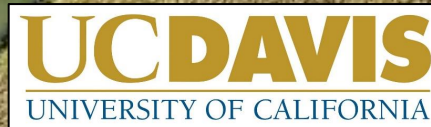


Assessing the Aquatic Health of San Francisco's Tidal Wetlands

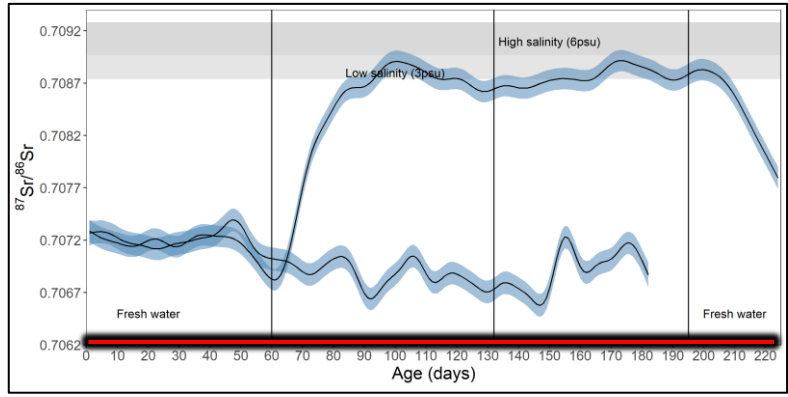
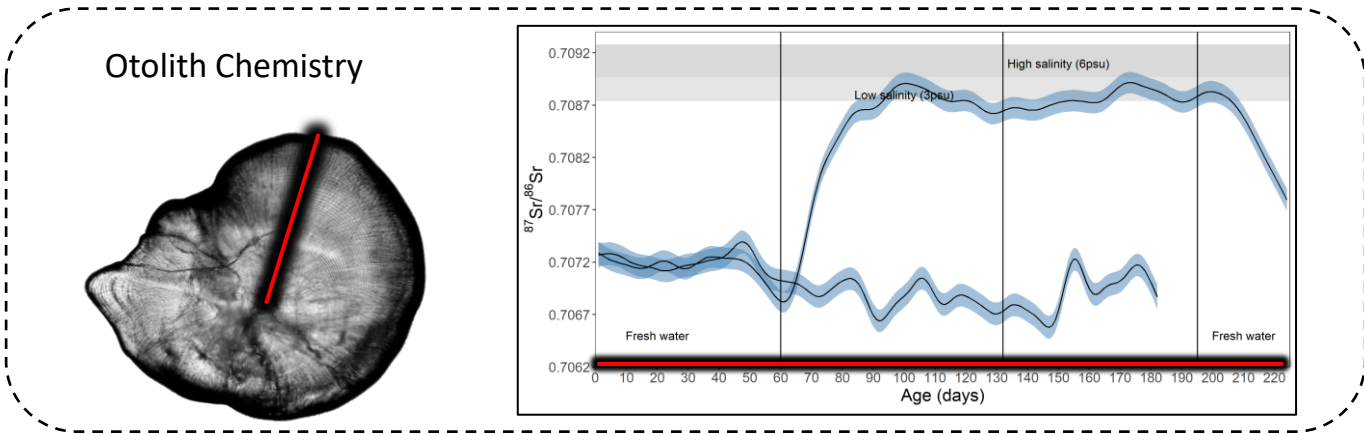
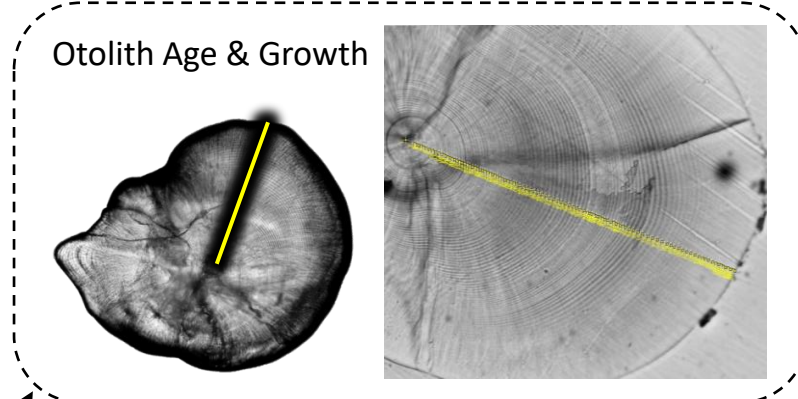
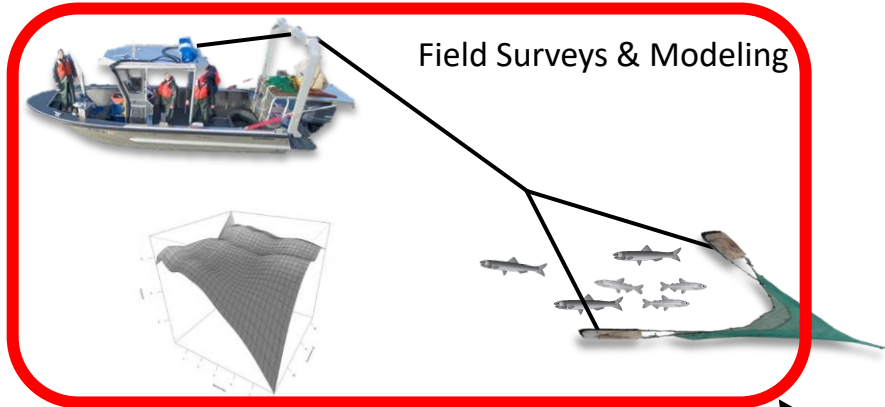
Levi S. Lewis

Otolith Geochemistry & Fish Ecology Laboratory
Dept. Wildlife, Fish and Conservation Biology
University of CA, Davis

lslewis@ucdavis.edu
www.ogfishlab.com



Otolith Geochemistry & Fish Ecology Laboratory



Otolith Geochemistry & Fish Ecology Laboratory



Alec Scott
Junior Specialist



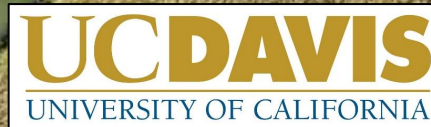
<http://hobbslab.com/news/>

Assessing the Aquatic Health of San Francisco's Tidal Wetlands

Levi S. Lewis

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www.ogfishlab.com



SBOTS: South Bay Otter Trawl Survey

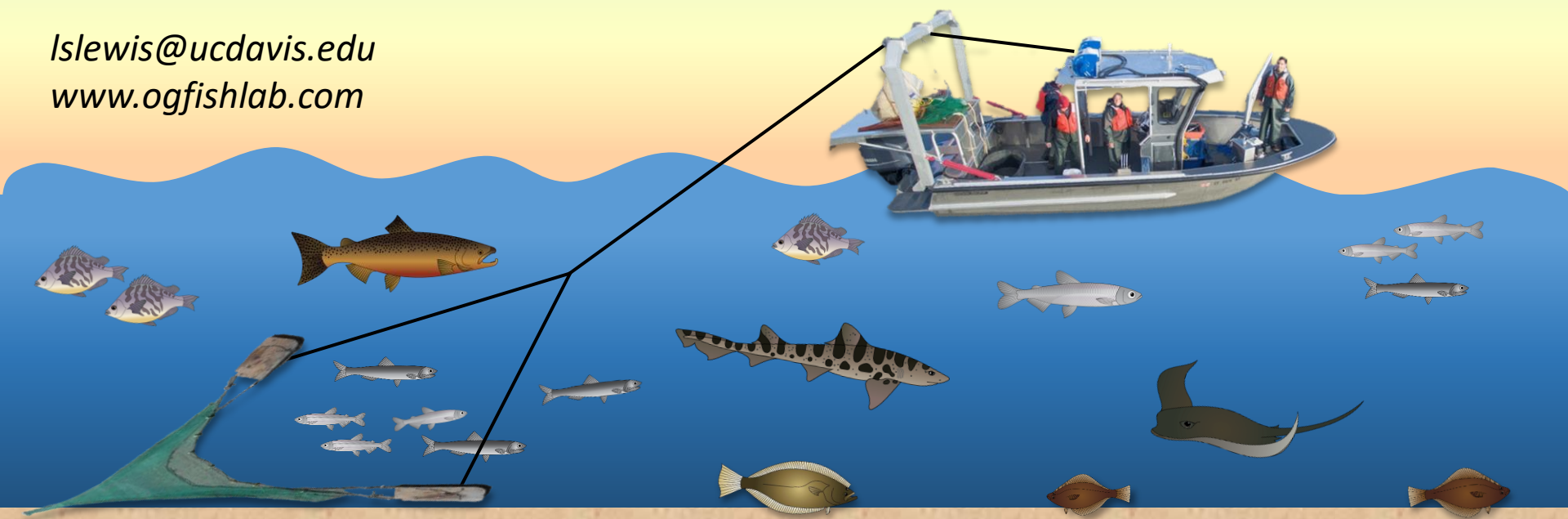


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UC DAVIS
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CONSERVATION BIOLOGY



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www.ogfishlab.com






South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay



Aquatic Species Response to Restoring Tidal Flows to the Pond A8 Complex




Alviso Marsh, South San Francisco Bay
Final Report
Survey Years 2014-2018

Prepared by:
James Hobbs,
Department of Wildlife, Fish and Conservation Biology
University of California Davis

Prepared for:
Santa Clara Valley Water District
&
South Bay Salt Pond Restoration Project Don Edwards San Francisco Bay NWR
1 Marshlands Rd.
Fremont, CA 94555

This report was prepared to fulfill contract #12-065 Amendments 3 & 4 and contract #10-570 from the California Coastal Conservancy to Dr. David Stotum UCD, entitled "South Bay 2012 Slough Fish Bioassess Mercury Study".

Comparison of Nekton Assemblages Among Restoring Salt Ponds in the Alviso Marsh, San Francisco Estuary



Prepared by:
James Hobbs,
Department of Wildlife, Fish and Conservation Biology
University of California Davis

Prepared for:
Santa Clara Valley Water District
&
South Bay Salt Pond Restoration Project Don Edwards San Francisco Bay NWR
1 Marshlands Rd.
Fremont, CA 94555

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San Francisco Bay Nutrient Management Strategy



San José-Santa Clara
Regional Wastewater Facility



SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

Dissolved Oxygen in South San Francisco Bay:

Variability, Important Processes, and Implications for Understanding Fish Habitat

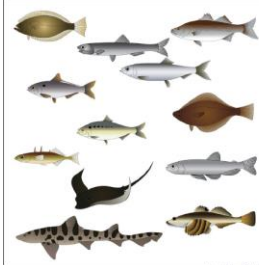
Prepared by:
Lisa Marlowe, Phillip Tomaskovich, Levi Lewis, James Hobbs, Zephyr Schindler, Taylor Winkler, and David Sosa

San Francisco Estuary Institute, Richmond, CA
University of California, Davis, CA

SAN FRANCISCO ESTUARY INSTITUTE and the AQUATIC SCIENCE CENTER
601 Central Avenue, Richmond, CA 94801 • P: 510-286-2281 (ext. 1) • F: 510-746-2200 • www.sfei.org

CHAPTER 3 Habitat Quality and Fish Abundance in the Alviso Marsh Complex 2010-2016

Dr. Levi Lewis and Dr. James Hobbs
Department of Wildlife, Fish and Conservation Biology
University of California, Davis



Prepared for the San Francisco Estuary Institute
SFEI Publication No. 1778




SAN FRANCISCO ESTUARY PARTNERSHIP

Wetlands Regional Monitoring Program



WRMP: Guidelines for Fish and Fish Habitat Monitoring



Overview

I. Purpose
This document is intended to provide monitoring recommendations for fish and salmon to the Steering Committee (SC) of the Wetland Regional Monitoring Program (WRMP), and to explain the rationale for the provided recommendations with respect to the WRMP framework and the management needs of regulatory agencies. The monitoring recommendations herein were developed by the Fish and Fish Habitat Working Group (FFHWG) of the WRMP's Technical Advisory Committee (TAC) to address Management Question 4b. *How are habitat or environmental conditions of fish and wildlife in tidal marsh ecosystems changing over time?* and Management Question 4b. *How are the distribution and abundance of key resident species of fish and wildlife of tidal marsh ecosystems changing over time?* identified by the WRMP in the Plan for the San Francisco Estuary.

II. Scope
This document should outline the "what" (species, life stages, and associated data), "how" (spatial & methods), "when" (time of year and frequency), and "where" (general and specific locations/habitats) regarding FFH monitoring, as well as "why" (justifications for each of the above recommendations as they pertain to the monitoring goals specified by the FFH working group (below)).

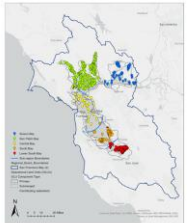
III. General Monitoring Goals Identified by the FFH

1. Establish long-term Wetland Monitoring that yields periodic unadulterated data that can be used to describe long-term ecological trends in wetland FFH throughout the SFE, including presence/absence, local abundance/biomass (within upper and lower reaches) and seasonal density of select fish species and functional groups at established benchmark, reference, and project sites.
2. Monitor the use of Wetland Habitats by Resident Species. Provide data regarding the presence/absence of state and federally managed species including green sturgeon (*A. g. gairdneri*), coho salmon (*Oncorhynchus kisutch*), winter steelhead salmon (*Oncorhynchus tshawytscha*), longfin south sierrachest (salicidid), and Delta South (*Apogonops* group) (fish).
3. Provide Context and Guidance to Individual Projects. Provide temporal and regional ecological context with metrics to allow for adaptive management of the WRMP and to guide and evaluate future special studies, permitted projects, and restoration actions.

Lower San Francisco Estuary Fish Monitoring Inventory

Database Development and Preliminary Analysis

Z. Duckworth, S. Randall, A. Weber-Stover, L. Lewis, C. Toms, E. Farley, M. Williams
April 2022



Impacts to SFE Wetlands

1. Dams & Exports

- IEP, Water Board, Outflow Mgmt.

Management Efforts

2. Wastewater

- Nutrient Management Strategy; WRMP

3. Industry & Development

- Salt Pond Restoration Program; WRMP

4. Climate Change

- Modeling of future conditions & species responses (+ prayer)
- Living Shorelines; WRMP

Improvements to SFE Wetlands

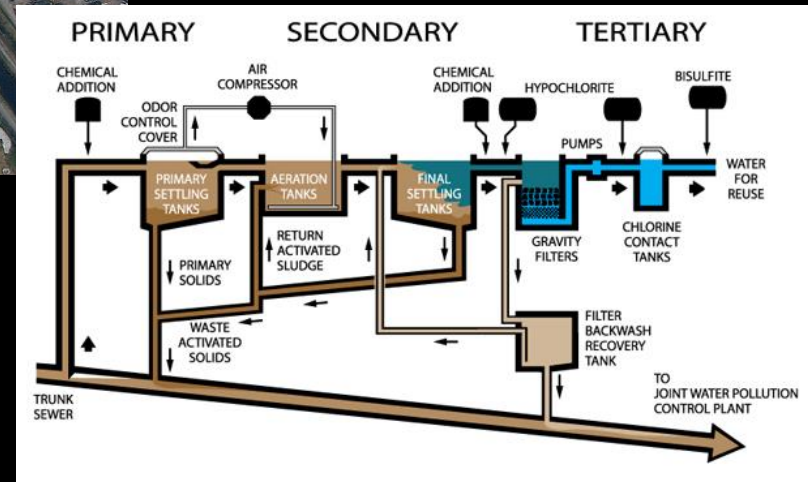
Wastewater treatment

San Jose-Santa Clara Regional Wastewater Facility



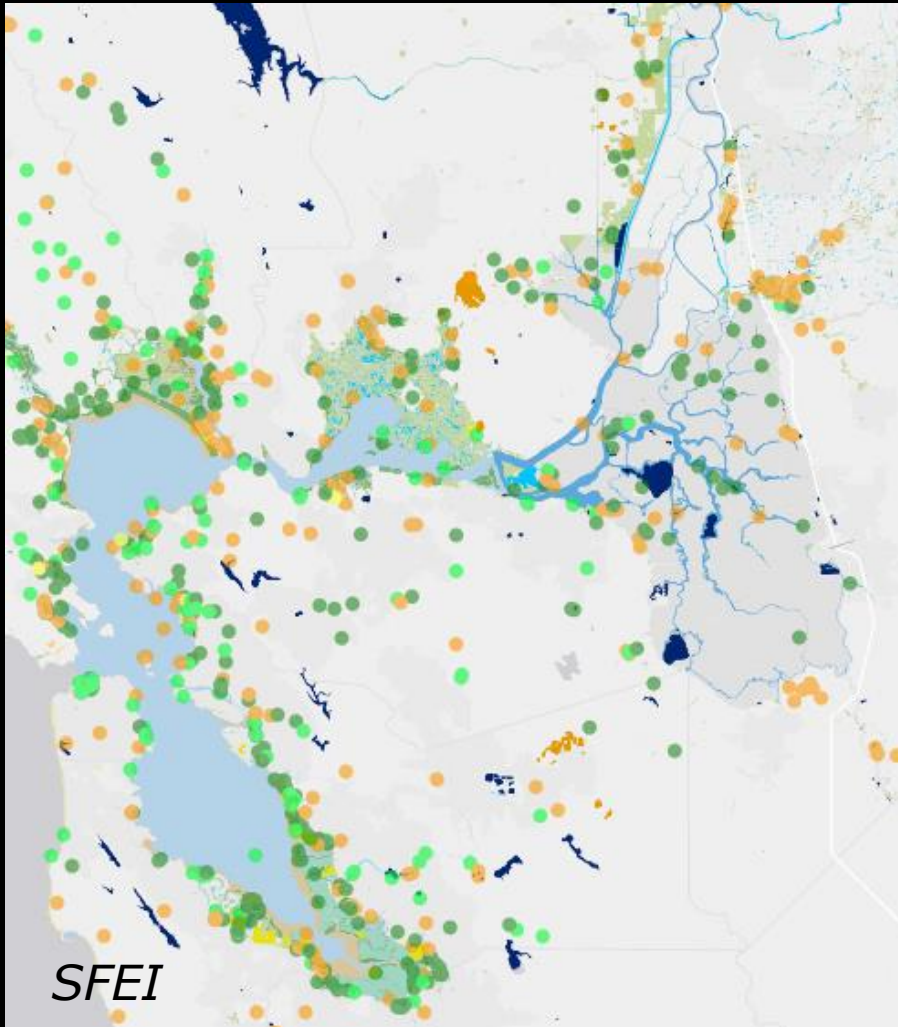
Tertiary-treatment, nitrification

- Low salinity (fresh)
- High NO_3 , low NH_3
- Reduced contaminants
- Highly oxygenated



Improvements to SFE Wetlands

Restoration



- **Estuary-Wide**
 - *100's small projects*
- **Delta**
 - *Fish habitat (10,000 acres)*
- **North Bay**
 - *Napa Salt Ponds (1,500 acres)*
- **South Bay**
 - *Alviso Salt Ponds (15,000 acres)*

Improvements to SFE Wetlands



Photo Credit: Herb Linggi

Improvements to SFE Wetlands

Former Salt Pond (A21)



What about the Biota?

A key motivation for restoration is to benefit ecosystems

“Terrestrial” Wildlife



Aquatic “Wildlife”?

*The sad fact is that the ocean could be empty,
and it would still look the same.*

– Carl Safina

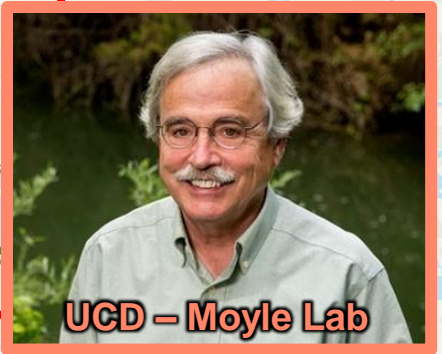


San Pablo Bay Marshes

Suisun Marsh

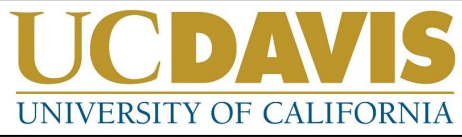
40 Years of Monthly Surveys

5 Years of Monthly Surveys



UCD - Moyle Lab

Aquatic Wildlife

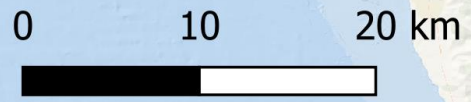


UCD - Lewis Lab (OGFL)



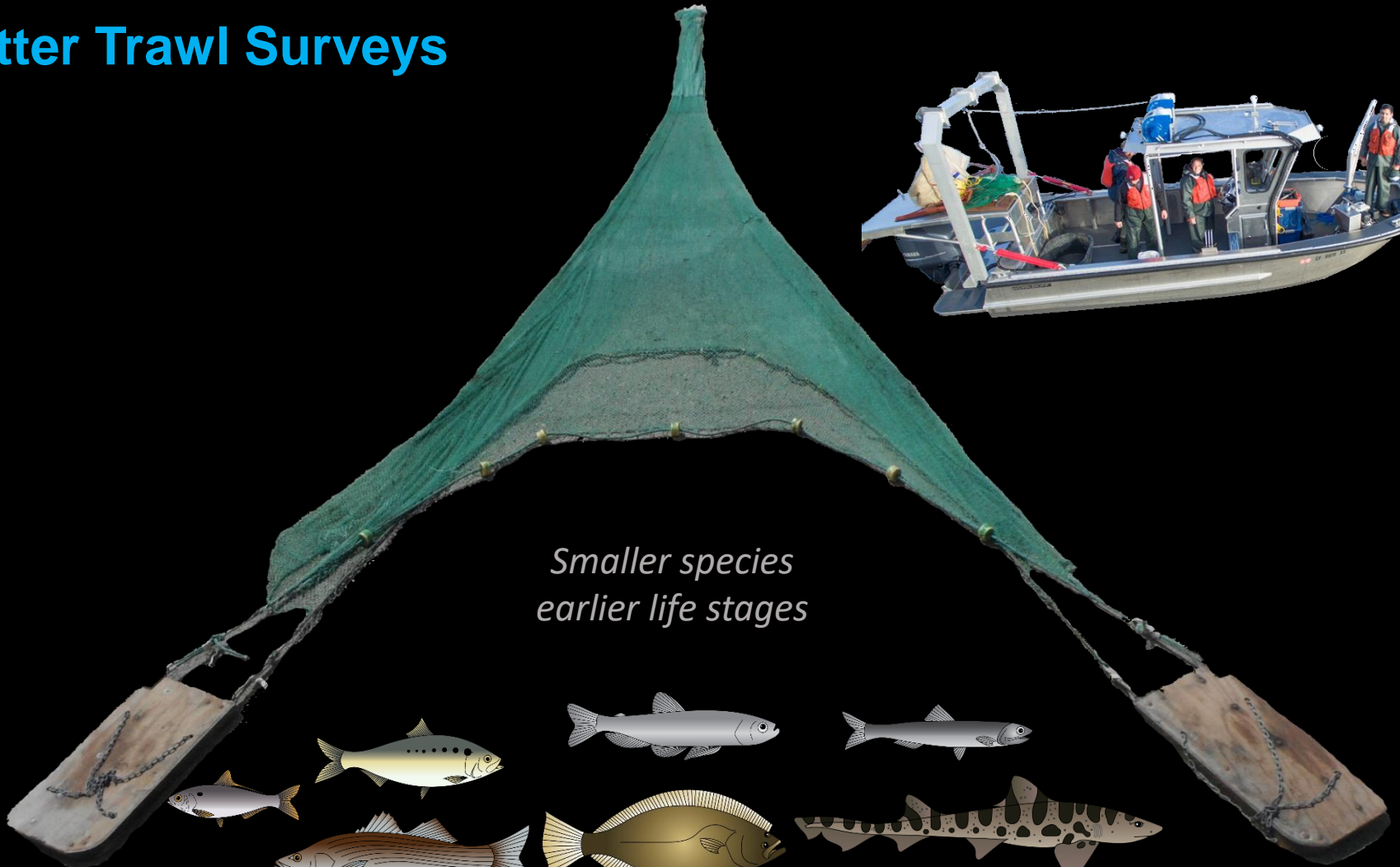
South San Francisco Bay Marshes

12 Years of Monthly Surveys

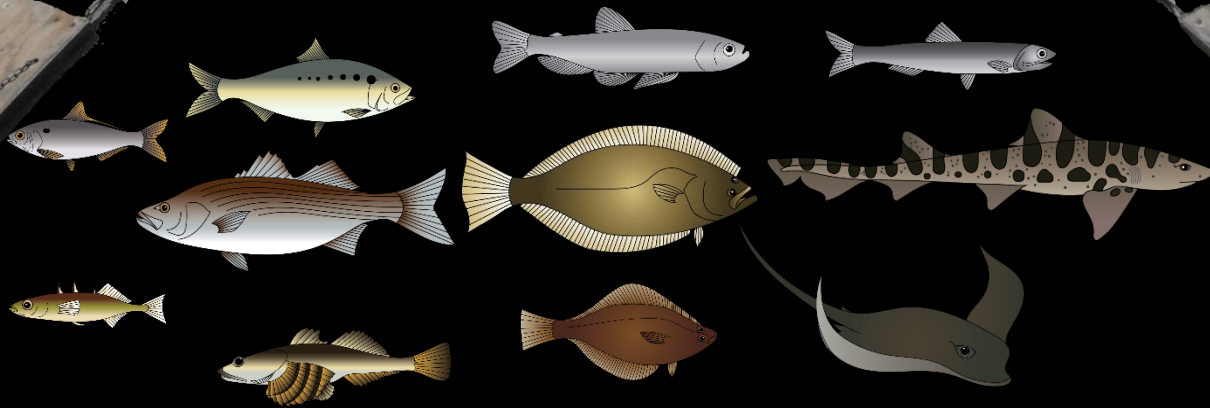


SFEI

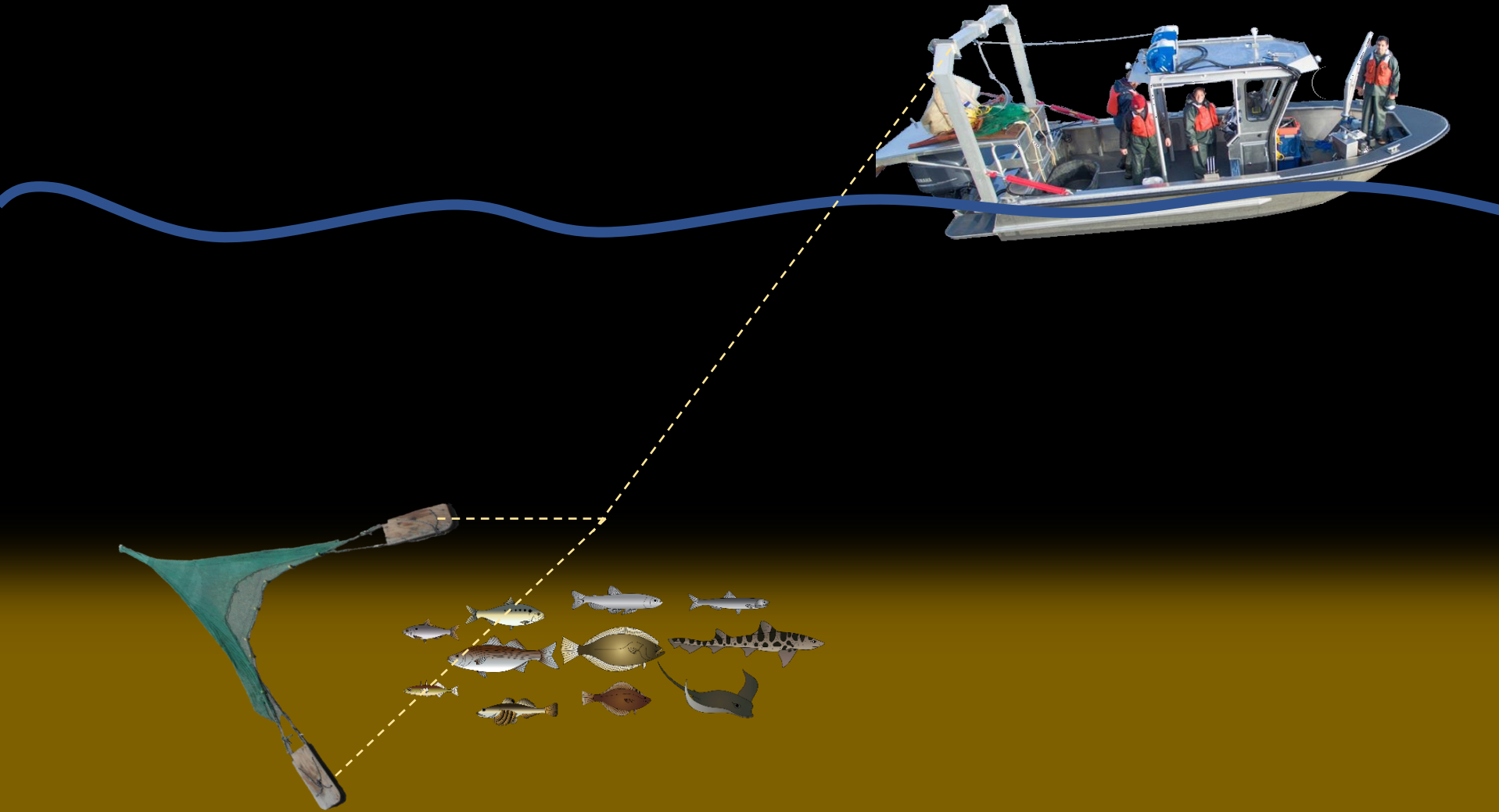
Otter Trawl Surveys



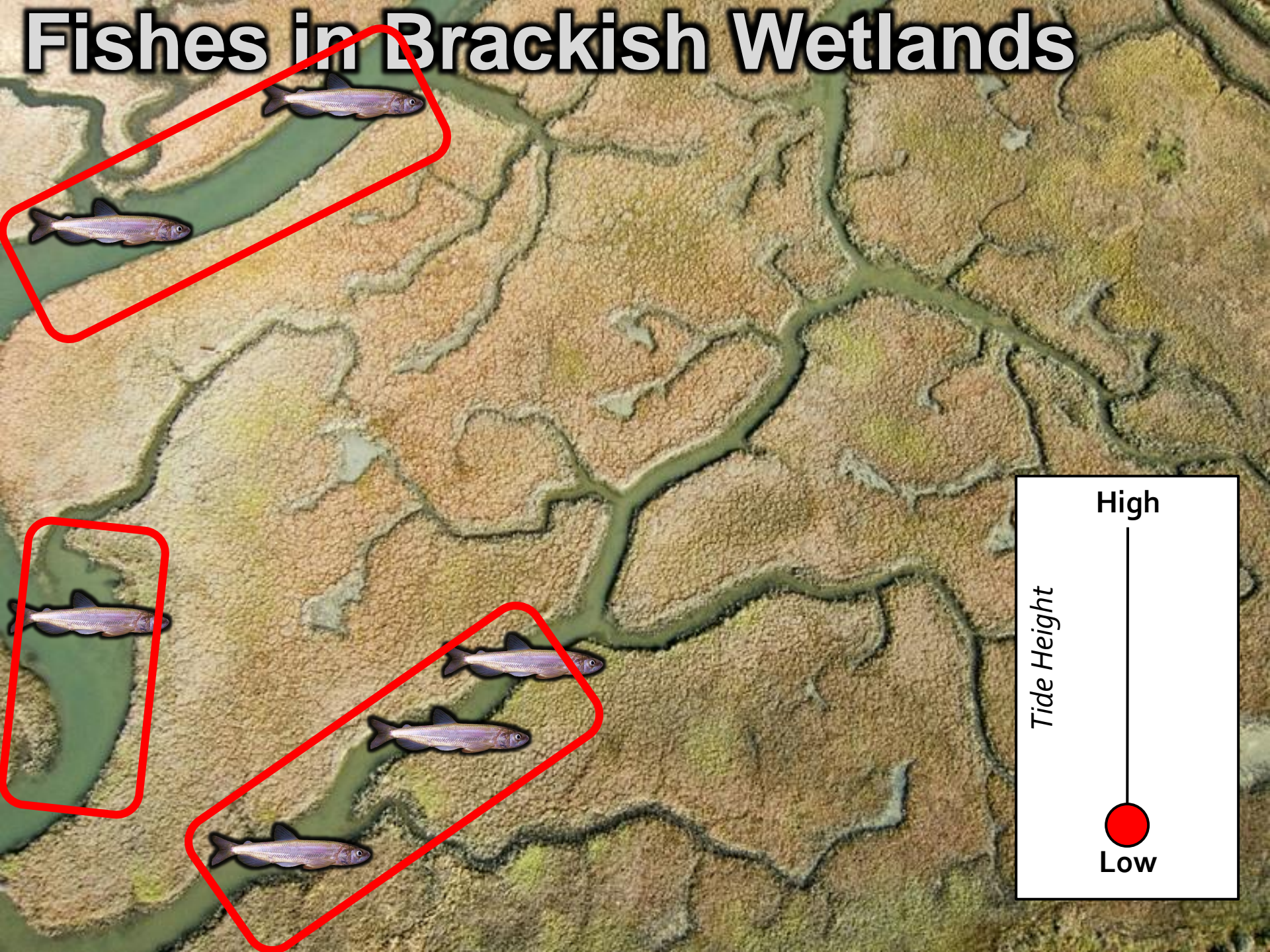
*Smaller species
earlier life stages*



Otter Trawl Surveys



Fishes in Brackish Wetlands



Otter Trawl Surveys



Otter Trawl Surveys



Photo Credit: Jim Ervin

Otter Trawl Surveys



Photo Credit: Jim Ervin



Photo Credit: Jim Ervin

Otter Trawl Surveys



Photo Credit: Jim Ervin

Otter Trawl Surveys



Butter Sole

California Halibut

California Tonguefish

Speckled Sanddab

Photo Credit: Jim Ervin

Otter Trawl Surveys

Profile



Photo Credit: Jim Ervin

Otter Trawl Surveys



Big mouth

Otter Trawl Surveys



Photo Credit: Jim Ervin

Otter Trawl Surveys



Otter Trawl Surveys



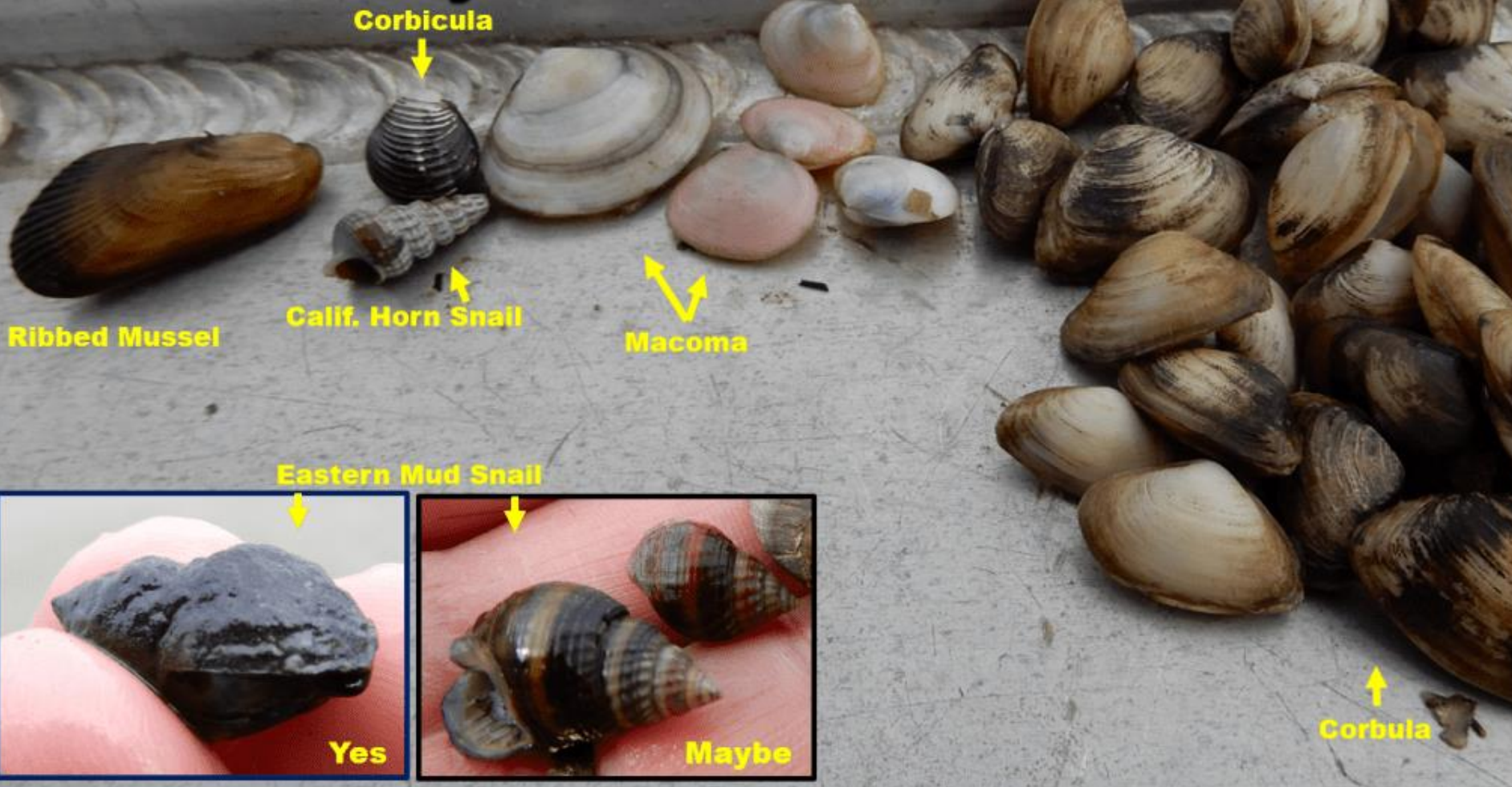
Photo Credit: Jim Ervin

Otter Trawl Surveys



Photo Credit: Jim Ervin

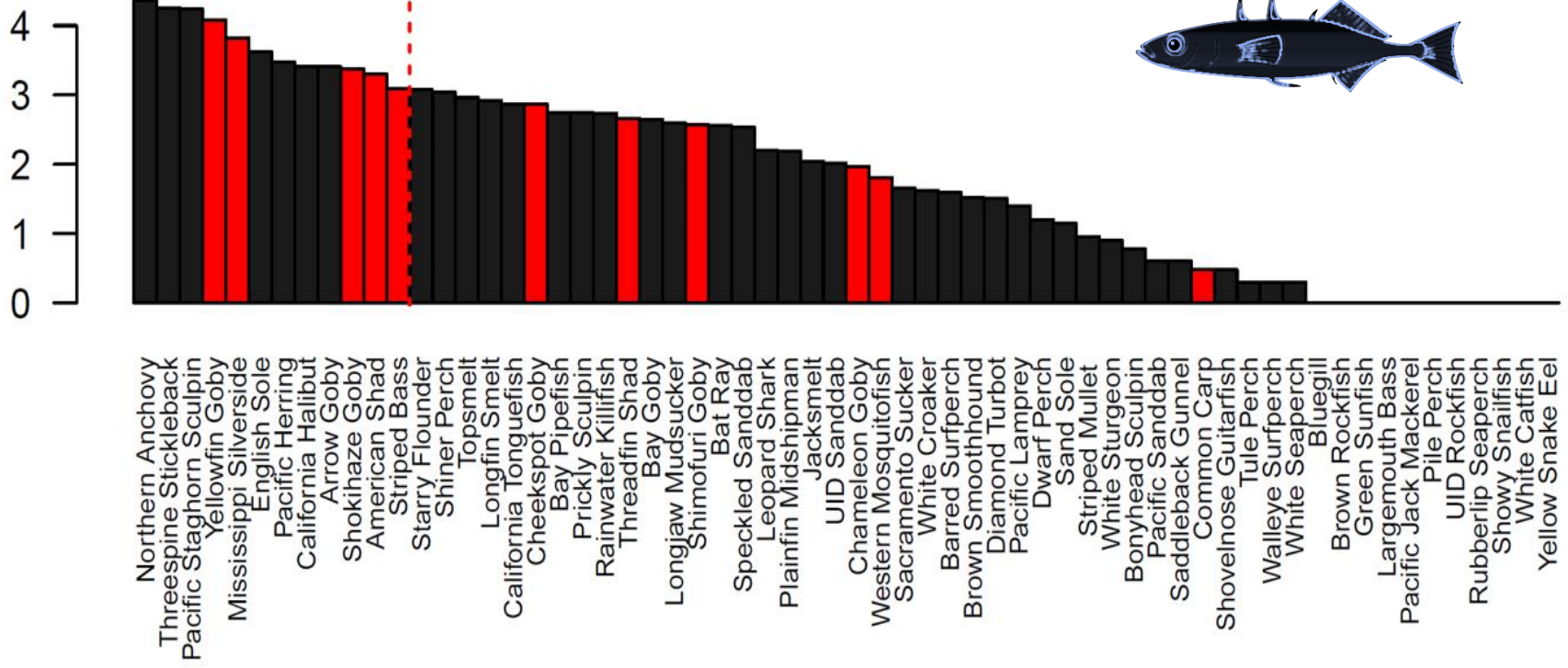
Otter Trawl Surveys



Otter Trawl Surveys

60+ Species of Fish Utilize SFE Marshes

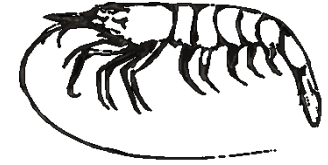
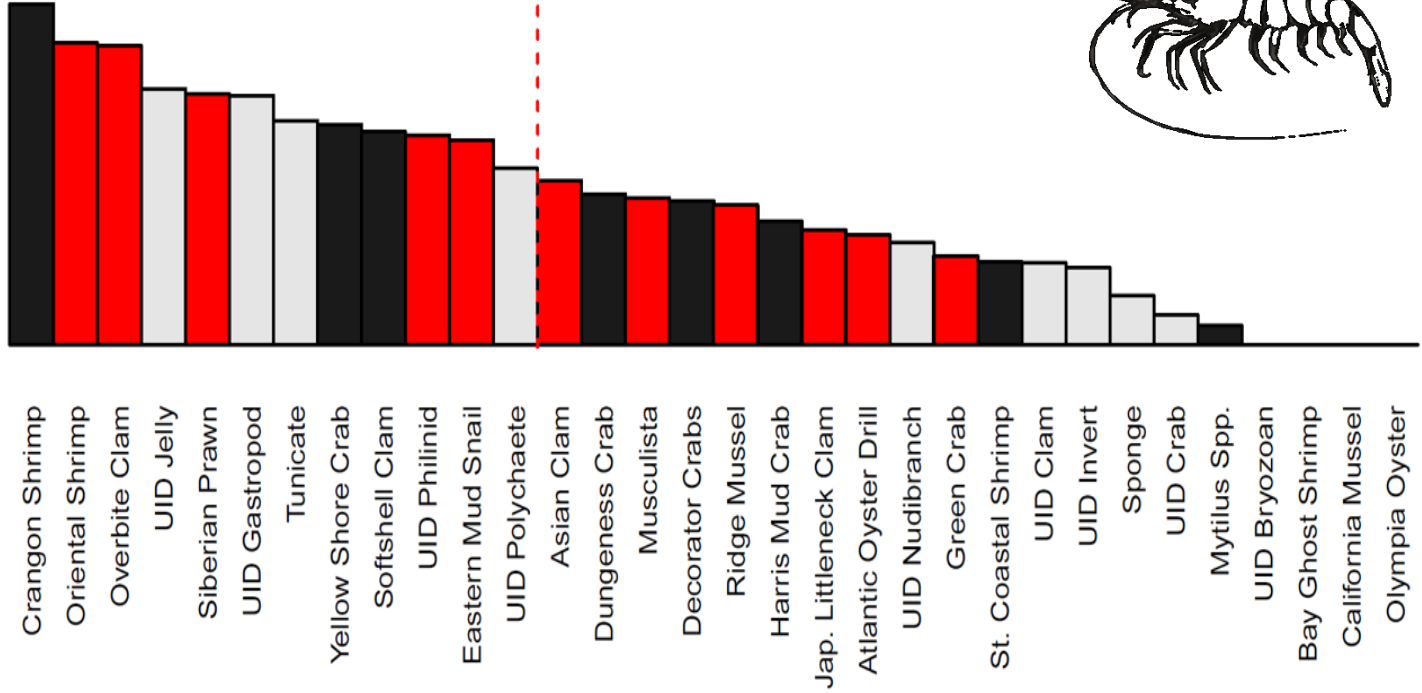
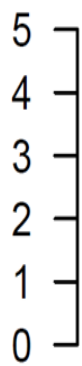
Log(count)



Otter Trawl Surveys

30+ Species/Groups of Macro-Inverts Utilize SFE Marshes

Log(count)



Blog: "Fish in the Bay"

<http://ogfishlab.com/news/>

By Jim Ervin



Fish in the Bay – March 2022: A Crazy & mixed up month!

March 4, 2022 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

March was an unusual month that we still have not completely figured out. We are in the start of a...

[READ MORE](#)



Fish in the Bay – February/March 2022 Supplemental Report: Gobies, Shrimp, etc.

March 2, 2022 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

SF Bay fishes are very active in winter through spring. Charismatic pelagic fishes like Longfin Smelt, Anchovies, Herring, Topsmelt, and...

[READ MORE](#)

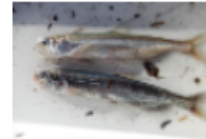


Fish in the Bay – February 2022: Another Record Catch.

February 4, 2022 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

February was another great month if you like small pelagic bait fishes.... And, who doesn't? The February Longfin Smelt...

[READ MORE](#)



Fish in the Bay – January 2022: Anchovies and Longfins, yes! But, no Crangon brooding.

January 2, 2022 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

Good News! Our streak of phenomenal finfish production continues. This time last year, we were marveling over the uncharacteristic boom...

[READ MORE](#)



Fish in the Bay – January 2021: Mud Shrimp Alert – Upogebia Explosion on New Year's Day!

January 1, 2021 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

Happy New Year! The new word for 2021 is "Upogebia," aka Mud Shrimp. We caught our first Upogebia in Pond...

[READ MORE](#)



Fish in the Bay – December 2021: End of the first Dry La Nina Year.

December 4, 2021 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

2021 was a very good year in Lower South SF Bay (LSB) – for most fishes. Many records were broken...

[READ MORE](#)



Fish in the Bay – December 2021: Longfin Alert! Longfin Smelt have commenced Spawning in Lower South San Francisco Bay!

December 1, 2021 · Jim Ervin · Fieldwork, Fish in Lower South Bay, News · 0 Comments

The first spawning of Longfin Smelt in the 2021 (2020 spawning season) has been reported. This exciting happens in...



 NATIONAL
GEOGRAPHIC

The Water Crisis | Natio... 

THE LAST DROP ^{H2O}



The Water Crisis | National Geographic



<https://www.nationalgeographic.com/tv/movies-and-specials/the-last-drop>

SAN FRANCISCO

ESTUARY

Hatchery Smelt Sample Life in the Wild

Natives Who Can Rough It

South Bay Survey Surprises

Tire Specks Kill Coho

The Complexities of Monitoring Steelhead

BiOps Breakdowns

Sturdy Sturgeon

Go Fish



FISH TALES

Stories of fins and scutes, smelt and salmon, gut rot and egg loss, and the myriad fishes tracked, tagged, trawled, and hatched in the San Francisco Estuary.

WATER
ENVIRONMENT
CLIMATE
EQUITY

MARCH 2022
NEWS MAGAZINE
VOL. 31, NO. 1

ONLINE FEATURES
[WWW.SFESTUARY.ORG/
ESTUARY-NEWS](http://WWW.SFESTUARY.ORG/ESTUARY-NEWS)



South Bay Trawls Show Fish Like Restored Shores

ESTUARY MARCH 2022

14

15

FISHES OF THE SAN FRANCISCO ESTUARY



A selection of diverse fish species representative of those present in the San Francisco Estuary. Illustrations by Adi Khan; background photo by Laci Lemis.

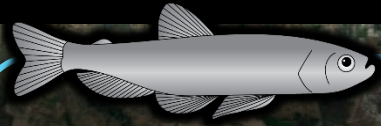
Three Fishy Stories about the SFE

1. A Tale Of 2 Marshes: The Northern vs Southern SFE
2. A Fish Is Not a Fish (*What is Habitat Quality?*)
3. An Unlikely Place for a Threatened Species

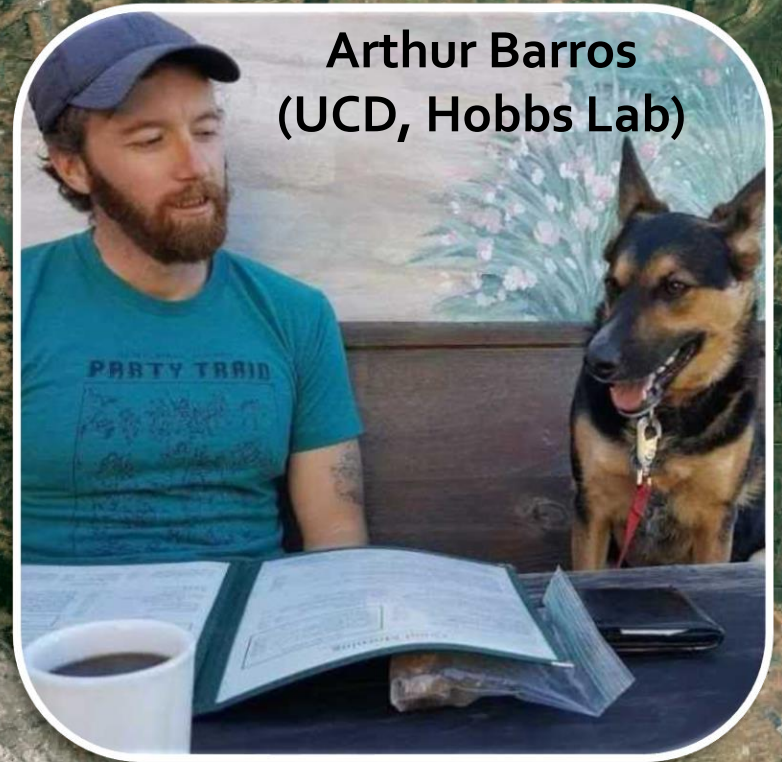
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1. A Tale Of 2 Marshes: The Northern vs Southern SFE



North Bay
2015-2019



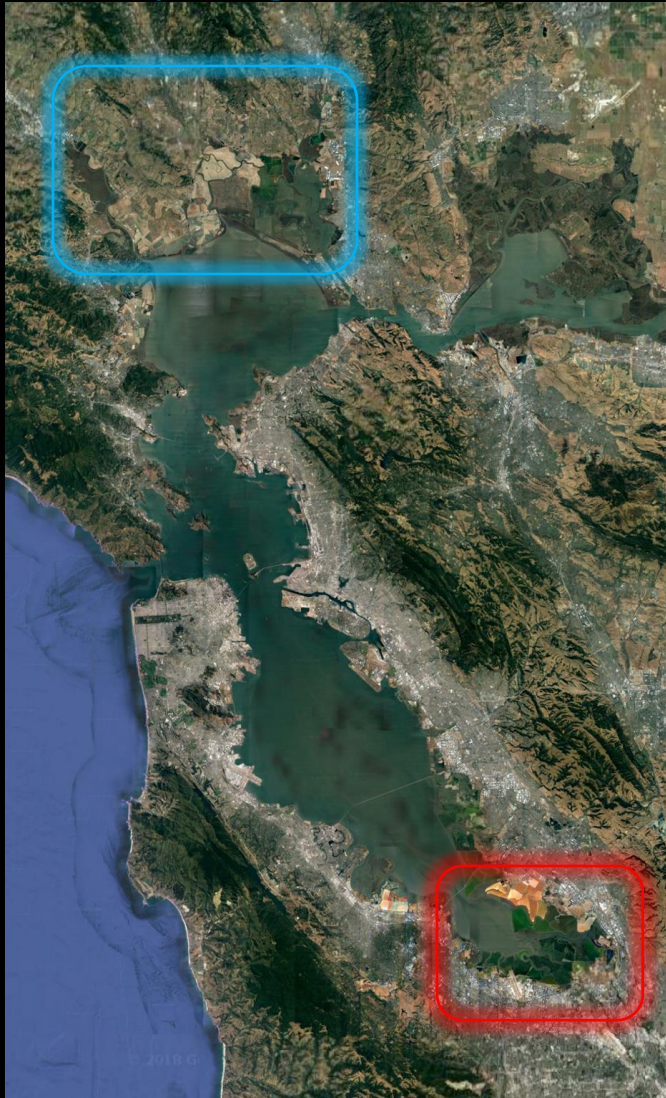
Arthur Barros
(UCD, Hobbs Lab)

Comparative
Assessment of
Marsh Fish
Communities

South Bay
2015-2019

1. A Tale Of 2 Marshes: The Northern vs Southern SFE

Sampling Areas



1. A Tale Of 2 Marshes: The Northern vs Southern SFE

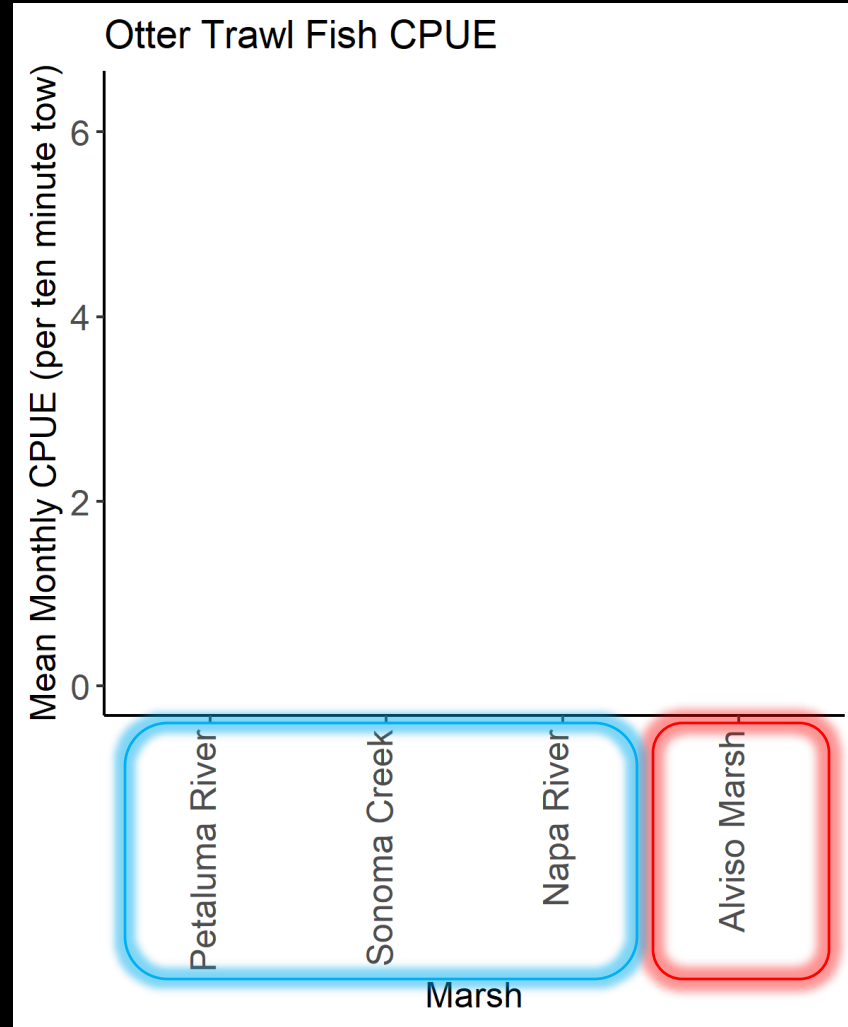
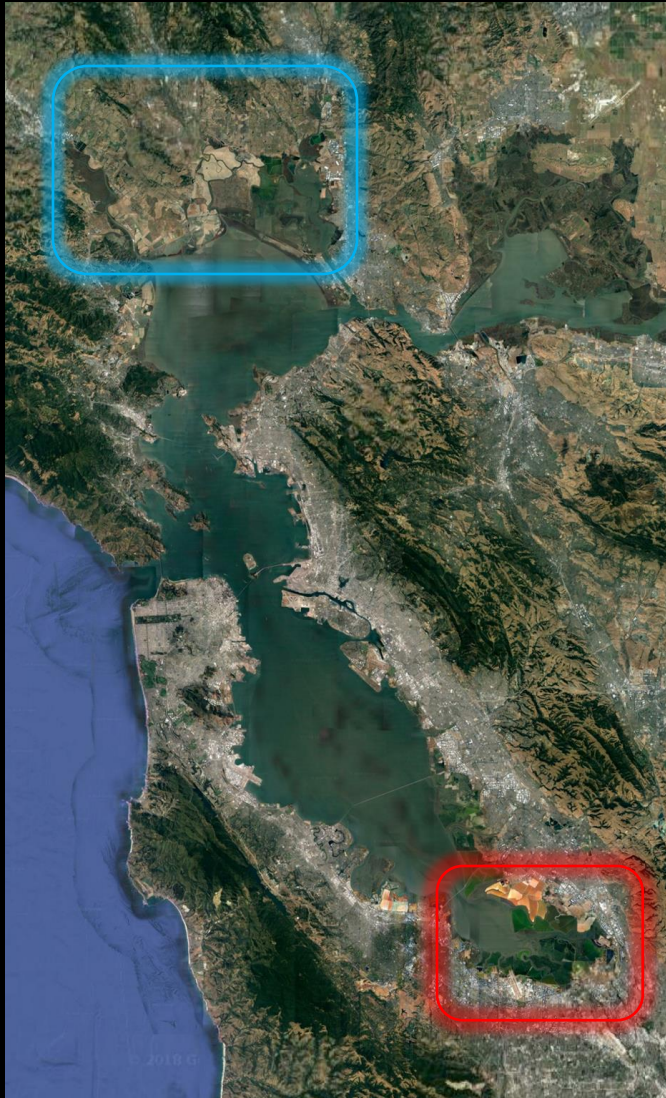
QUESTION:

Are communities in North Bay and South Bay similar?

1. Abundance?
2. Diversity?
3. Community Structure?

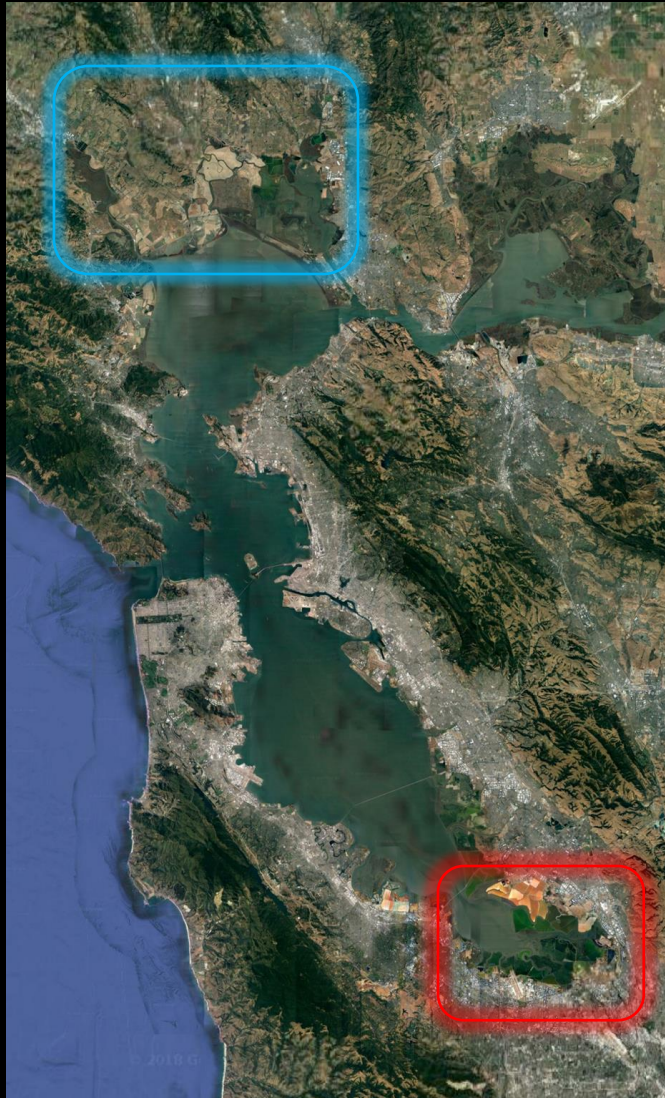
1. A Tale Of 2 Marshes: The Northern vs Southern SFE

Fish Abundance (2015-2019)

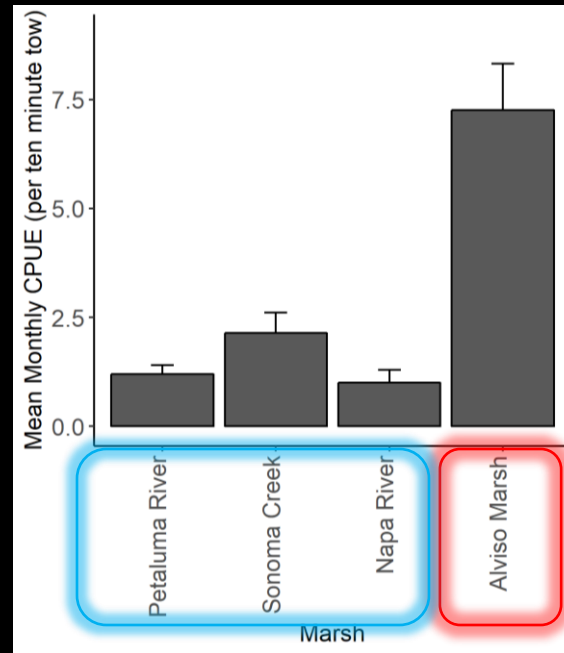


1. A Tale Of 2 Marshes: The Northern vs Southern SFE

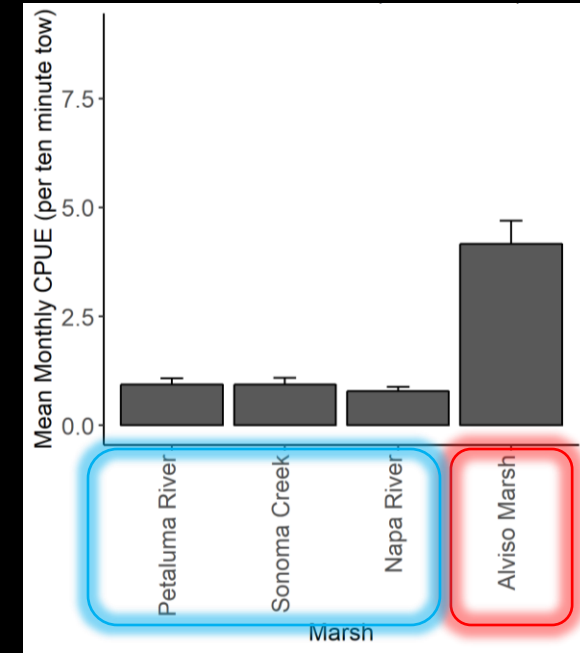
Fish Abundance (2015-2019)



Warm/Dry (June-Oct)

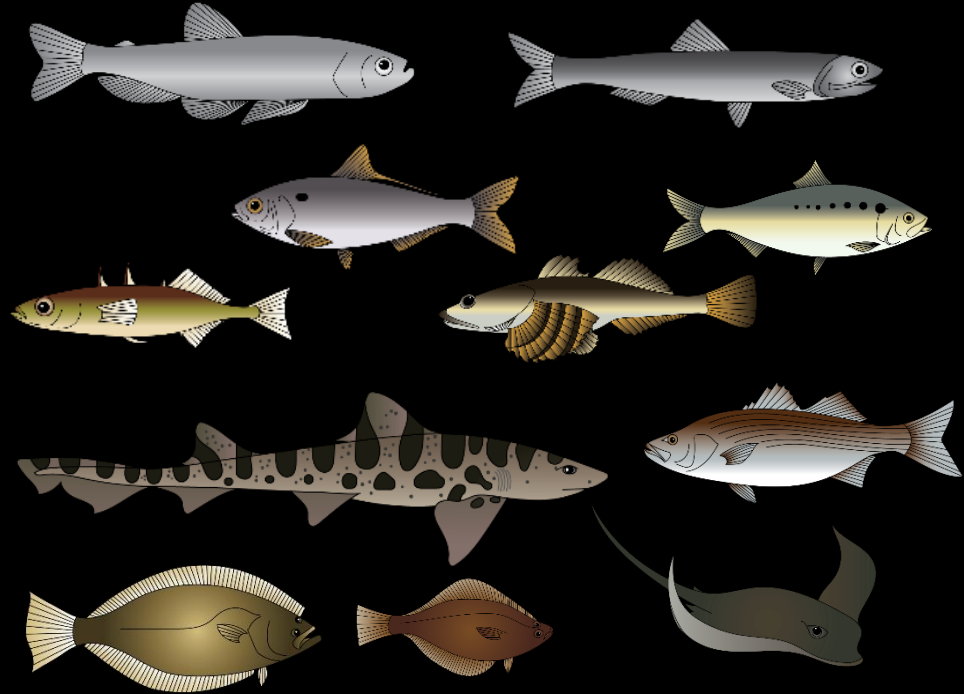
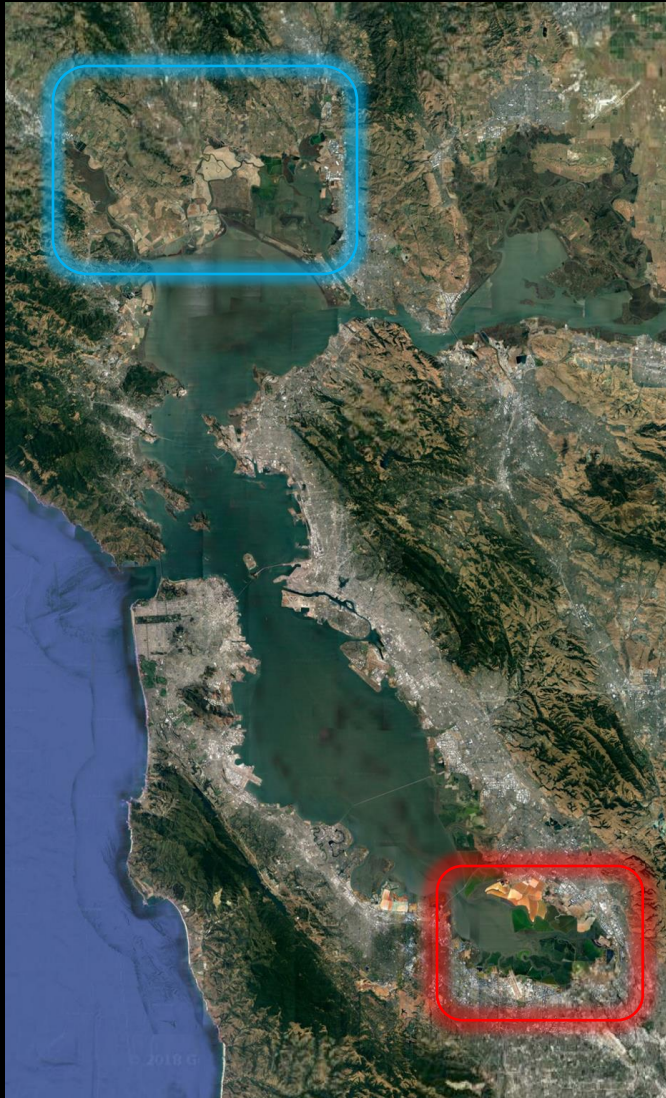


Cool/Wet (Nov-Apr)



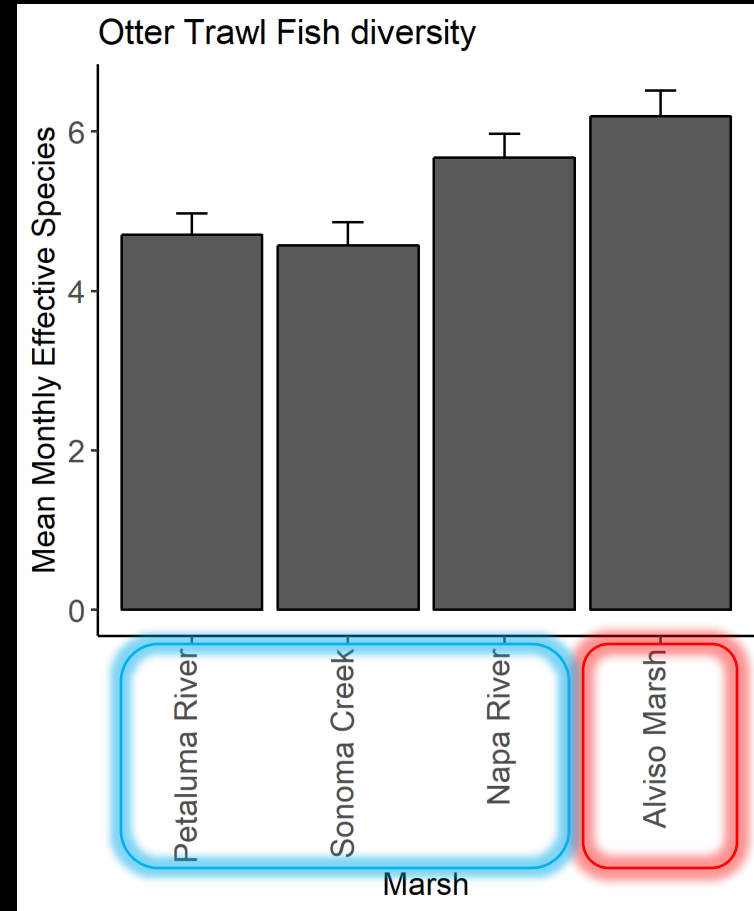
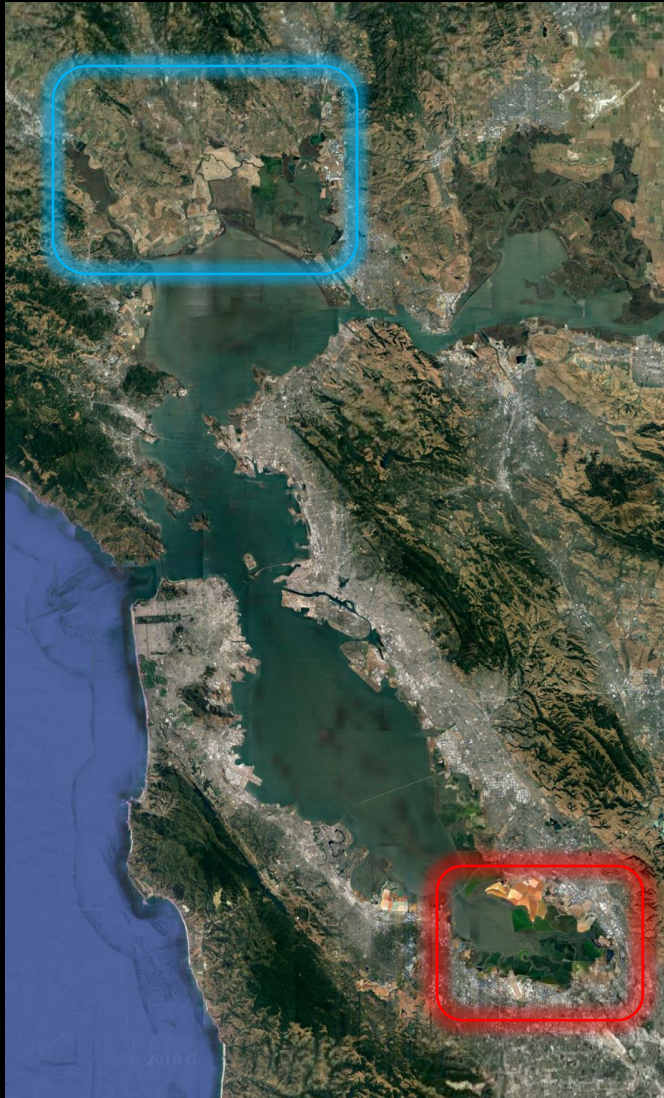
1. A Tale Of 2 Marshes: The Northern vs Southern SFE

Species “True” Diversity (2015-2019)



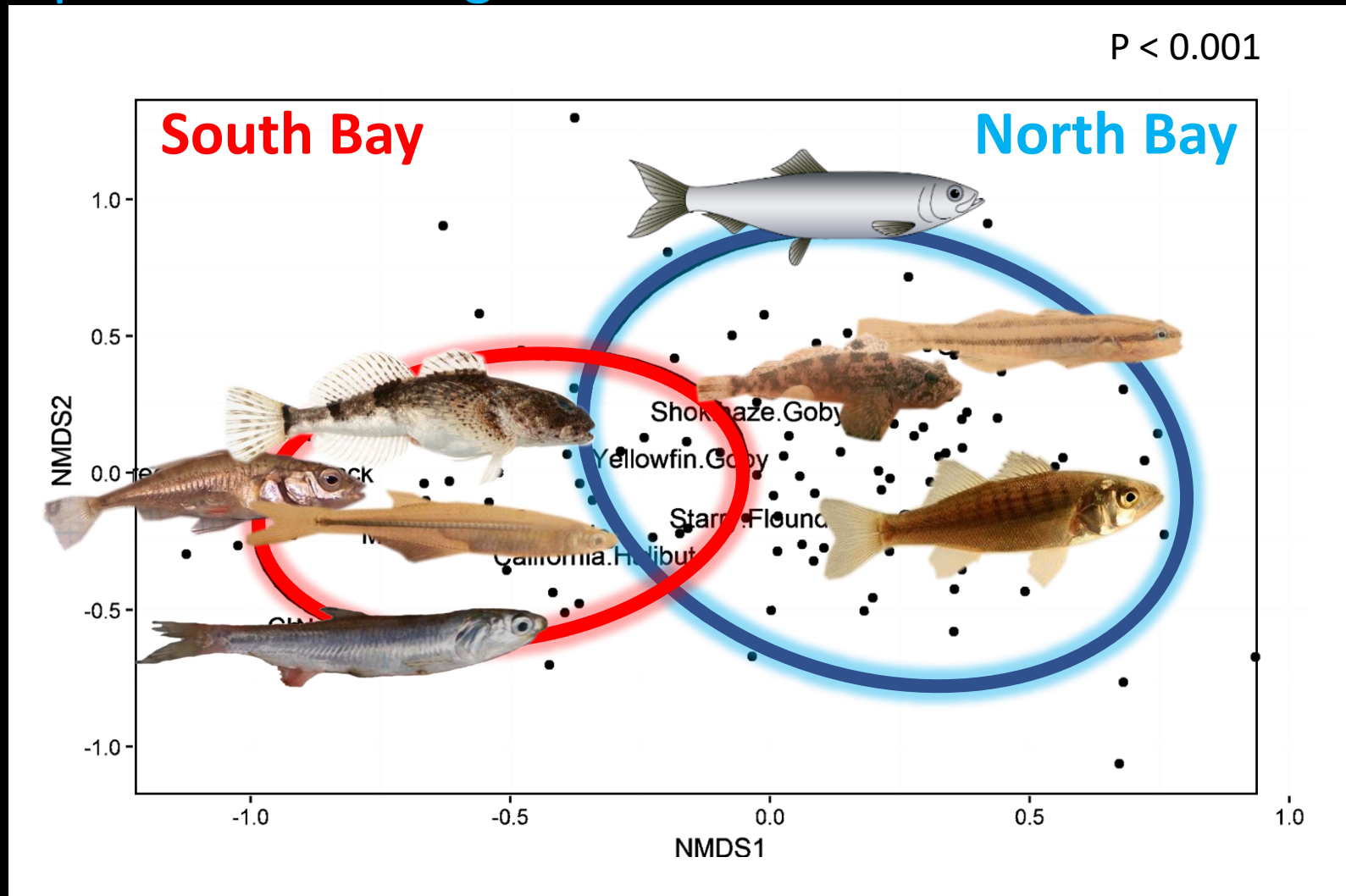
1. A Tale Of 2 Marshes: The Northern vs Southern SFE

Species “True” Diversity (2015-2019)



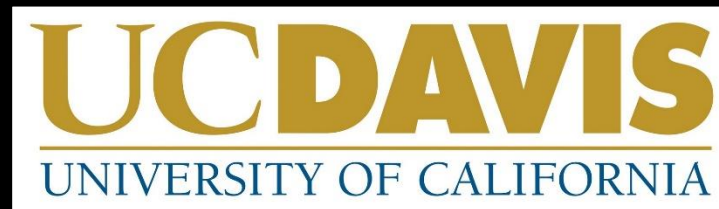
1. A Tale Of 2 Marshes: The Northern vs Southern SFE

Species Assemblages



1. A Tale Of 2 Marshes: The Northern vs Southern SFE

- South Bay wetlands exhibited higher abundance, higher richness, and a unique species assemblage
- Restored ponds had fewer inverts, but similar or more fish than adjacent sloughs (restored ponds = fish habitat).
- Standardized long-term sampling across marshes, regions, & estuaries is needed to inform restoration/management.



Three Fishy Stories about the SFE:

1. A Tale Of 2 Marshes: The Northern vs Southern SFE
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)
3. An Unlikely Place for a Threatened Species

2. A Fish Is Not a Fish is Not a Fish (*What Is Habitat Quality?*)

DISSOLVED OXYGEN IN SOUTH SAN FRANCISCO BAY: VARIABILITY, IMPORTANT PROCESSES, AND IMPLICATIONS FOR UNDERSTANDING FISH HABITAT

Lissa MacVean¹, Philip Trowbridge¹, Levi Lewis², James Hobbs²,
Zephyr Sylvester¹, Taylor Winchell¹ and David Senn¹

1. San Francisco Estuary Institute, Richmond, CA
2. University of California, Davis, CA

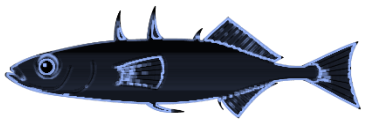
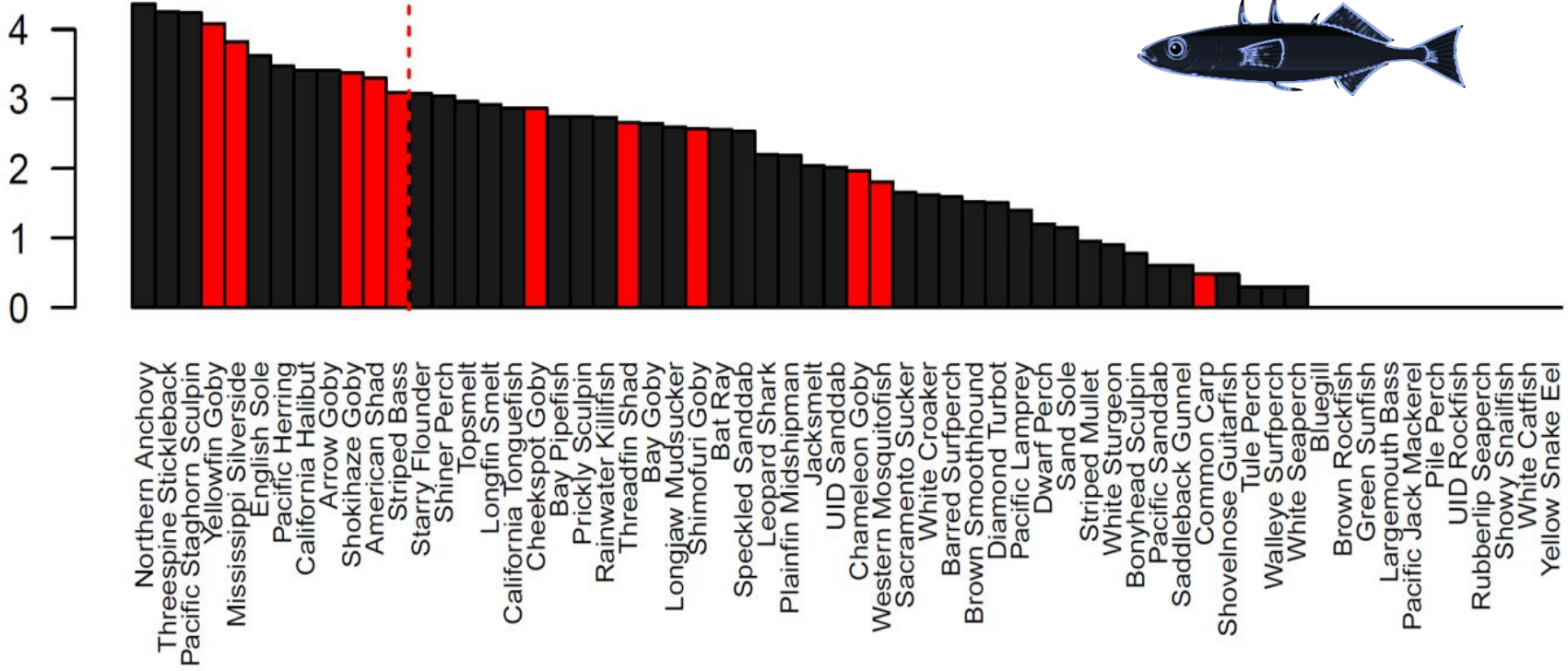


How do low concentrations of dissolved oxygen (i.e., hypoxia) impact the quality of fish habitat in South Bay wetlands?

2. A Fish Is Not a Fish is Not a Fish (What Is Habitat Quality?)

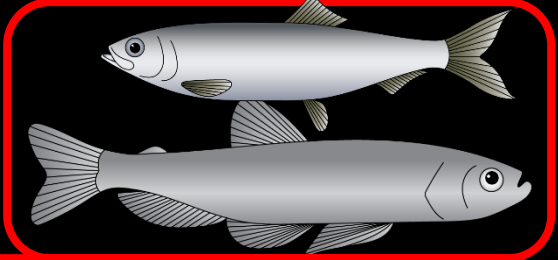
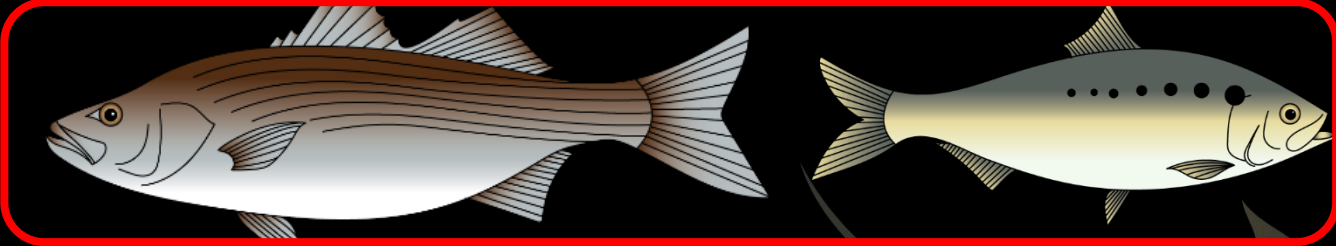
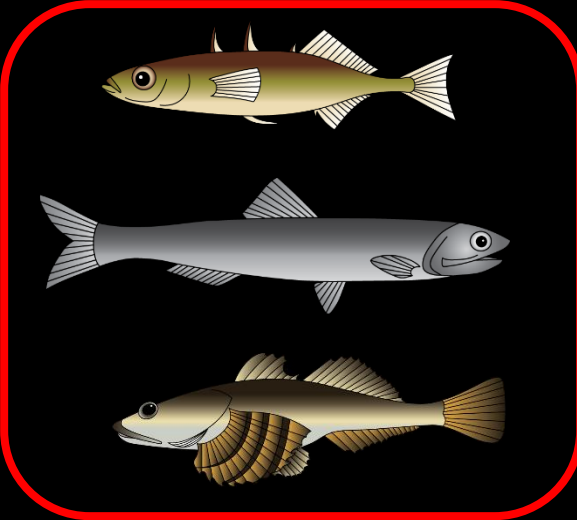
60+ Species of Fish Utilize SFE Marshes

Log(count)



2. A Fish Is Not a Fish is Not a Fish (*What Is Habitat Quality?*)

Select Species



Artwork by Adi Khen

2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

Fish & Invertebrate Surveys (2015-2019)

Otter Trawl (nekton)

Sonde (Water Quality)



+



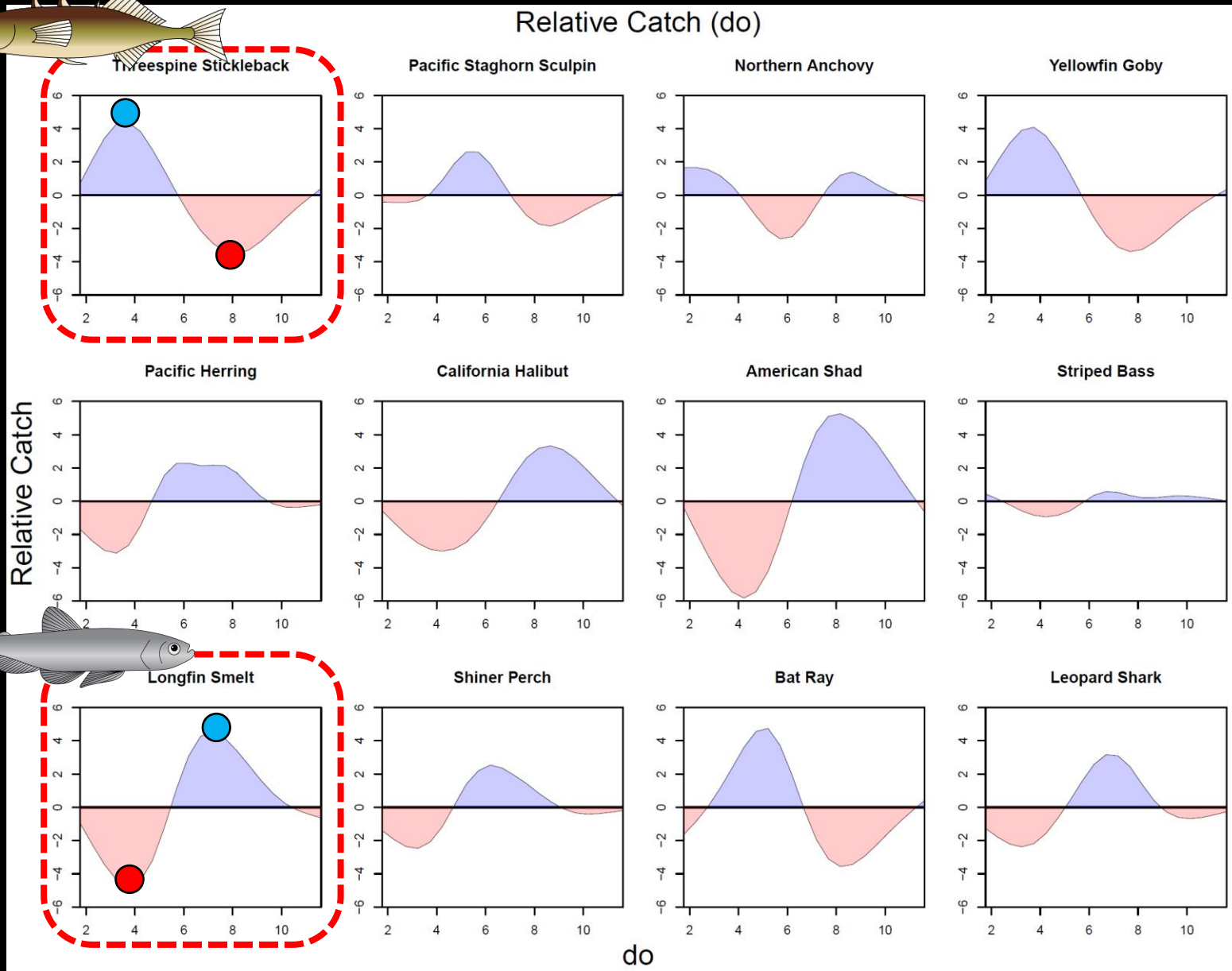
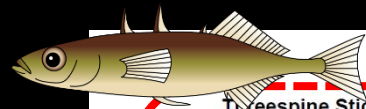
DO
Temp
Sal

NOTE: UC DAVIS SURVEYS ARE THE ONLY FISH MONITORING PROGRAMS IN THE SFE THAT CAN ADDRESS RESPONSES OF ESTUARINE FISHES TO OXYGEN

2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

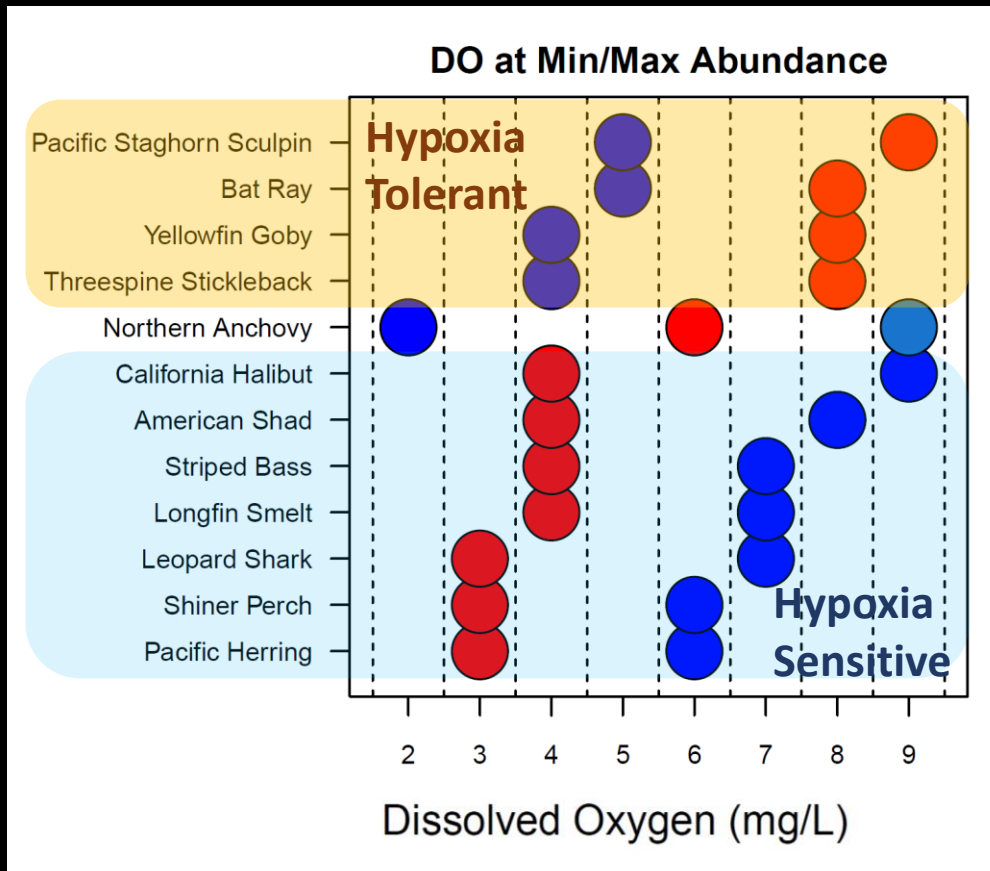
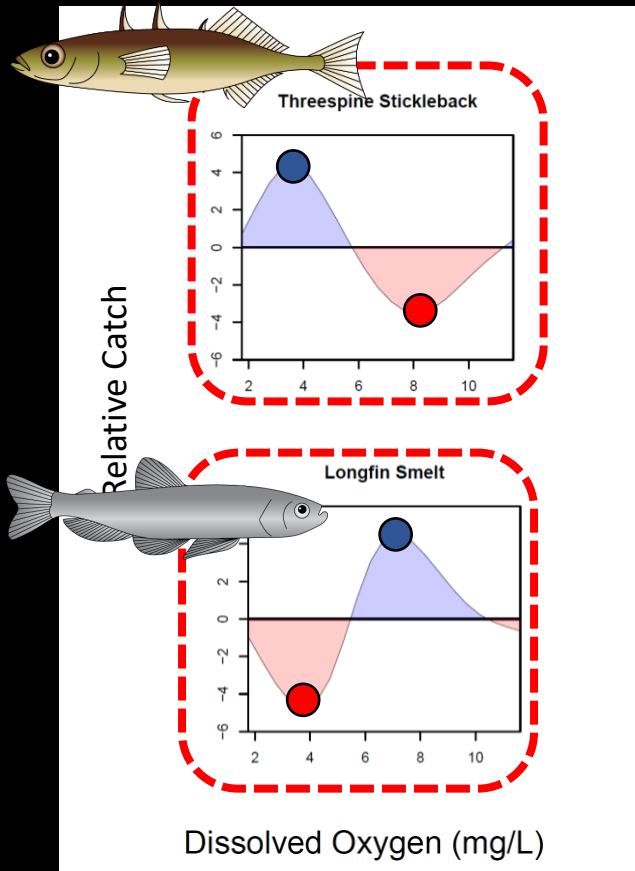
Responses to Hypoxia are Species-Specific

DO



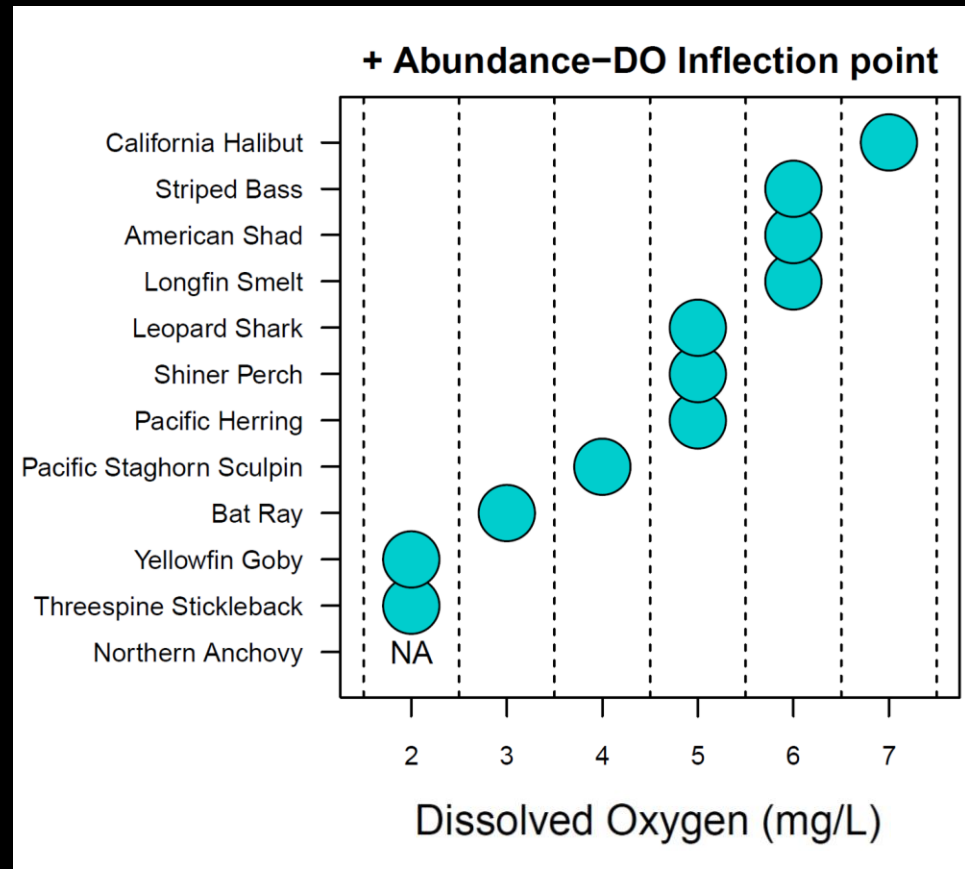
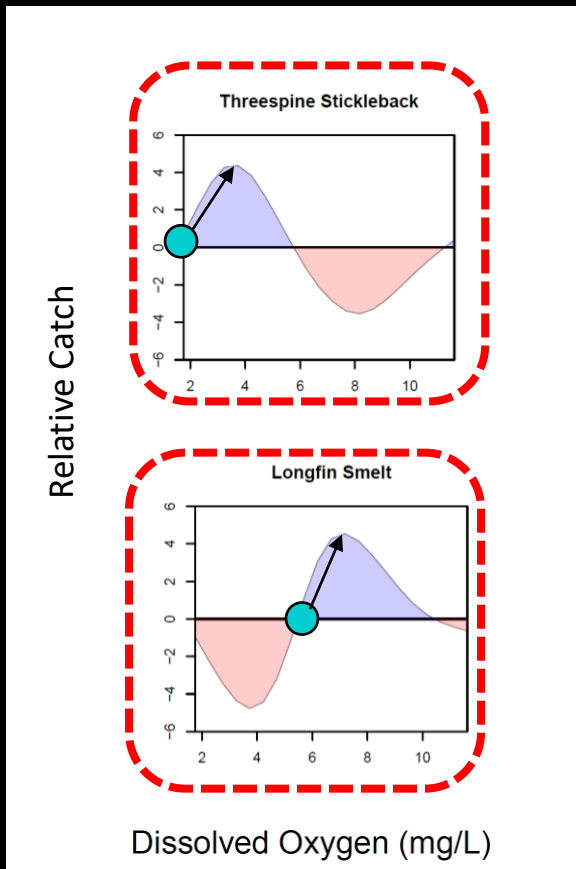
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

Likely responses to **hypoxia**: MAX/MIN ABUNDANCE



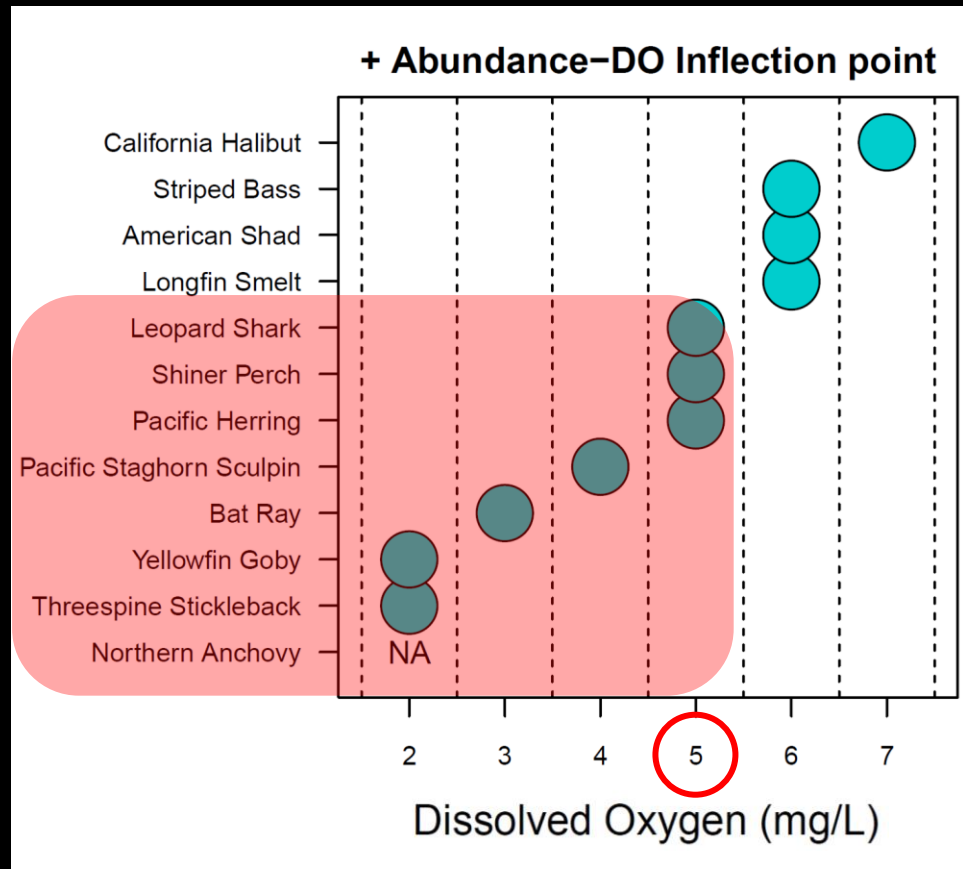
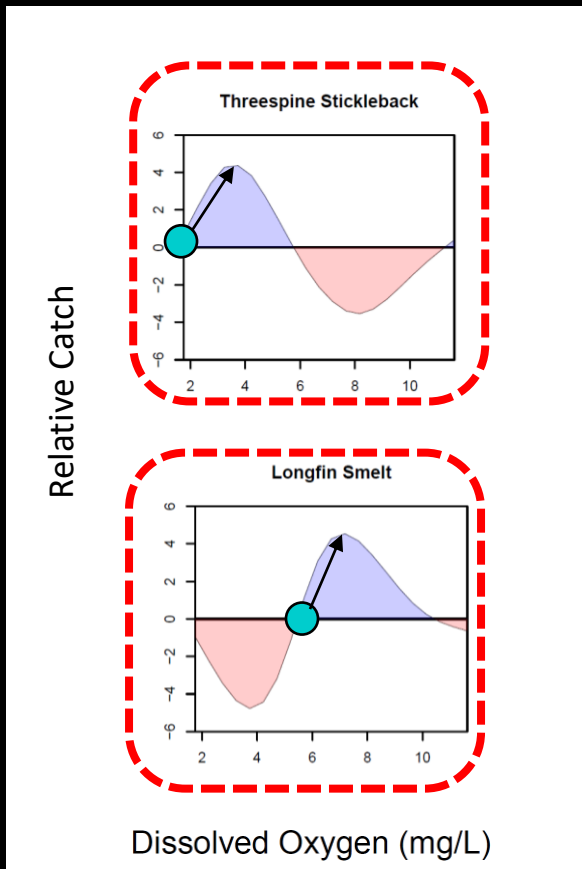
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

Likely responses to **hypoxia**: **+ DO INFLECTION**



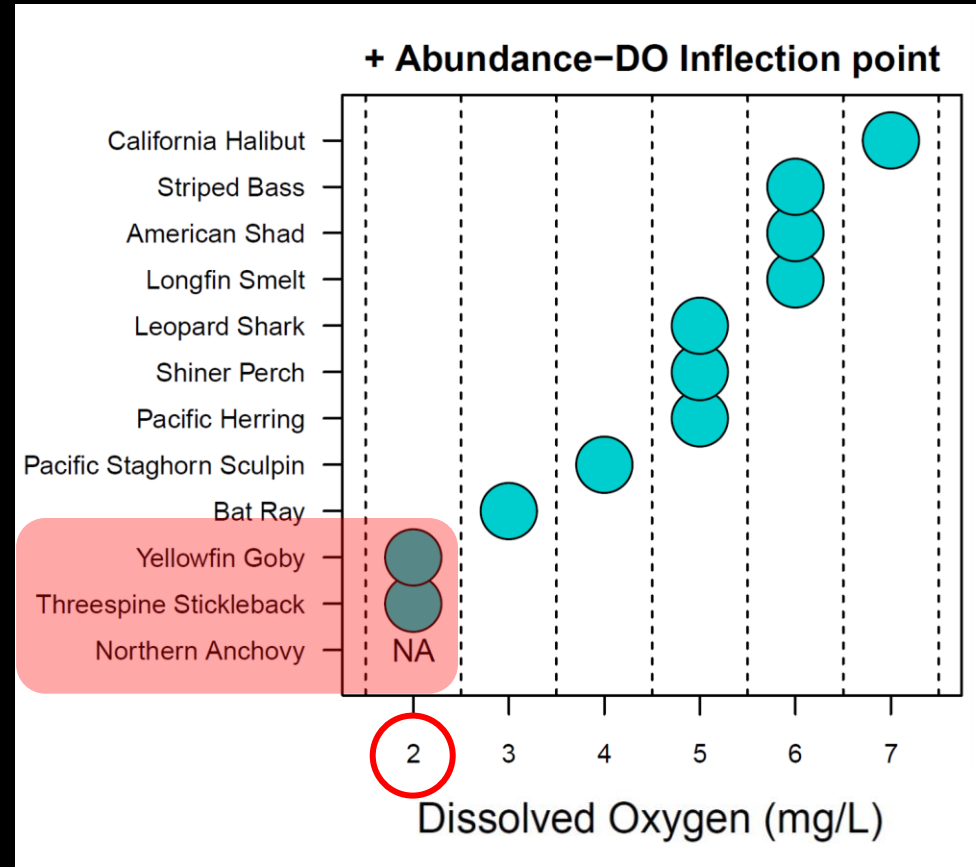
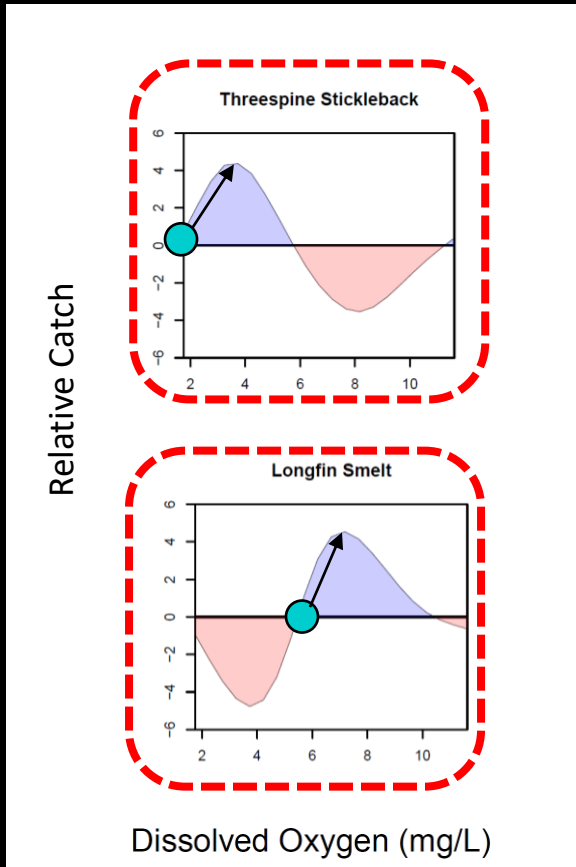
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Likely responses to **hypoxia**: **+ DO INFLECTION**



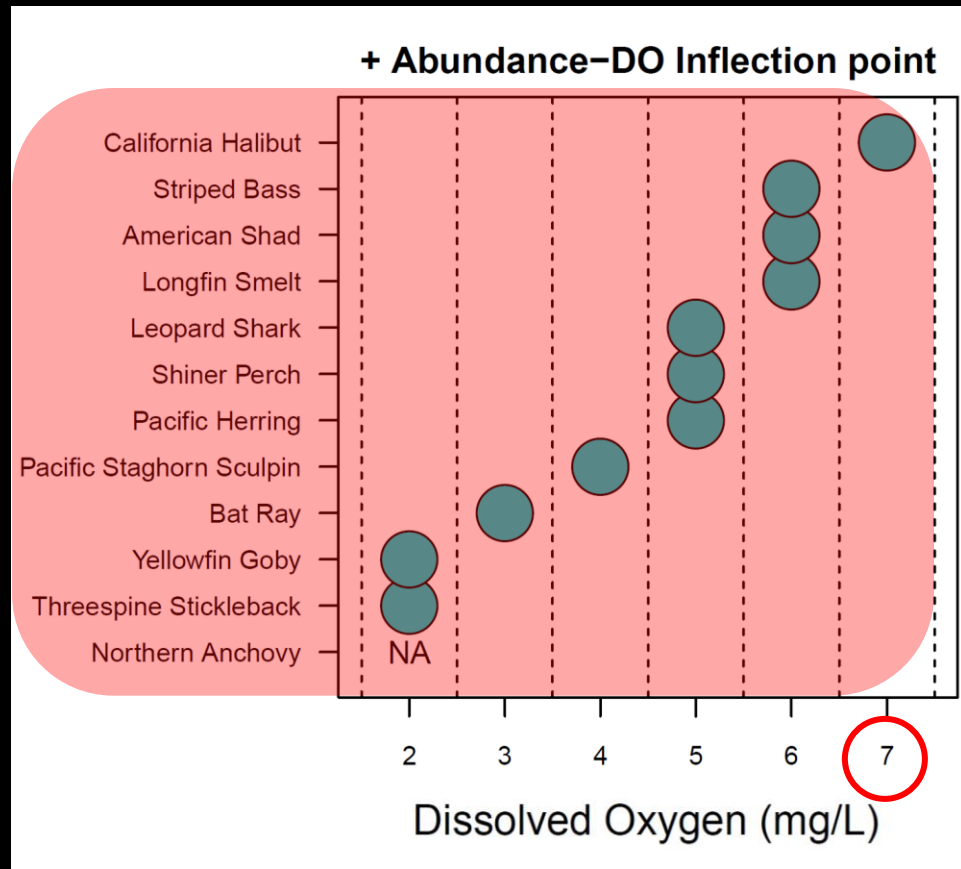
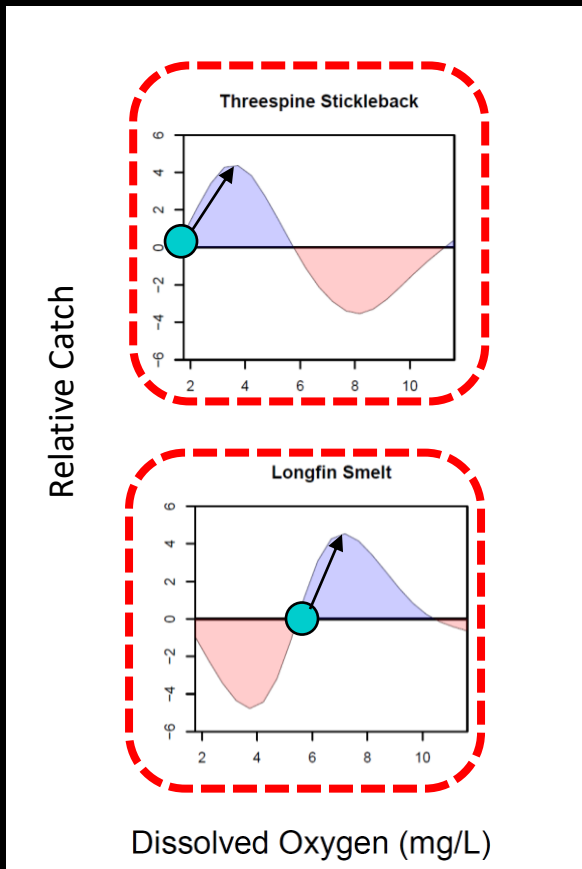
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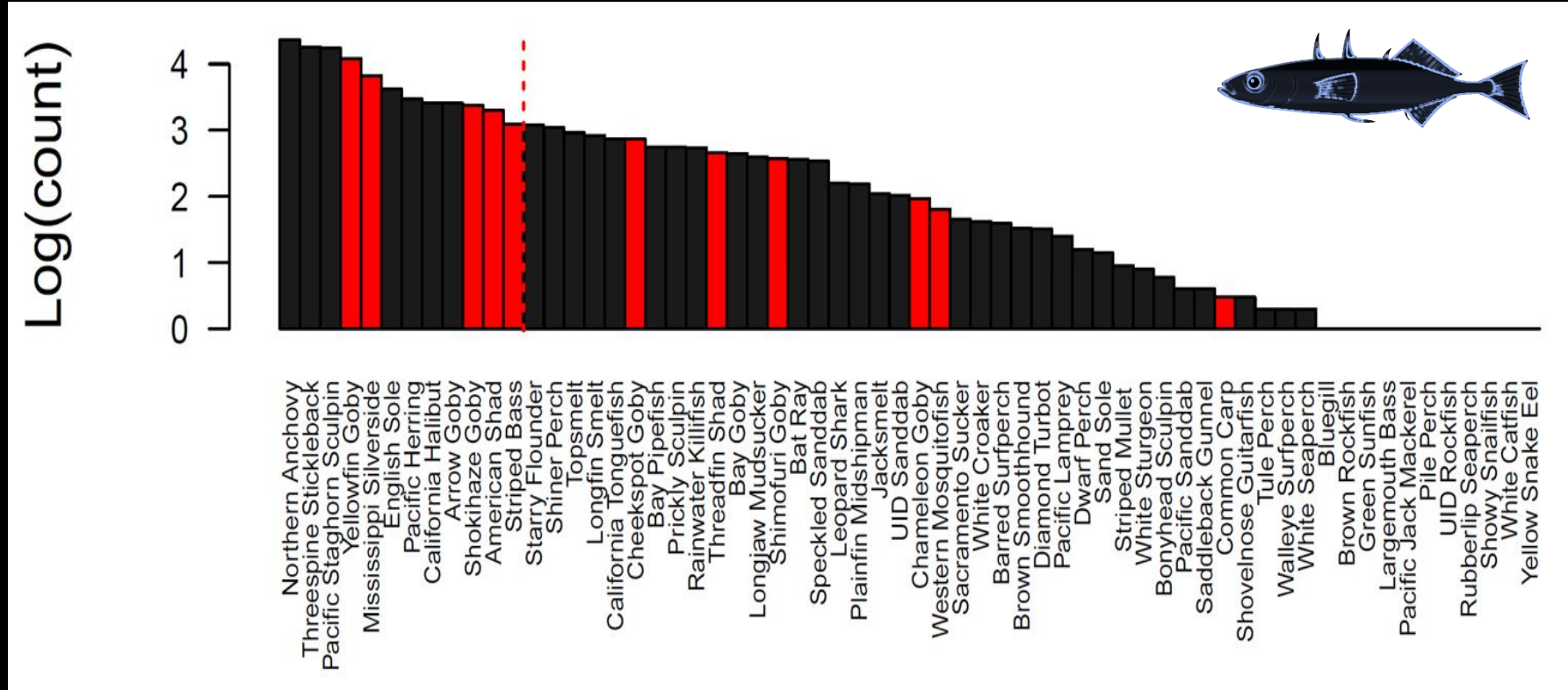
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

Likely responses to **hypoxia**: **+ DO INFLECTION**



2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

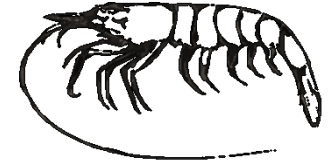
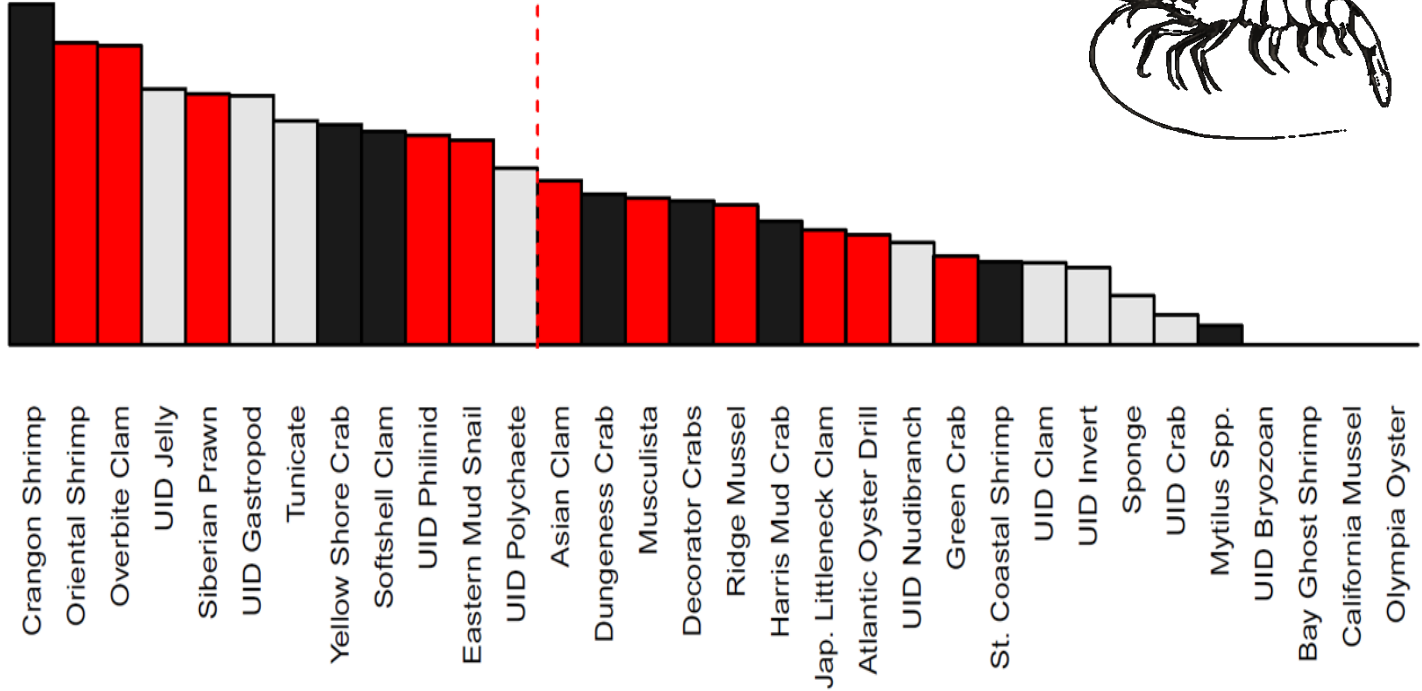
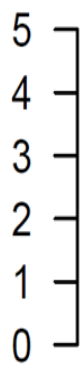
Can be applied to the 60+ species of FISH



2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

Can be applied to the 30+ taxa of MACROINVERTS

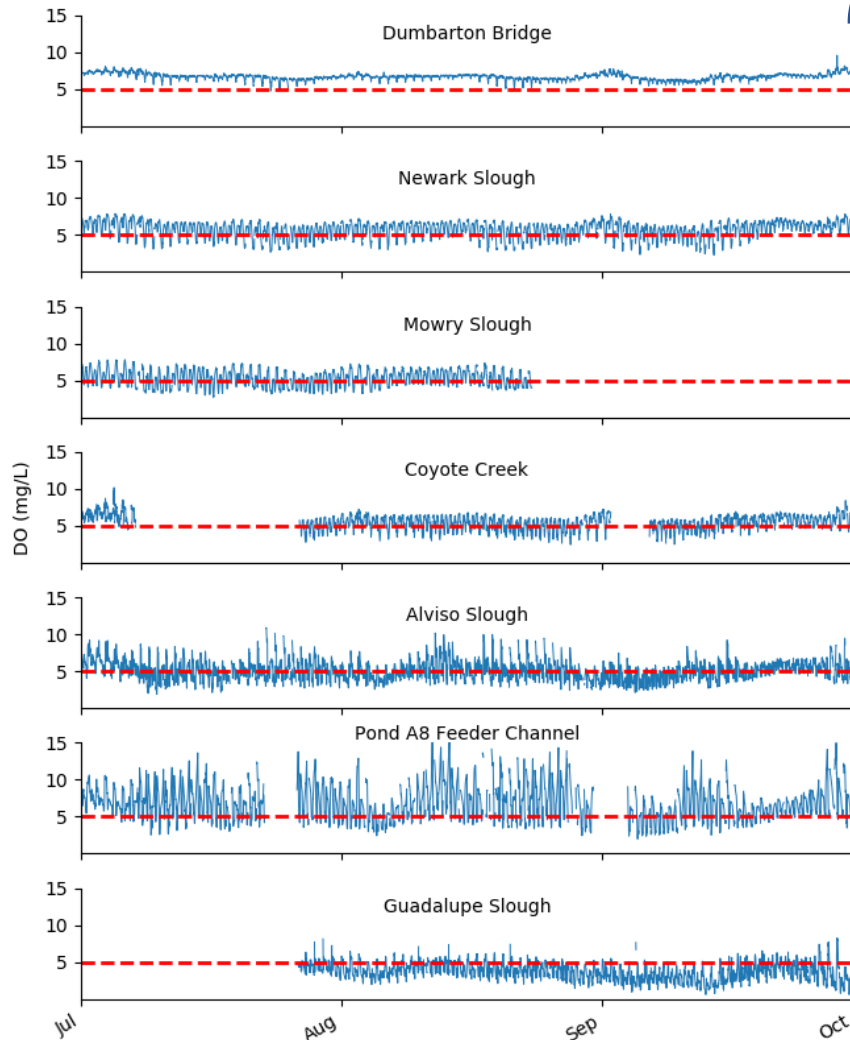
Log(count)



2. A Fish Is Not a Fish is Not a Fish (What is Habitat Quality?)

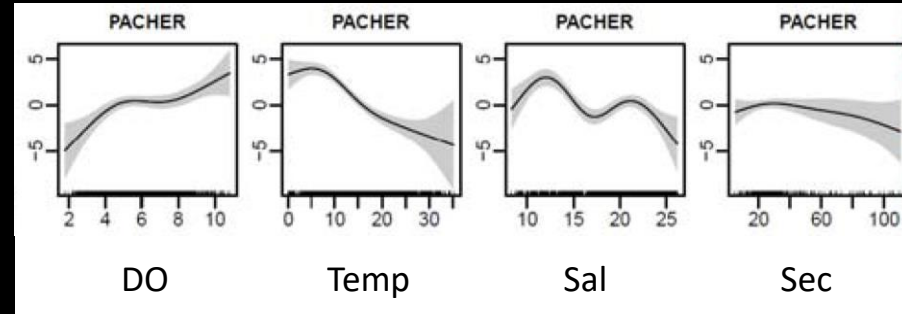
Taxon-specific Habitat Suitability Functions (GAMs)

Continuous Monitoring Data (DO)

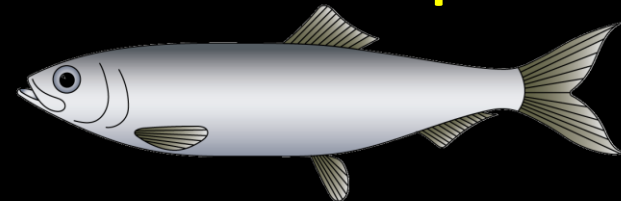


MacVean et al. 2018

Habitat Suitability Model



HSI_{sp}



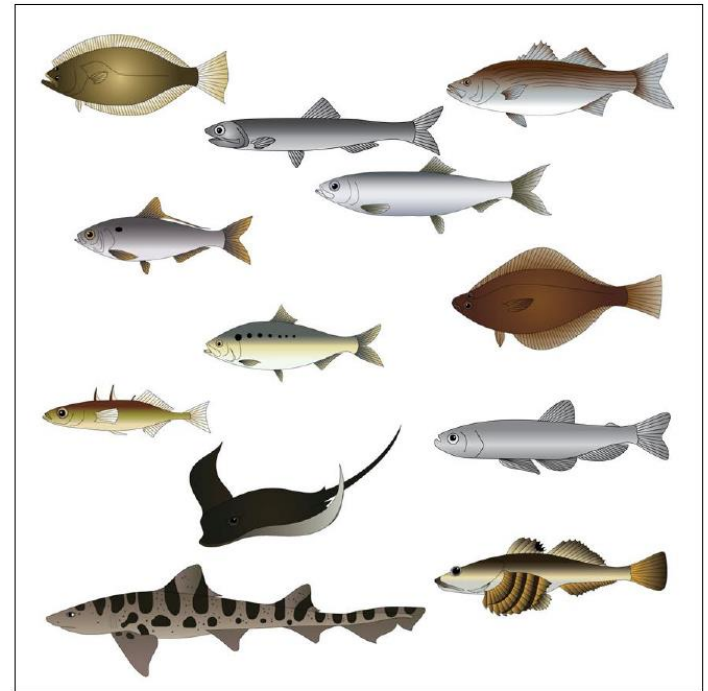
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)

- Hypoxia did not appear to suppress abundance or diversity of fishes in Alviso Marsh (other metrics, other locations)?
- Species exhibited complex responses to water quality: *“Some like it hot, some like it cold...”*
- Habitat quality for “fish” is undefined. *“A fish is not a fish.” (must be specific)*
- Solution: seasonal focal assemblages?
- Solution: GAMs (models) – continuous taxon-specific suitability can be assessed & aggregated among focal species.

Habitat Quality and Fish Abundance in the Alviso Marsh Complex 2010-2016

Dr. Levi Lewis and Dr. James Hobbs

Department of Wildlife, Fish and Conservation Biology
University of California, Davis



Artwork by Adi Khen

Prepared for the San Francisco Estuary Institute
SFEI Subcontract No: 1276

Three Fishy Stories about the SFE:

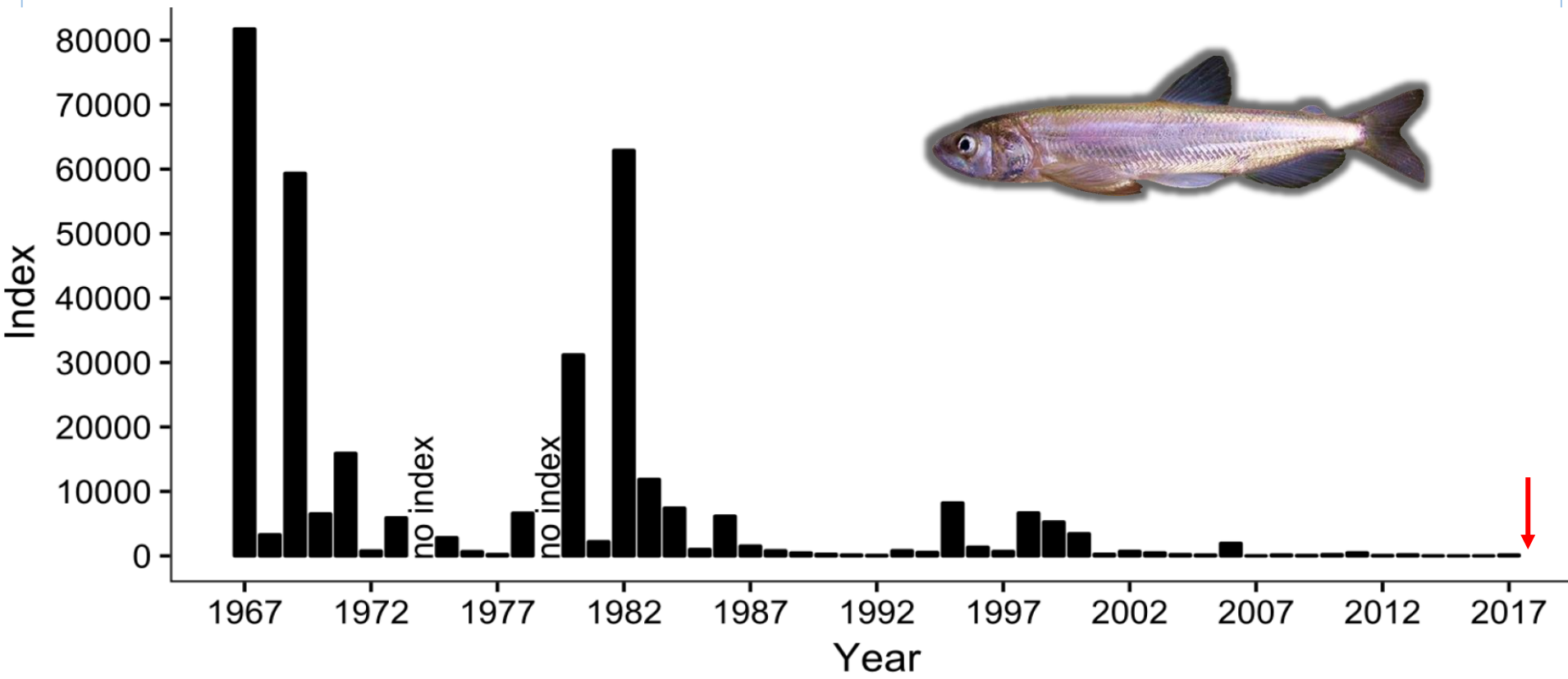
1. A Tale Of 2 Marshes: The Northern vs Southern SFE
2. A Fish Is Not a Fish is Not a Fish (*What is Habitat Quality?*)
3. An Unlikely Place for a Threatened Species

Sponsored by the Delta Science Program and the UC Davis John Muir Institute of the Environment

ESSAY

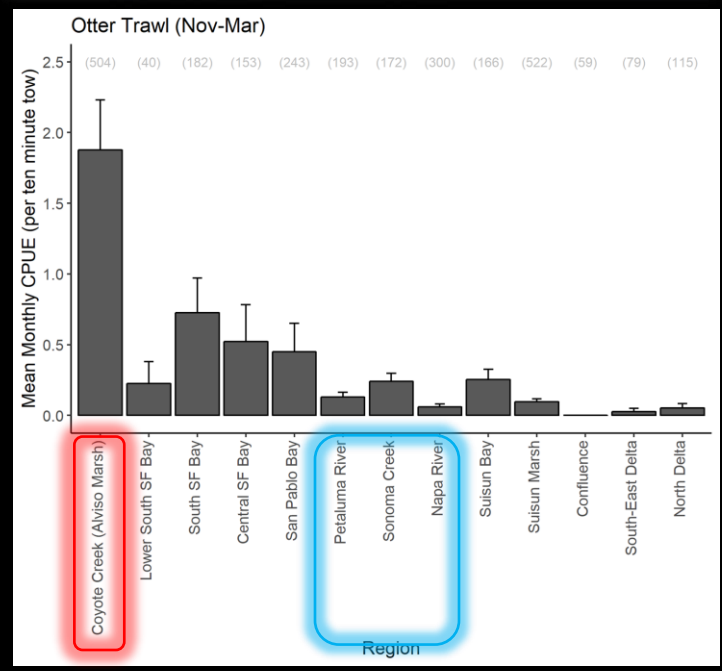
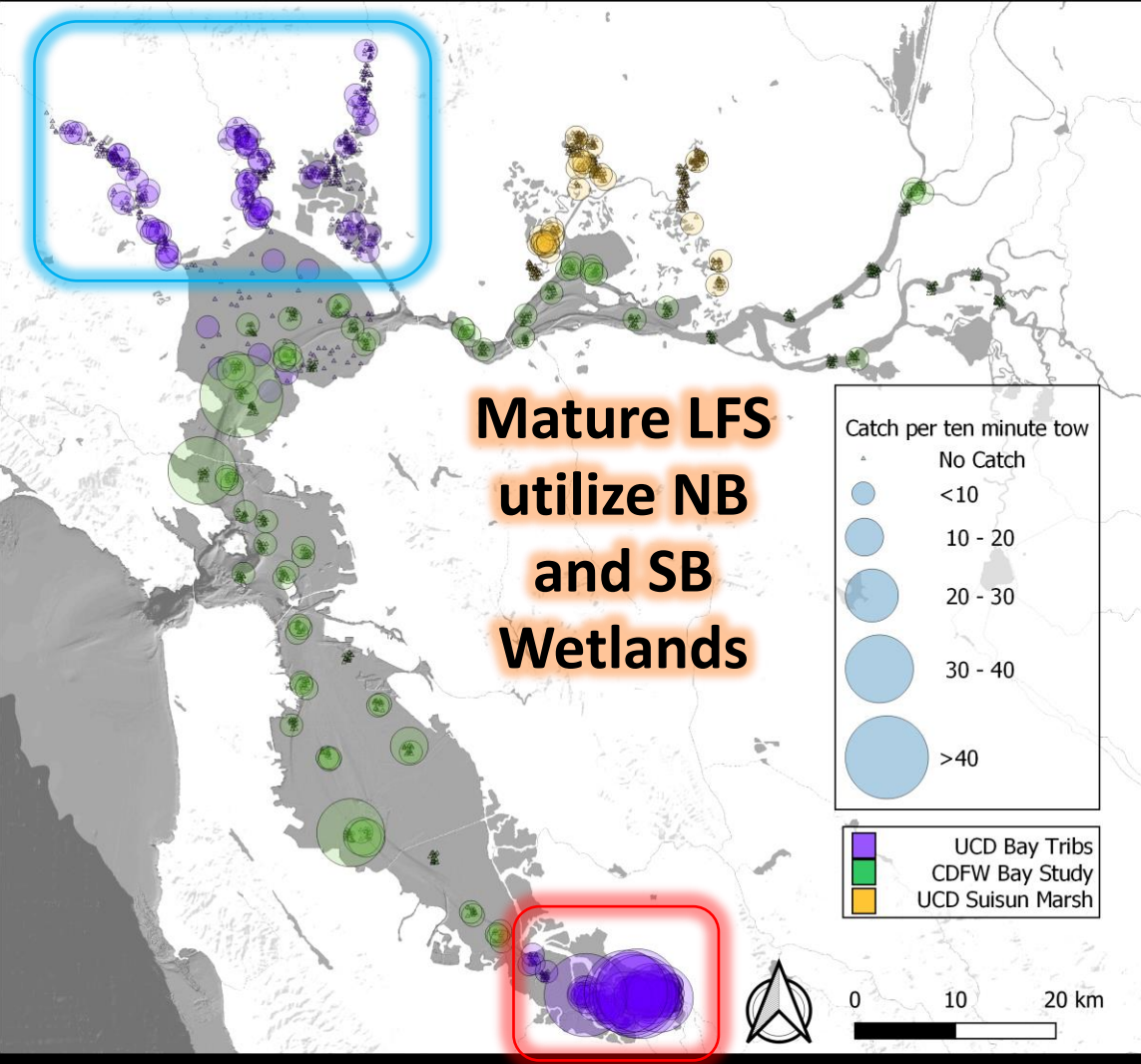
Is Extinction Inevitable for Delta Smelt and Longfin Smelt? An Opinion and Recommendations for Recovery

James A. Hobbs^{*,1}, Peter B. Moyle^{1,2}, Nann Fangué¹, and Richard E. Connon³

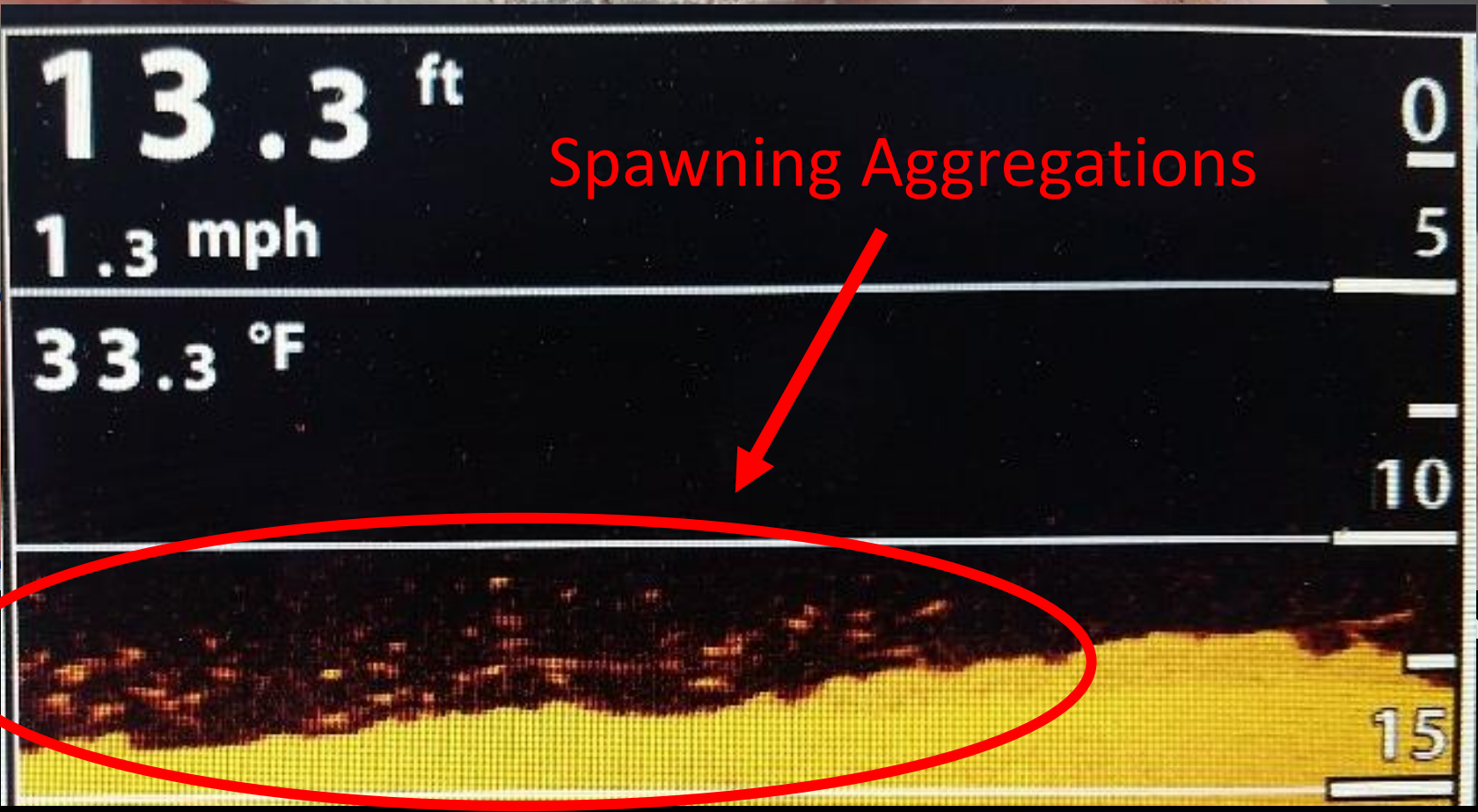


3. A Threatened Species in Unlikely Places

Adult Longfin Smelt (Nov-Mar, 2015-19)

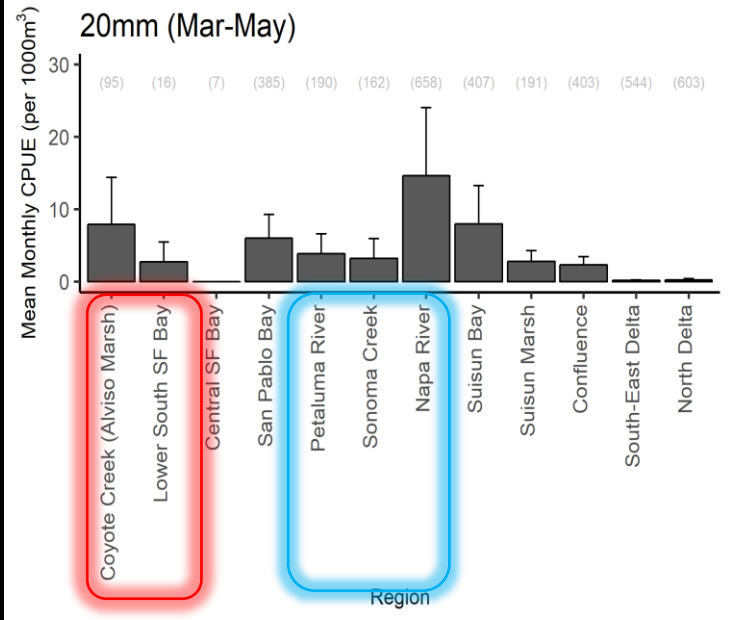
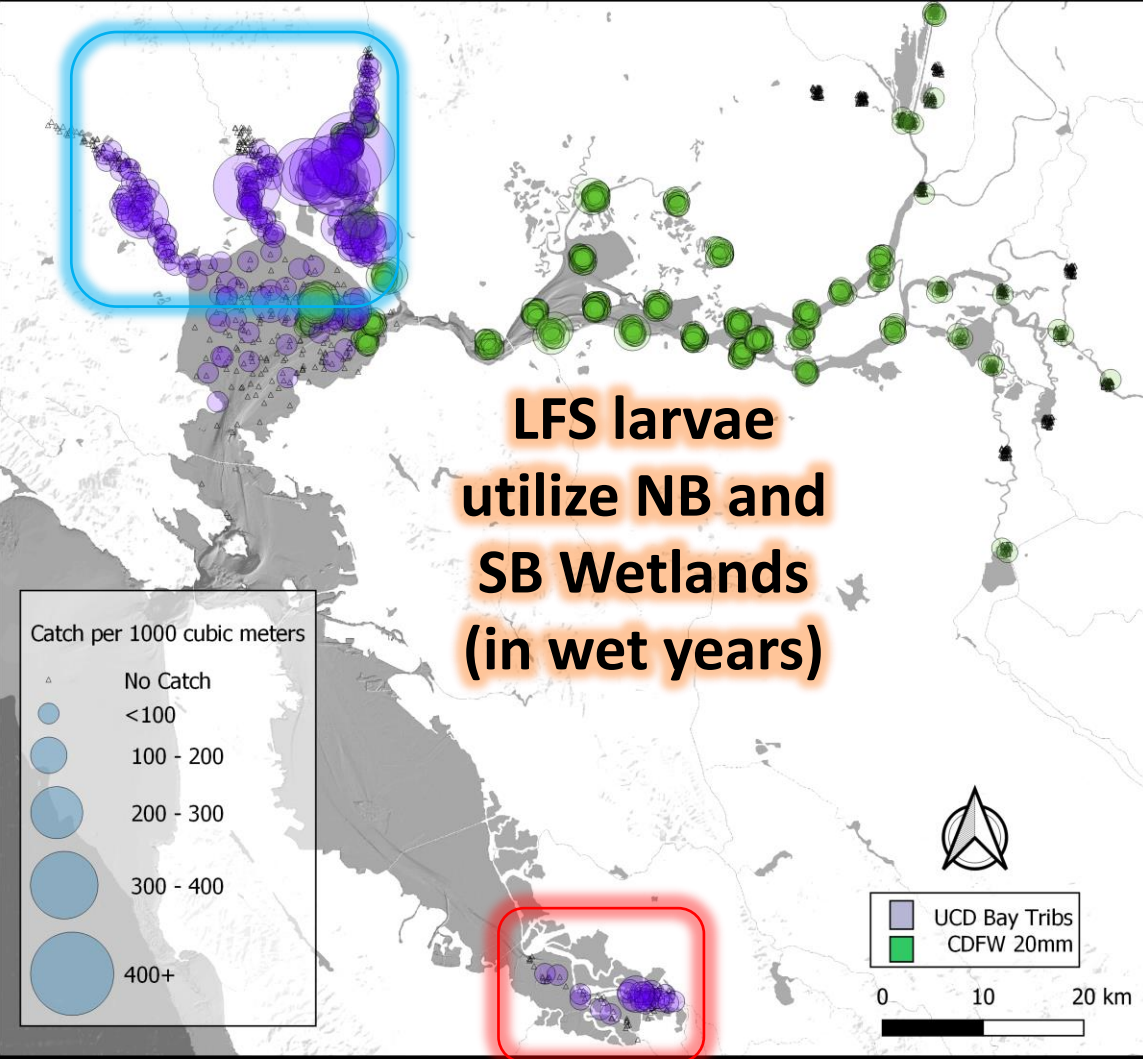


3. A Threatened Species in Unlikely Places



3. A Threatened Species in Unlikely Places

Larval Longfin Smelt (Mar-Apr, 2016-19)

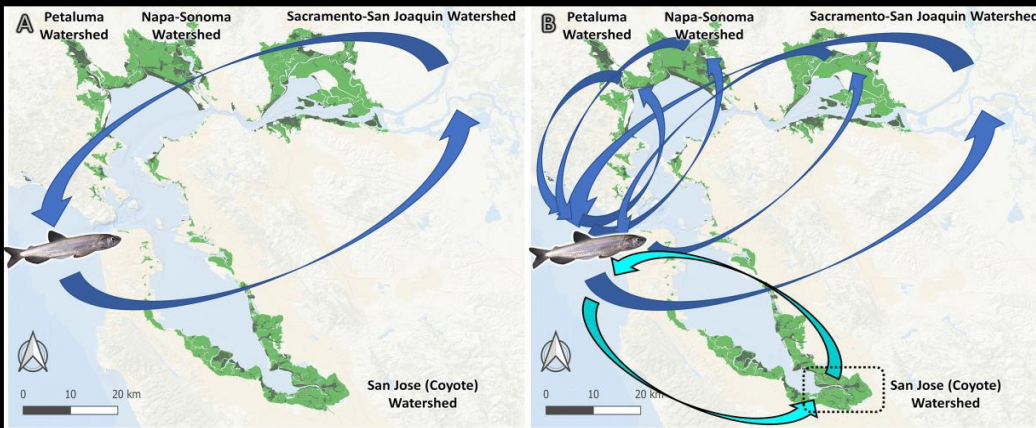


3. A Threatened Species in Unlikely Places

Newly discovered spawning and recruitment of threatened Longfin Smelt in restored and under-explored tidal wetlands

Levi S. Lewis  Malte Willmes, Arthur Barros, Patrick K. Crain, James A. Hobbs

First published: 28 August 2019 | <https://doi.org/10.1002/ecy.2868>



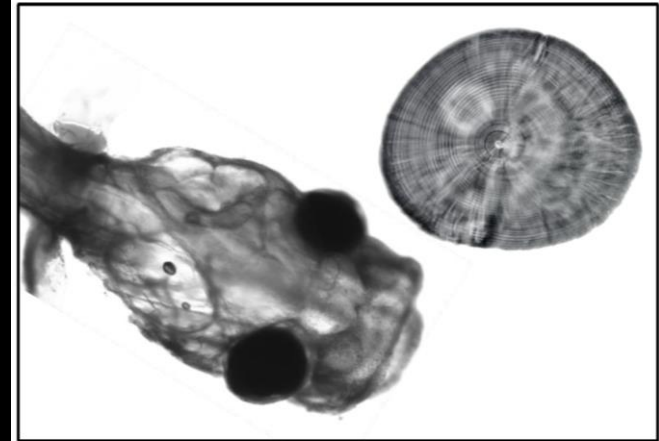
Interdisciplinary Studies on Longfin Smelt in the San Francisco Estuary

Levi Lewis^{1*}, Arthur Barros¹, Malte Willmes¹, Christian Denney¹, Christina Parker¹, Micah Bisson¹, James Hobbs¹, Amanda Finger², Grace Auringer², Alyssa Benjamin²

*Corresponding author: lslewis@ucdavis.edu

¹Biogeochemistry & Fish Ecology Laboratory, Department of Wildlife, Fish and Conservation Biology, UC Davis, One Shields Ave, Davis, CA 95616

²Genomic Variation Laboratory, Department of Animal Science, UC Davis, One Shields Ave, Davis, CA 95616

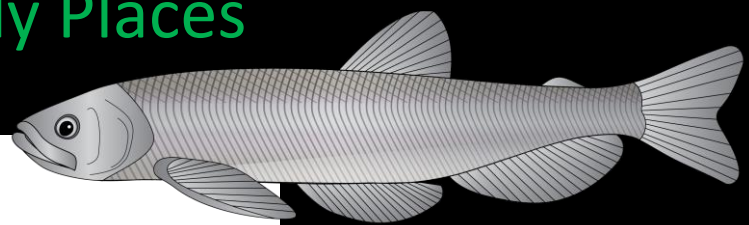


Prepared for:

California Department of Water Resources &
IEP Longfin Smelt Technical Team

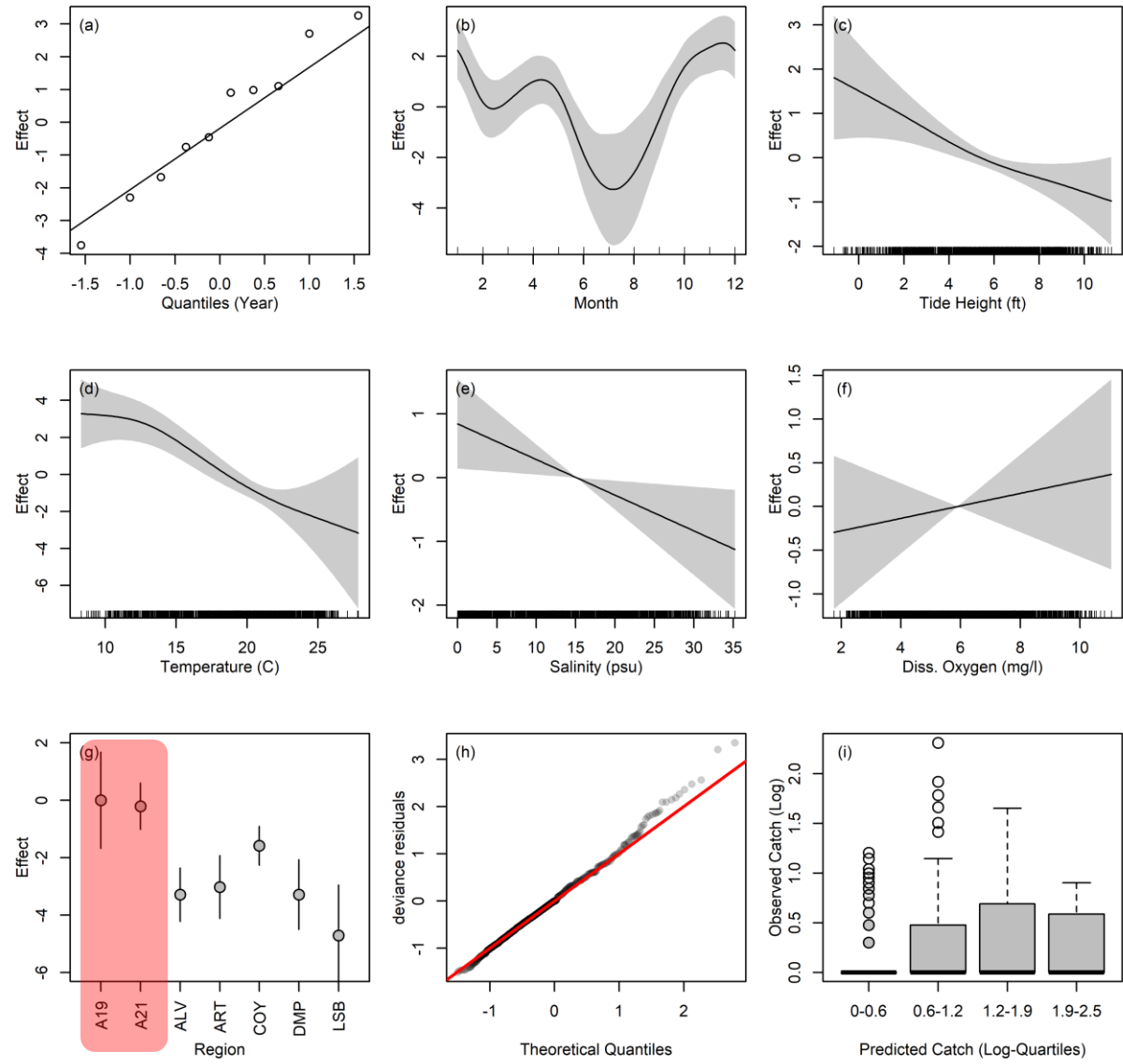
3. A Threatened Species in Unlikely Places

Generalized Additive Model



Longfin Smelt

Longfin Smelt m14



Highest catches in restored ponds

What have we learned?

1. Lower South Bay marshes are loaded with fish

- High abundance, diversity, and a unique community vs. North Bay marshes
- Restored ponds are providing habitat for many species.

2. Diverse fish communities exhibit diverse behaviors

- Hypoxia not depressing total fish abundance and diversity; possibly diversity/structure
- Assessing habitat quality for fish requires careful selection of spp. , season, etc.

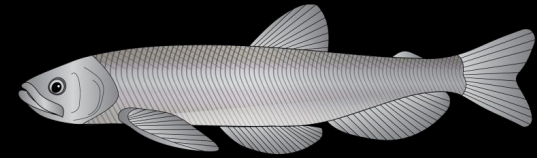
3. Discovered new spawning/rearing habitats for Longfin Smelt

- Present in all Bay tributaries
- Abundant in Alviso Marsh & restored ponds
- Evidence of spawning in wet years(eggs, milt, & larvae)
- May benefit from tidal marsh & watershed restoration

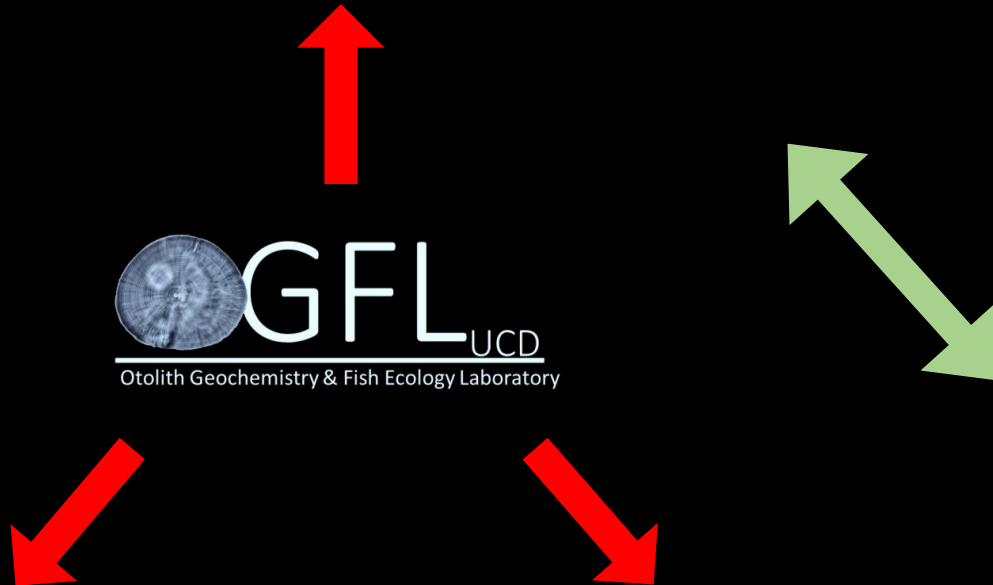
Forward Thinking



OPPORTUNITIES FOR SYNERGY

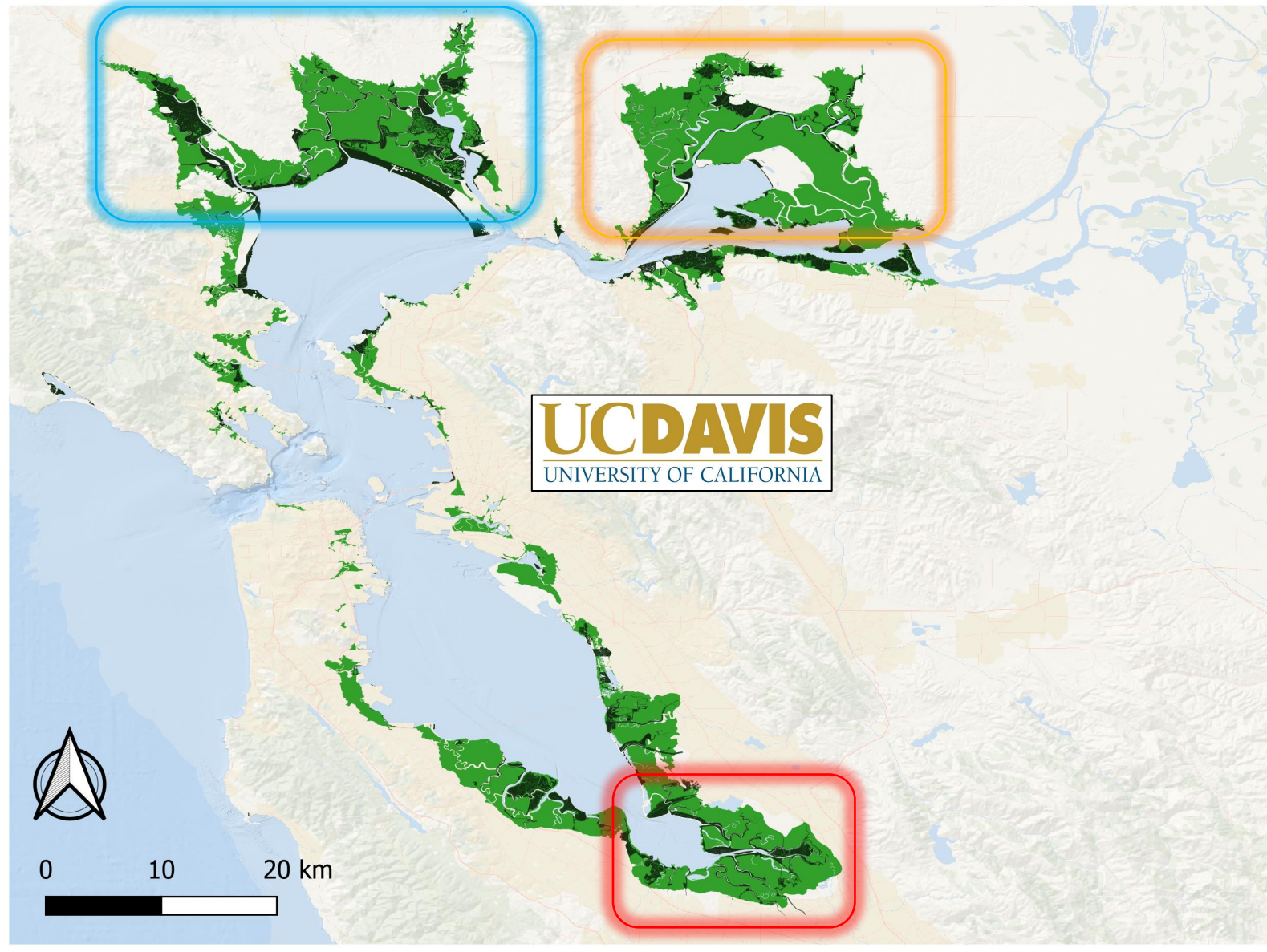


LFSSP



OPPORTUNITIES FOR SYNERGY

Aquatic Species?



Bay

*The sad fact is that the ~~ocean~~ could be empty,
and it would still look the same.*

– ~~Carl Safina~~ Levi Lewis



Assessing the Aquatic Health of San Francisco's Tidal Wetlands

Levi S. Lewis

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