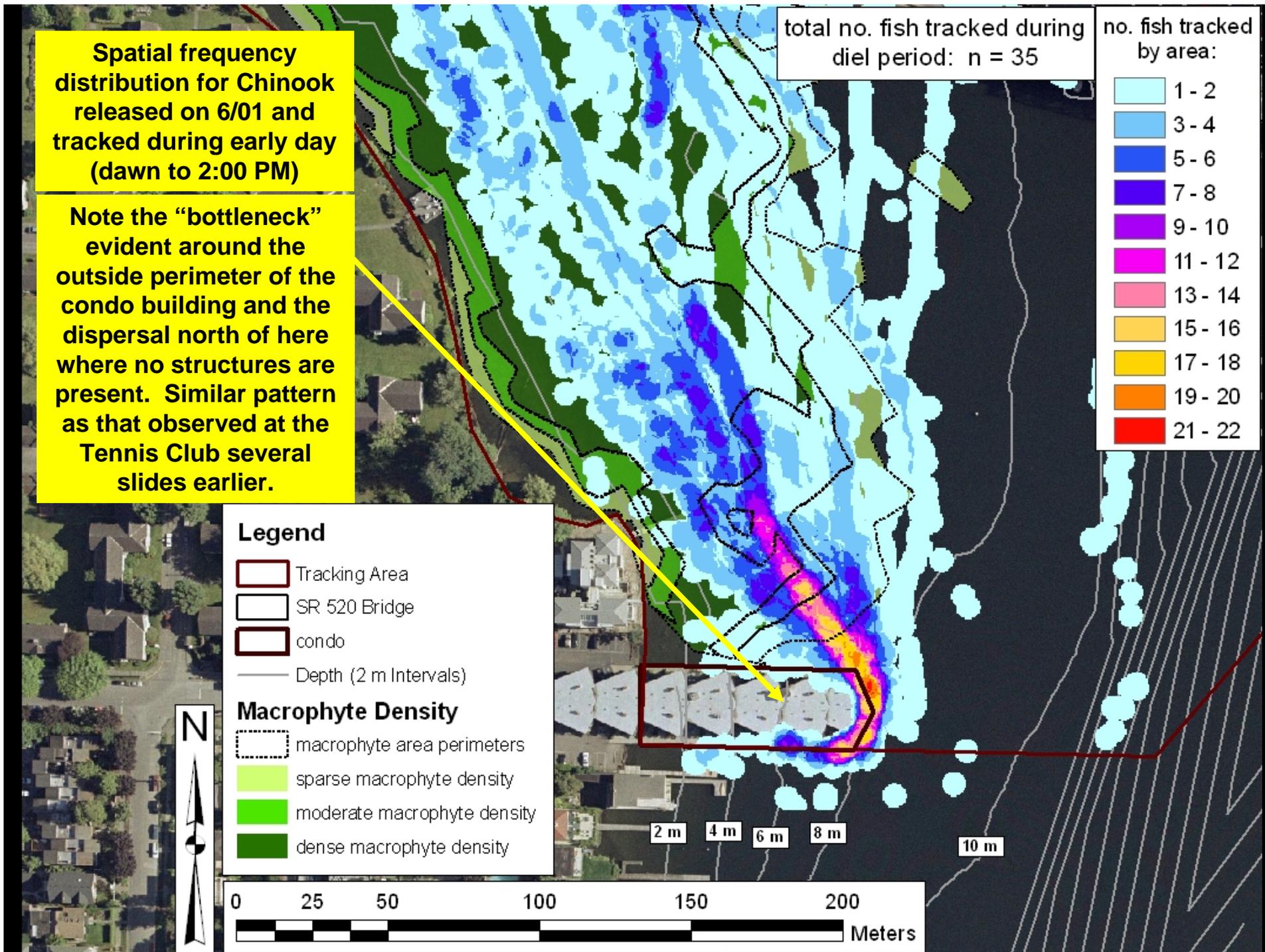
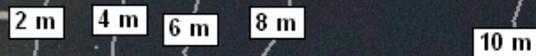
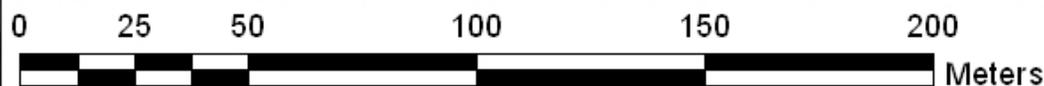


**Legend**

- Tracking Area
- SR 520 Bridge
- condo
- Depth (2 m Intervals)

**Macrophyte Density**

- macrophyte area perimeters
- sparse macrophyte density
- moderate macrophyte density
- dense macrophyte density



**Mark Celedonia:**

**(360) 534-9327**

**mark\_celedonia@fws.gov**

**Roger Tabor:**

**(360) 753-9541**

**roger\_tabor@fws.gov**

**copies of reports:**

**[http://www.fws.gov/westwafwo/fisheries/wwfish\\_pub1.html](http://www.fws.gov/westwafwo/fisheries/wwfish_pub1.html)**