SWFSC CV Chinook telemetry, predation and marine studies

Team members
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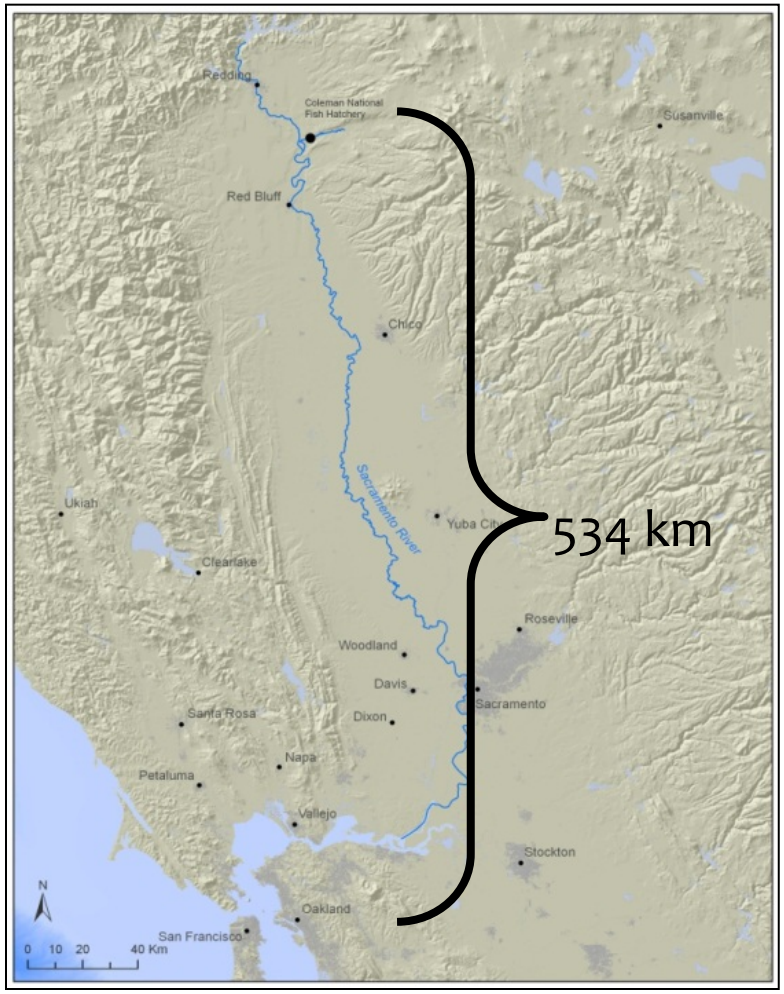
Collaborations:
UC Davis, USFWS, CA DFW, Cramer Fish Sci, CA DWR

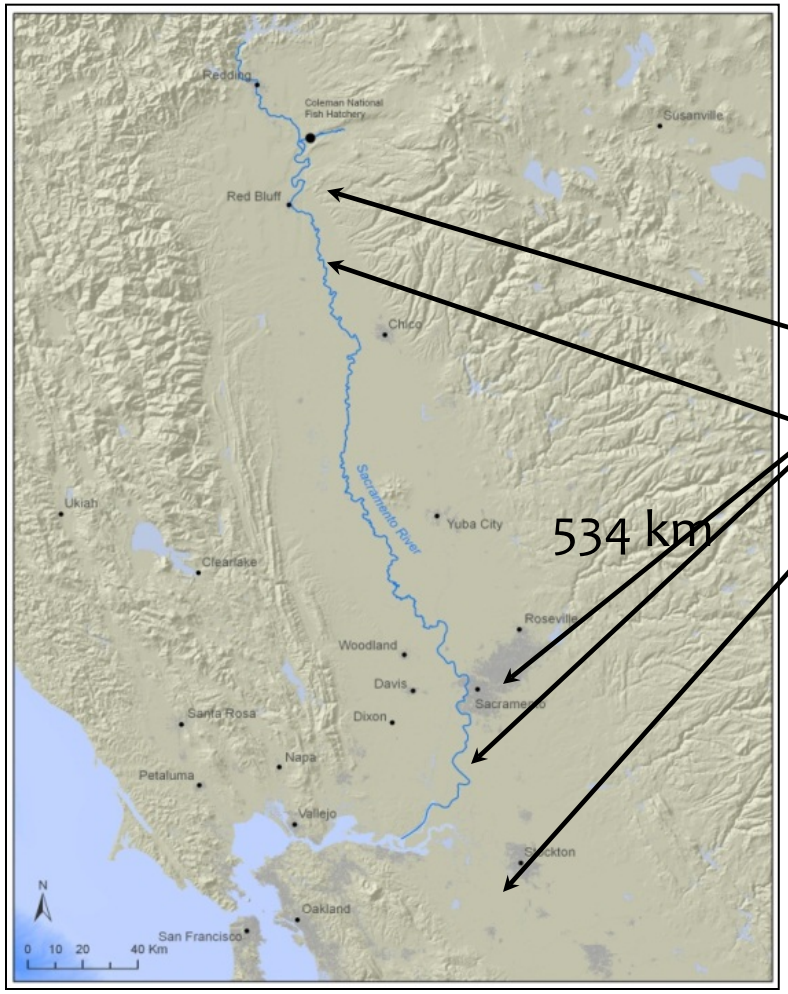
SWFSC Central Valley Study Objectives



Acoustic tagging

- Measure overall survival
- When/where fish die
- Movement behavior
- Stock specific differences

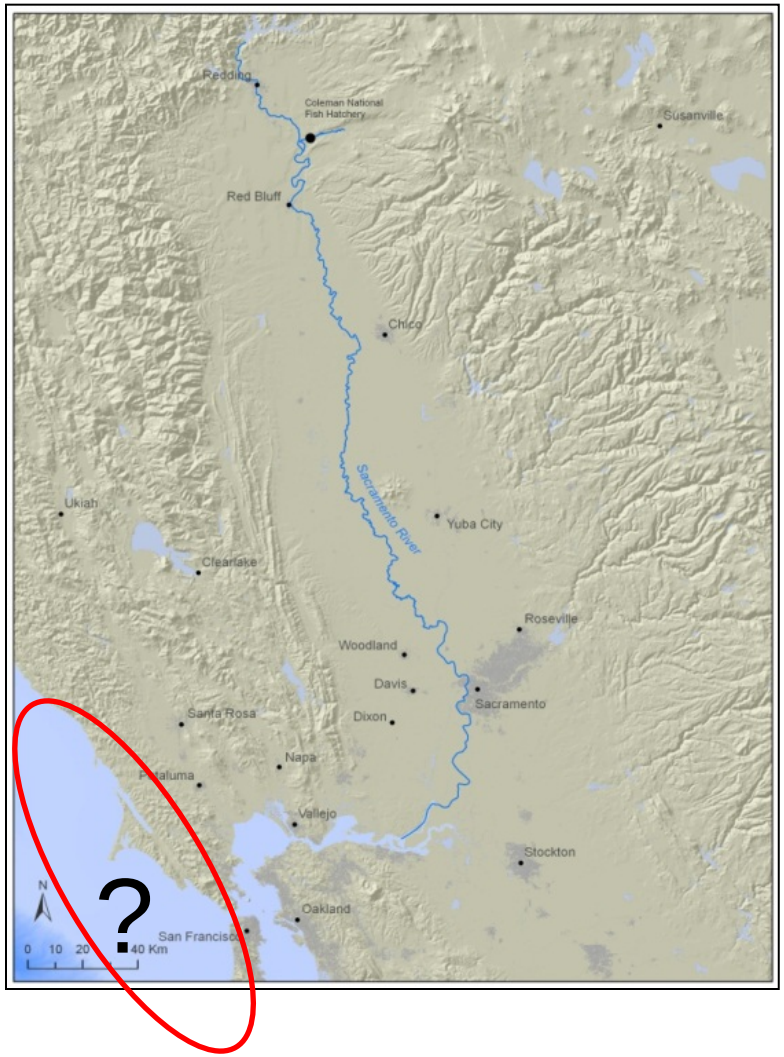
SWFSC Central Valley Study Objectives



Mortality investigations

- Targeted local surveys
  - Water Diversions
  - Areas where high mortality observed

SWFSC Central Valley Study Objectives



Bay/Ocean research

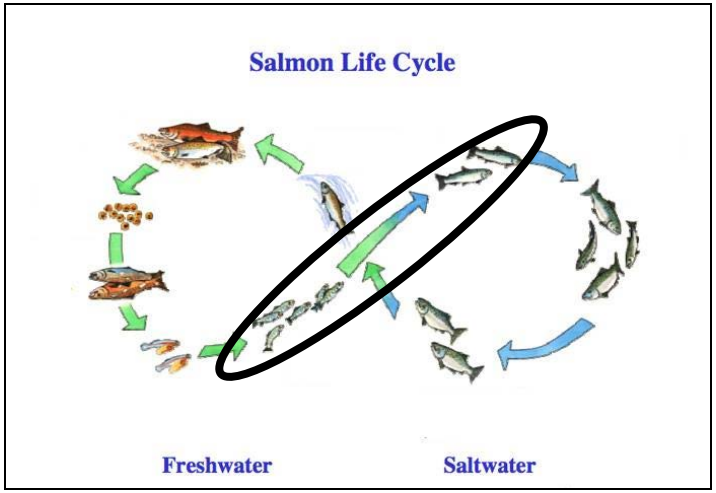
- Relative ocean recruitment
  - By stock
  - By hatchery/wild origin (calibrates wild recruitment to hatchery telemetry studies)
- Early marine survival
  - Ocean influences on...
  - Develop early warning for stock crashes

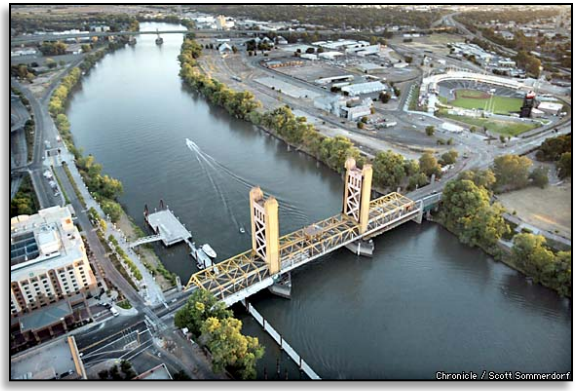
Basin Scale Acoustic Telemetry

- Past/Present work and goals
  - Late fall Chinook 2007-2011 (VEMCO)
  - Hatchery Fall, Winter, Spring 2012-2015+ (JSATS)
  - Wild Fall, Spring,(Winter?)- 2013-2015+ (JSATS)
- Comparative results
  - Within basin (implication for wild fish)
  - With other rivers
- Are predators the cause?
- Marine Survival implications

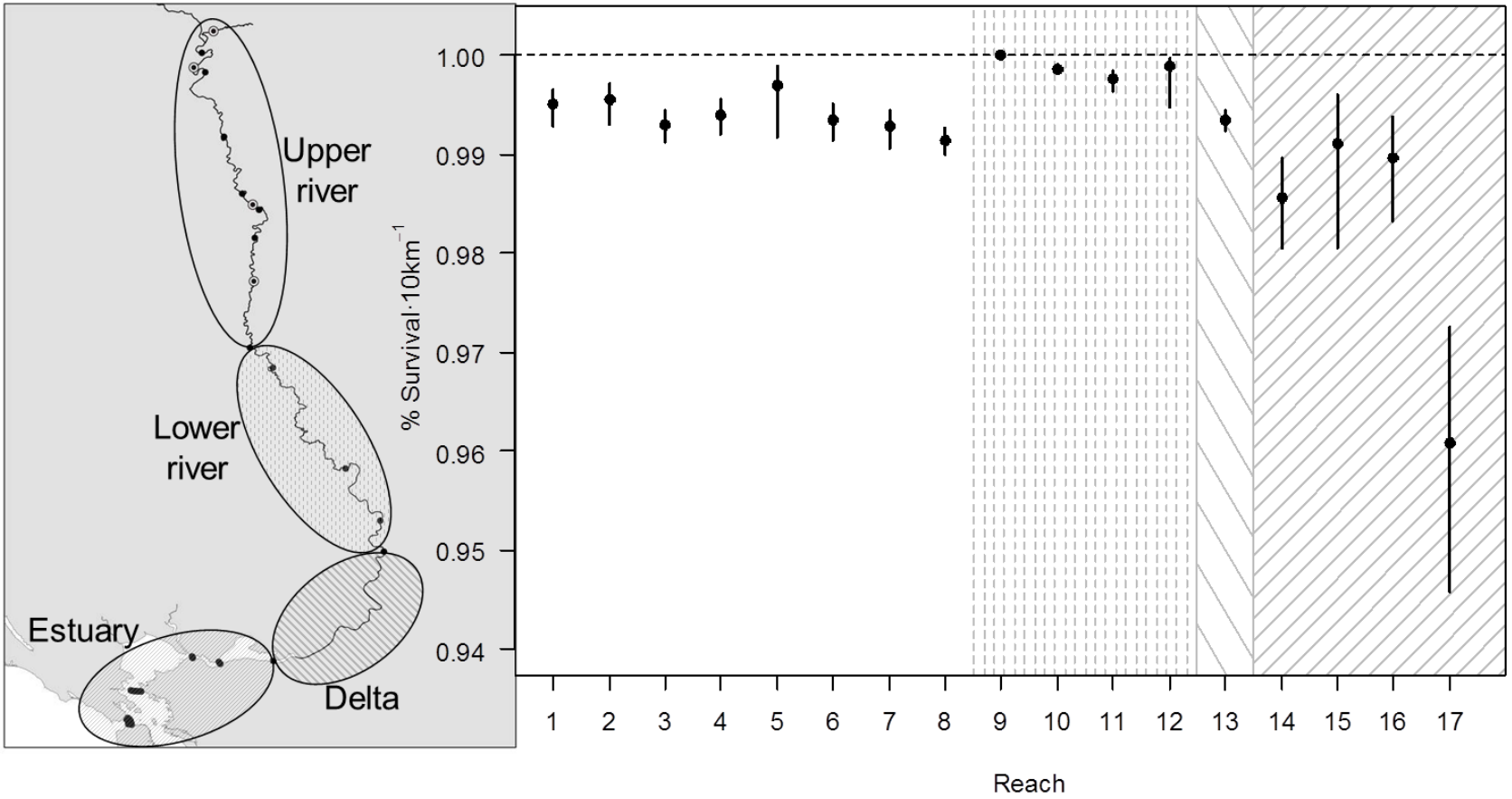
In-river migration survival

- During migration, Chinook salmon smolts transit many habitats that can affect survival differently, including the estuary

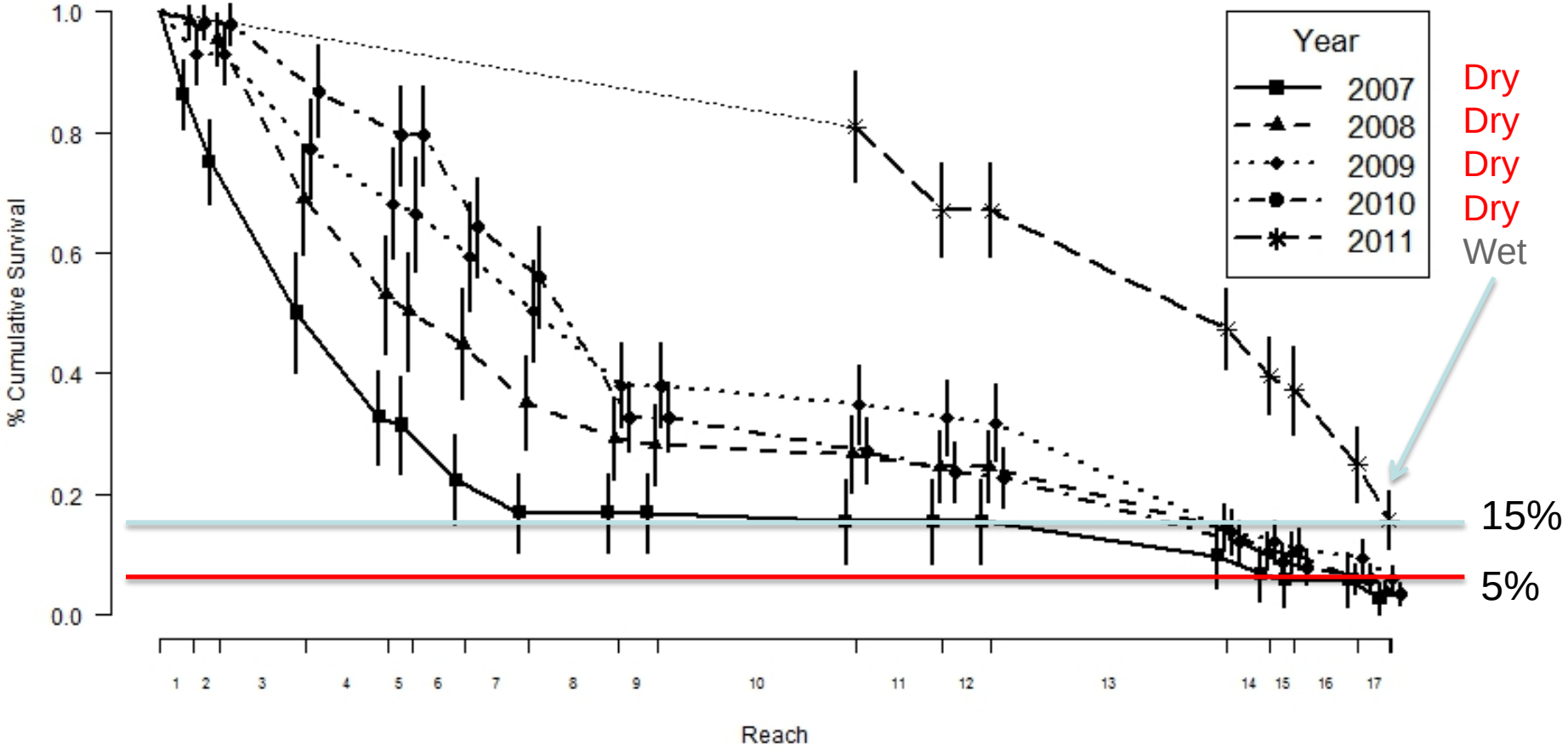




Late Fall Chinook
Using data from 2007-2011
(5 years)



Late Fall Chinook Survival to Golden Gate 2007-2011 (5 years)



Late Fall Chinook Survival to Golden Gate 2007-2011 (5 years)

Why does survival improve during wet years?

- Faster outmigration in 2011
  - Less exposure time to areas of high mortality?

<u>Travel time from release to ocean</u>

2007: 24.2 +/- 3.3 SE Dry
2008: 28.9 +/- 2.8 Dry
2009: 24.5 +/- 4.3 Dry
2010: 26.4 +/- 6.1 Dry
2011: 18.9 +/- 2.0 Wet

Comparative results

Run	Years	Survival	Transit time (days)	Area of Peak Mortality
Late Fall	2007-2011	3-16%	15-28	SF Bay
Fall	2012	3-5%	8-17	SF Bay
Spring	2012	<3%		Feather River
Winter	2013	4%	33-54	Middle Sac (rkm

- Observations
  - stocks move at different rates
  - stocks experience mortality in different areas
  - survival varies between years

What's survival like in other rivers?

Fraser River 2.0 – 32.2 %
(Welch et al. 2008)

Columbia River 28%
(Rechisky et al. 2009)

Predator densities and associated salmonid smolt mortality around water diversions

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NOAA National Marine Fisheries Service
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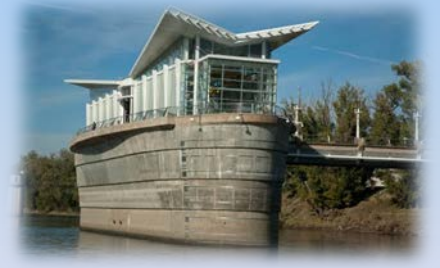
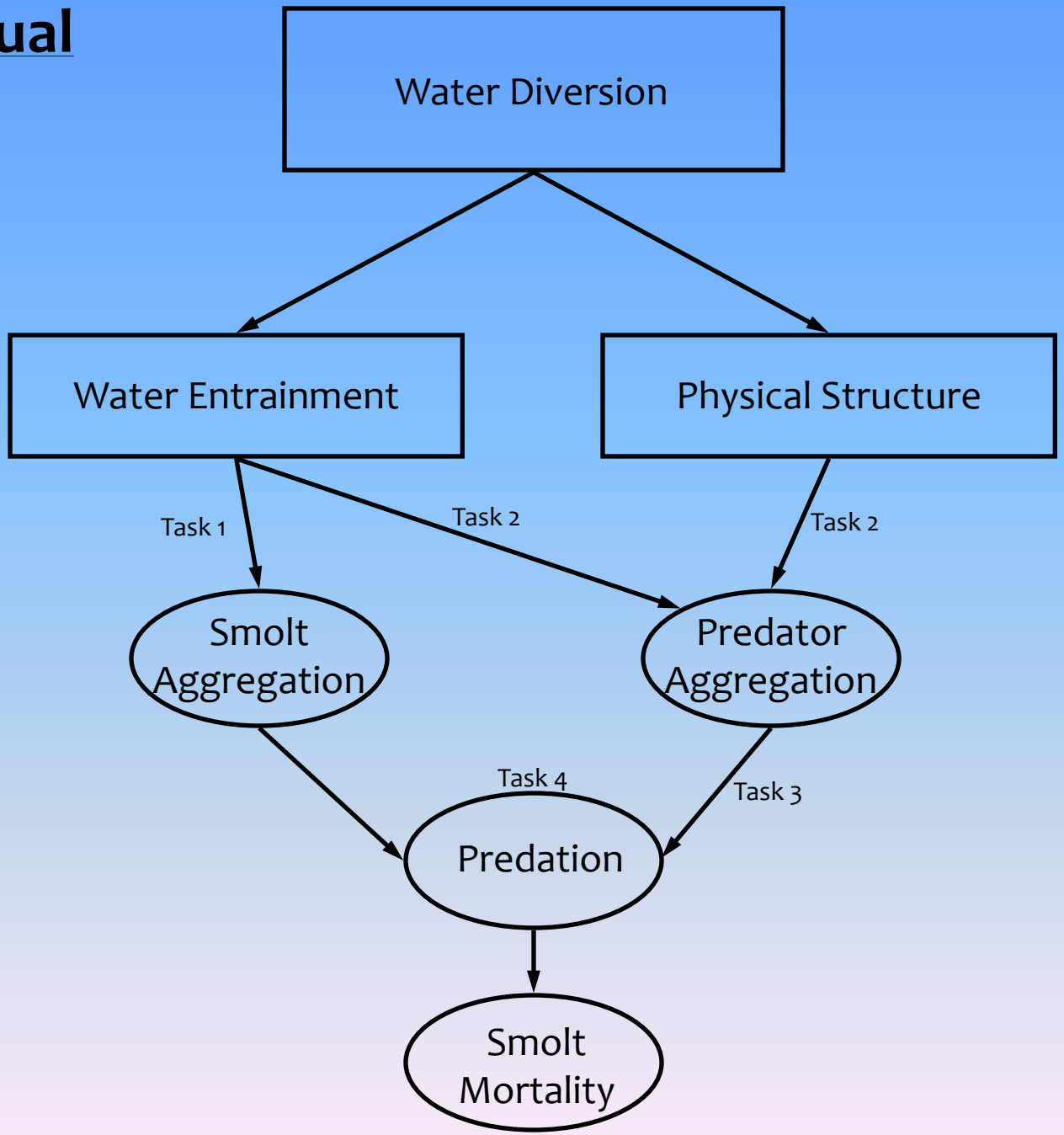
Freeport Regional Water Authority Intake Facility

Sacramento Water Treatment Plant Diversion



Conceptual Model



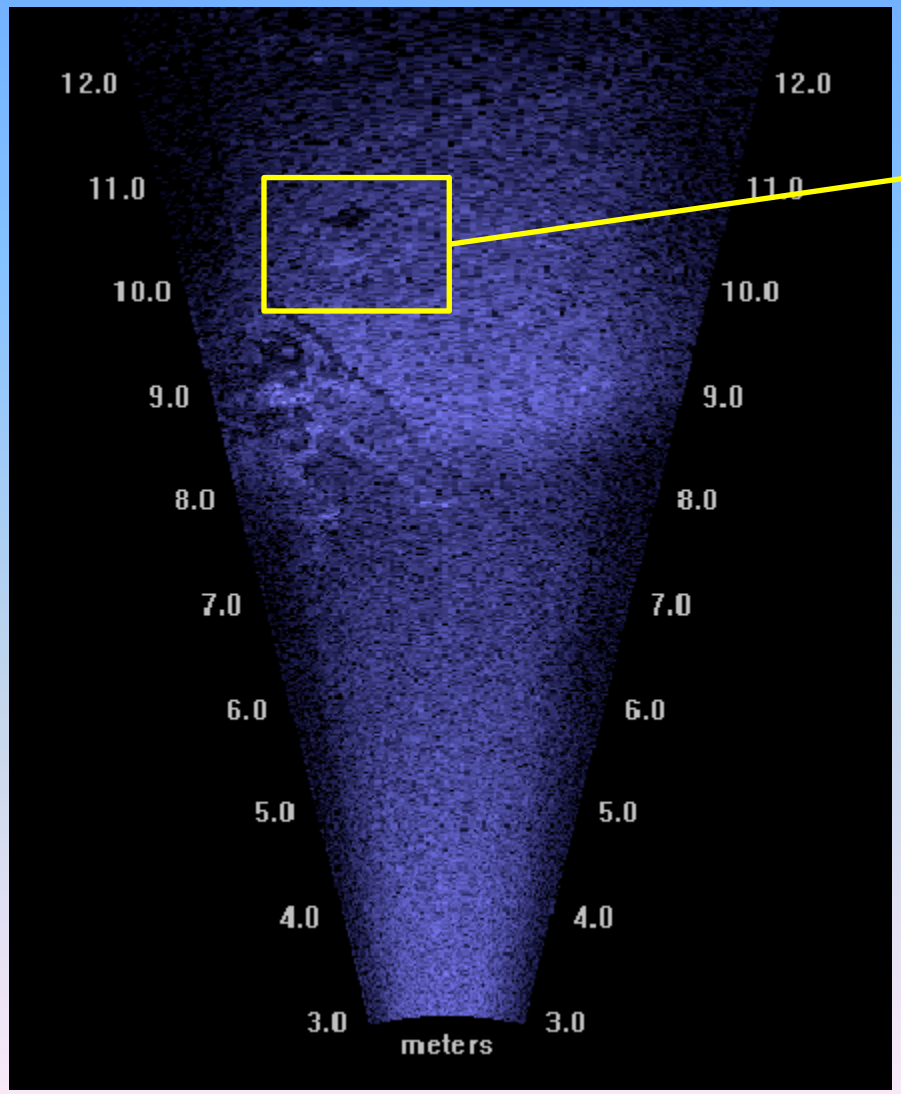
Task 2: Predator densities

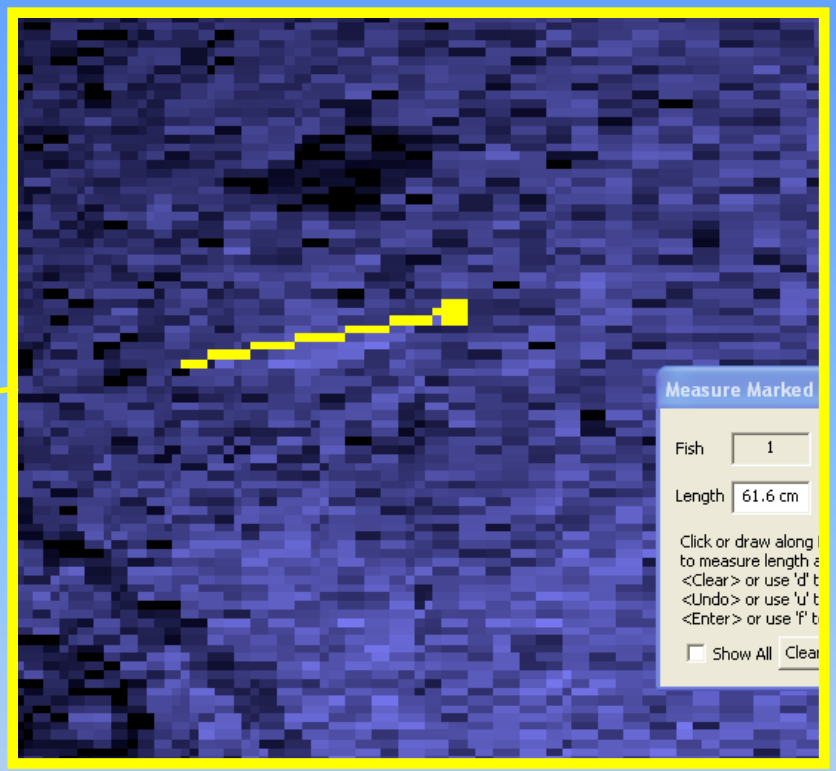
- Used a dual frequency identification sonar (DIDSON) to scan the study site for predators

- From 2011-2012, 66 scans were perfomed throughout the **fall run Chinook salmon** smolt outmigration season, varying time of scan between dawn, dusk, day, and night

Question: Are predator densities higher in the vicinity of the diversion?

The Predators

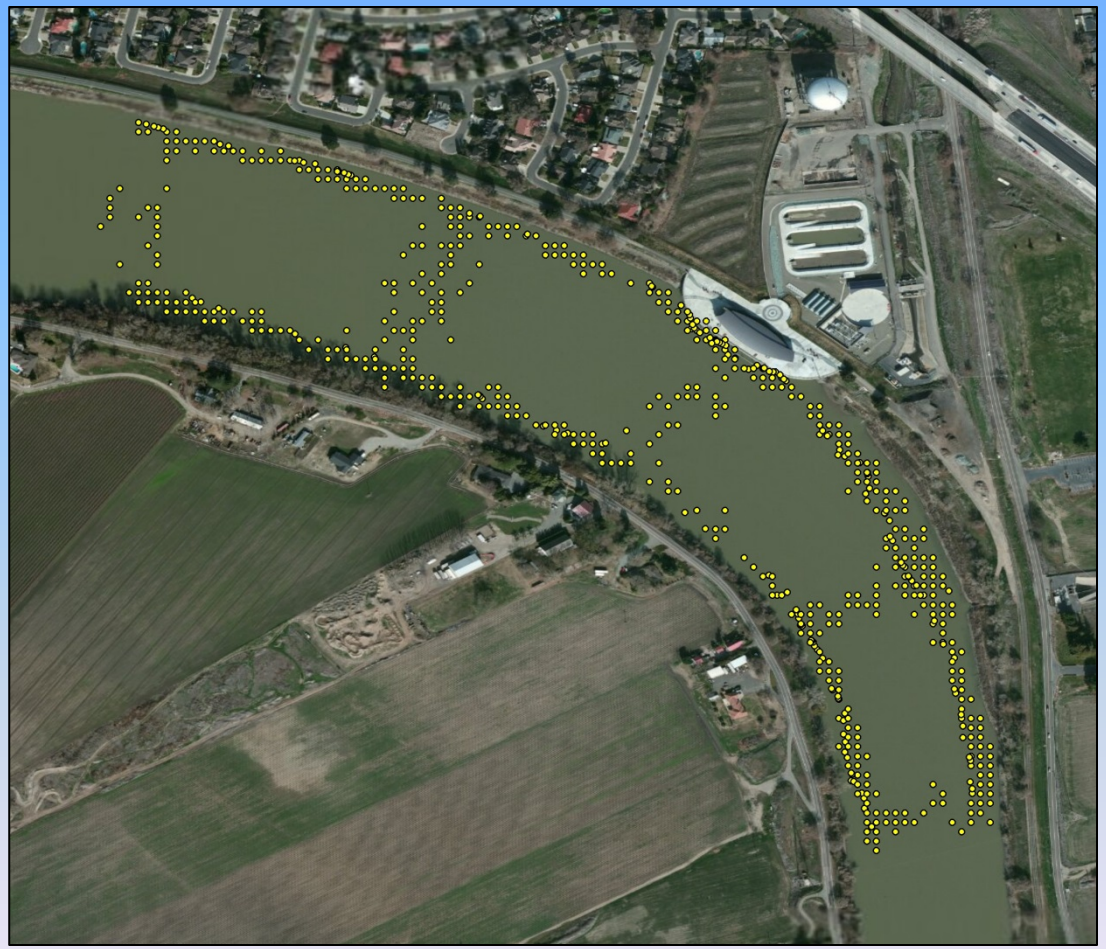


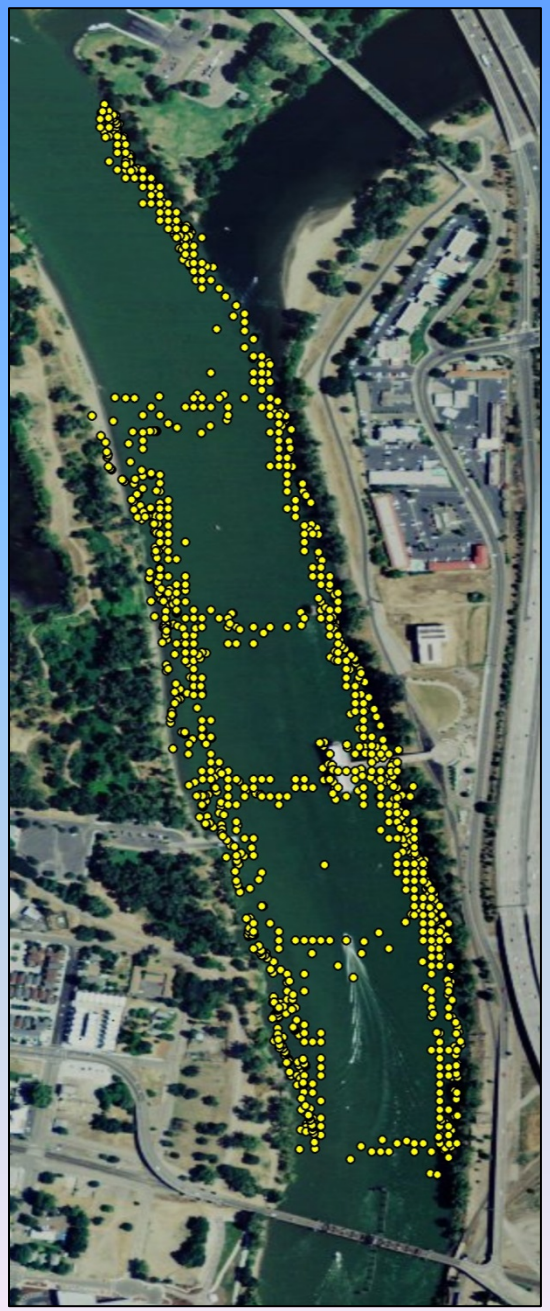


- All fish measured over 30 cm were considered “predators”

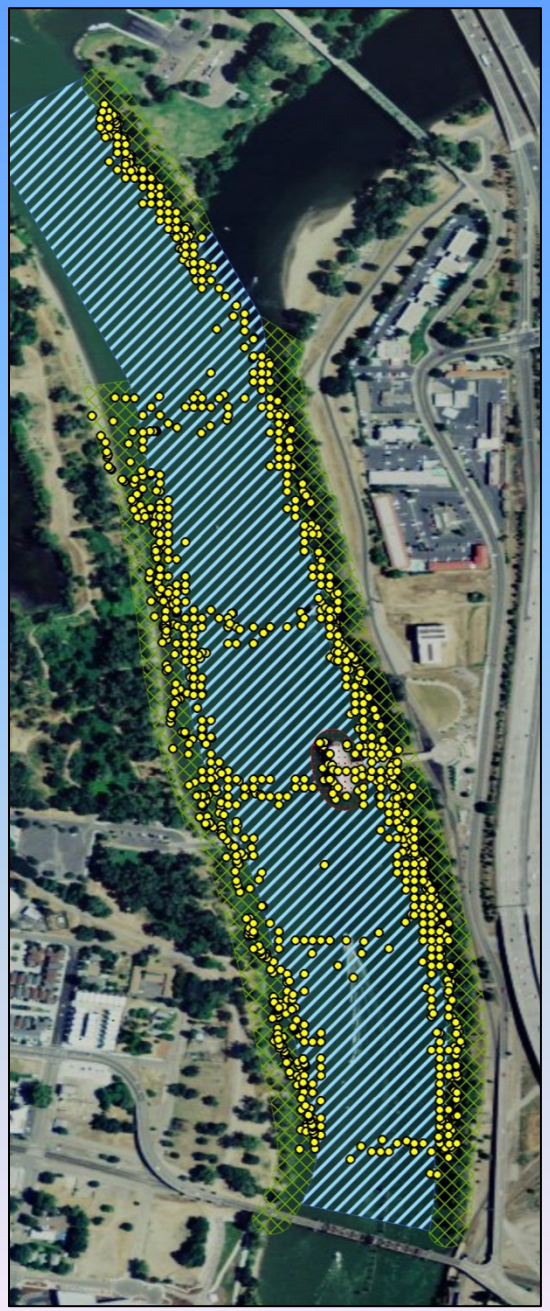
The Transects

The Predators

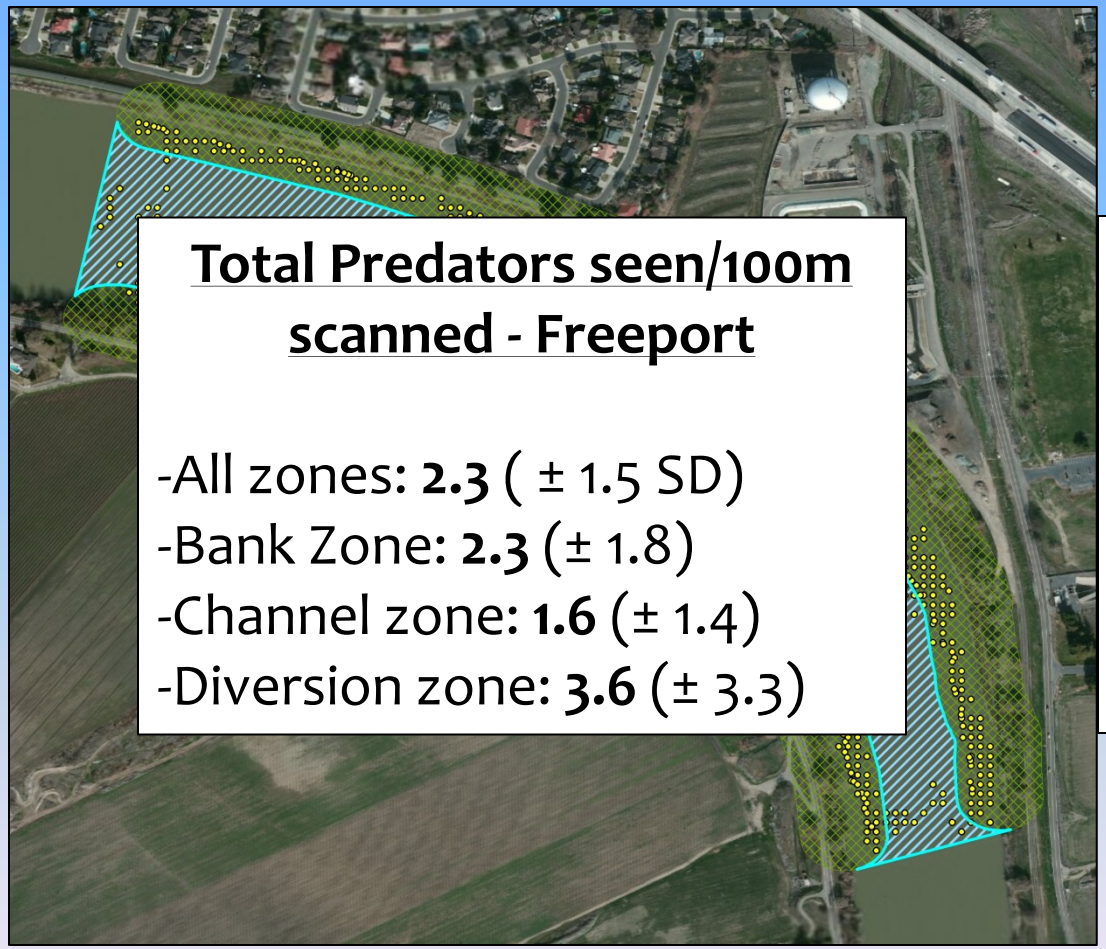




The Zones

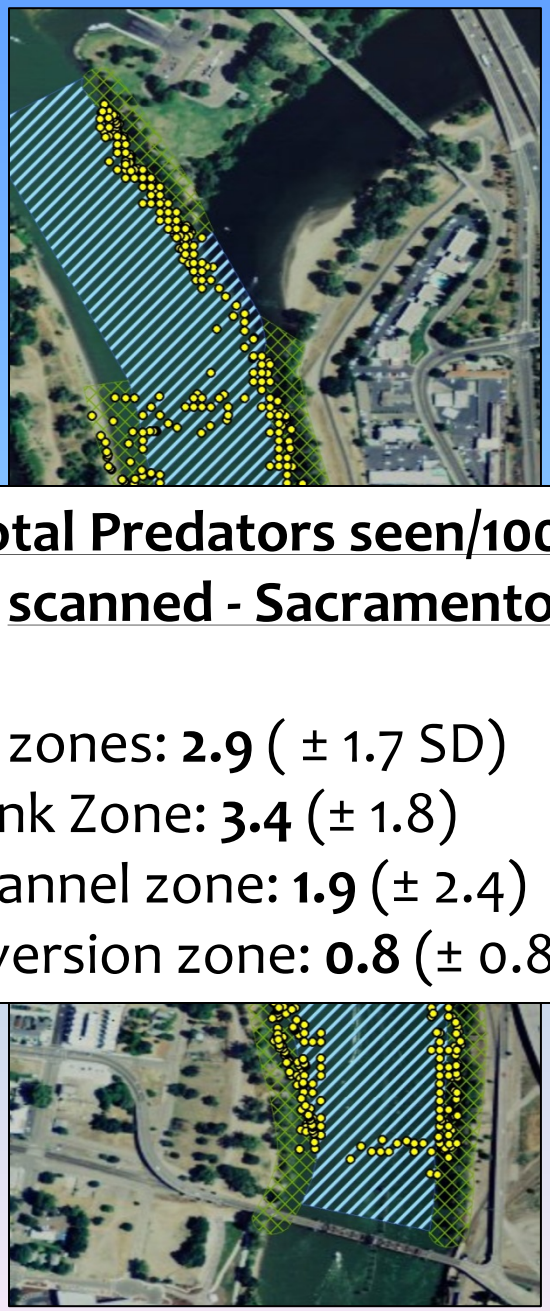


Predators per zone



Total Predators seen/100m scanned - Freeport

-All zones: **2.3** (± 1.5 SD)
-Bank Zone: **2.3** (± 1.8)
-Channel zone: **1.6** (± 1.4)
-Diversion zone: **3.6** (± 3.3)



Total Predators seen/100m scanned - Sacramento

-All zones: **2.9** (± 1.7 SD)
-Bank Zone: **3.4** (± 1.8)
-Channel zone: **1.9** (± 2.4)
-Diversion zone: **0.8** (± 0.8)

Task 3: Predator diets

- Captured predators using tethers and hook and line sampling with live salmon smolts as bait

- In the 3 study years, **155** gastric lavages performed, including:
  - 118 striped bass
  - 10 Sacramento pikeminnow
  - 10 smallmouth bass
  - 9 largemouth bass

- All species and field sites combined:
  - 39.4% stomachs were empty
  - 20.0% of stomachs had unidentified fish parts
  - 1.9% of stomachs had salmon smolt parts

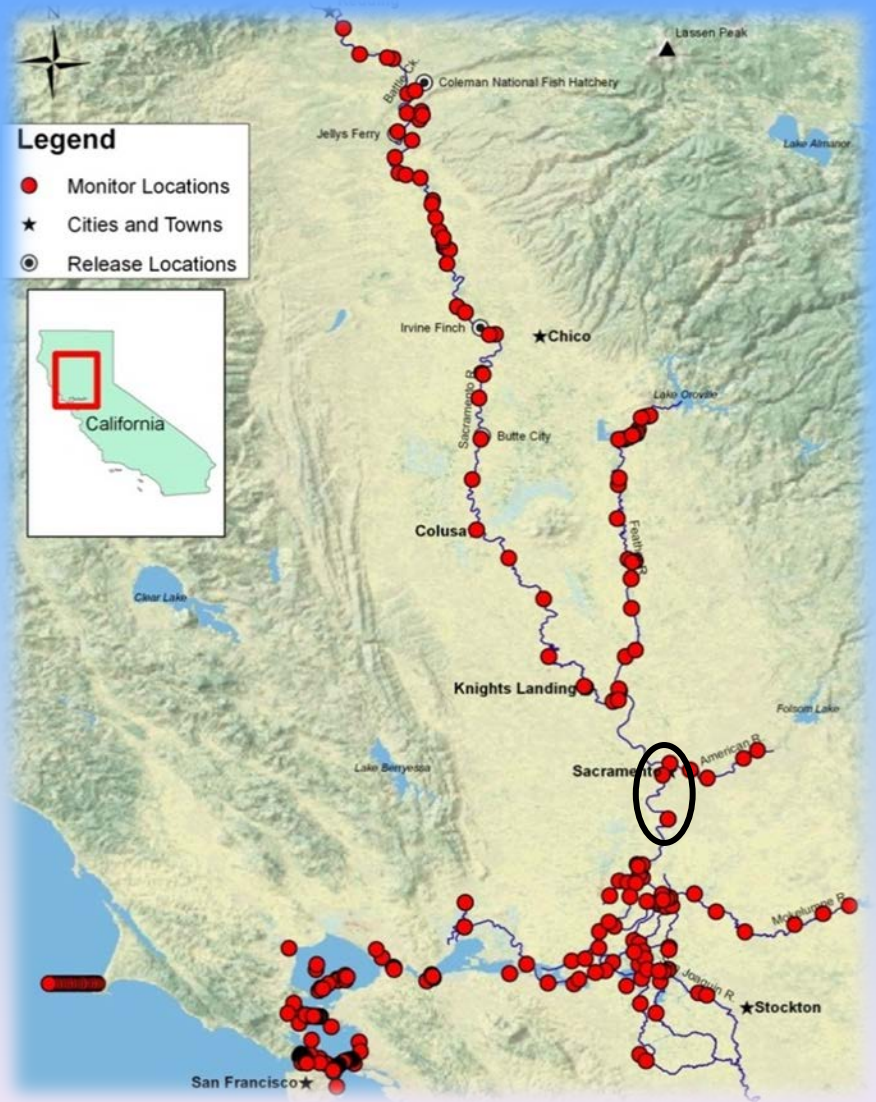
Task 3: Predator home range

Between 2011 and 2013, 140 predators have been acoustic tagged, including:

- **104** striped bass ranging from 22 to 63 cm
- **21** Sacramento pikeminnow ranging from 24 to 54 cm

Question: Are these predators aggregating near the diversions for long periods of time?

Home range?



For 2011 and 2012 seasons:

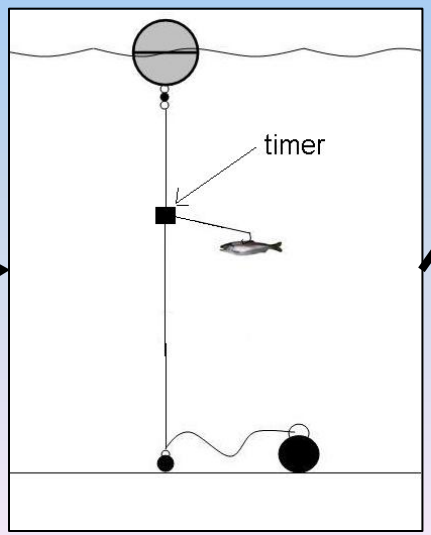
- **52** of the **57** striped bass left the study sites within 2 days of tagging, most moving downstream to the West Delta and Suisun Bay
- The remaining **5** striped bass stayed near the study sites for 2-5 months

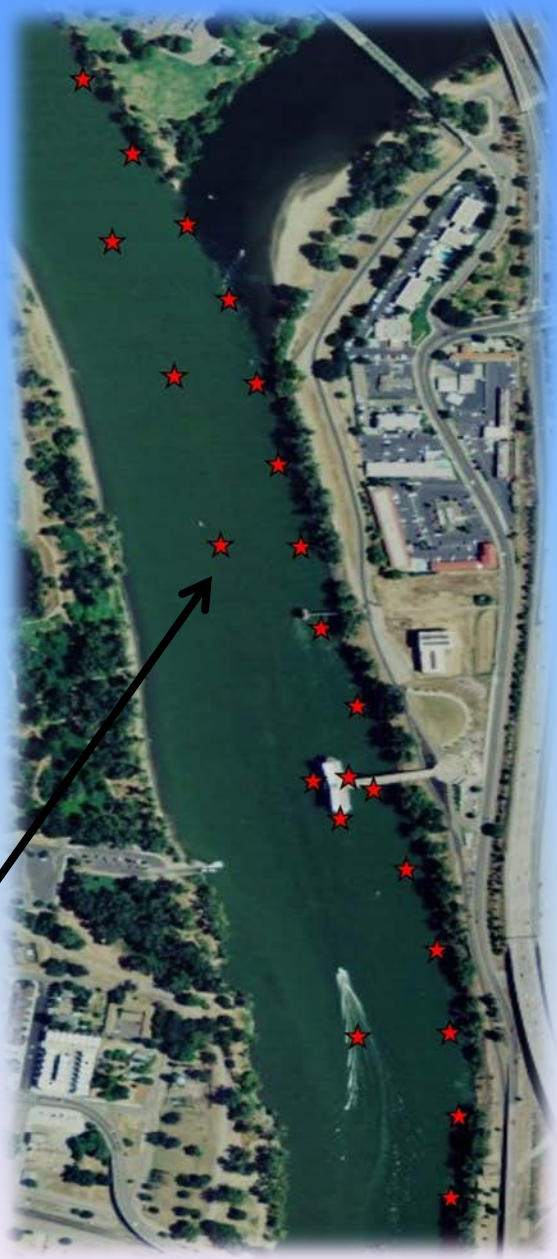
- **5** of the **9** pikeminnow stayed in the study site for several months
- The remaining **4** pikeminnow left the study site with 2 days of tagging, most moving downstream to the North Delta

Task 4: Tethering

- Deploy tethering units baited with a live Chinook salmon smolt throughout study site
- Leave them out for an hour at a time
- Deploy in tandem with DIDSON scan during dawn, dusk, day, and night events, during **fall run Chinook salmon** smolt outmigration season

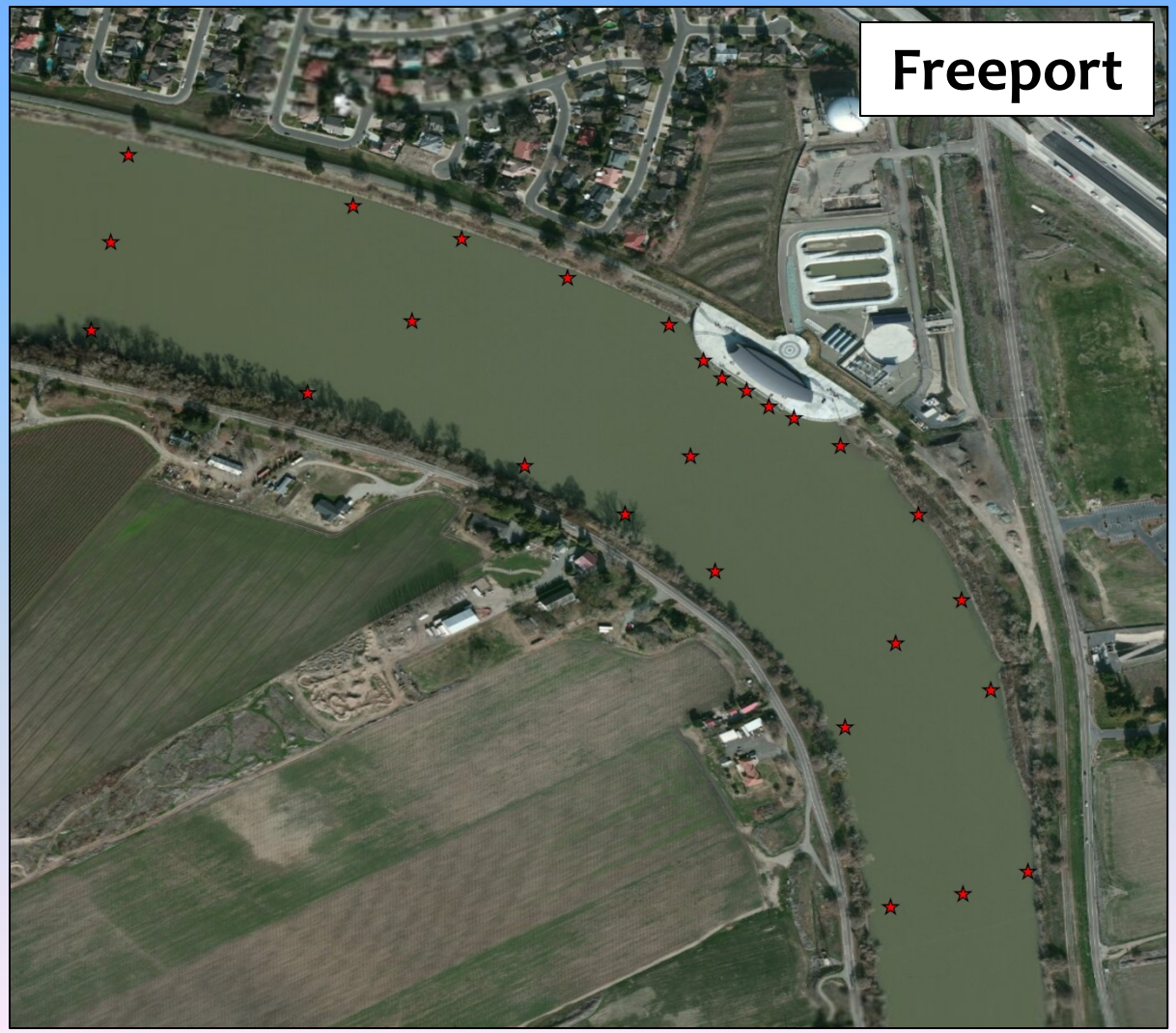
Question: Are relative predation rates higher around the diversion versus other areas?

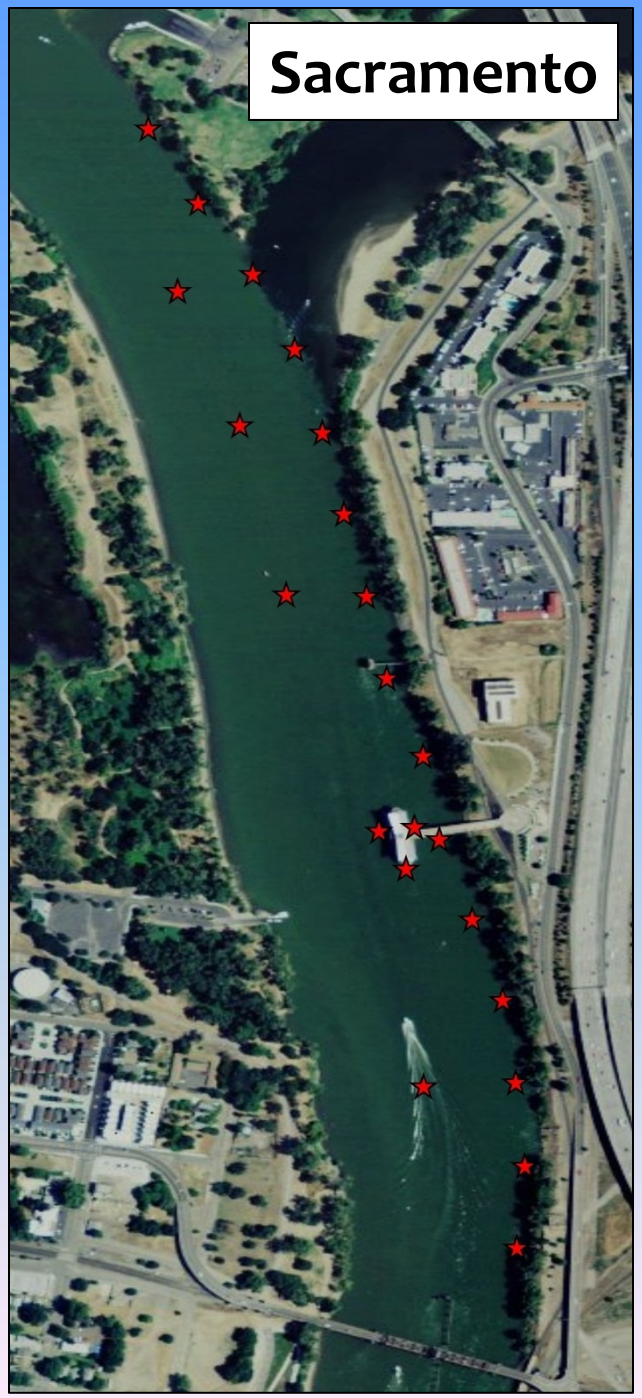




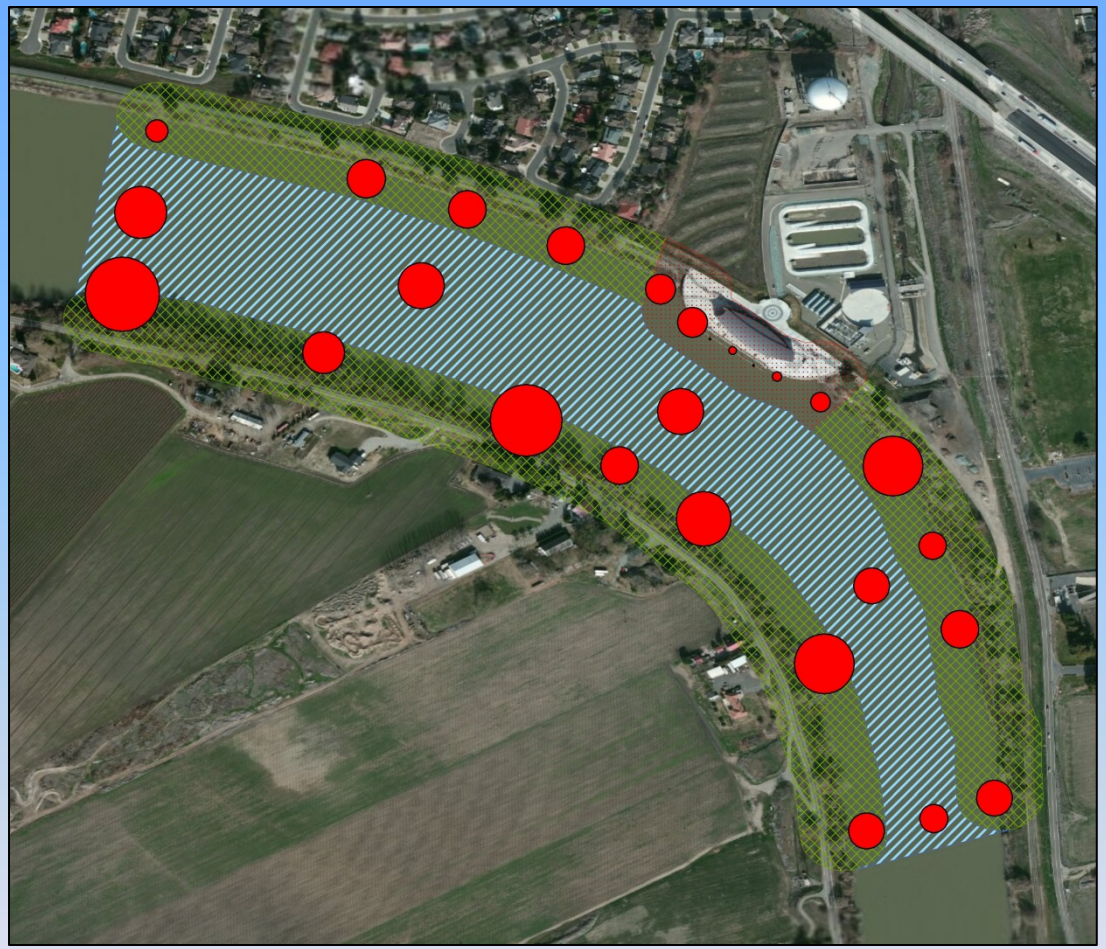
Tether sites: large diversions

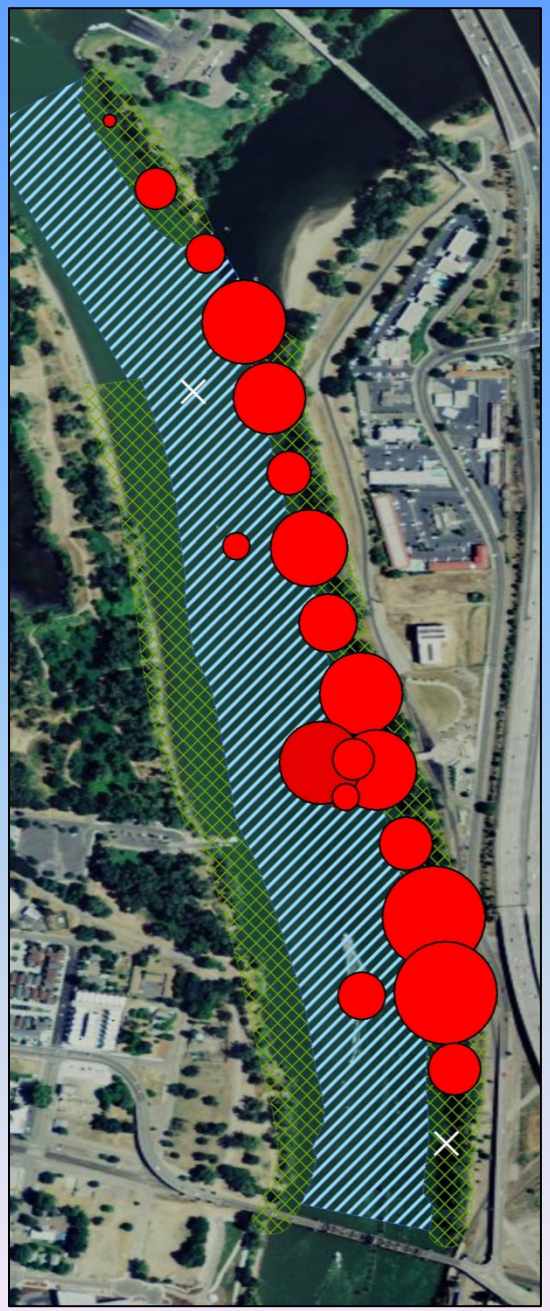
From 2011 to 2012, a total of 64 tether events performed, deployed for 1 hour each



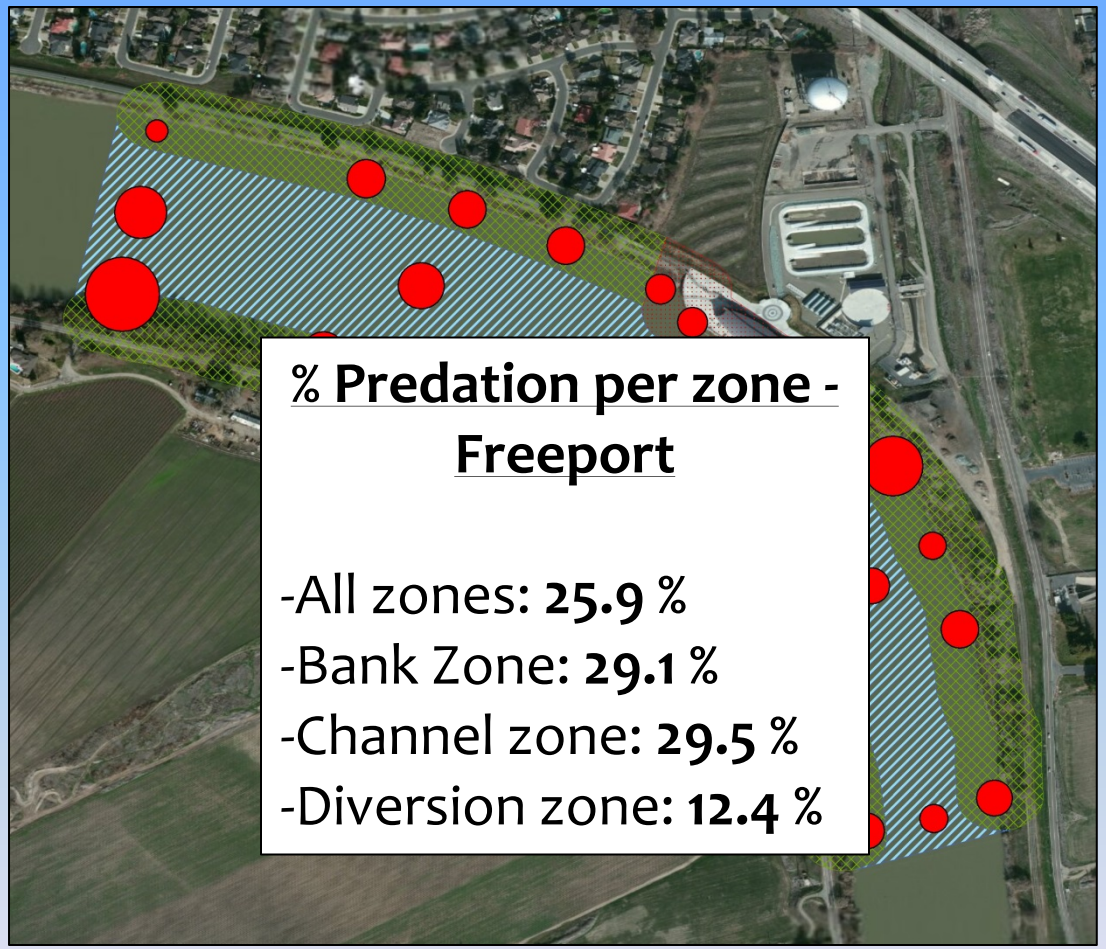


Relative predation rates



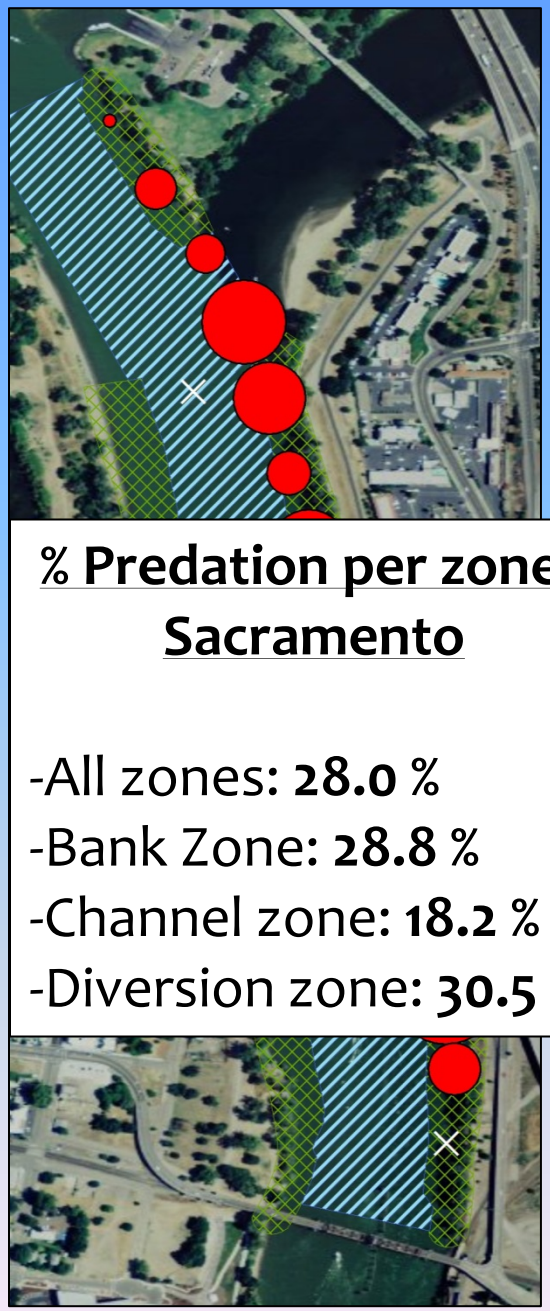


Relative predation rates



% Predation per zone - Freeport

-All zones: **25.9** %
-Bank Zone: **29.1** %
-Channel zone: **29.5** %
-Diversion zone: **12.4** %



% Predation per zone - Sacramento

-All zones: **28.0** %
-Bank Zone: **28.8** %
-Channel zone: **18.2** %
-Diversion zone: **30.5** %

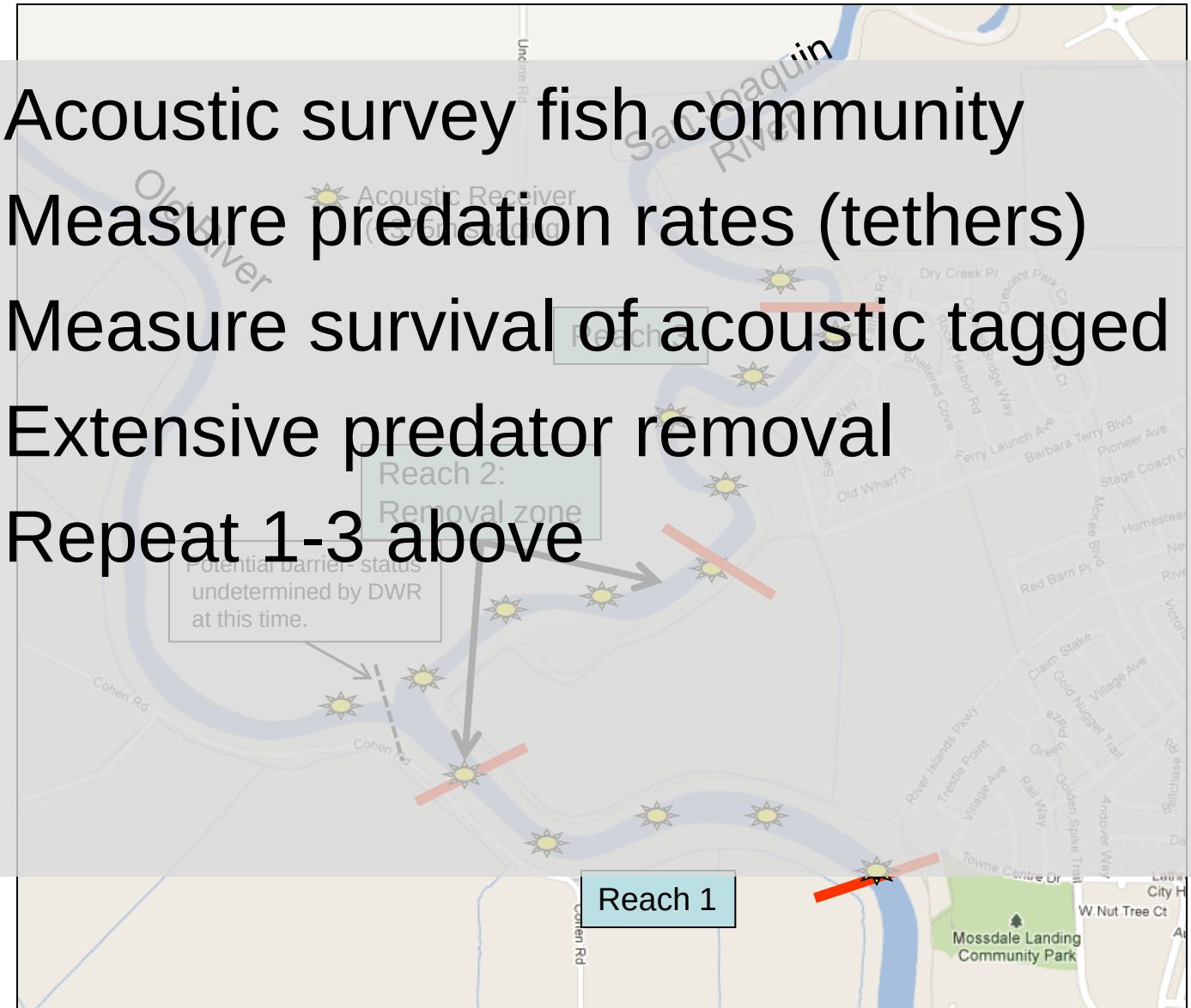
Predators and predation through the fall run smolt outmigration season

	Early April	Late April	Early May	Late May	Early June
Sacramento					
Predators/100m scanned	0.80	1.88	7.21	3.32	3.37
Chance of predation (%)	18.2	26.7	29.2	32.8	28.8
Freeport					
Predators/100m scanned	0.92	2.36	4.36	3.26	2.62
Chance of predation (%)	23.1	28.6	17.8	36.5	27.1

San Joaquin predator study

(2014-2015)

1. Acoustic survey fish community
2. Measure predation rates (tethers)
3. Measure survival of acoustic tagged fish
4. Extensive predator removal
5. Repeat 1-3 above



NMFS Ocean Salmon Trawl Survey
1998 – 2005
(resumed 2011-2013)

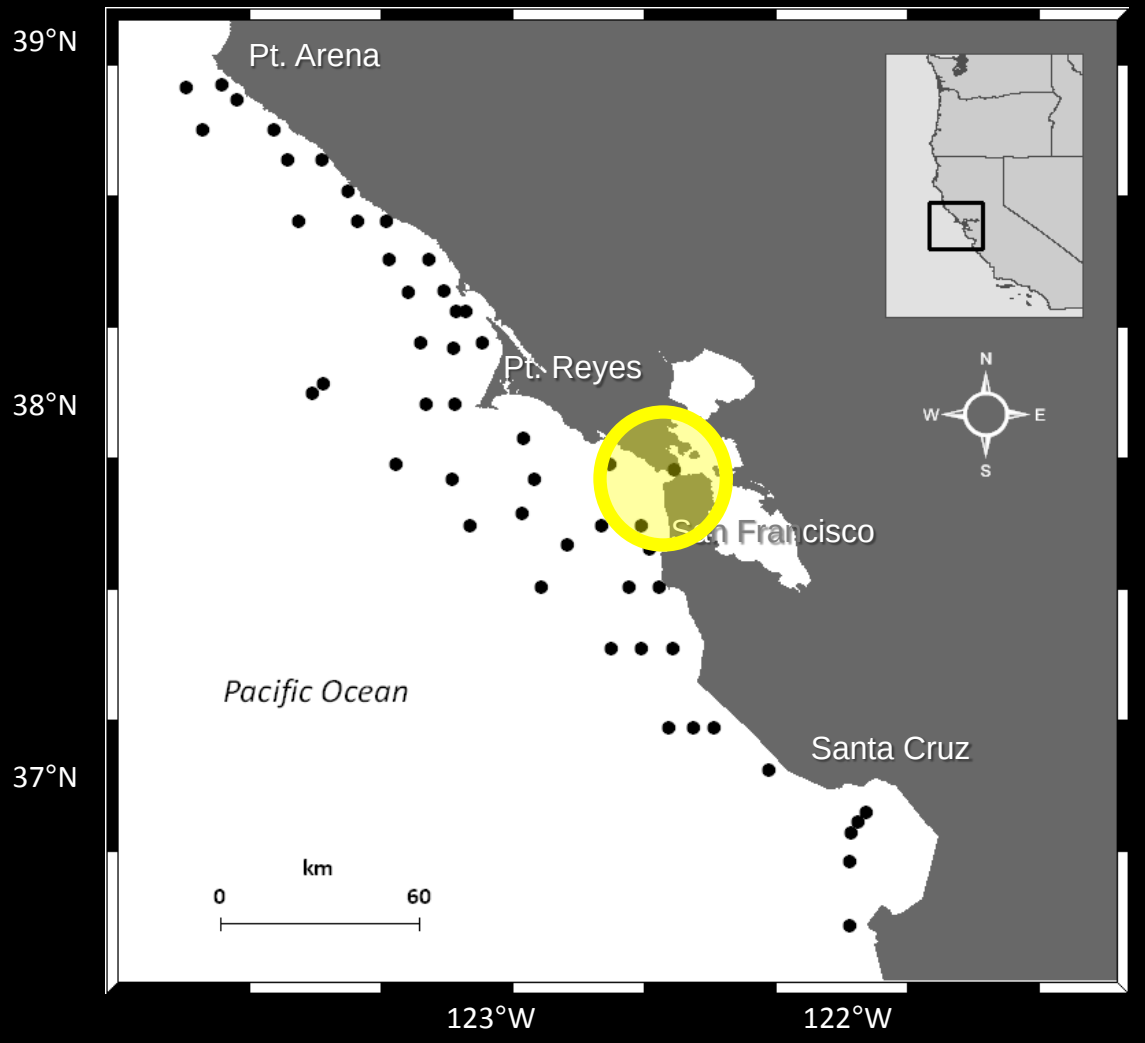
South West Fisheries Science Center, Santa Cruz Laboratory

Sampling Design

Golden Gate (GG)
May and June

Summer Ocean (SO)
June and July

Fall Ocean (FO)
October



Sampling Design

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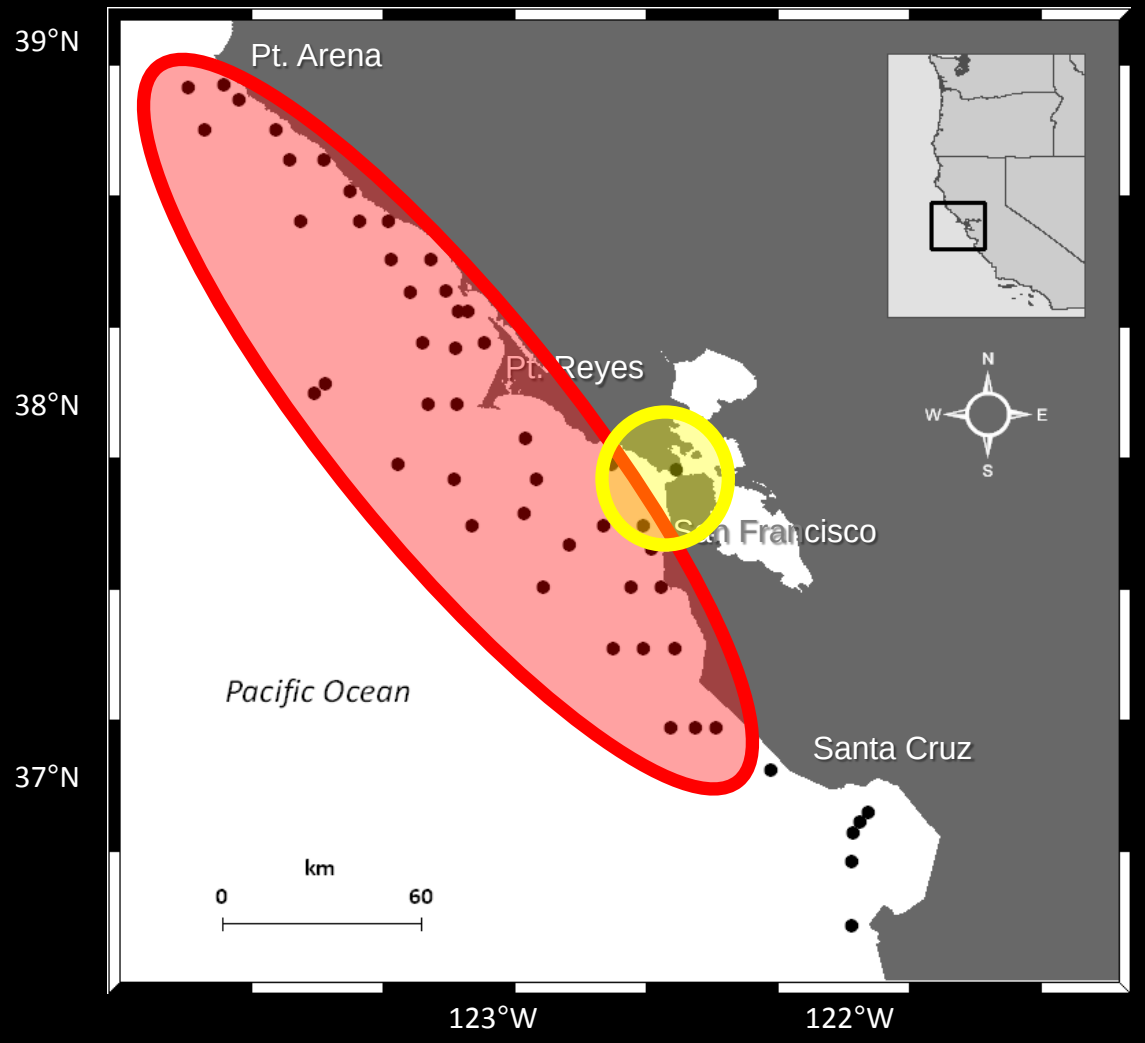

Sampling Design

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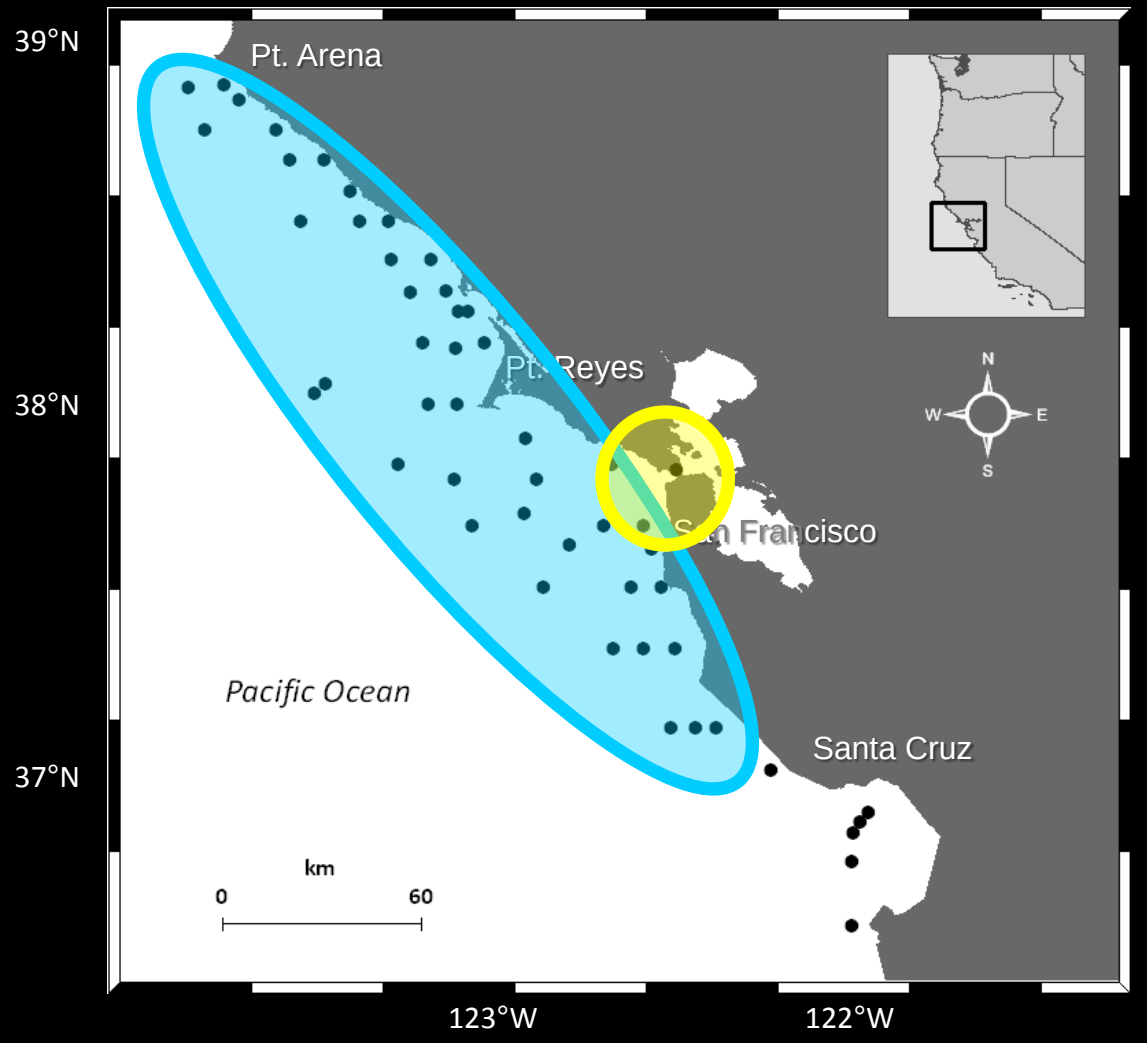
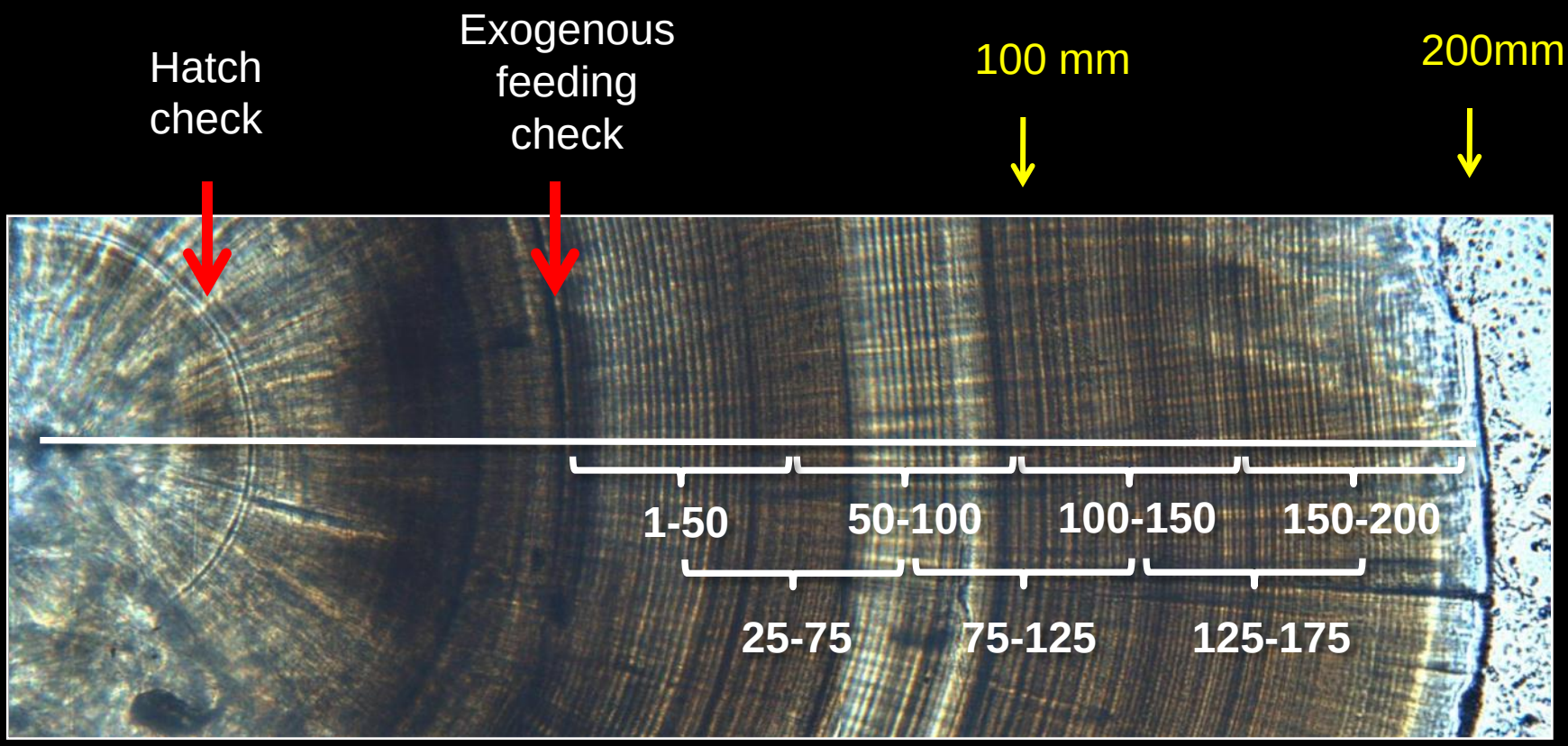
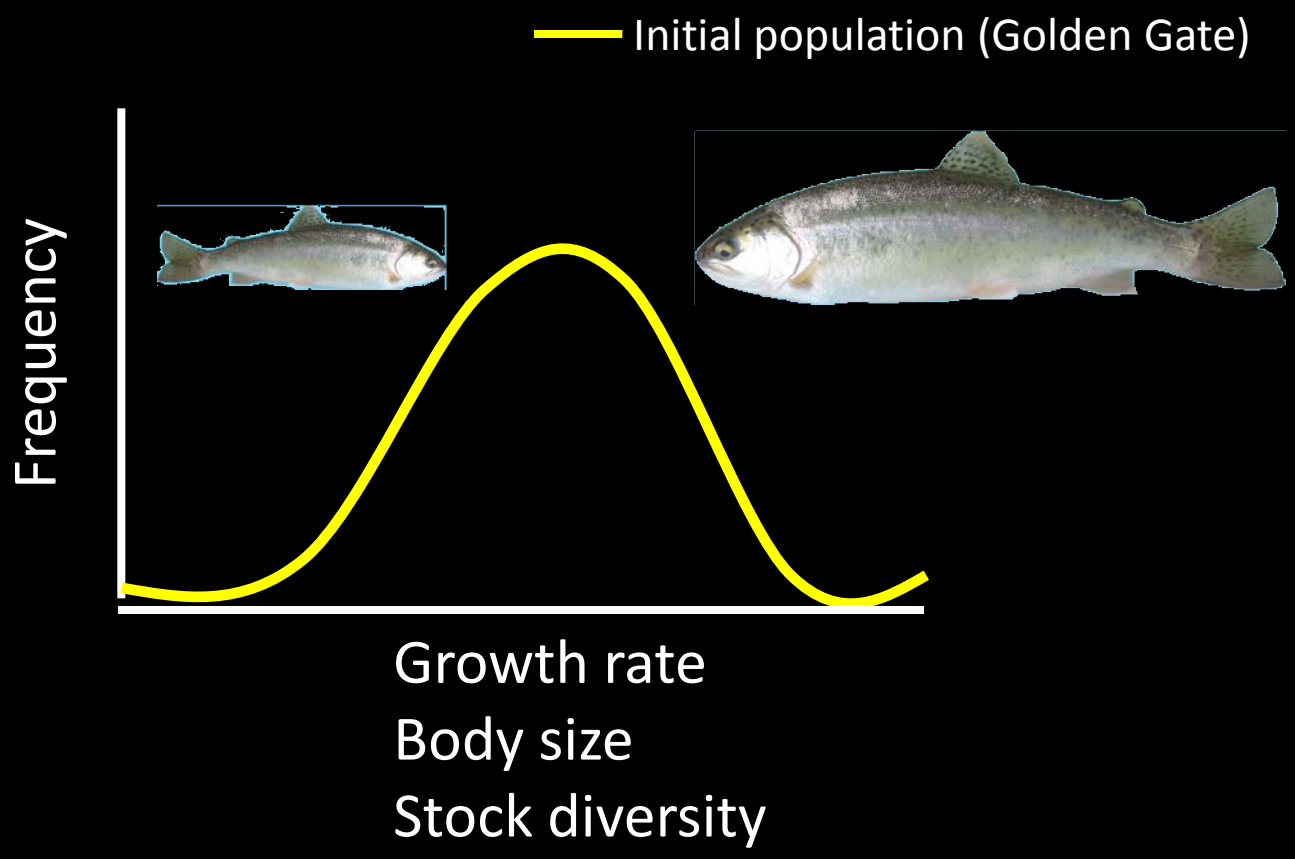


Growth rate

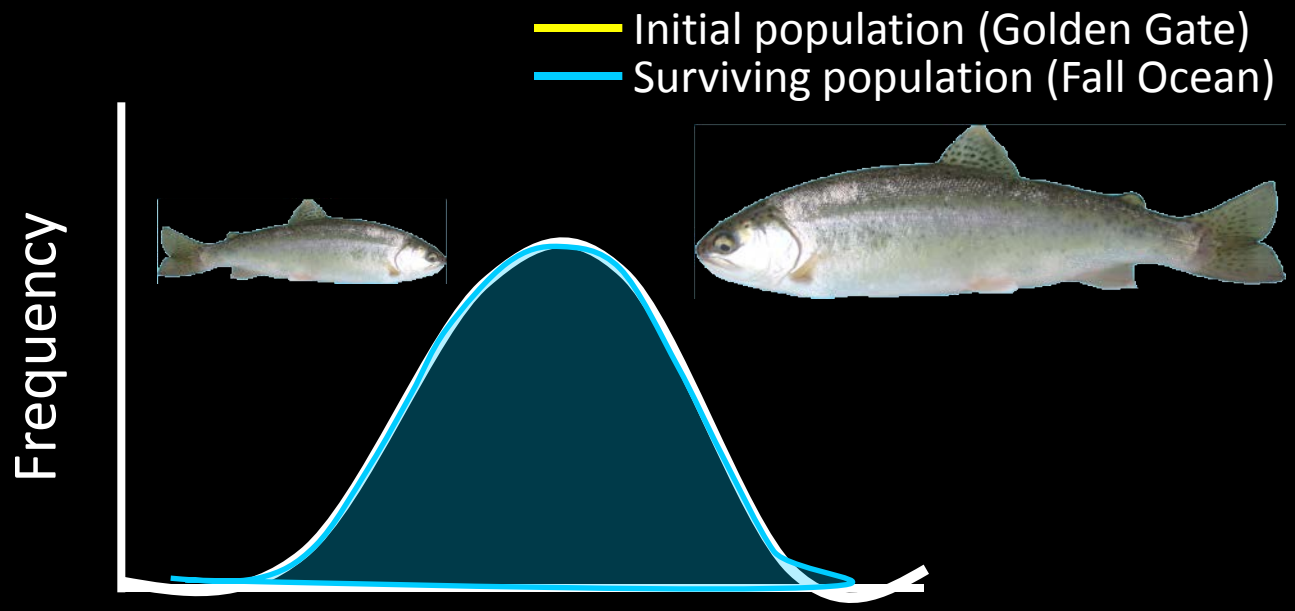

Hatch check
Exogenous feeding check
100 mm
200mm
1-50
50-100
100-150
150-200
25-75
75-125
125-175

Reconstructing Selective Mortality



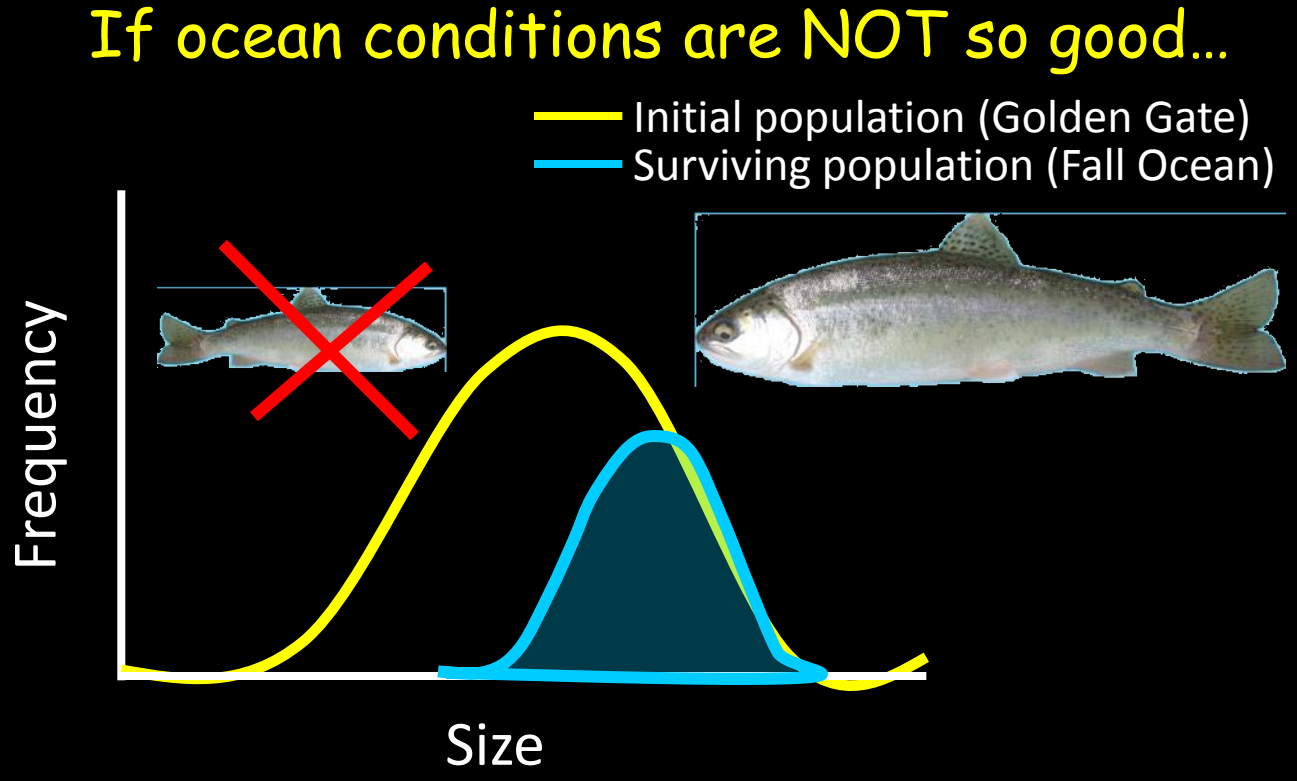
Reconstructing Selective Mortality

If ocean conditions are good…



Similar distributions – NO selective mortality

Reconstructing Selective Mortality



Different distributions = Size selective mortality

Lindsay E. Woodson, Brian K. Wells, Rachel C. Johnson, Peter K. Weber, R. Bruce MacFarlane George E. Whitman. *In press.* Using size, growth rate and rearing origin to evaluate selective mortality of juvenile Chinook salmon *Oncorhynchus tshawytsch*a across years of varying ocean productivity. Marine Ecology Progress Series