

# Linking Predation Mortality to Predator Density and Survival for Out-Migrating Chinook Salmon in the Lower San Joaquin River and Delta

\*Alison Collins, Shawn Acuña, Michael Beakes, Annie  
Brodsky, Brad Cavallo, Marin Greenwood, Lenny  
Girmaldo, Jason Hassrick, and Steve Zeug

\*The Metropolitan Water District of Southern California  
Cramer Fish Sciences  
ICF International

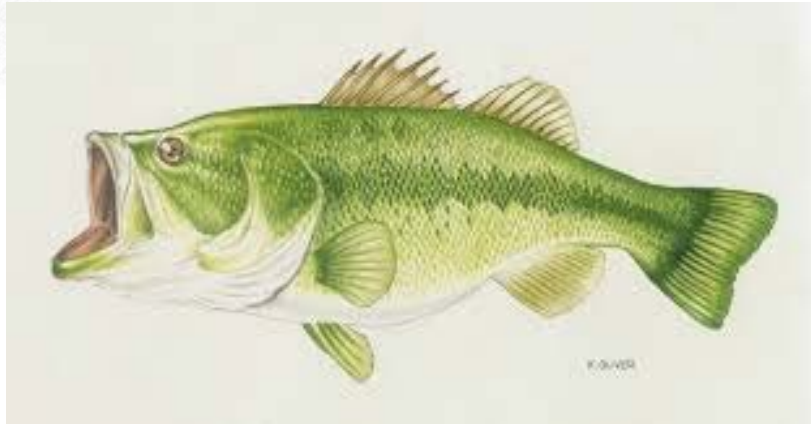
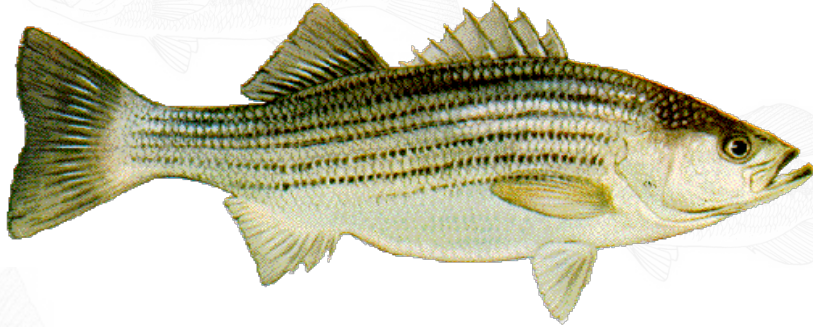
# Is predation a substantial component of salmonid mortality and circumstances of predation?

- Predation mortality rates
- Predator abundance and composition
- Characterize environmental covariates and identify structures associated predation hotspots

# Is predation a substantial component of salmonid mortality and circumstances of predation?

- Predation mortality rates
- Predator abundance and composition
- Characterize environmental covariates and identify structures associated predation hotspots

# Key information on Delta predators is limited



- 31 predator species
  - Fish, reptiles, amphibians, mammals, birds
- Difficult to quantify the impact that predators have on prey populations

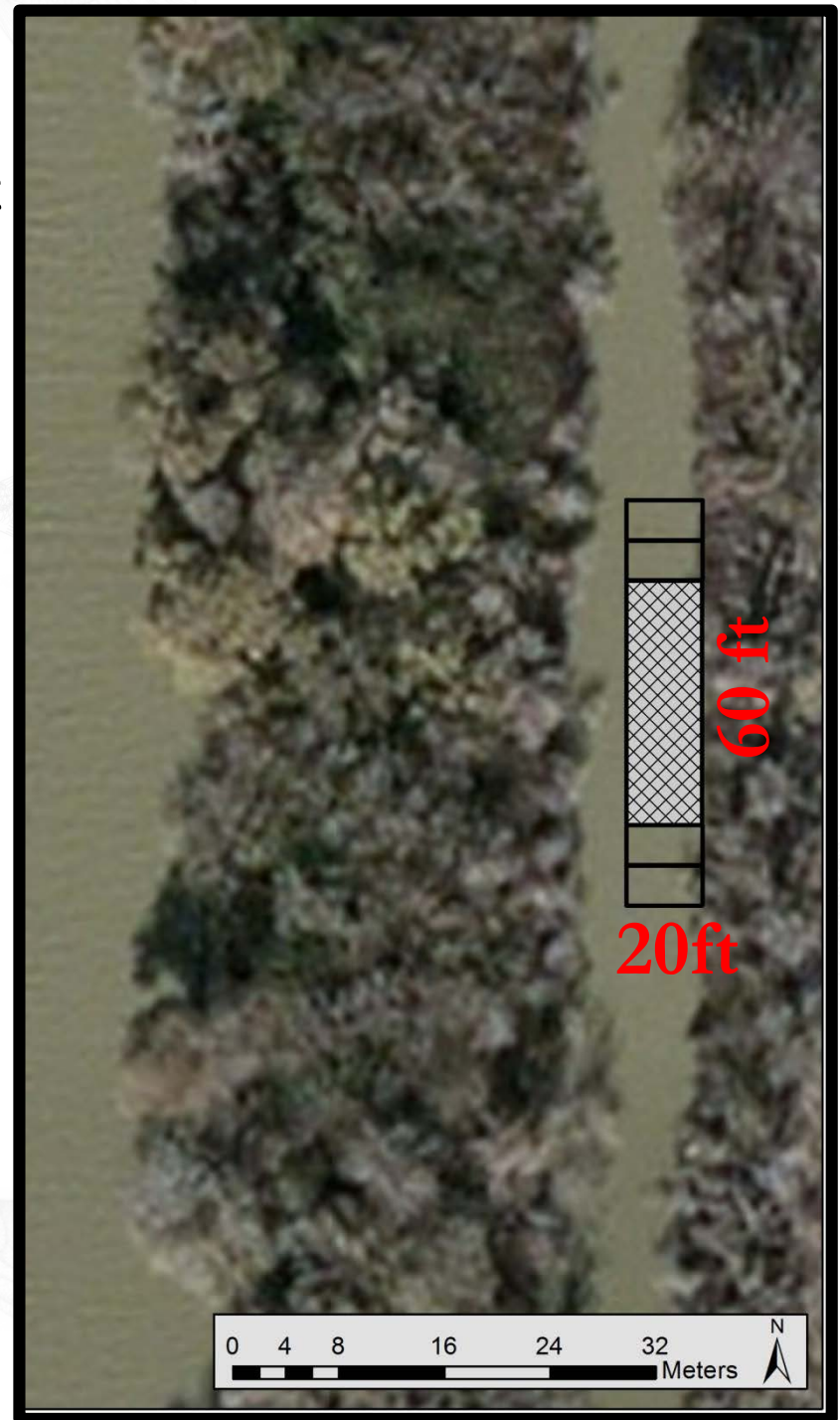
# Our study estimates predation mortality based on predator density and how habitat modifies predation mortality

- Predator enclosures
  - Keep predators in
  - Juvenile salmonids can swim through
  - Predatory density and habitat can be directly manipulated
  - Estimate survival and predation mortality
- Phase I: pilot study
- Phase II: full study



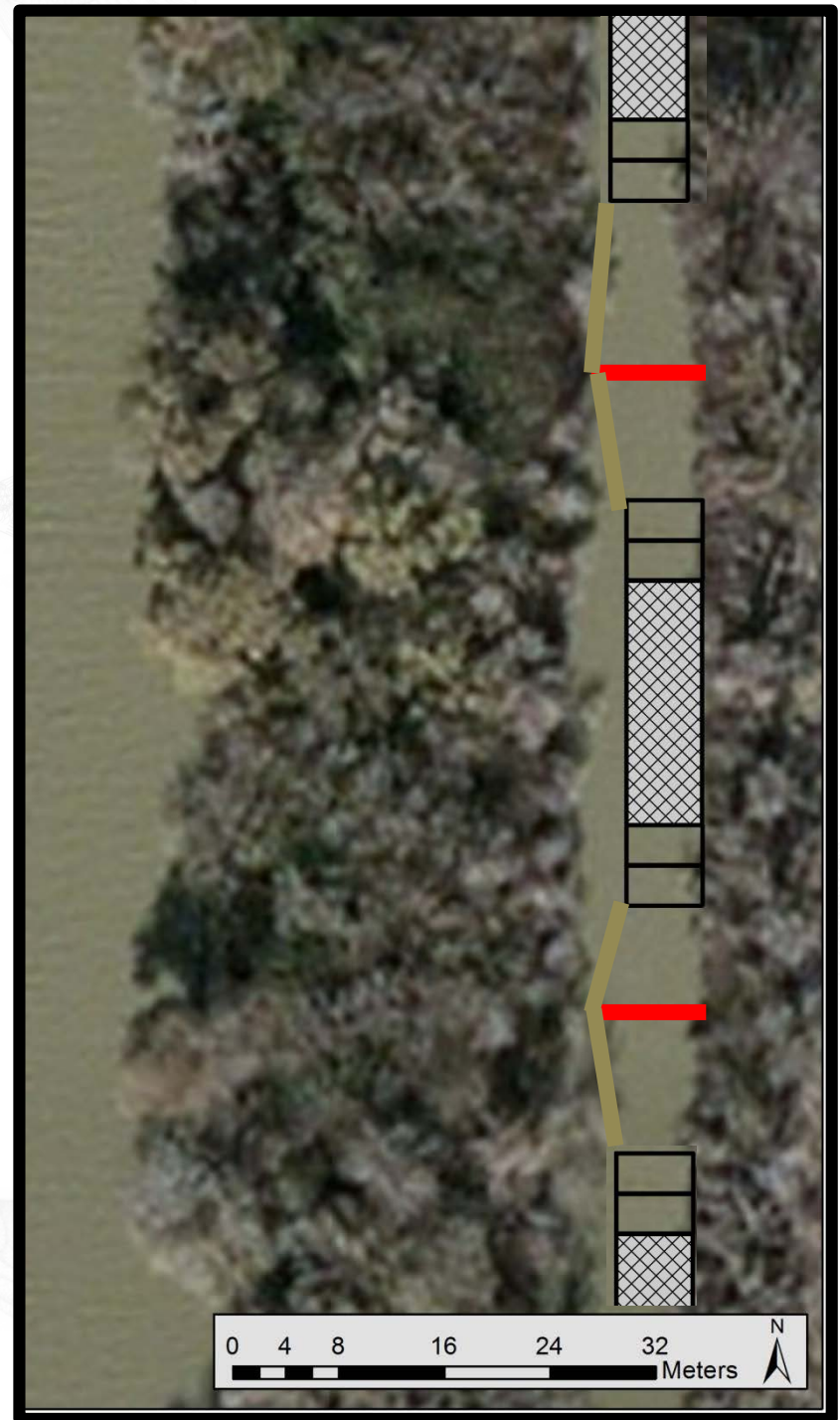
# Predator enclosure

- Large mesh on ends
- One side includes shoreline
- Small mesh on other lateral side
- Area = 100 m<sup>2</sup>
- Predators and fish directly added



# Estimate survival with PIT technology

- PIT tag antenna between each treatment
- Mesh between enclosure and antenna
- Amount of time that tagged fish will spend in the enclosures



# Phase I

How long will fish spend in enclosures?  
What is the best PIT antenna configuration?

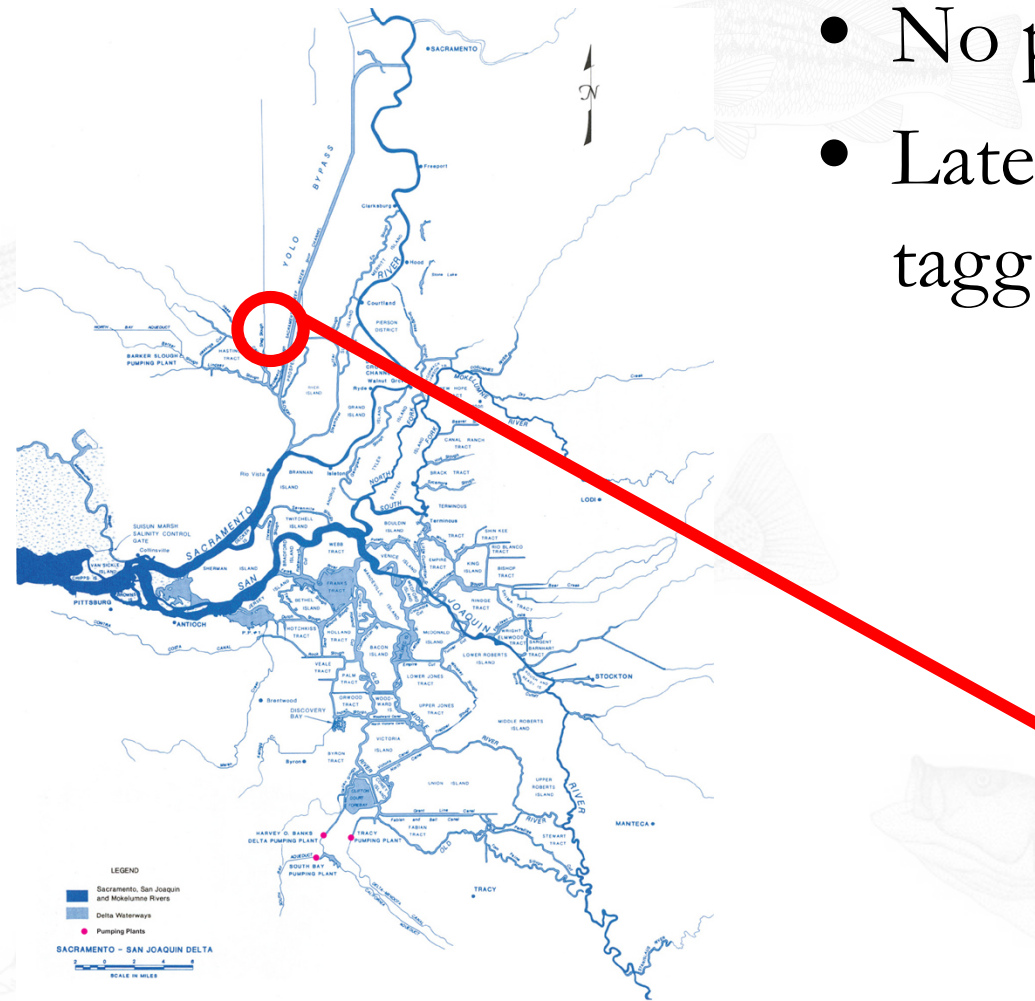
- Timing and movement of tagged fish through enclosures
  - Move on tide, at night, do they school and leave as a group, do they move through as individuals?
- Strategy for releasing tagged fish
  - All together, batches, location in enclosure?
- Efficiency of PIT tag antenna
  - Determine best configuration to ensure high efficiency of tagged fish leaving enclosure



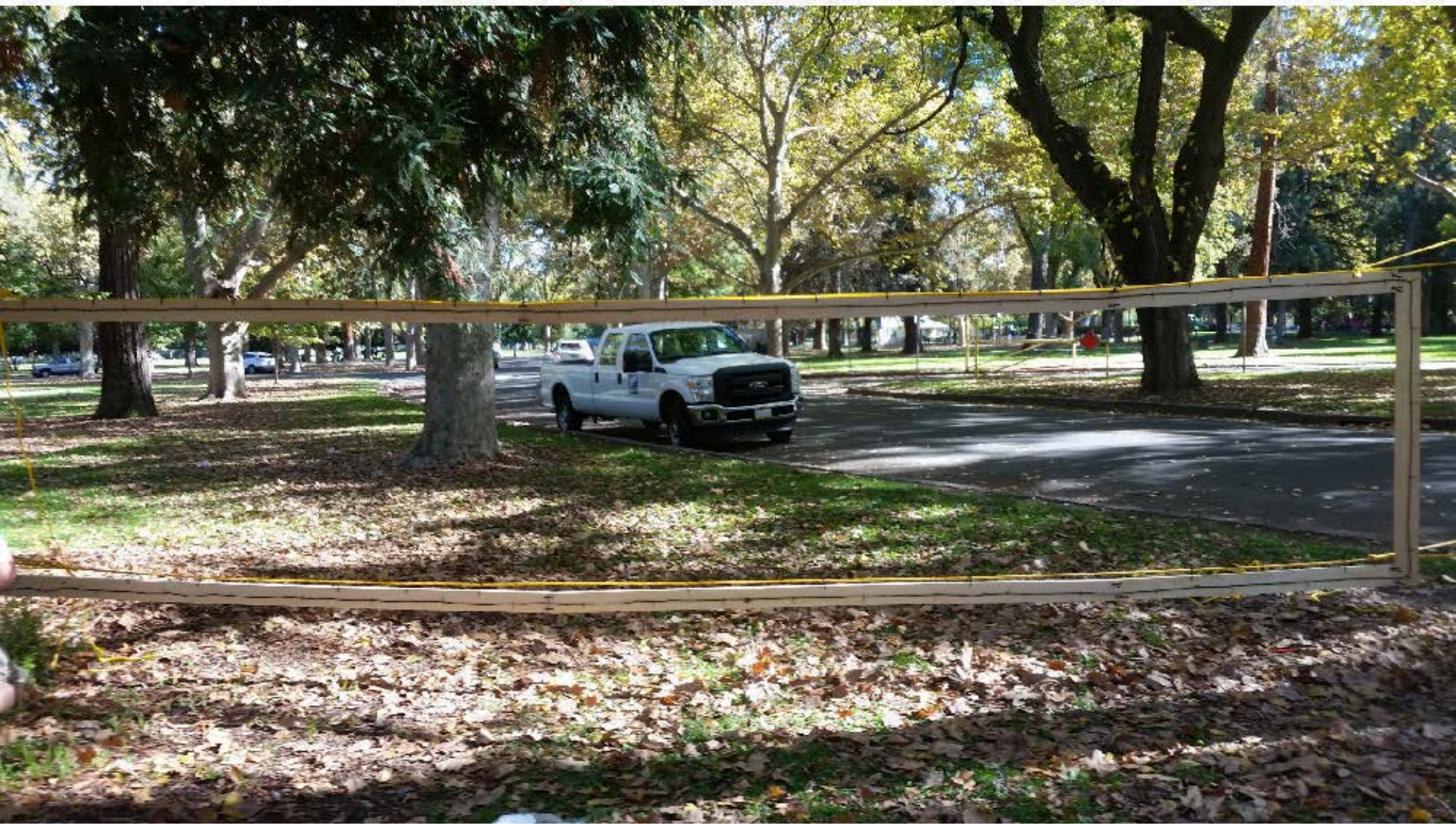
# Phase I

Build enclosure and PIT antenna; release tagged fish

- No predators
- Late fall run Chinook salmon tagged and released

































# Phase II

Estimate how predator density and habitat modify predation mortality

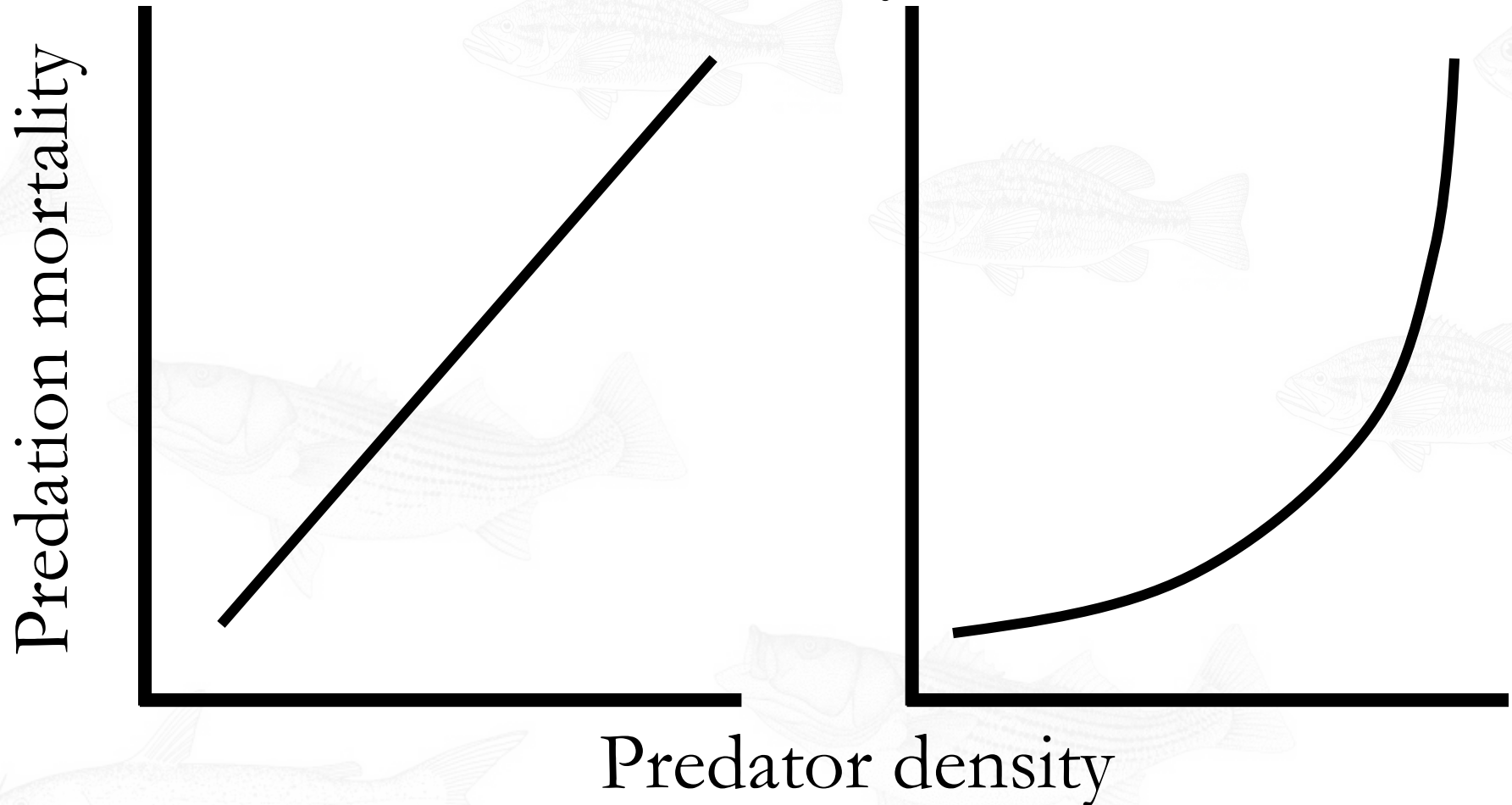
**Predator density experiment**



**Habitat experiment**



What is the functional response of predation mortality to predator density?





# Little Holland Tract 2017



# Sherman Island 2018

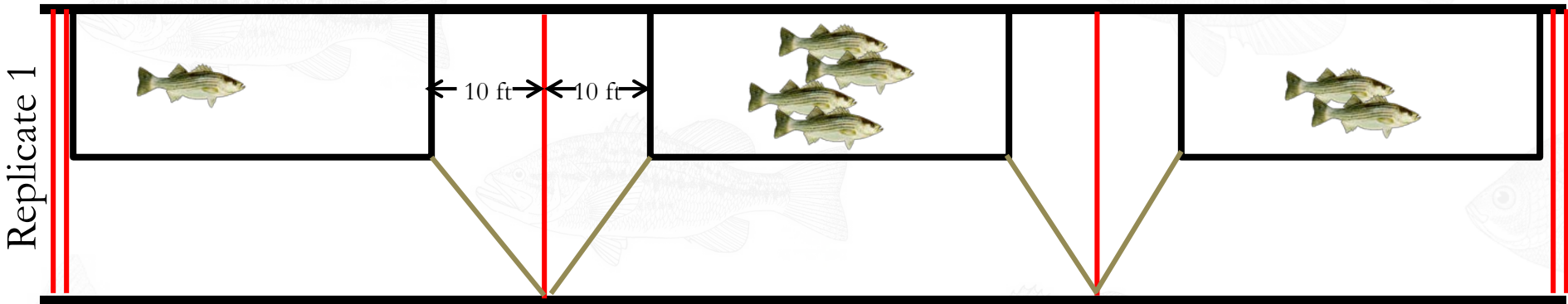


LEGEND  
 Sacramento, San Joaquin  
 and Mokelumne Rivers  
 Delta Waterways  
 Pumping Plants

SACRAMENTO - SAN JOAQUIN DELTA

SCALE IN MILES

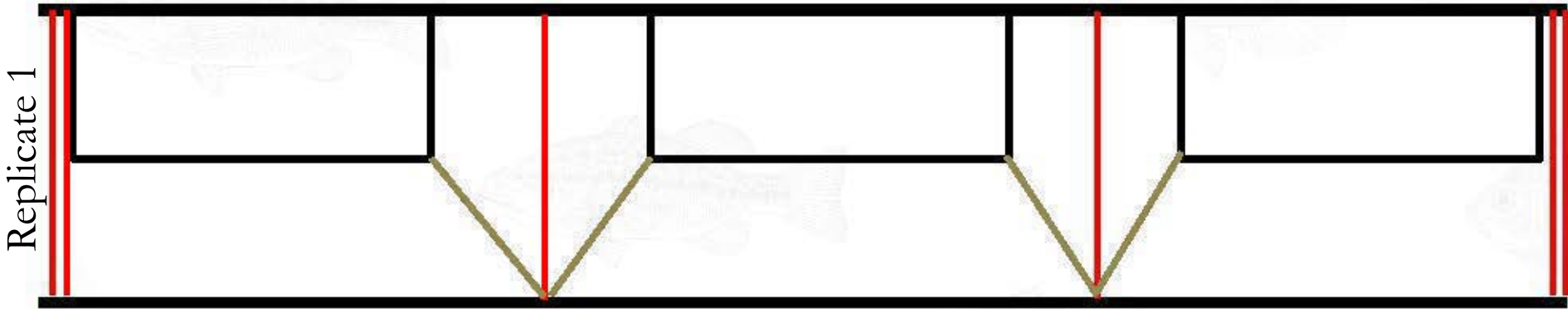
# How does predator density influence predation mortality?



- Predators stocked at different densities
- PIT antennas between enclosures
- PIT tagged fish released simultaneously into each enclosure

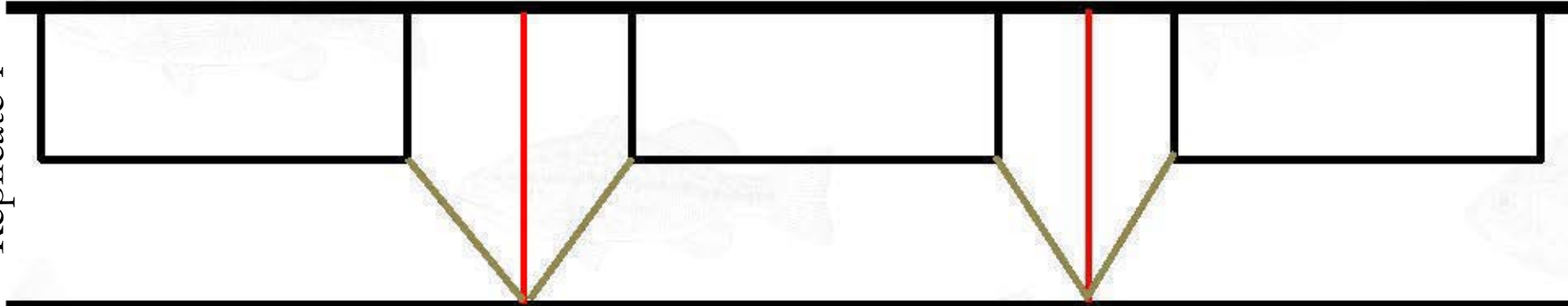


# Predators removed

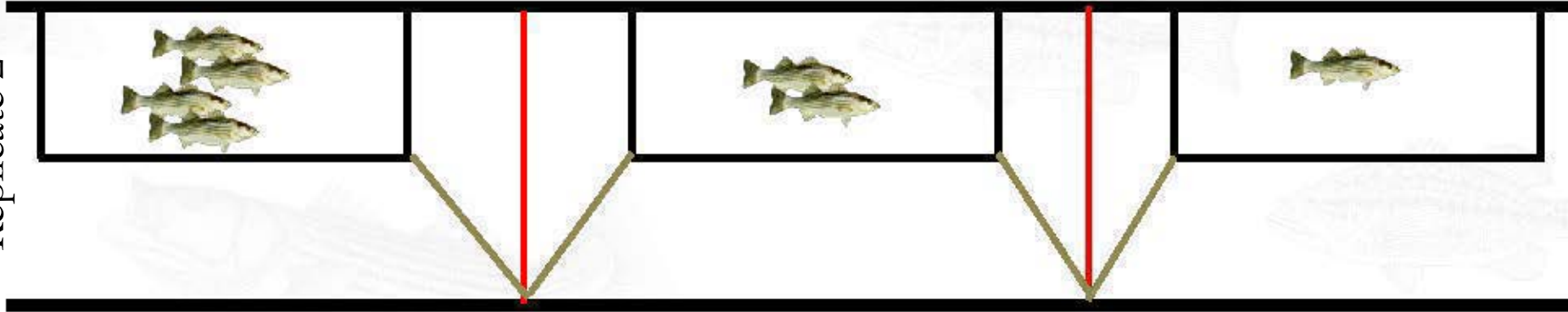


# Predators density rotated into new enclosure

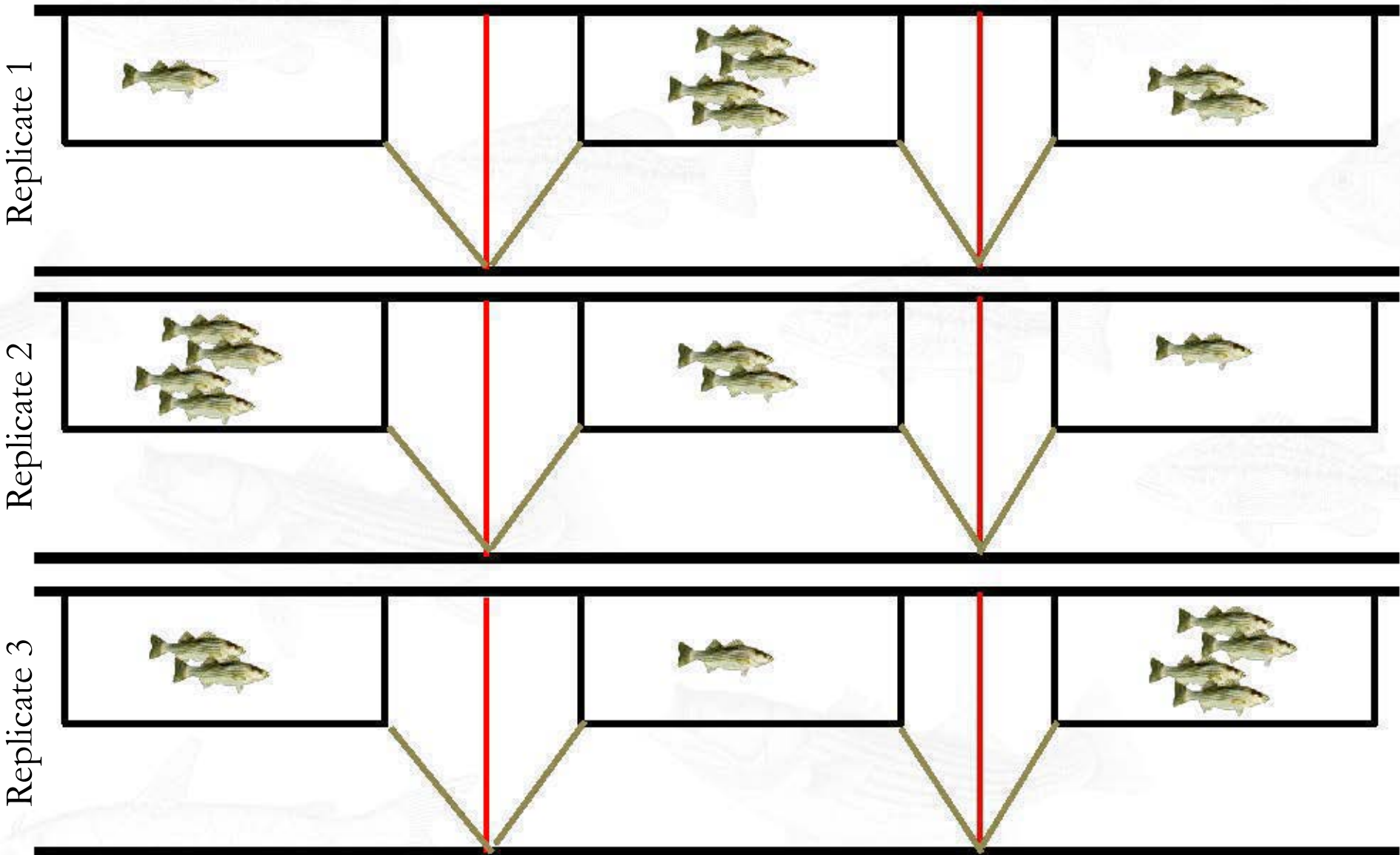
Replicate 1



Replicate 2

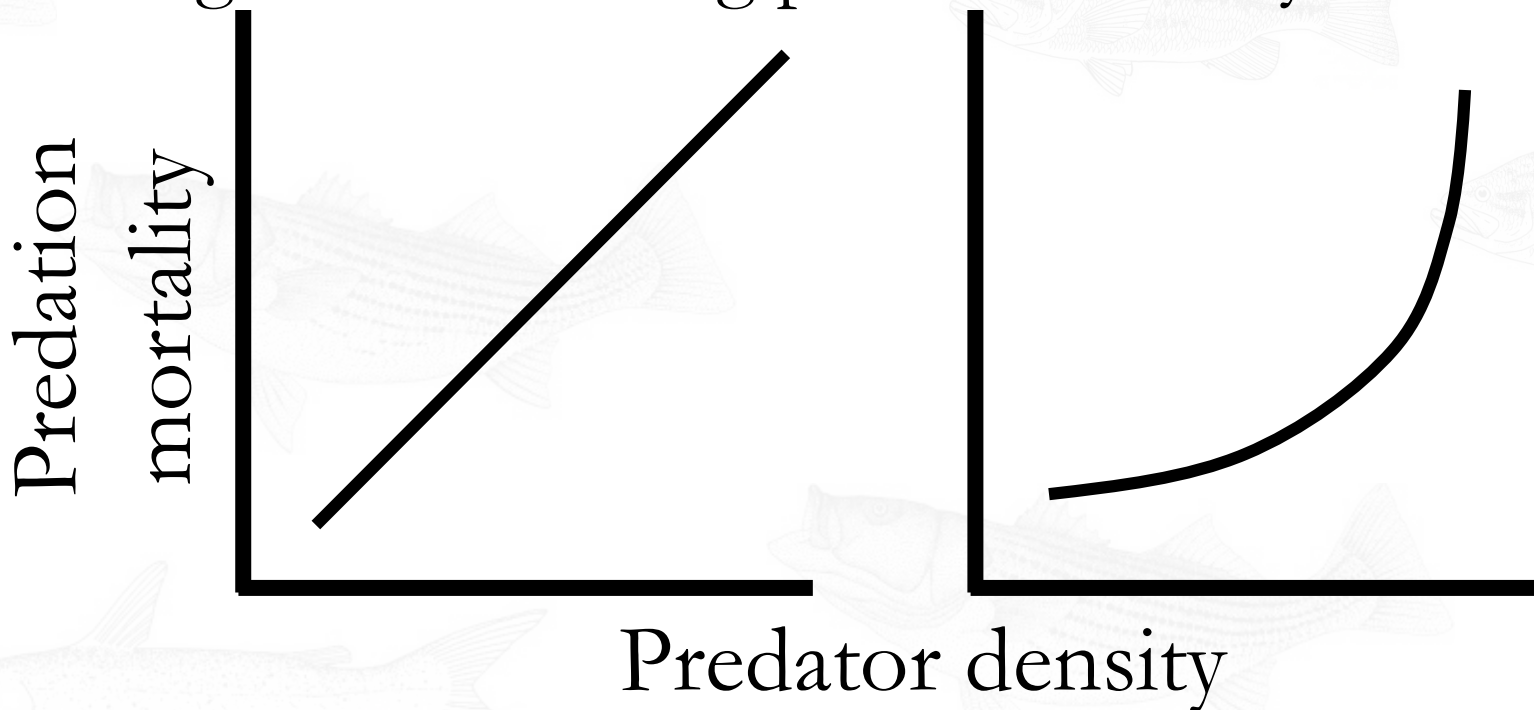


# Predator densities rotated through each enclosure



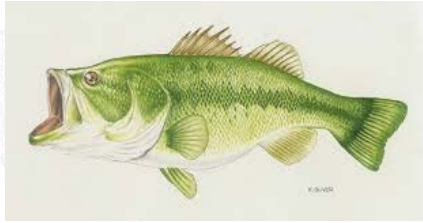
# Estimates of predation mortality inform predation related management actions

- Estimate predation mortality based on predator density in different areas of the Delta
- Targets for reducing predator density





# Habitat modifies predation mortality



**Ambush Predator**



**Roving Predator**

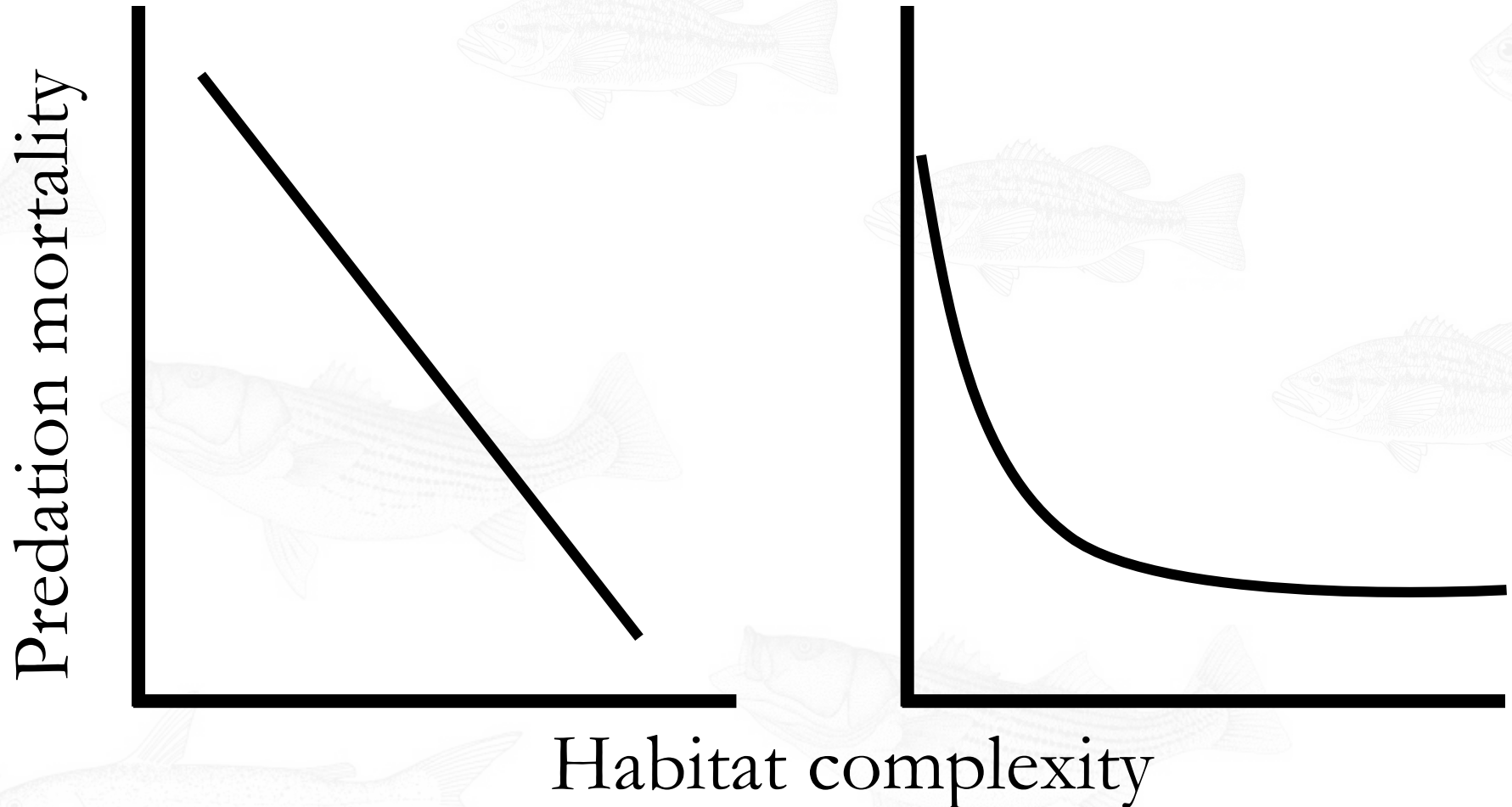


<http://www.koiphen.com/forums/showthread.php?132521-Water-Hyacinth-OMG!>

- More efficient predator
- Sit and wait

- Less efficient predator
- Disrupted searching behavior

How does habitat complexity influence predation mortality?



# Test how three different habitats influence predation mortality?

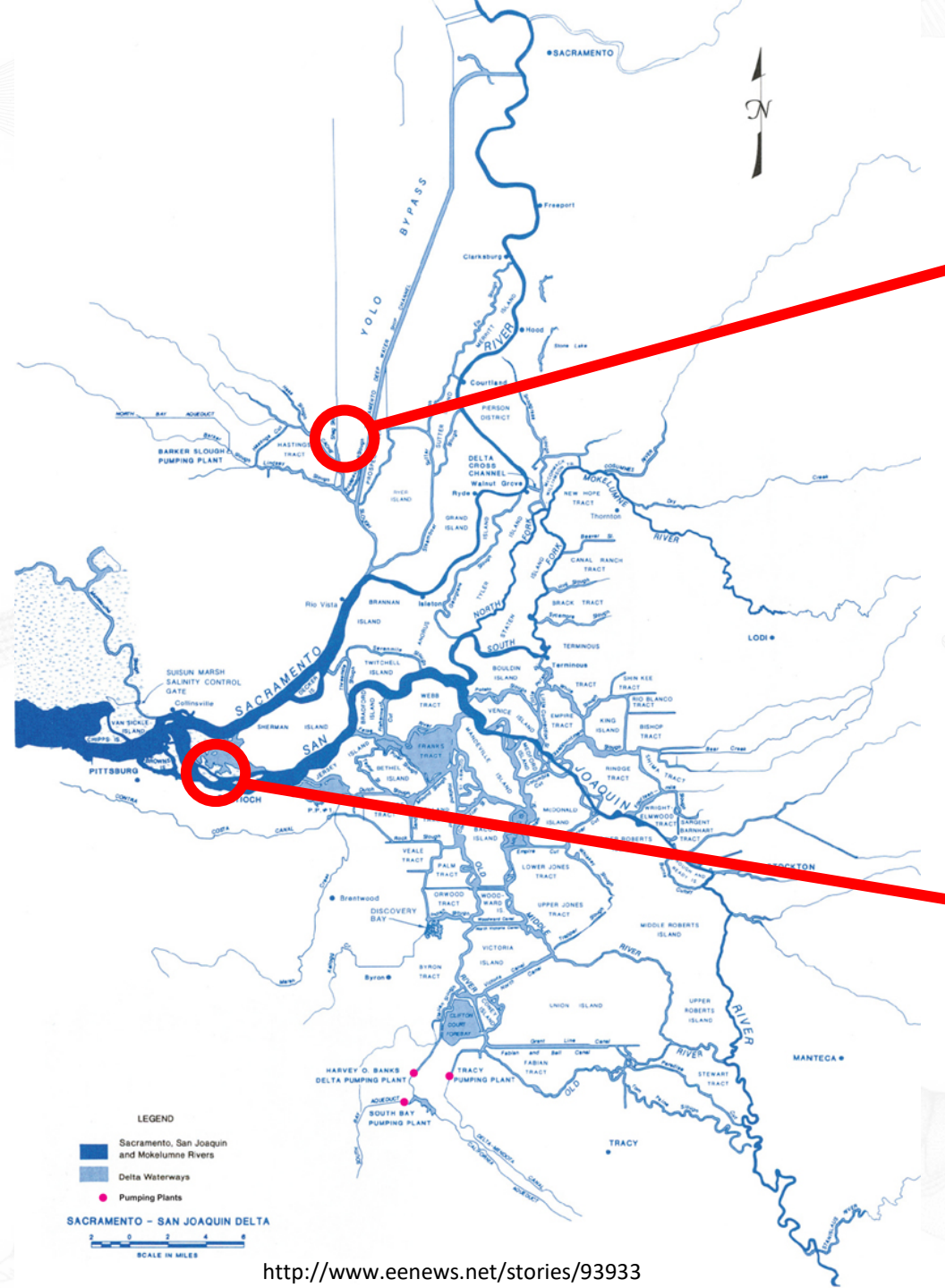




# Little Holland Tract 2017

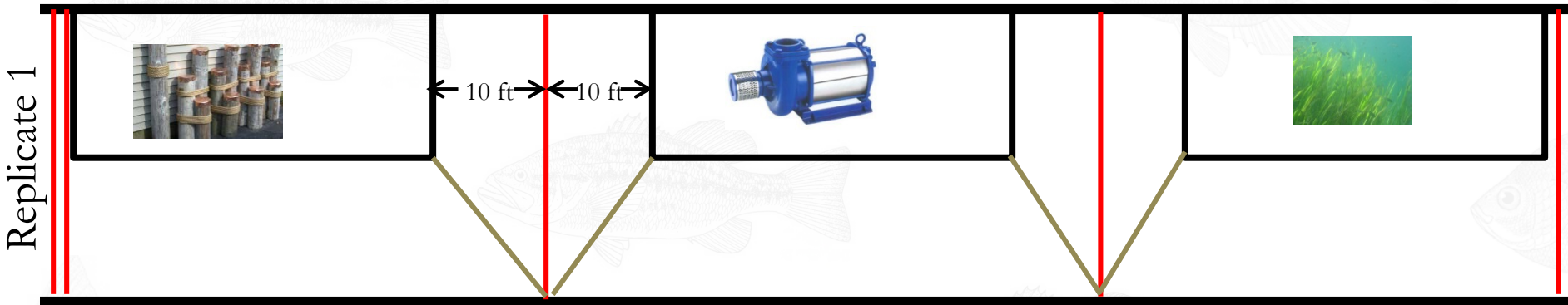


# Sherman Island 2018





# How does habitat type influence predation mortality?



- Habitats placed in each enclosure
- PIT antennas between enclosures
- Predator density held at medium value
- PIT tagged fish released simultaneously into each enclosure

# All habitat types rotated through each enclosure

Replicate 1



Replicate 2



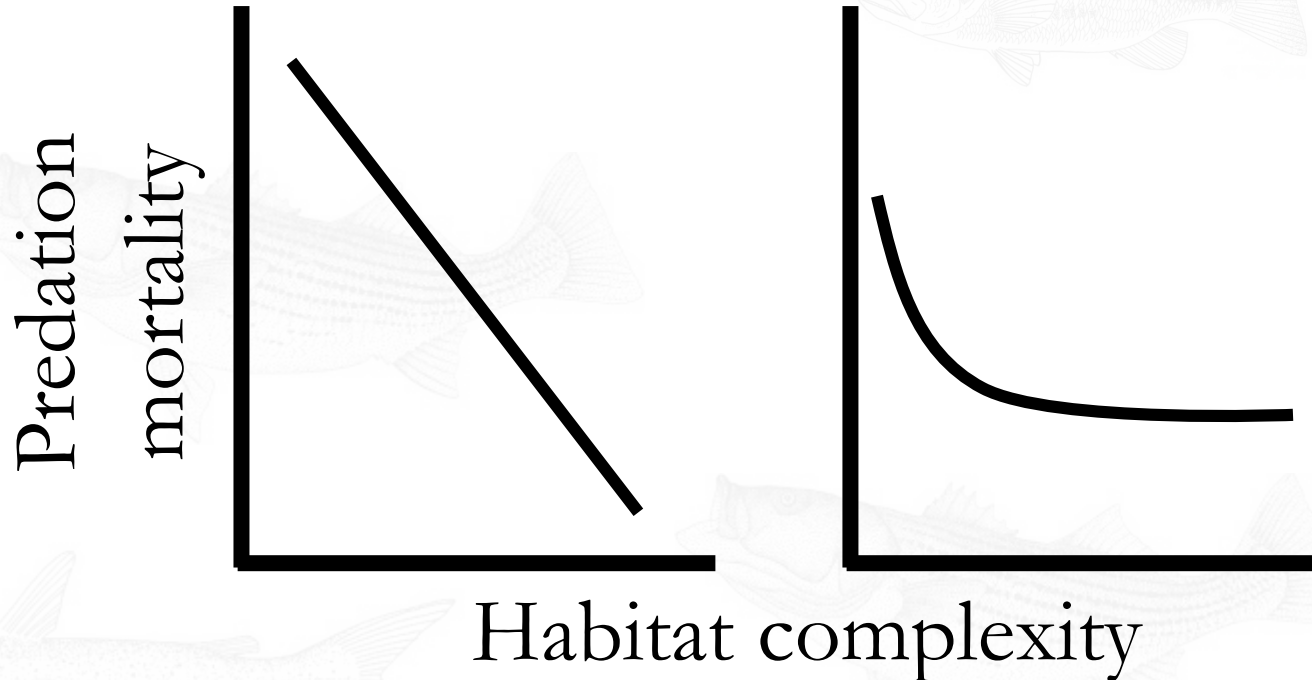
Replicate 3





# Estimates of predation mortality in different habitats inform restoration actions

- Remove simple habitats
- Restore complex habitats
- Level of complexity that is restored



# Is predation a substantial component of salmonid mortality and circumstances of predation?

- Predation mortality rates
- Predator abundance and composition
- Characterize environmental covariates and identify structures associated predation hotspots
- **Determine which factors are most likely to influence salmon predation**
- **Generate Delta-wide spatial-temporal estimates of predation mortality risk and predator density**



# Thank you and questions



Alison Collins: [acollins@mwdh2o.com](mailto:acollins@mwdh2o.com)

