Beneath the Surface, Below the Delta

Expanding our knowledge of aquatic wetland ecosystems across the SFE

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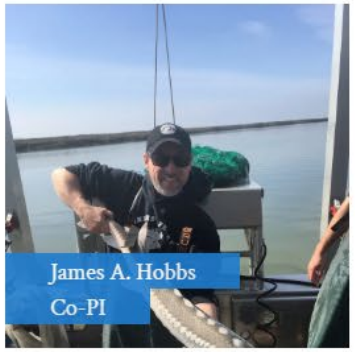
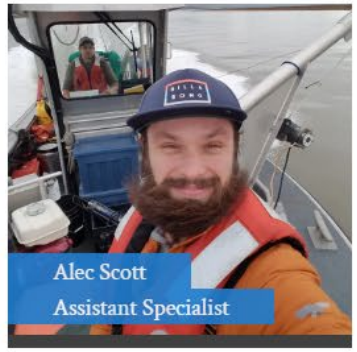
Acknowledgements: OGFL Team





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UC Davis

UCDAVIS WILDLIFE, FISH, & CONSERVATION BIOLOGY

Center for Watershed Sciences

UCDAVIS Fish Conservation and Culture Laboratory

Genomic Variation Laboratory, University of California, Davis, GVL

Federal

United States Environmental Protection Agency

National Oceanic and Atmospheric Administration, U.S. Department of Commerce, NOAA

U.S. Fish & Wildlife Service, Department of the Interior

USGS science for a changing world

State

Department of Water Resources, State of California

California Department of Fish & Wildlife

Sea Grant California

California Water Boards, State Water Resources Control Board

Local

South Bay Salt Pond Restoration Project

SFEI Aquatic Science Center, San Francisco Estuary Institute & the Aquatic Science Center

San José-Santa Clara Regional Wastewater Facility

San Francisco Estuary Partnership, Wetlands Regional Monitoring Program

Stillwater Sciences

Valley Water, Santa Clara Valley Water District

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Outline

1. **Introduction to FFH in the SFE**
2. **The WRMP & FFH Monitoring Guidelines**
3. **Past FFH Monitoring** (OGFL Reviews)
4. **FFH Monitoring Studies (OGFL examples)**
5. **FFH Data Integration** (OGFL examples)
6. **The Future of Aquatic Wetland Ecology in the SFE**

"A society grows great when old men plant trees in whose shade they shall never sit."
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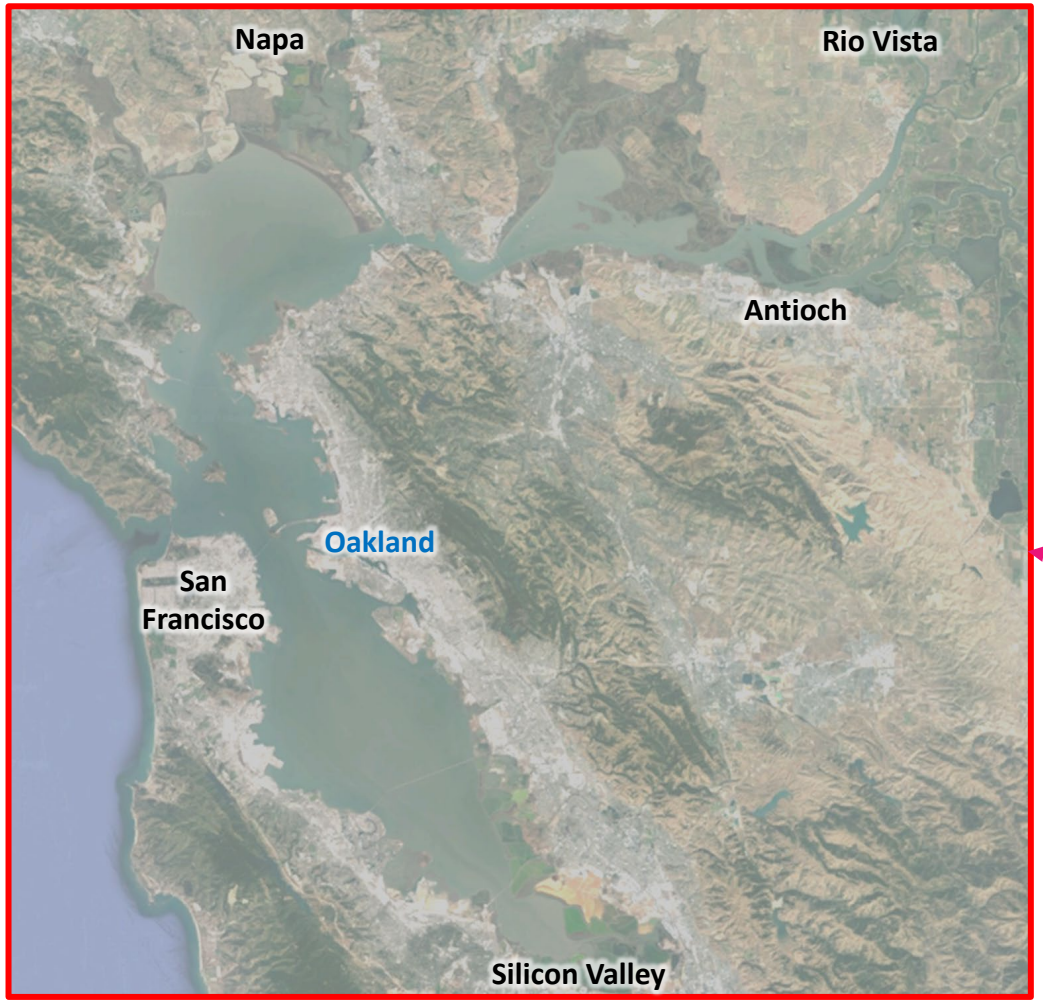
The San Francisco Estuary



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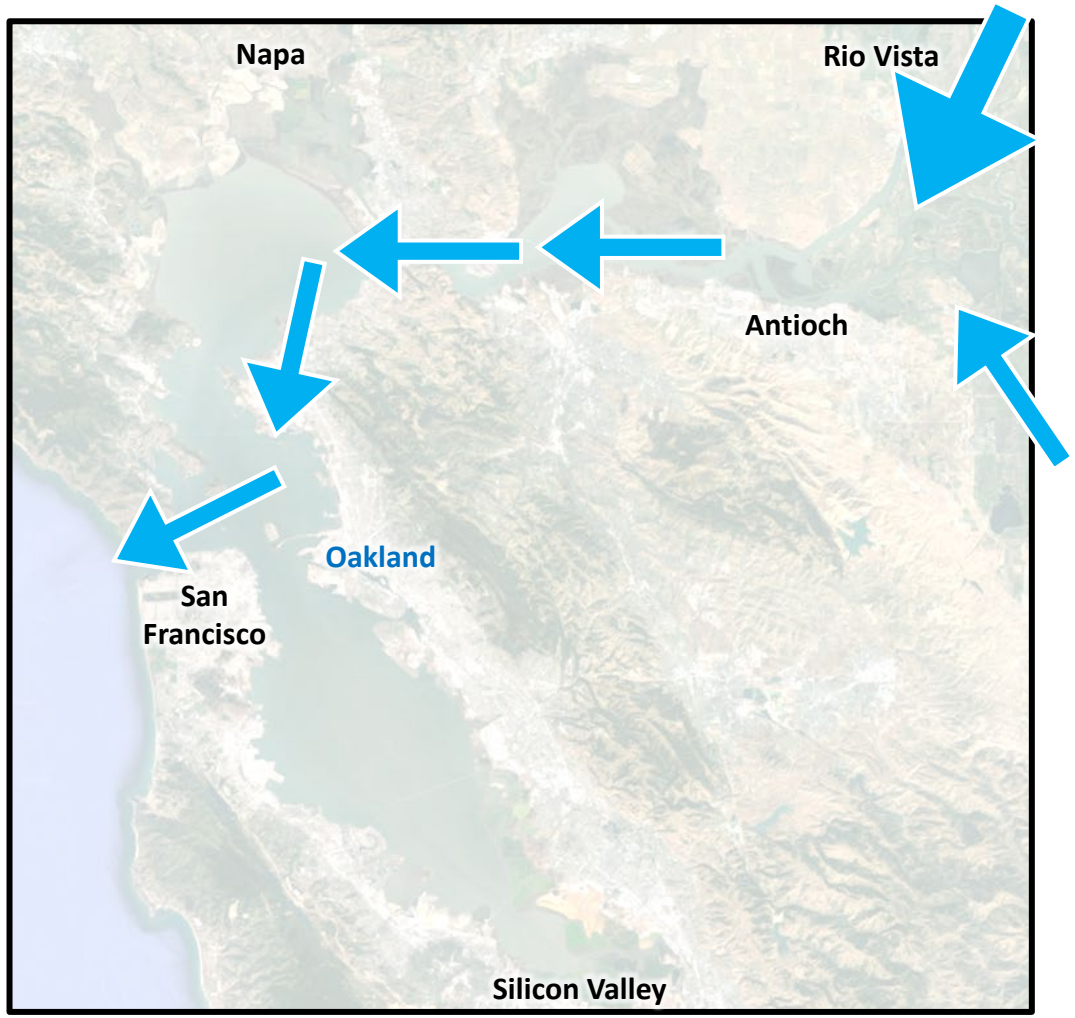

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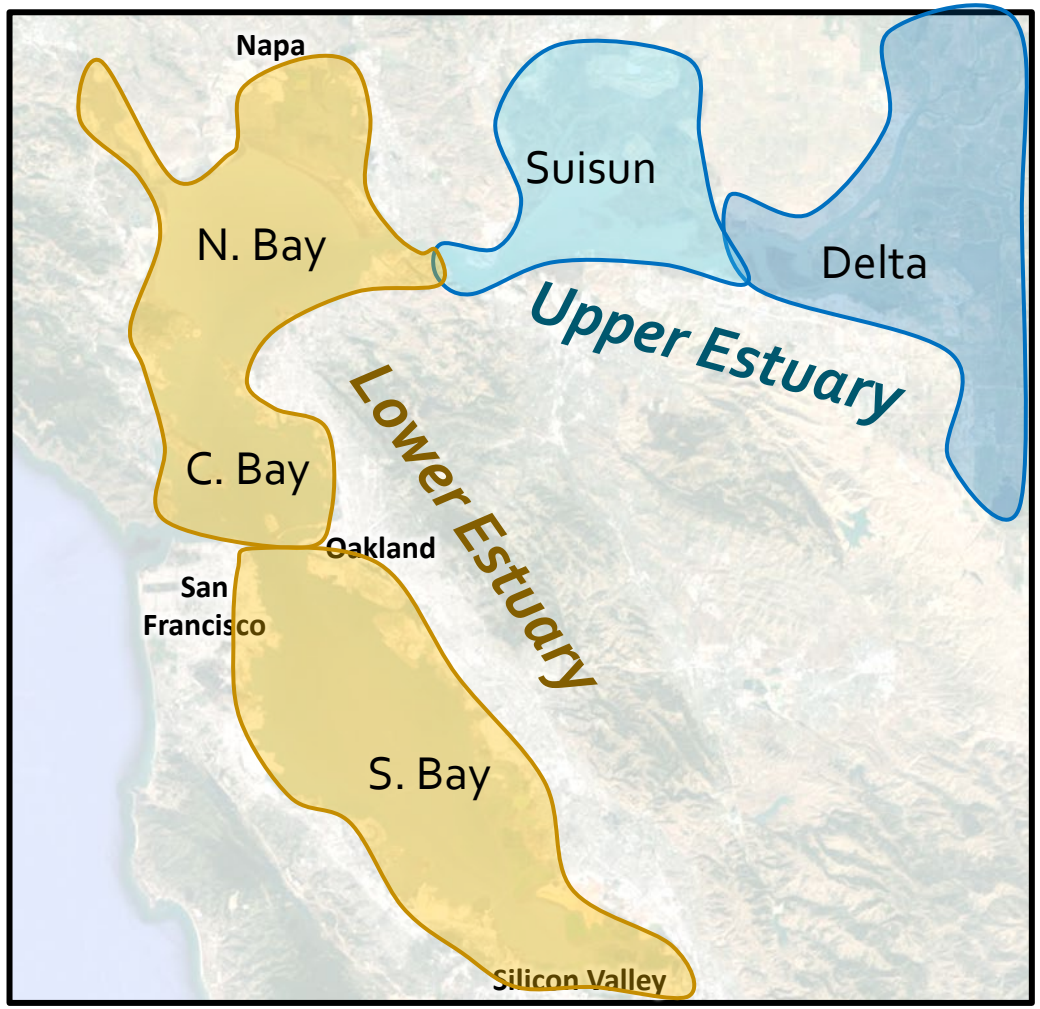
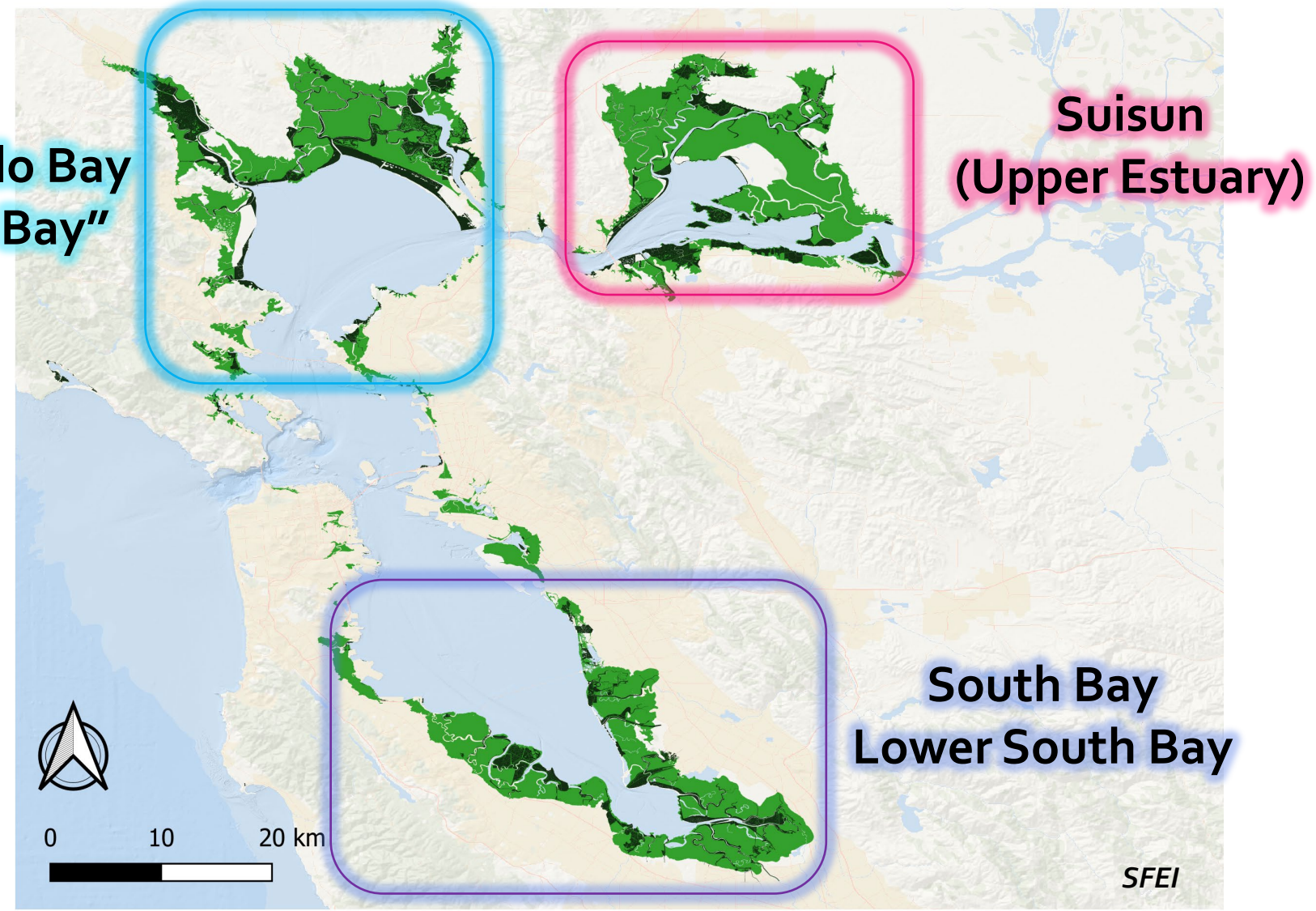


Brackish Wetlands of the SFE



1. Introduction

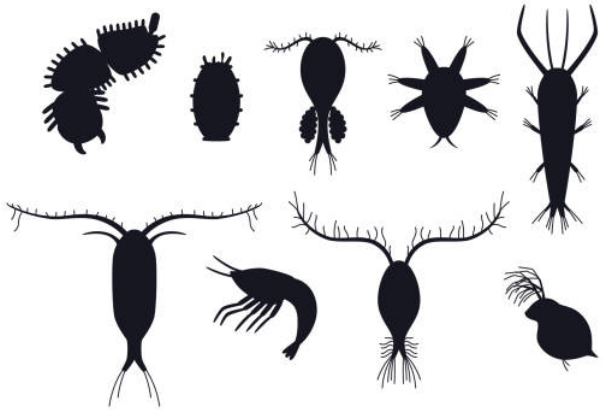
Wetlands

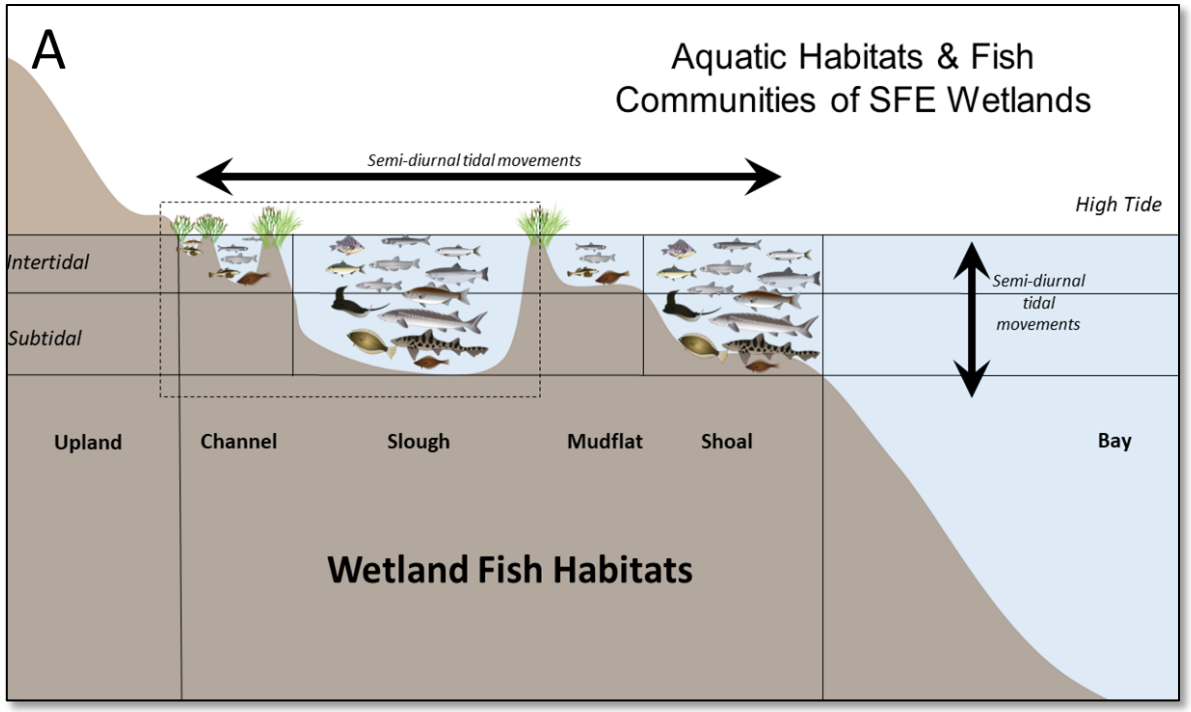
Definition

Ecology

Value

Conservation





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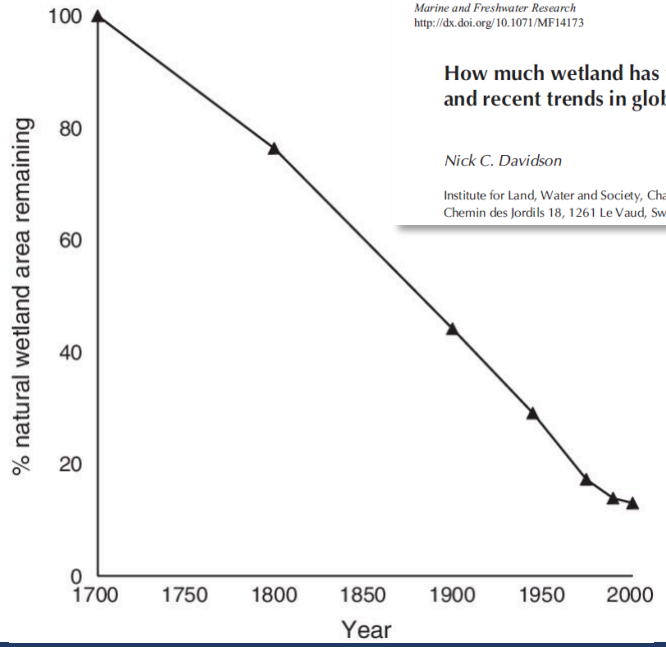


CSIRO PUBLISHING
Marine and Freshwater Research
http://dx.doi.org/10.1071/MF14173
Short communication

How much wetland has the world lost? Long-term and recent trends in global wetland area

Nick C. Davidson

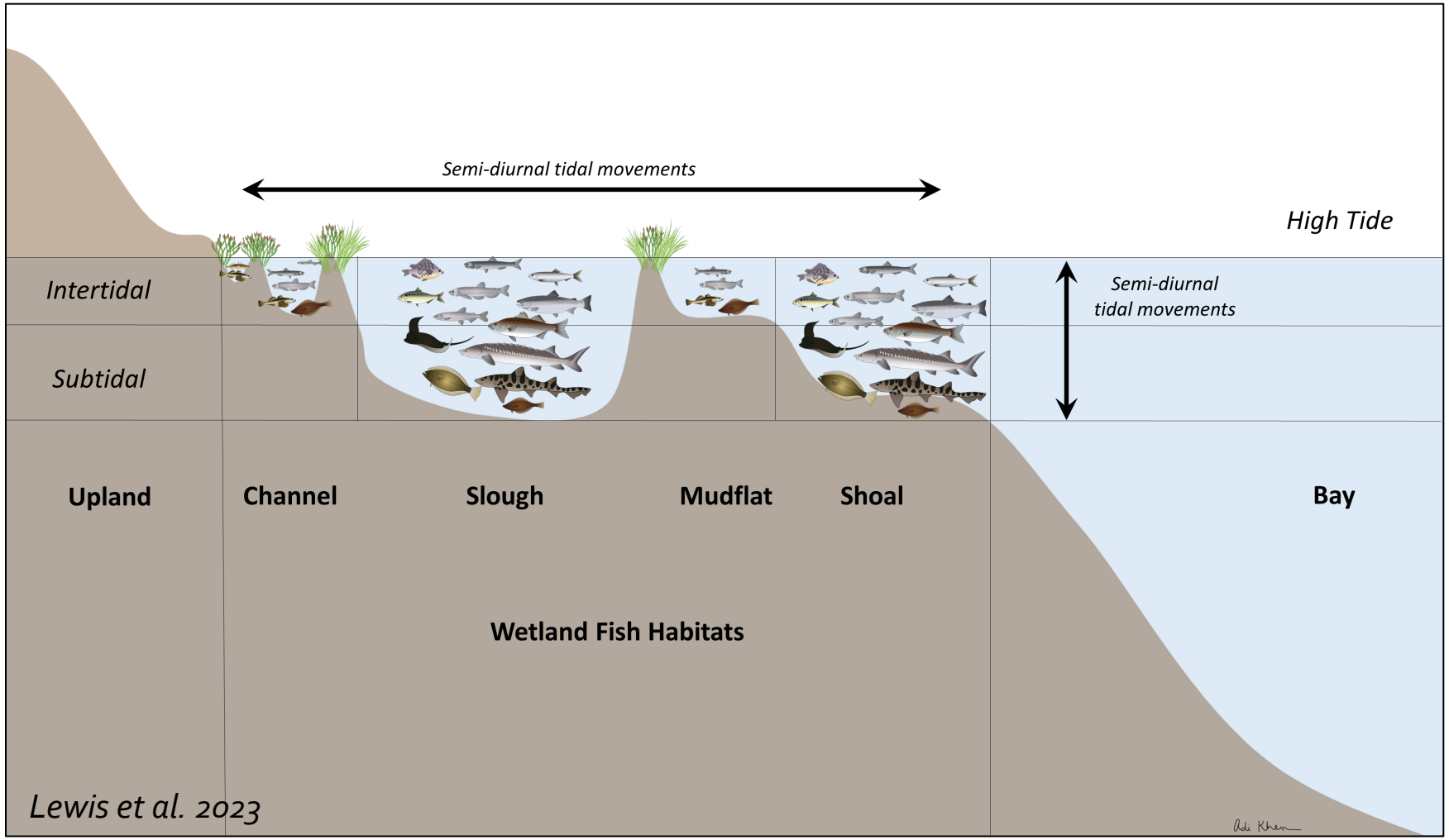
Institute for Land, Water and Society, Charles Sturt University, Albury, NSW, Australia; and Chemin des Jordils 18, 1261 Le Vaud, Switzerland. Email: arenaria.interpres@gmail.com

The Modification of an Estuary

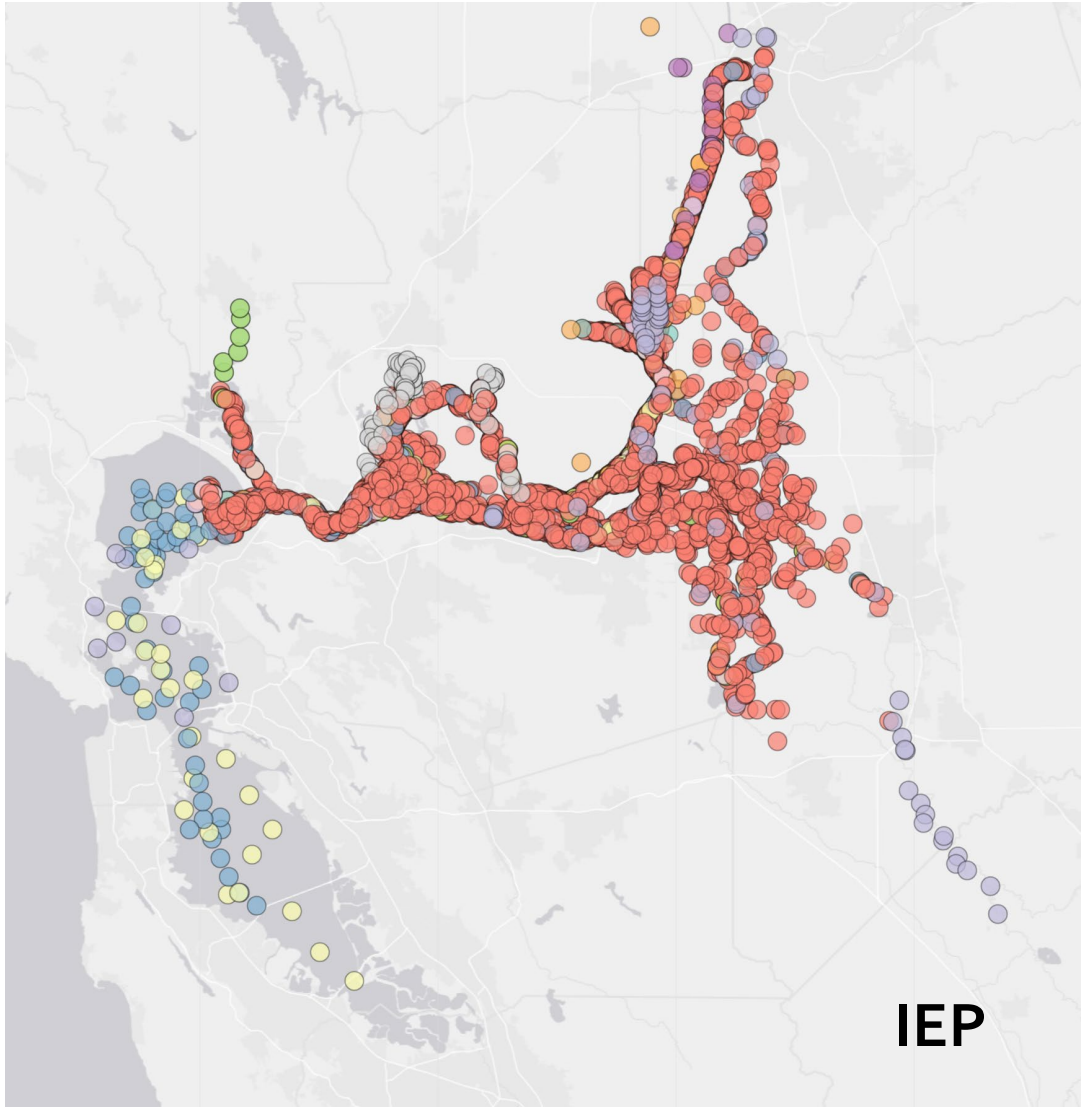
Frederic H. Nichols, James E. Cloern, Samuel N. Luoma, David H. Peterson

"Of the original 2200 km^2 of tidal marsh, only about 125 km^2 of undiked marsh remains today" (**95% degraded**)

Wetland Fishes of the SFE



Brackish Wetlands:
FFH Monitoring in the SFE



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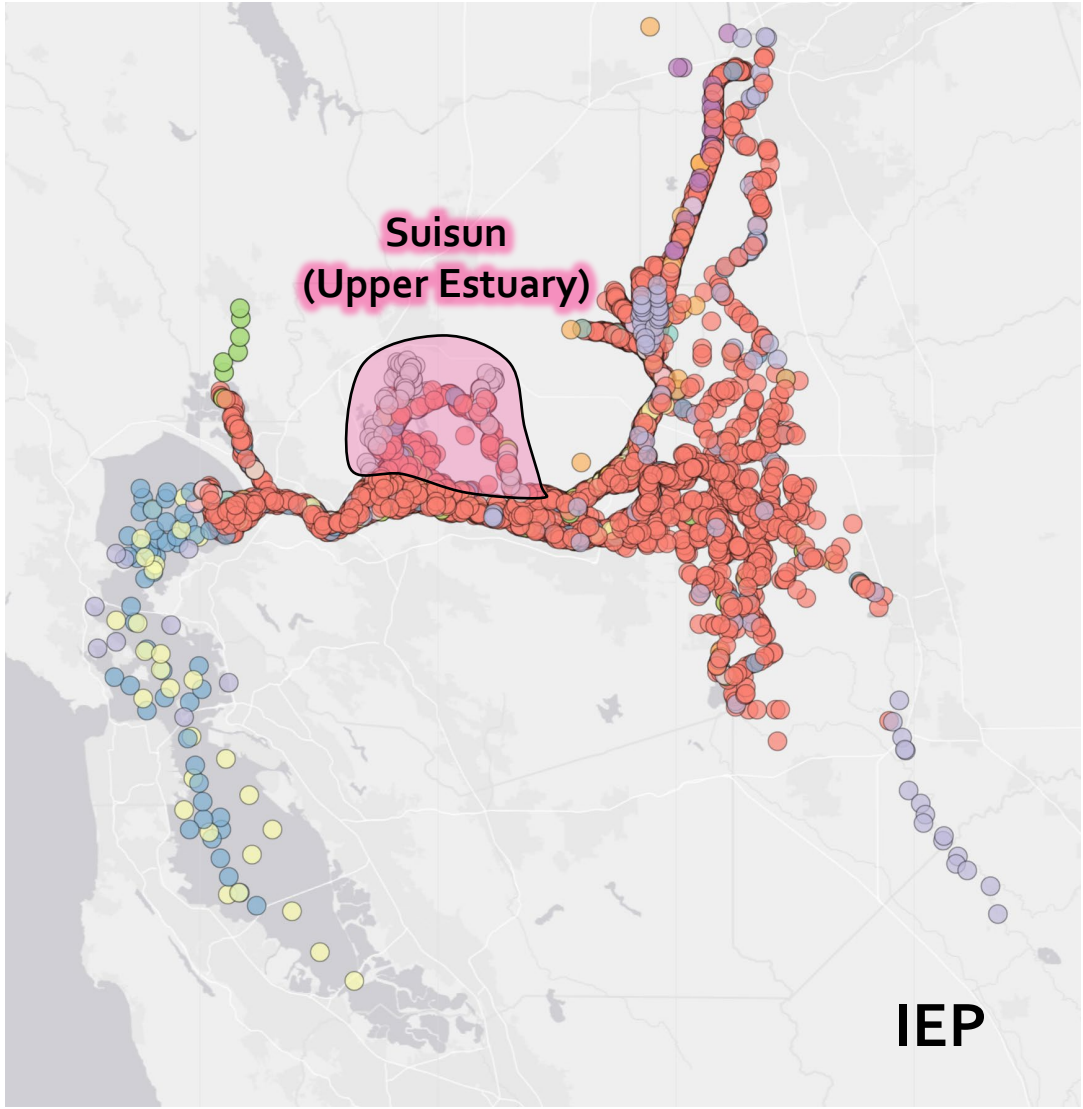

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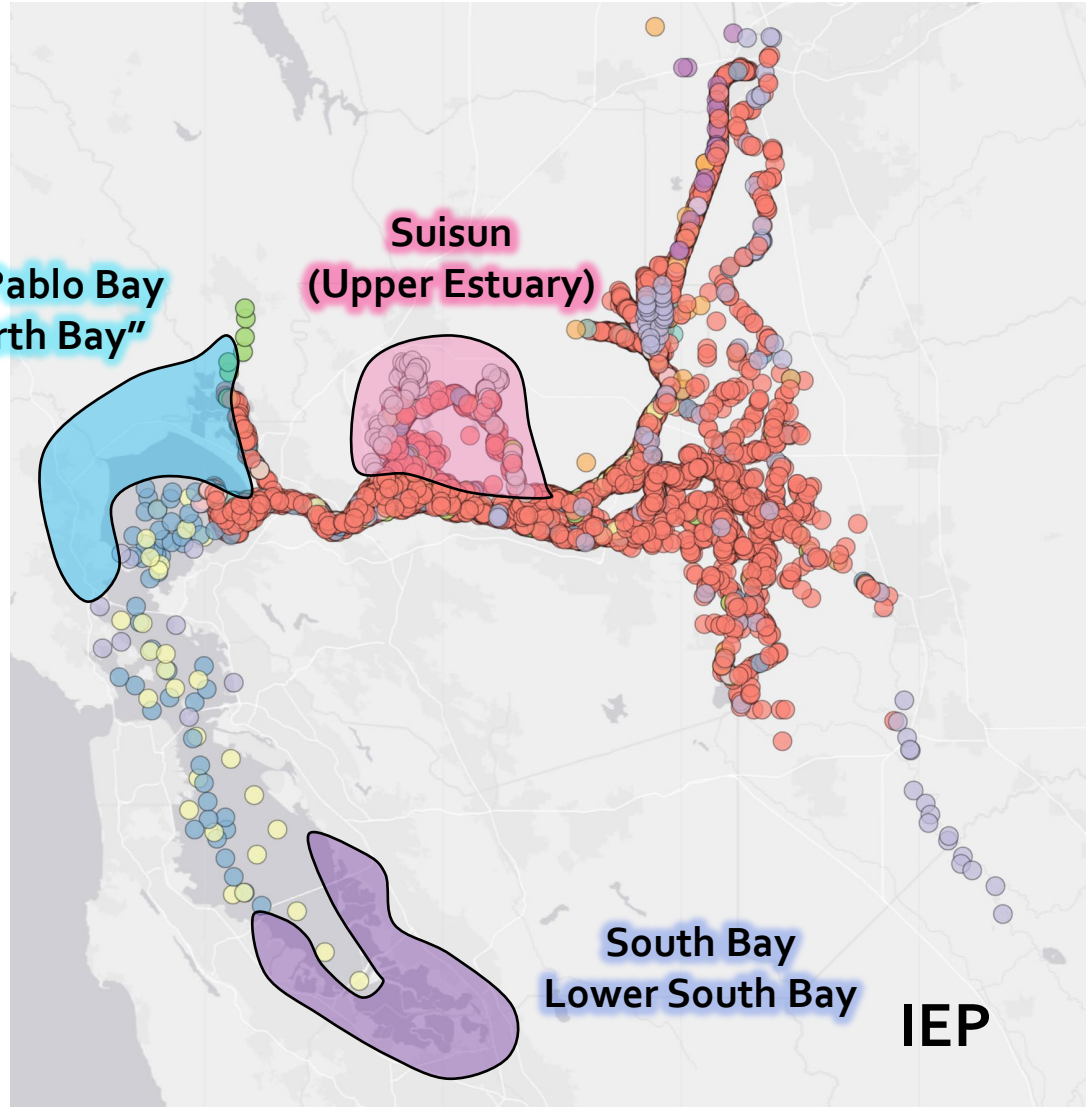
Brackish Wetlands: FFH Monitoring in the SFE

- Only Suisun Marsh has been included in long-term monitoring
- No long-term monitoring in most North Bay and South Bay Wetlands



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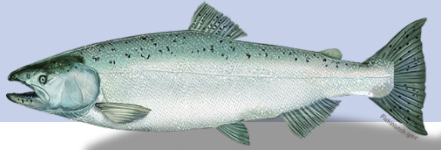


The Current View

State

INTERAGENCY ECOLOGICAL PROGRAM TECHNICAL REPORT

Effects of Tidal Wetland Restoration on Fish

A Suite of Conceptual Models

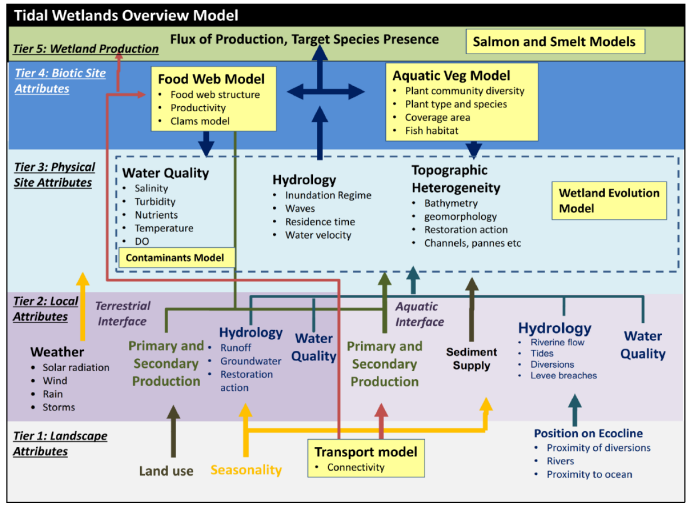
Edited by Stacy Sherman, Rosemary Hartman, and Dave Contreras

California Department of Fish & Wildlife
Bay Delta Region, Fish Restoration Program
2109 Arch Road, Suite 100, Stockton, CA 95206
November 2, 2017

Fish Restoration Program

Interagency Ecological Program
Cooperative Ecological Investigations Since 1970

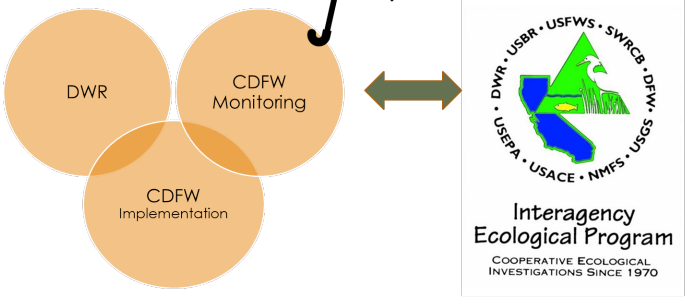
Suggested citation: Sherman, S., R. Hartman, and D. Contreras, editors. 2017. Effects of Tidal Wetland Restoration on Fish: A Suite of Conceptual Models. IEP Technical Report 91. Department of Water Resources, Sacramento, California.



Fish Restoration Program

IEP

IEP Tidal Wetland Monitoring Project Work Team



Interagency Ecological Program
Cooperative Ecological Investigations Since 1970

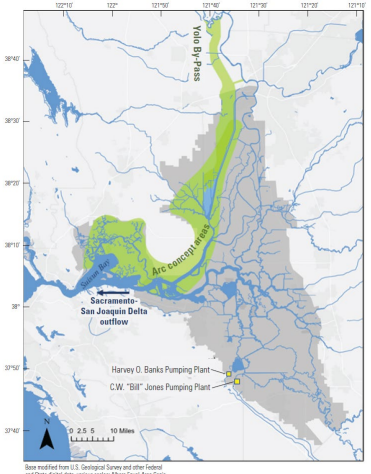
Federal

USGS science for a changing world

Water Availability and Use Science Program

Prepared in cooperation with the Bureau of Reclamation

Physics to Fish: Understanding the Factors that Create and Sustain Native Fish Habitat in the San Francisco Estuary



Open-File Report 2023–1087

By Larry R. Brown, David E. Ayers, Brian Bergamaschi, Jon R. B
Evan T. Dailey, Bryan Downing, Maureen Downing-Kunz, Freder
Brock M. Huntsman, Tamara Kraus, Tara Morgan, Jessica R. La
Francis Parchaso, Catherine A. Ruhl, Elizabeth Stumpner, Paul S
Janet Thompson, and Matthew J. Young

U.S. Department of the Interior
U.S. Geological Survey

1. Introduction

"An abundant, diverse community of fish that is dominated by native species, which in turn are widespread throughout their native range, is an indicator of a healthy Estuary."

"In San Francisco and San Pablo Bays, this long-term data set is from sampling only the offshore areas of the bay and may not reflect benefits to fish populations from recent wetland restoration.

INDICATOR	STATUS AND TREND	AT A GLANCE
FRESHWATER FLOW	ESTUARY	Freshwater flows in the Estuary have been highly altered, causing reductions in inter-annual and seasonal variability, and peak-flows. Freshwater flows into the Estuary in recent years reflect chronic artificial drought conditions, in sharp contrast to unimpaired flows.
TIDAL MARSH	BAY, DELTA	Tidal marsh acreage throughout the Estuary has declined significantly from the historical amount, but restoration efforts are bringing back this critical ecosystem and associated benefits. Projects in the Bay are making extensive contributions to tidal marsh area, while efforts in the Delta are beginning to make progress towards regional goals.
FISH	BAY, DELTA	The condition of fish communities varies across the Estuary. In the lower Estuary, fish communities are abundant, diverse, and dominated by native species. However, in the brackish and freshwater upper Estuary, native fish communities are in poor condition. Based on long-term monitoring data, native fish communities across the Bay are declining. In San Francisco and San Pablo Bays, this long-term data set is from sampling only the offshore areas of the Bay and may not reflect benefits to fish populations from recent wetland restoration.
BENEFICIAL FLOODS	BAY, DELTA	The frequency, magnitude, and duration of floodplain inundation in both the Bay and the Delta are too low to support healthy estuarine habitats and sustain important ecological processes. While conditions have been variable over time, they have, in general, remained poor in the Delta and have declined in the Bay.
URBAN WATER USE	BAY, DELTA	In both the Bay and Delta, total and per-capita urban water use have declined over the last several decades, despite growing populations. More efficient urban water use means that both regions met and exceeded benchmarks for per-capita use and drought-reduction targets. The regions have modestly increased water use since the end of the drought but still maintained improvements over their 2020 benchmarks for reductions in per-capita use.

LEGEND

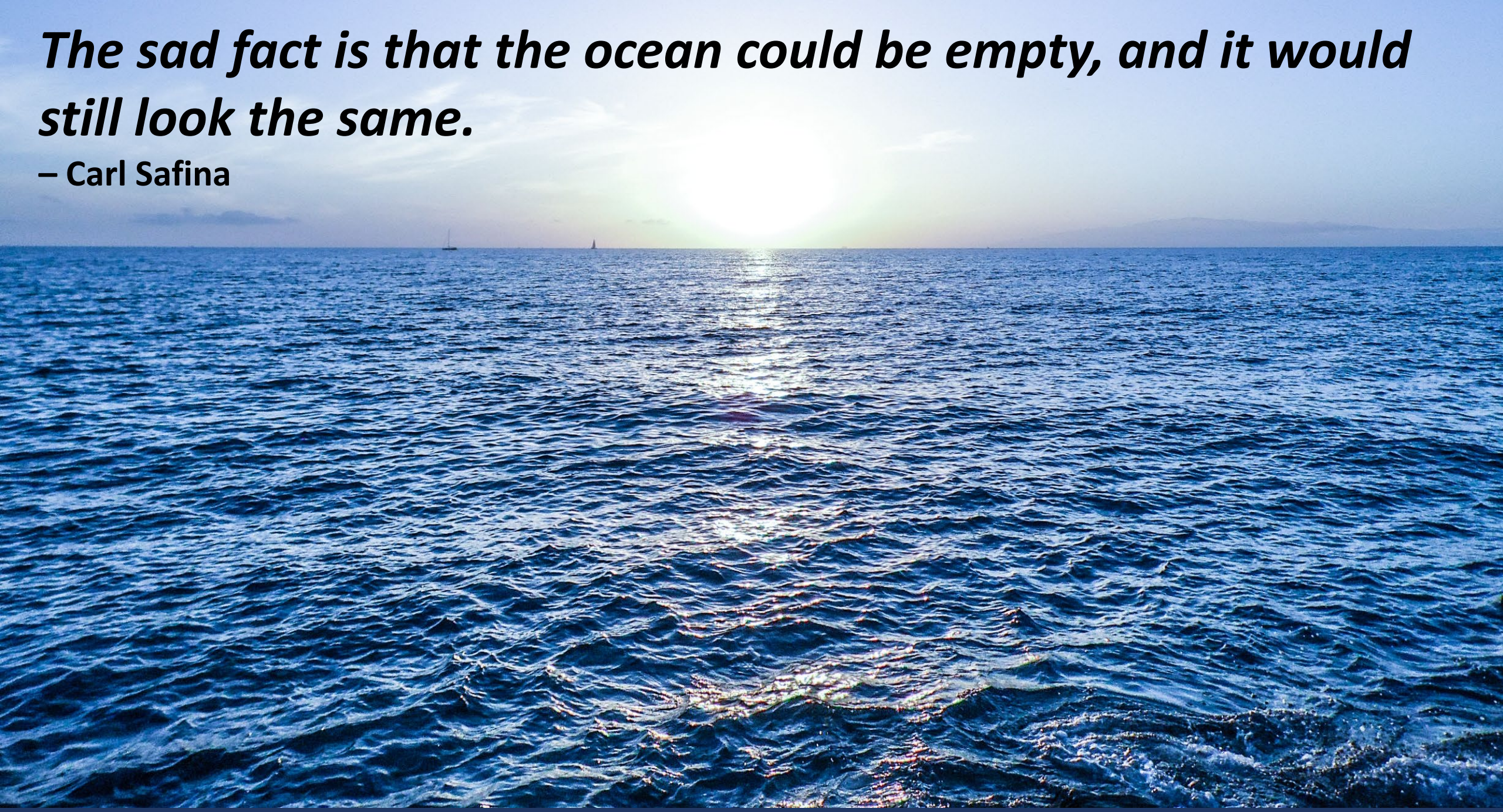
STATUS: Good, Fair, Poor

TREND: Improving, No Change, Declining, Mixed

UPPER ESTUARY FISH COMMUNITIES			
UPPER ESTUARY INDICATORS	SUBREGION	STATUS	TREND
Native Fish Abundance	Suisun Marsh	Fair	Declining
	Suisun Bay Pelagic	Very Poor	Declining
	Central-West Delta Pelagic	Very Poor	Declining
	Delta Beach Zone	Very Poor	Declining
Percent Native Fish	Suisun Marsh	Poor	Improving
	Suisun Bay Pelagic	Poor	Stable
	Central-West Delta Pelagic	Very Poor	Stable
	Delta Beach Zone	Very Poor	Declining
Percent Native Species	Suisun Marsh	Poor	Stable
	Suisun Bay Pelagic	Fair	Stable
	Central-West Delta Pelagic	Very Poor	Declining
	Delta Beach Zone	Very Poor	Stable

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

– Carl Safina



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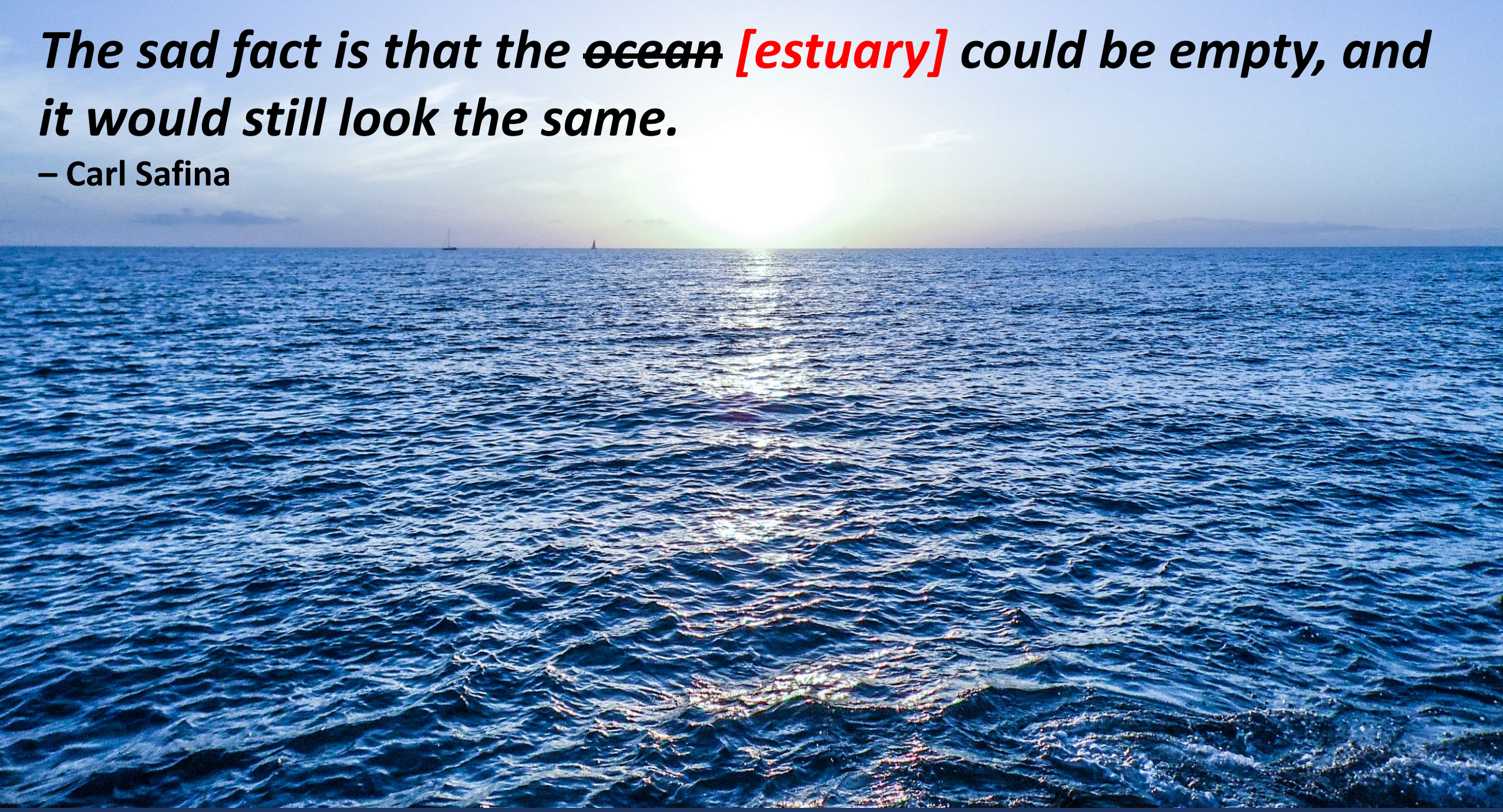

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2. WRMP FFH Guidelines

SF ESTUARY
Wetlands Regional Monitoring Program

Monitoring Fish and Fish Habitats (FFH) in wetlands of the lower estuary is one of many goals of the WRMP.

Figure 2.1. The study area includes the watersheds and bayland habitats located within San Francisco Bay, from the Golden Gate to Broad Slough. Subembayments are based on Operational Landscape Unit (OLU) boundaries and USGS sediment flux monitoring locations.

2. WRMP FFH Guidelines

The Value of WRMP FFH Monitoring

- Broad integration of prior data with new data from across the Estuary
- New information re: biological integrity of wetlands across the SFE
- New information re: use of wetlands by ESA/CESA listed species
- Improved understanding of ecological patterns/outcomes estuary-wide
- Support restoration practitioners and community partners
- Take and incidental harassment authorization efficiencies
- Guidance re: monitoring associated with restoration projects/permitting
- Robust data for informing fish conservation and management
- Robust baselines for assessing ecological impairment
- Integration into existing assessment

2. WRMP FFH Guidelines

Drafting a FFH SOP

Fish + Fish Habitat Workgroup

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Chris Jasper	Vollmar Consulting
Dylan Stompe	UC Davis
Isa Woo	USGS
Josh Collins	SFEI
Karen Thorne	USGS
Kevin Buffington	USGS
Susan de la Cruz	USGS

Timeline: 2020-2023

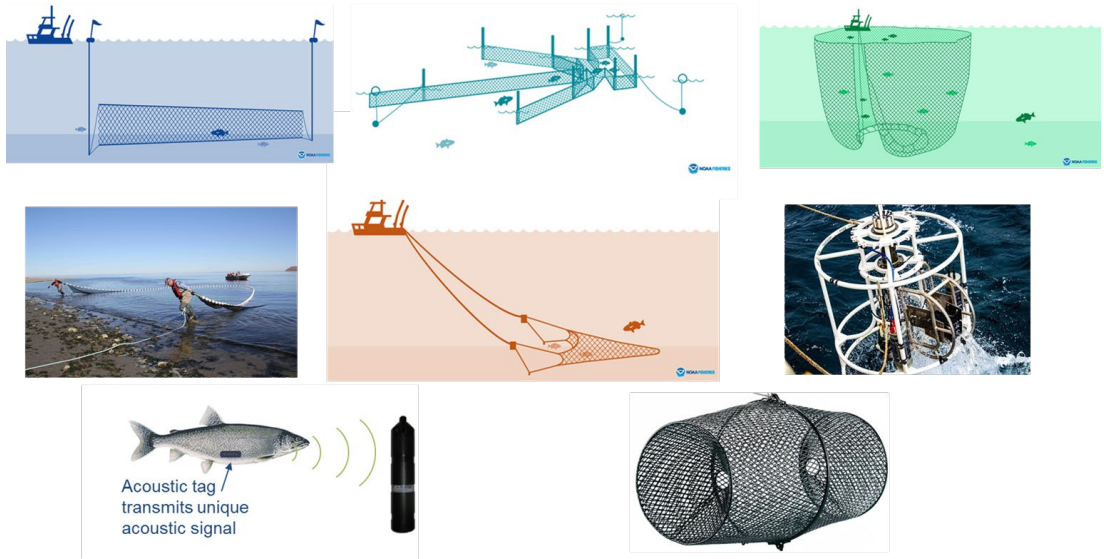
2. WRMP FFH Guidelines

Step 1: Identify FFH-specific Monitoring Goals

1. Establish long-term fish monitoring in wetlands bay-wide
2. Monitor the use of wetland habitats by ESA/CESA listed fish species
3. Provide context and guidance regarding fish responses to individual projects

Step 2: Develop Considerations for Proposed Monitoring

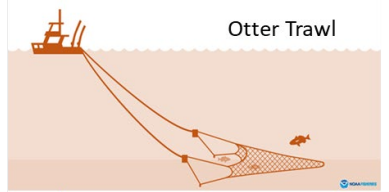
Consideration	Option	Small-Scale, Marsh-specifc	ESA/CESA Listed Species	Large-Scale, Regional	Composite
3.1. Functional Groups	3.1.1. Large-bodied fishes/fishery targets	2.5	4.5	3.5	3.5
	3.1.2. Slough/open-water forage fishes, recruits, and macro-invertebrates	3.5	5.0	4.8	4.4
	3.1.3. Marsh plain/pond forage fishes and macroinvertebrates	4.3	2.8	3.8	3.6
	3.1.4. ESA/CESA listed species	5.0	5.0	5.0	5.0
3.2. Monitoring Metrics	3.2.1. Fish/nekton data	5.0	5.0	5.0	5.0
	3.2.2. Water quality data	5.0	5.0	5.0	5.0
	3.2.3. Sampling data	5.0	5.0	5.0	5.0
3.3. Sampling Gears	3.3.1. Benthic otter trawl	3.8	4.5	4.8	4.4
	3.3.2. Shore-Based (Beach) seine	3.5	3.0	3.5	3.3
	3.3.3. Minnow trap	3.8	0.5	2.0	2.1
	3.3.4. Fyke or Block net	3.8	2.8	3.8	3.5
	3.3.5. Acoustic Tracking (Telemetry/PIT)	1.8	4.8	2.8	3.1
	3.3.6. eDNA	1.0	3.5	3.0	2.5
	3.3.7. Acoustic imaging (DIDSON/ARIS)	2.8	2.3	1.0	2.0
	3.3.8. Set net (Trammel/Gill)	1.8	5.0	4.0	3.6
	3.3.9. Boat-based Seine (Lampara net)	1.3	3.3	2.8	2.5
3.4. Habitats	3.4.1 marsh/pond/creeklet	4.3	3.0	4.5	3.9
	3.4.2 slough	4.3	4.8	5.0	4.7
	3.4.3 open-water	2.3	4.8	4.0	3.7
3.5. Sampling Frequency	3.5.1 monthly	5.0	5.0	5.0	5.0
	3.5.2 quarterly	4.0	4.0	4.0	4.0
	3.5.3 semi-annual	1.5	1.5	1.5	1.5
	3.5.4 annual	1.0	1.0	1.0	1.0
	3.5.5 bi-annual+	1.0	1.0	1.0	1.0
3.6. Sampling Teams	3.6.1 small (1-2 crew)	3.8	1.3	1.3	2.1
	3.6.2 med (3-4 crew)	4.3	3.5	3.5	3.8
	3.6.2 large (> 4 crew)	3.8	4.8	4.8	4.5
3.7-8 Data	3.7. Centralized Storage	4.0	5.0	5.0	4.7
	3.8. Consistency with Other Programs	4.5	4.5	5.0	4.7

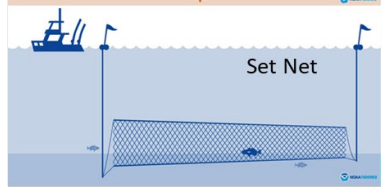


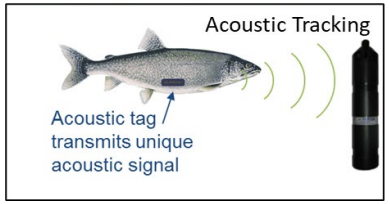
Step 3: Rank Alternatives Ability to Meet Monitoring Goals

Alternatives	Description	3.3.1. Benthic otter trawl	3.3.2. Beach seine	3.3.3. Minnow trap	3.3.4. Fyke or Block net	3.3.5. Telemetry/Acoustics	3.3.6. eDNA	3.3.7. Acoustic imaging	3.3.8 Trammel net/Gill net	3.3.9. Boat-based Seine	# Gears	1. Large-scale	2. ESA/CESA	3. Small-scale	Composite Rank
1	Forage Fishes: Otter Trawls	X									1	2.3	1.4	1	1.6
2	Large-bodied /Fishery Targets: Trammel Nets								X		1	1	1	0.9	1.0
3	Large-bodied/Fishery Targets: Acoustic					X					1	0.6	1	0.4	0.7
4	Marsh Plain/Pond Species: Minnow Trap			X							1	0.5	0.1	1.4	0.7
5	Marsh Plain/Pond Species: Fyke/Block				X						1	1.3	1	1.9	1.4
6	Marsh Plain/Pond Species: Beach Seine		X								1	1.3	1.3	1.9	1.5
7	Forage fishes+Listed Fishes: OT+ Trammel net	X							X		2	2.3	2.6	1.3	2.1
8	Large-bodied/Fishery Targets: Acoustic + Trammel Nets							X	X		2	1.3	1.5	0.5	1.1
9	Forage Fishes + Marsh Plain Fishes: Beach Seine + Minnow Trap		X	X							2	1	0.8	1.9	1.2
10	Forage Fishes + Marsh Plain Fishes: Beach Seine + Fyke		X		X						2	1	0.9	1.8	1.2
11	Forage Fishes + Listed spp + large-bodied: OT + Acoustic + Trammel Nets	X						X	X		3	2.3	2.8	1	2.0
12	Forage Fishes + Marsh Fishes + Large-bodied: OT + Trammel + Fyke	X			X				X		3	2.1	2.3	2.4	2.3
13	Forage Fishes + Marsh Fishes + Large-bodied: OT + Trammel + Beach Seine	X	X						X		3	2.4	2.5	2.5	2.5
14	Forage Fishes + Listed spp + Large-bodied + Marsh Fishes: OT + Acoustic + Trammel Nets + Minnow Trap	X		X				X	X		4	2.1	2.3	2.1	2.2
15	Forage Fishes + Listed spp + Large-bodied + Marsh Fishes: OT + Acoustic + Trammel Nets + Beach Seine	X	X					X	X		4	2.4	2.8	2.3	2.5

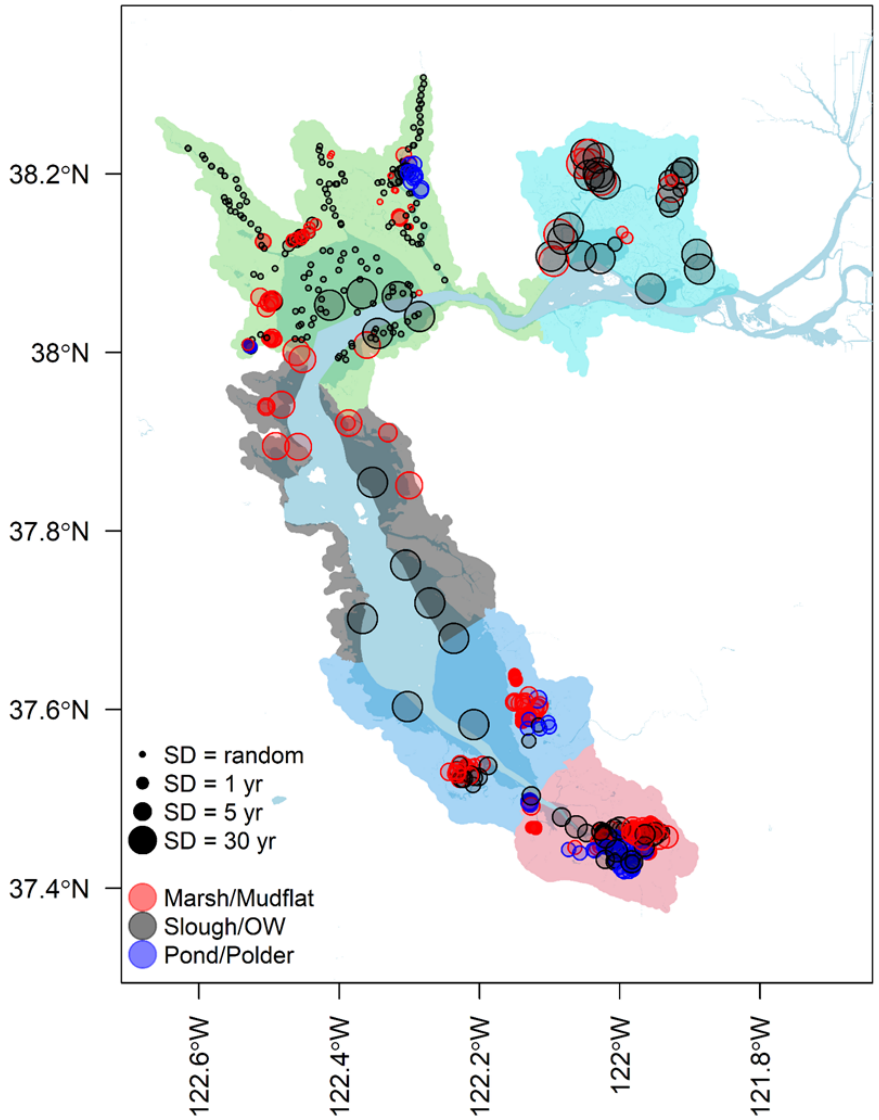
Rank	Description
0	fails to address goal
1	partially addresses goal
2	addresses goal
3	optimally addresses goal



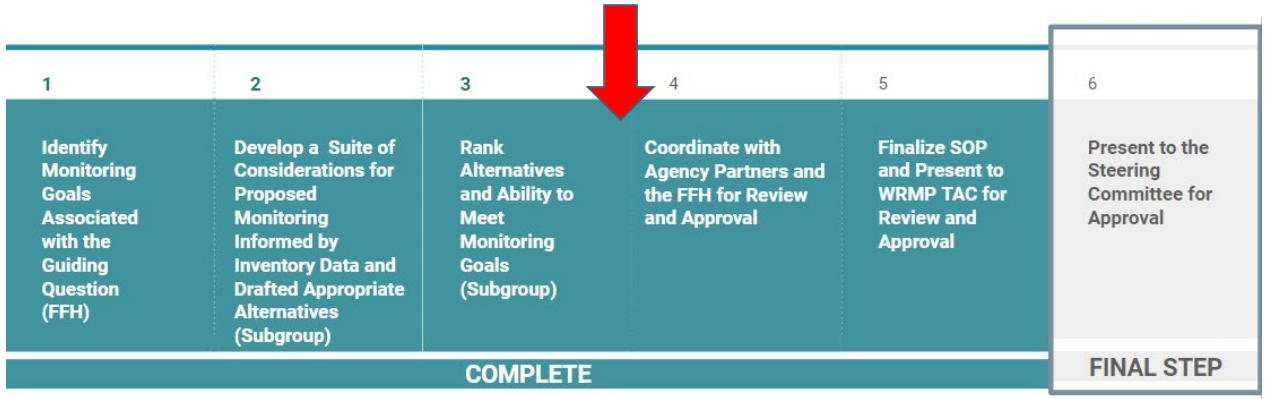




2. WRMP FFH Guidelines



Write the SOP;
Contrast with Existing Literature



2. WRMP FFH Guidelines

Step 4: Coordination with Partners

1	2	3	4	5	6
Identify Monitoring Goals Associated with the Guiding Question (FFH)	Develop a Suite of Considerations for Proposed Monitoring Informed by Inventory Data and Drafted Appropriate Alternatives (Subgroup)	Rank Alternatives and Ability to Meet Monitoring Goals (Subgroup)	Coordinate with Agency Partners and the FFH for Review and Approval	Finalize SOP and Present to WRMP TAC for Review and Approval	Present to the Steering Committee for Approval
COMPLETE					FINAL STEP

2. WRMP FFH Guidelines

Step 5: Finalize the SOP; Edits and Ratificaion by the TAC

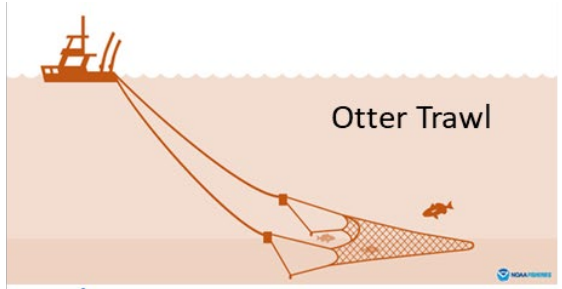
2. WRMP FFH Guidelines

Step 5: Edits and Ratification by the Steering Committee

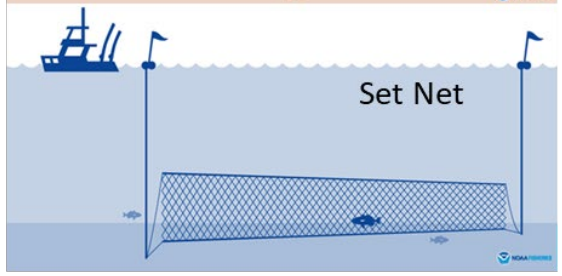
Completed in 2023

Recommendations & Justifications

- ***Habitats:*** complete tidal marsh ecosystem [CTME] (marsh, slough, mudflat, shoal)
- ***Focal groups:*** large-bodied, small-bodied, and marsh-plain, listed (CESA/ESA)
- ***Monitoring Data/Gear/Methods:*** Beach seines, otter trawls, set nets, acoustics *(consistent with past/existing MPs)*
- ***Data:*** Water Quality, QAQC, samping; WRMP-DMP
- ***Sites:*** Benchmark, reference (prioritization by SC)

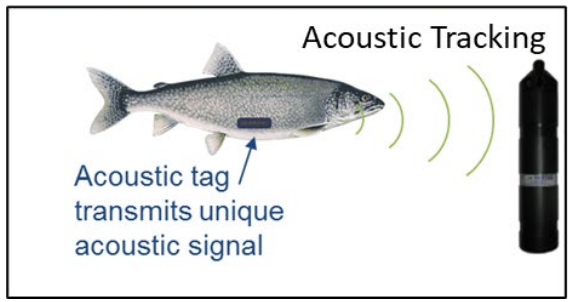


SMOTS, SBOTS, NBOTS, SFBS



CDFW Sturgeon Survey

DJFMP, SBMS

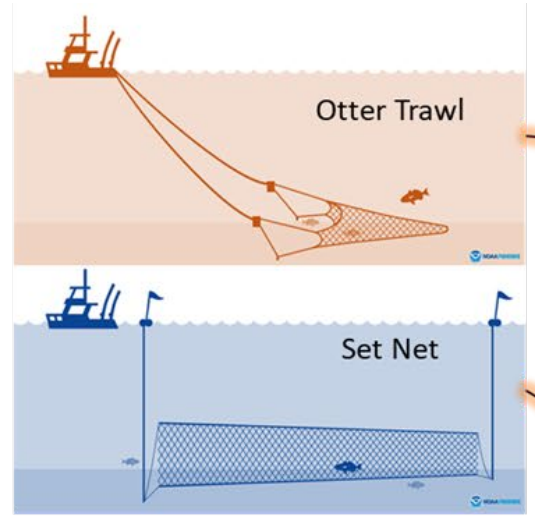


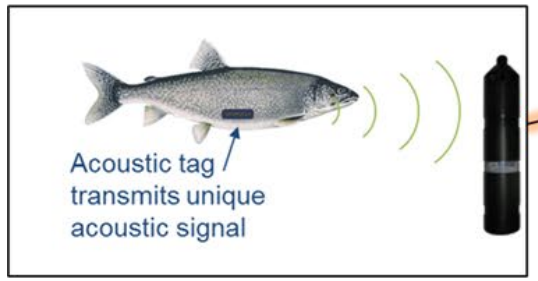
Multiple: Salmon, Sturgeon, Smelt?

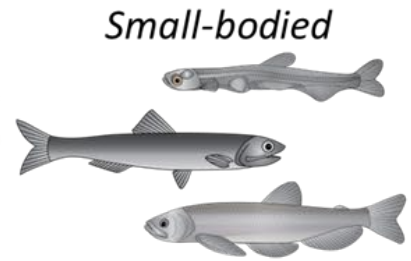
2. WRMP FFH Guidelines

Recommendations & Justifications

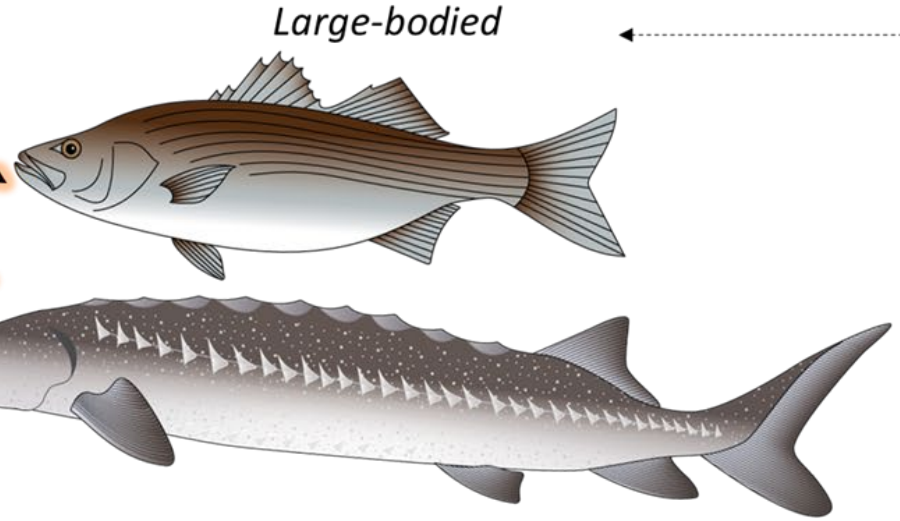
- Broad diversity of fish spp.





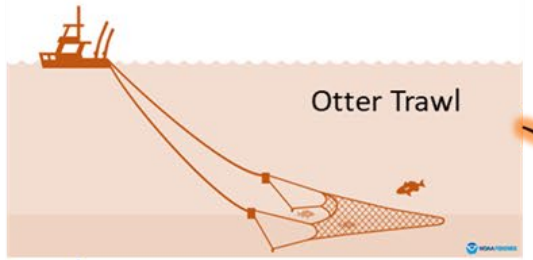


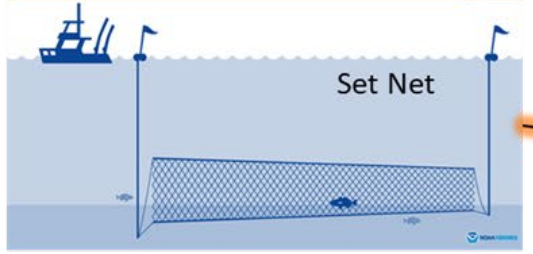
ESA/CESA Listed

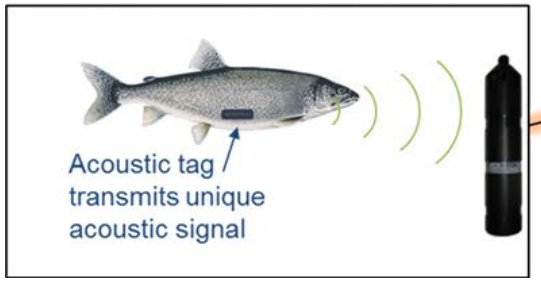


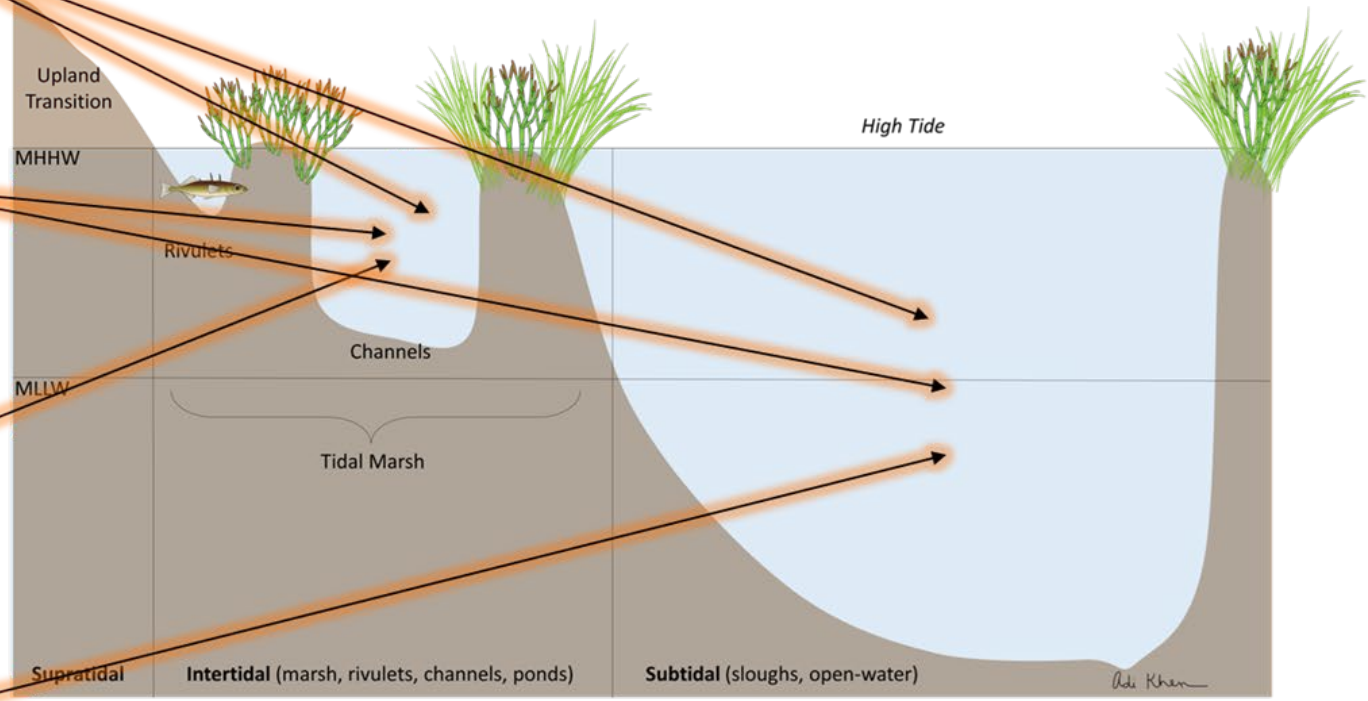
Recommendations & Justifications

- Broad diversity of fish spp.
- Occur in diversity of habitats









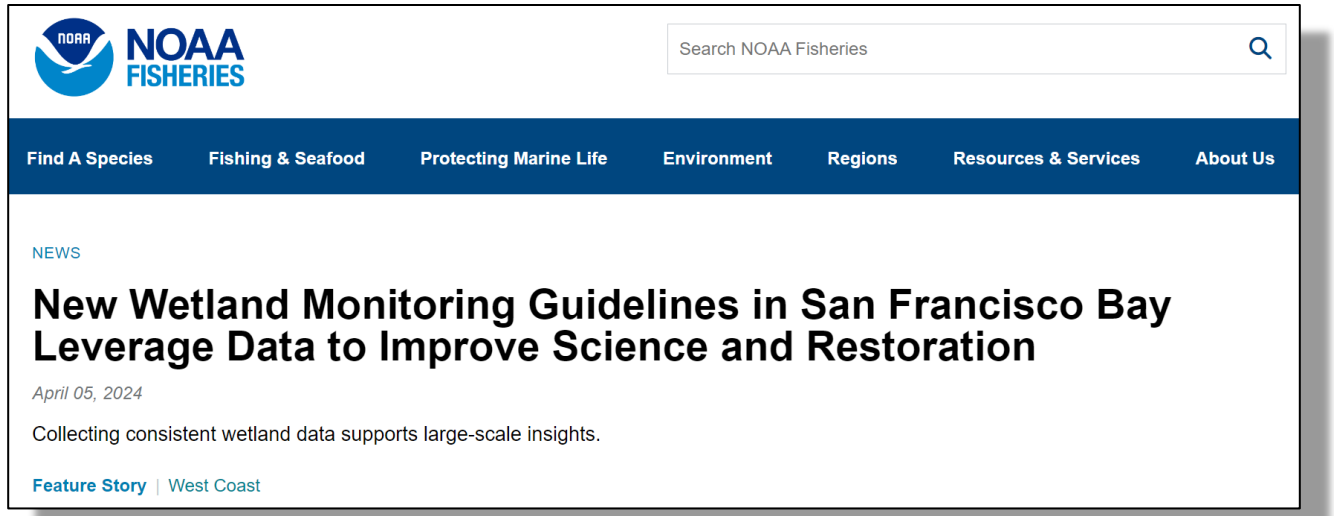
2. WRMP FFH Guidelines

Recommendations & Justifications

- Boat-based
- Maximize site access
- Minimize wildlife interactions & permitting conflicts

2. WRMP FFH Guidelines

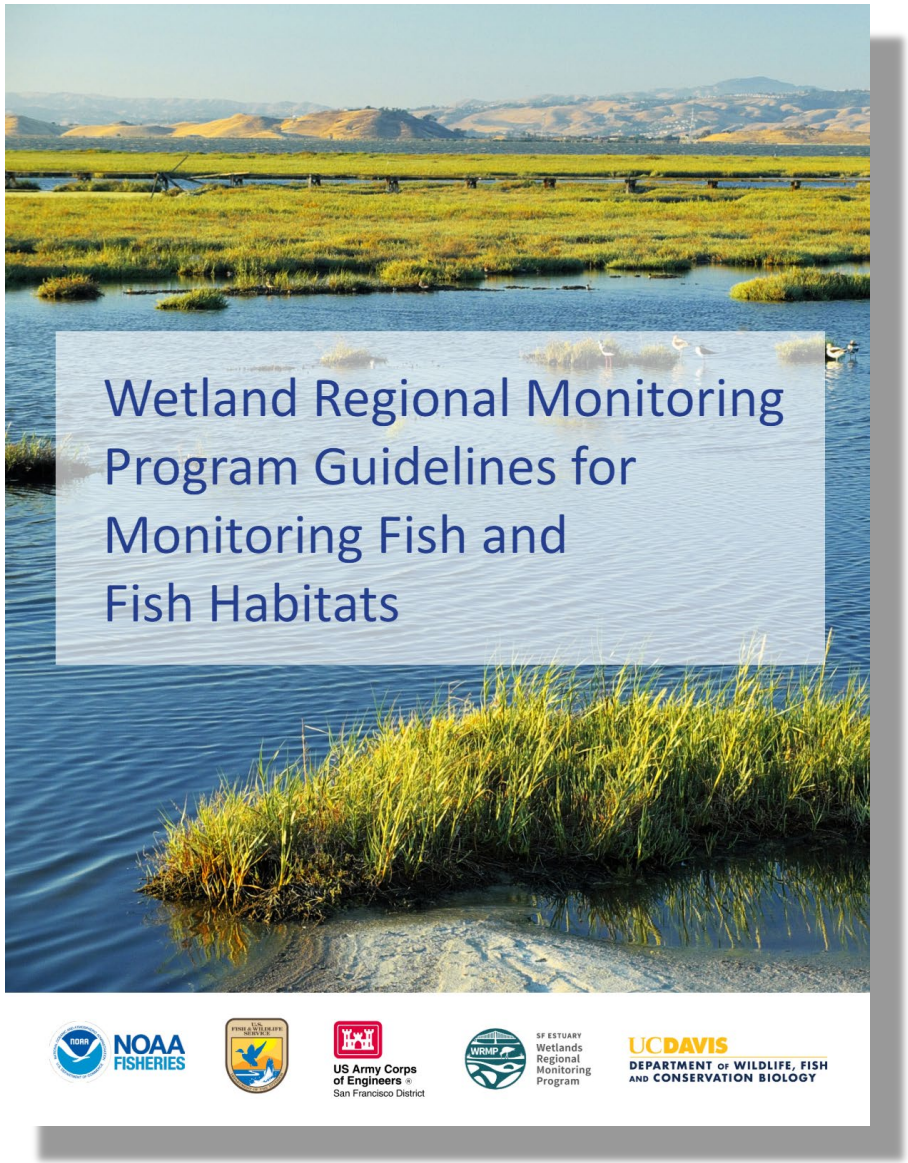
WRMP FFH Guidelines Published (2023)



https://www.wrmp.org/wrmp-guidance-on-fish-and-fish-habitat-monitoring/

https://www.fisheries.noaa.gov/feature-story/new-wetland-monitoring-guidelines-san-francisco-bay-leverage-data-improve-science-and

https://www.wrmp.org/wp-content/uploads/2024/03/wrmp-guidelines-monitoring-sf-bay-3-27-2024.pdf



Outline

1. Introduction to FFH in the SFE
2. The WRMP & FFH Monitoring Guidelines
3. **Past FFH Monitoring** (OGFL Review)
4. FFH Monitoring Studies (OGFL examples)
5. **FFH Data Integration** (OGFL examples)
6. The Future of Aquatic Wetland Ecology in the SFE

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3. FFH Review

(a) Literature Review (monitoring inventory , 2023)

Draft Manuscript

Ichthyofaunal Sampling in Brackish and Saline Wetlands of the San Francisco Estuary: *A review with implications for developing an integrated wetland monitoring program*

L. Lewis[1], A. Weber-Stover[2], Z. Duckworth[2], S. Randall[3, 4], L. Wang[2], E. Farley[3], M. Williams[3], C. Toms[3]

[1] University of California, Davis
[2] NOAA Fisheries, West Coast region
[3] San Francisco Bay Regional Water Quality Control Board
[4] San Francisco State University

Abstract

Long-term, standardized datasets are integral to understanding the status and dynamics of complex ecosystems. In wetlands, the monitoring of aquatic communities can provide valuable information regarding variation in water quality and ecosystem health, both of which are critical for guiding management and restoration. For example, patterns in the abundance, diversity, and structure of fish communities can be used to assess the responses of wetland ecosystems to human impacts, restoration, and climate change. Such information is critical to the San Francisco Estuary (SFE), where 95% of wetlands have been severely degraded. However, most long-term monitoring of aquatic wetland communities in the SFE has focused on freshwater and low-salinity habitats of the "Upper Estuary" (e.g., the Delta and Suisun Bay). Much less is known about the extensive brackish and saline wetlands throughout the "Lower Estuary", including San Pablo Bay and San Francisco Bay. Nevertheless, the collation and review of numerous short-term studies can provide valuable information to help guide future monitoring, management, and restoration in these ecosystems. Here we conducted a literature review to identify, catalog, and summarize prior and ongoing studies of fishes in brackish and saline tidal wetlands throughout the SFE. Specifically, we explored spatiotemporal patterns in prior monitoring efforts, including the regions and habitats sampled, gears utilized, environmental data collected, and observations of managed species. The results highlight best practices and critical information gaps–key information that will be used to guide future restoration and the establishment of long-term monitoring in wetlands of the lower SFE.

Project List

Project ID	Project Name
PGMTS	USGS Pond Gillnet & Minnow Trap Study
NBOTS	UCD North Bay Otter Trawl & Plankton Study
SBOTS	UCD South Bay Otter Trawl & Plankton Study
AMMBS	UCD Alviso Marsh Mercury Beach Seine Study
CCFNS	SFSU China Camp Fyke Net Study
CCSSM	SFSU China Camp Source or Sink of Mysids
SFEFA	WSU SF Estuary Fish Assemblage Study
SPRFM	HELIX and FISHBIO Sears Point Restoration Fish Monitoring
JSCWC	CCCPWD and Jones & Stokes Chinook in Walnut Creek
HAMRP	Hamilton Wetlands Restoration Project
SFBLS	SCC SF Bay Living Shorelines: Near-shore Linkages Project
SPVFI	SJSU Salt Pond variation and impacts on fish and inverts
SPWQF	USGS Salt Pond water quality impacts on fish assemblages
SBWF	NOAA South Bay wetlands fisheries
FCSPR	UCD Fish Communities response to salt pond restoration
SOGRW	UCD Steelhead Out Migration in Guadalupe River Watershed
LSSPR	UCD Leopard Shark benefits from salt pond restoration
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NASP	URS/NOAA Napa Salt Ponds
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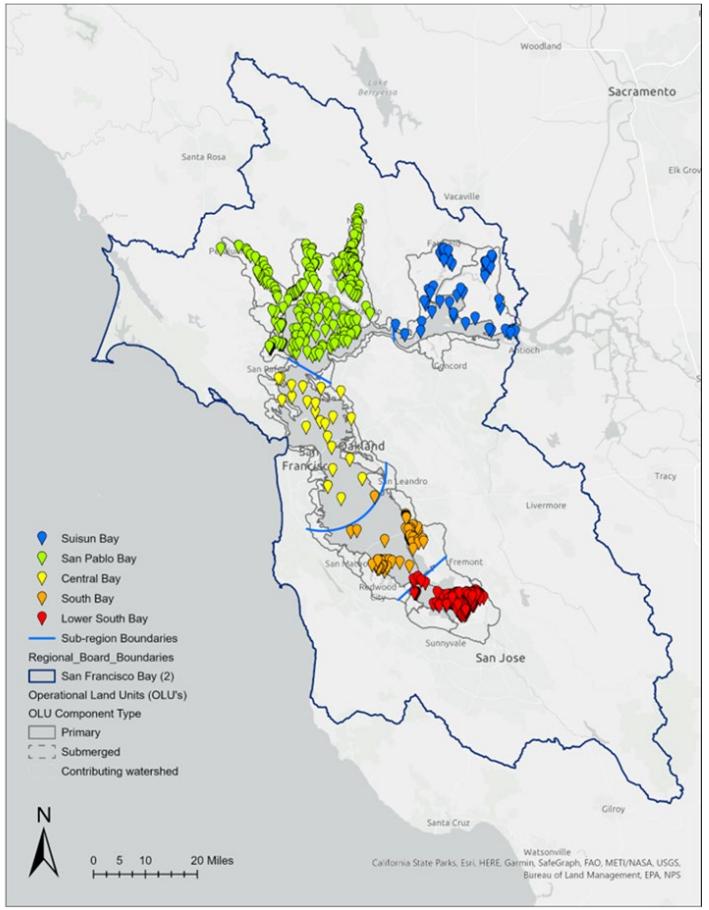
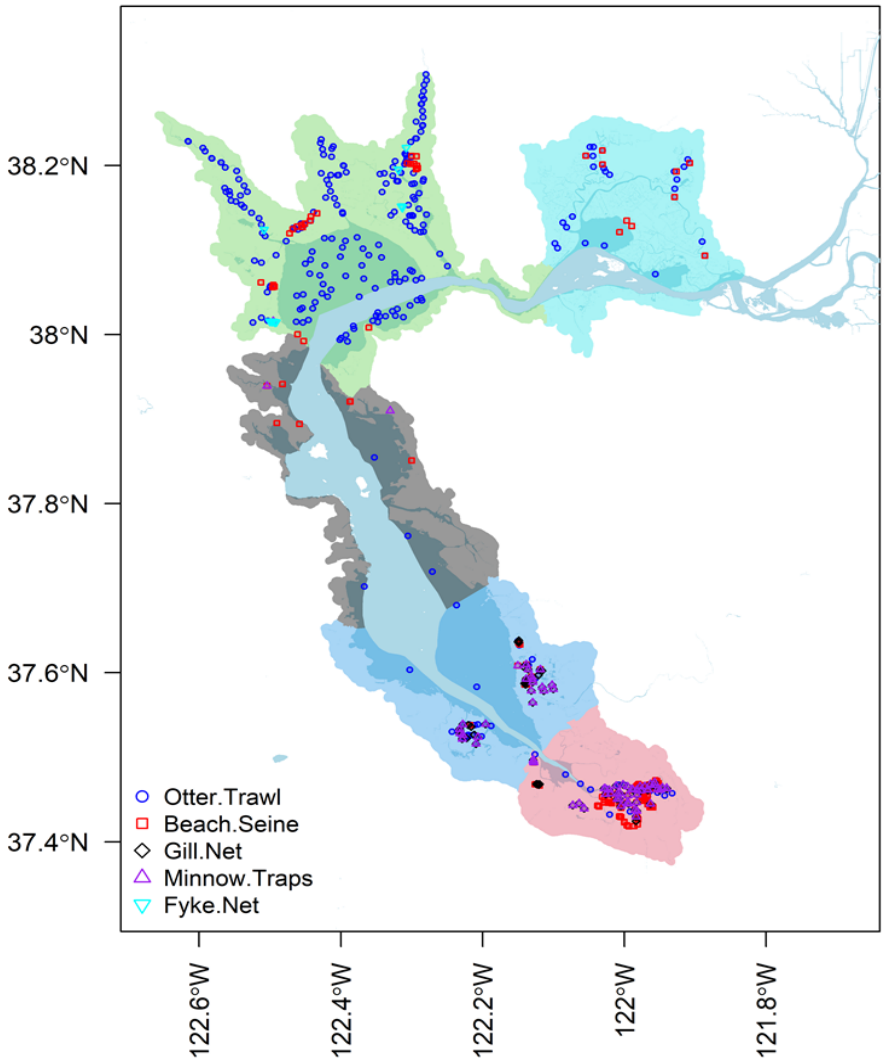
SFBS*	CDFW San Francisco Bay Study Otter Trawl & Midwater Trawl Study
DJFMP*	USFWS Delta Juvenile Fish Monitoring Program Beach Seine Study*
FRMP*	CDFW Fish Restoration Monitoring Program*

Station Mapping

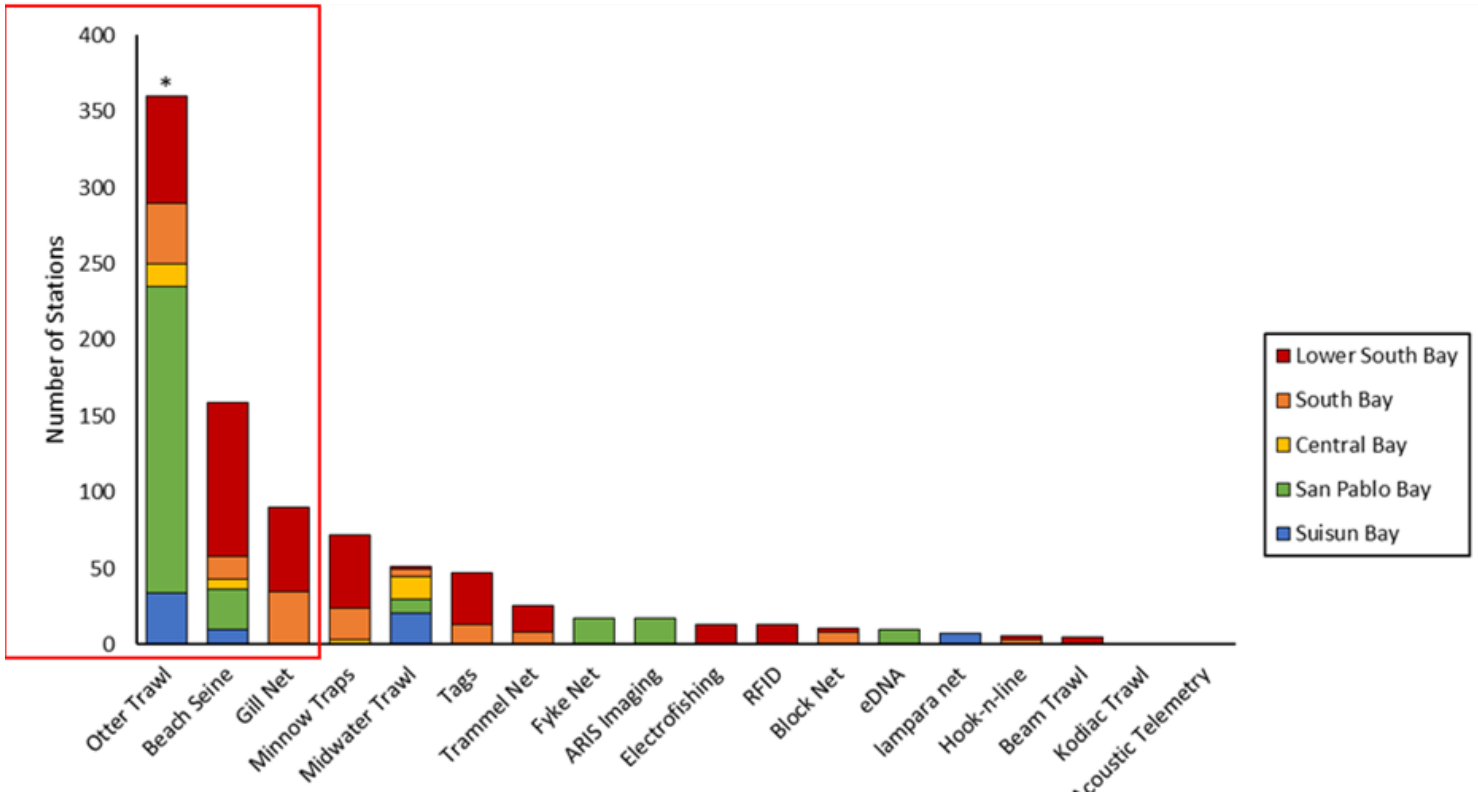


3. FFH Review

(a) Literature Review (monitoring inventory , 2023)



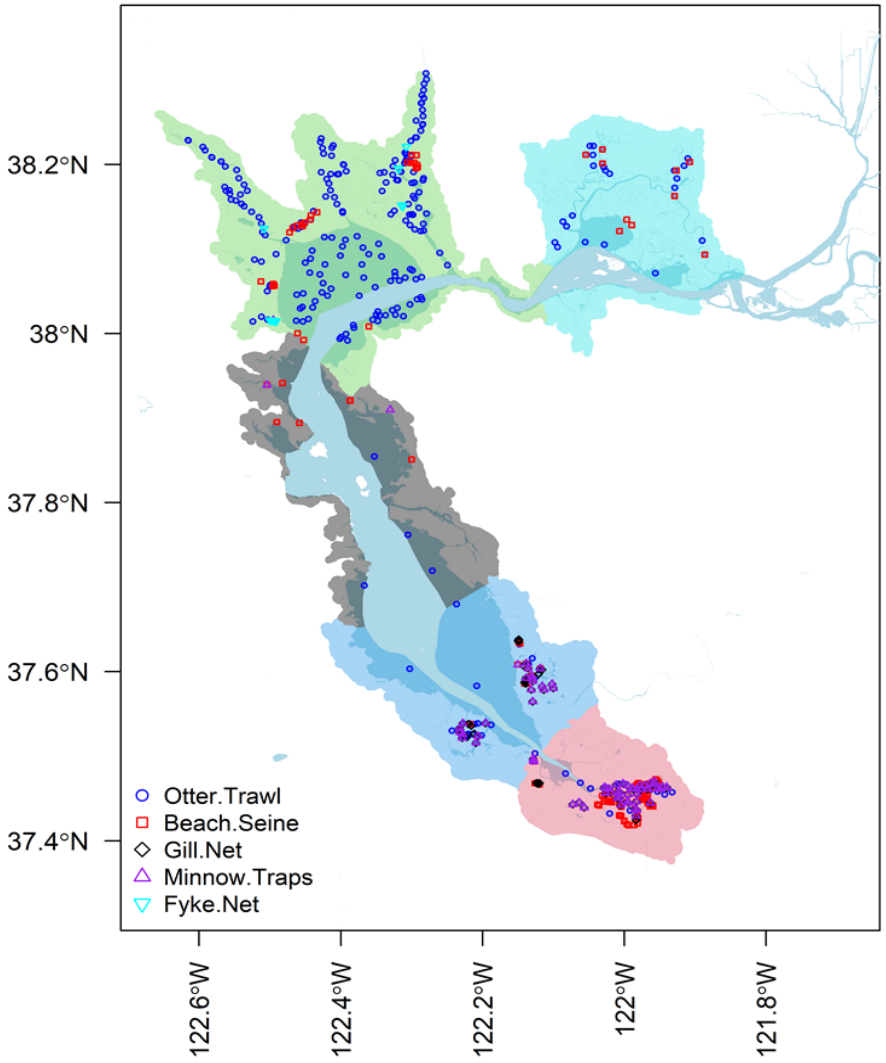
- Individual Projects (restoration, mitigation, etc.)
- Gear use among SFE regions

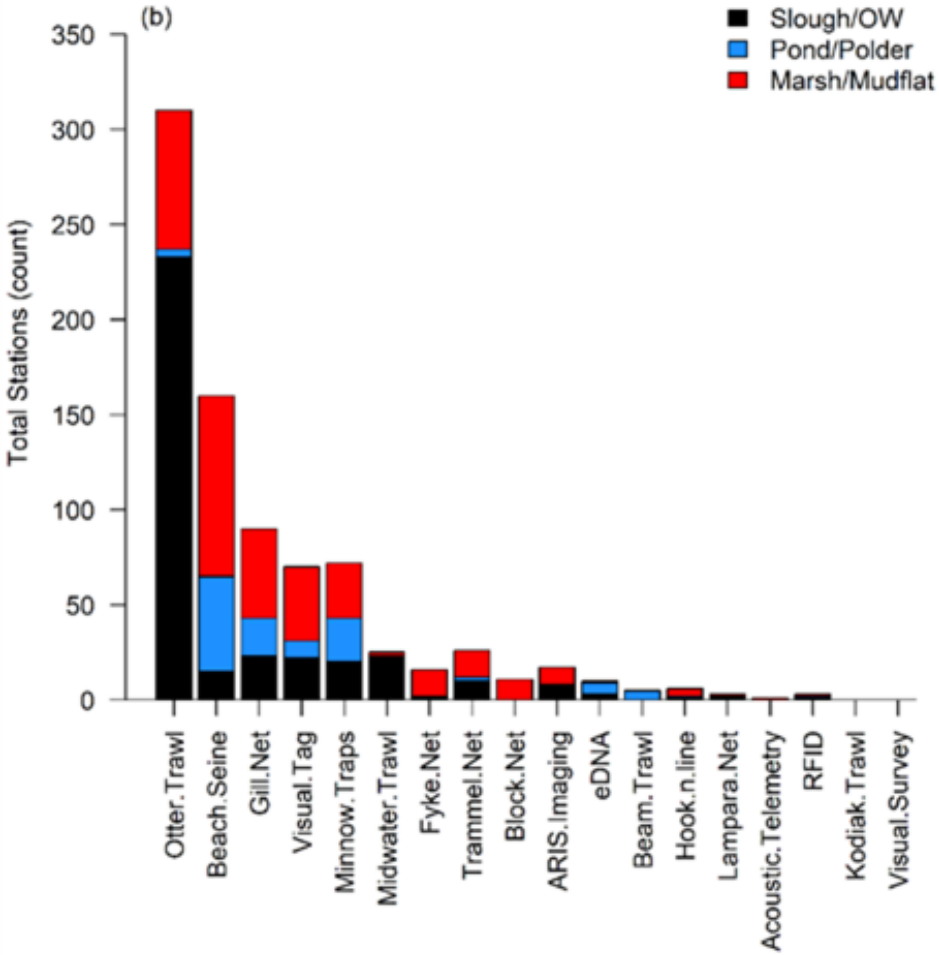


3. FFH Review

(a) Literature Review (monitoring inventory, 2023)

- Gear use among projects
- Gear use among habitat types





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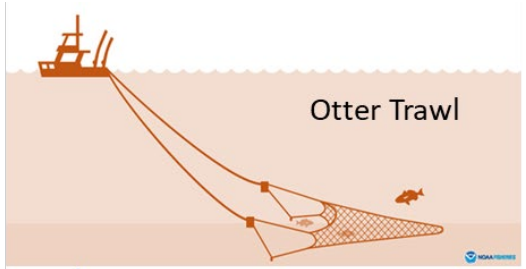

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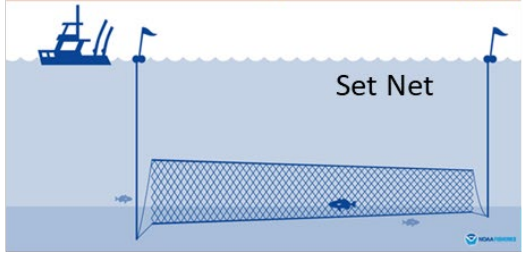

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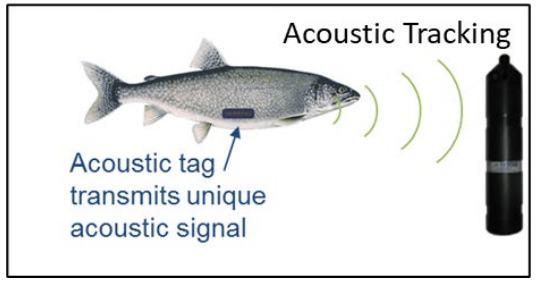

Multiple: Salmon, Sturgeon, Smelt?

- The FFH SOP was drafted to be in agreement with common/best practices used by other wetland fish monitoring programs and studies.
- Facilitates integration & maximizes value.

3. FFH Review

(b) Literature Review (master database, 2024)

South Bay Salt Pond Restoration Project

- Tow-level catch & env. data
- Incorporation into an online data portal
- Beginning of WRMP FFH database

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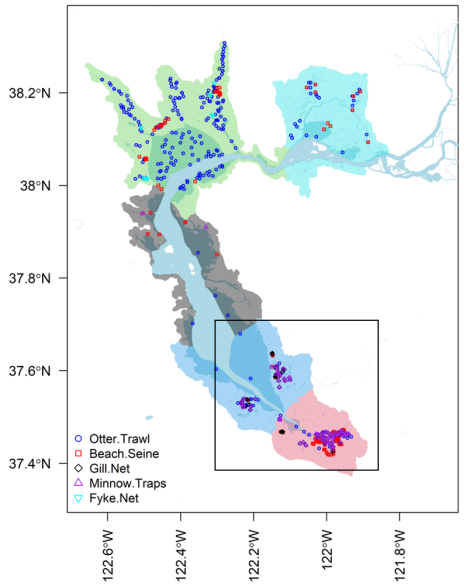

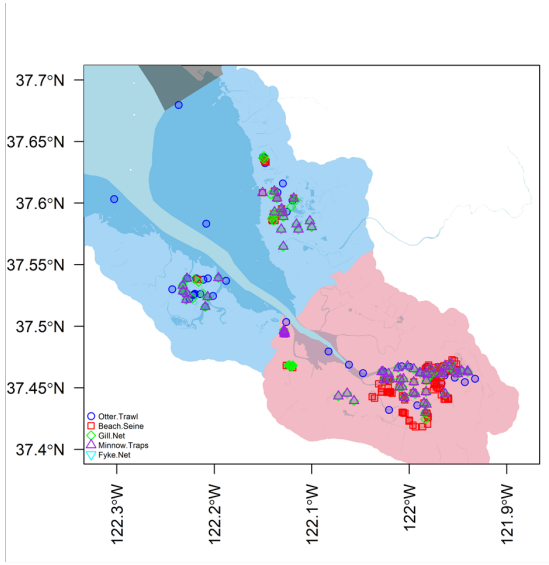

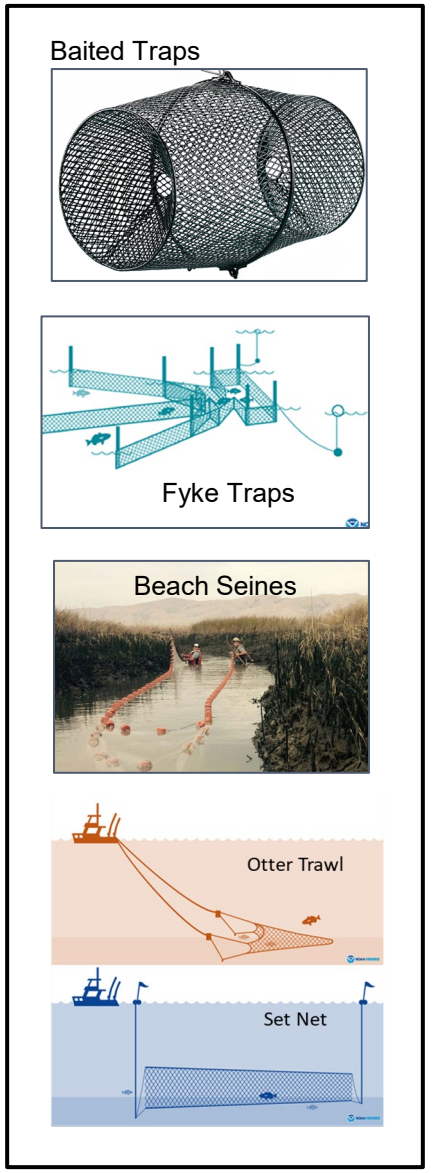

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4. FFH Monitoring Studies (OGFL examples)

OGFL FFH Projects

1. **Restoration** (2014-17, 2023-25)
   - *SBSPRP Salt Ponds, ValleyWater*
2. **Endangered Spp** (2015-pres)
   - *DWR LFS Distributions/Broodstock*
3. **Wastewater Effluent** (2016-pres)
   - *SJSCRWF*
4. **Summer Hypoxia** (2021)
   - *SFEI nutrient strategy*
5. **Contaminants** (Hg, 2023-25)
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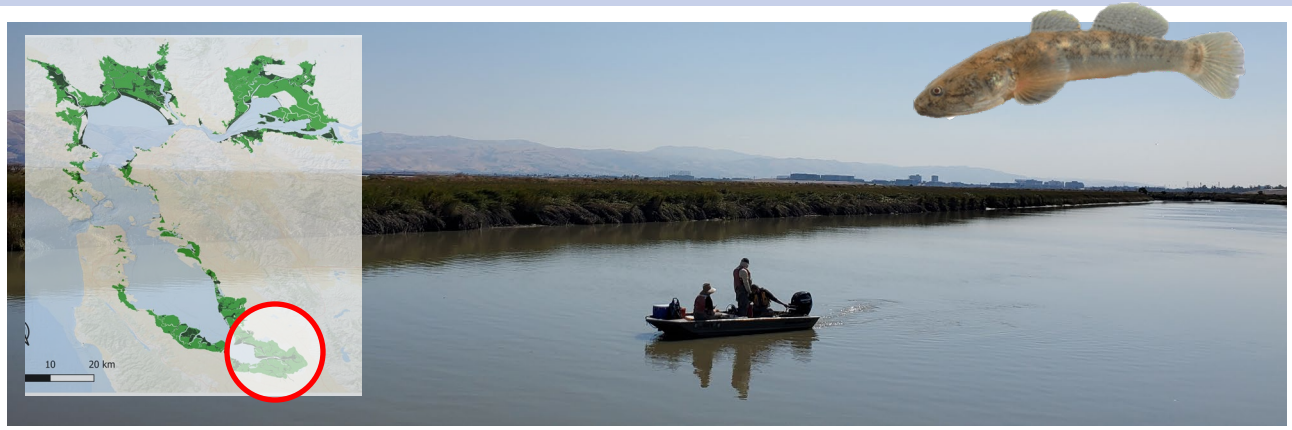
6. **Ben. Use of Dredge** (2023-25)
   - *ACE, USGS*



South Bay Salt Pond Restoration Project

Valley Water
SANTA CLARA VALLEY WATER DISTRICT

Stillwater Sciences

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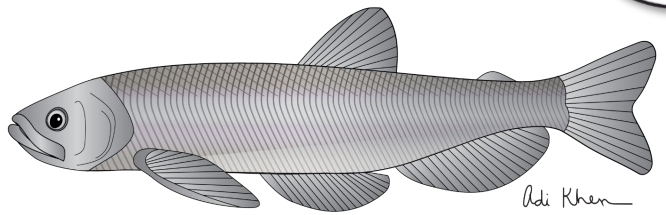

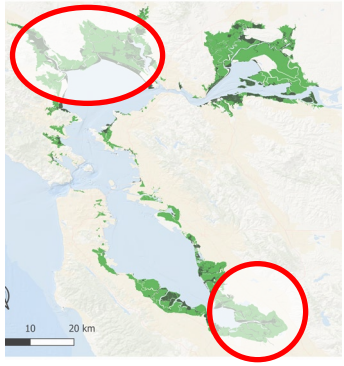

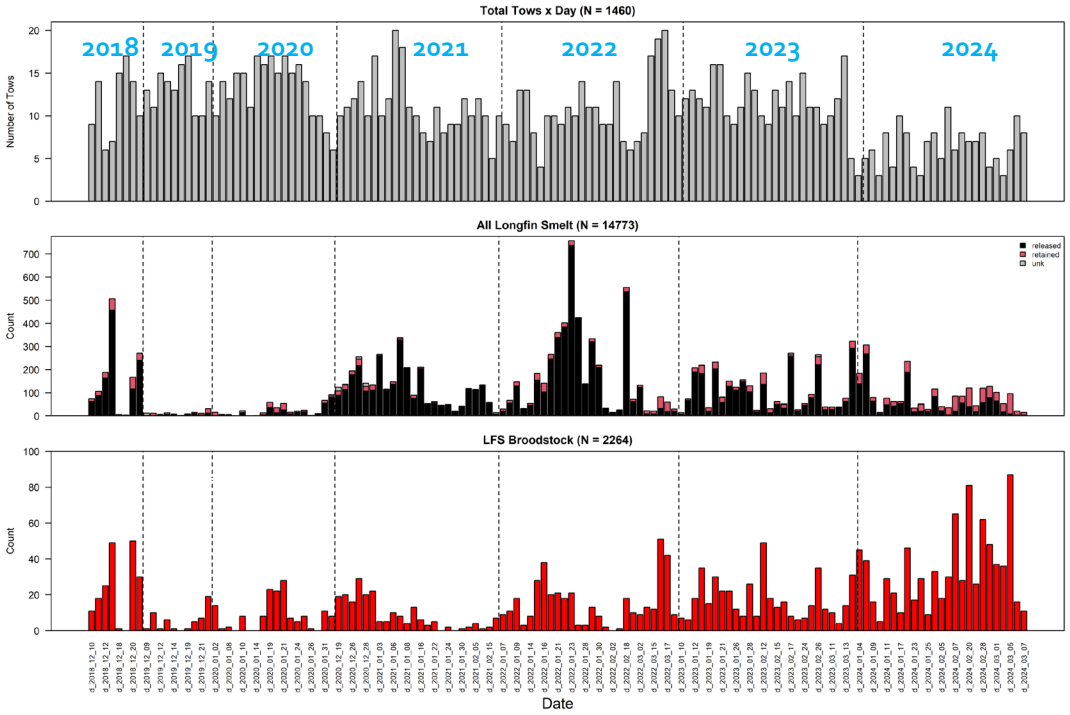

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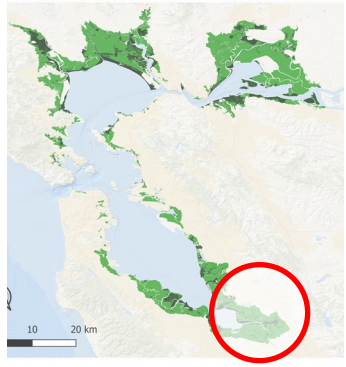
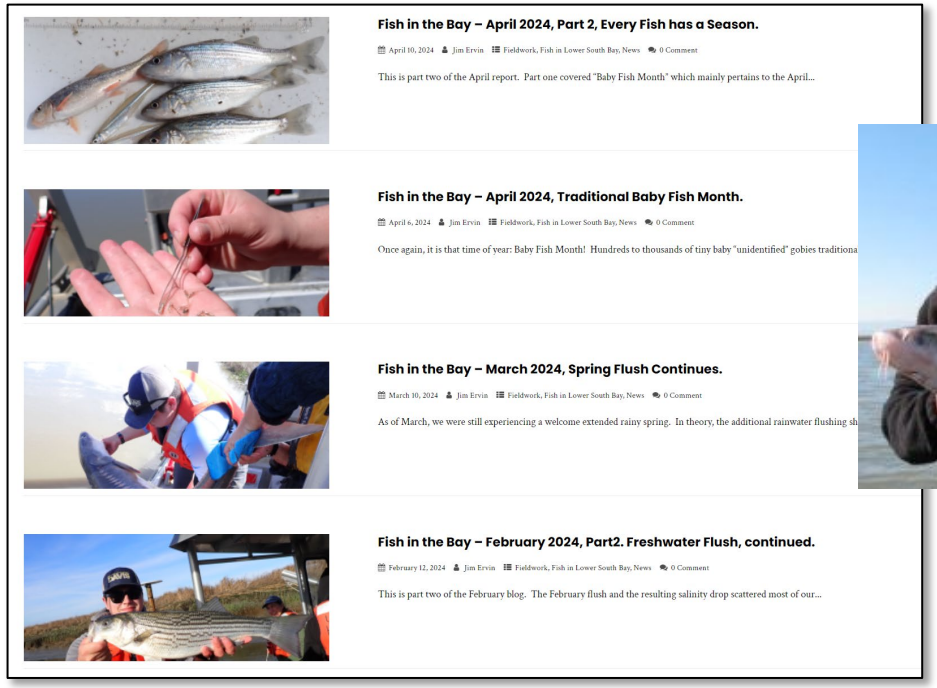
San José-Santa Clara Regional Wastewater Facility



OGFL Blog: "Fish in the Bay"
https://www.ogfishlab.com/news/



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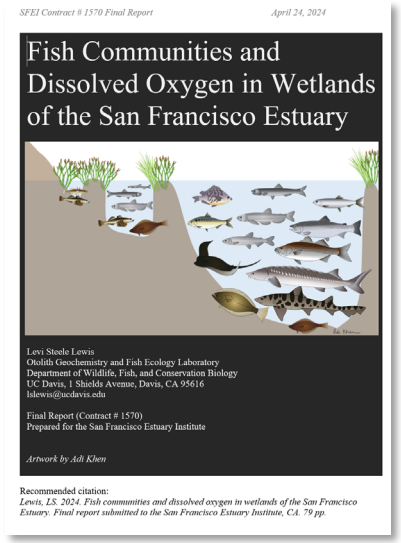
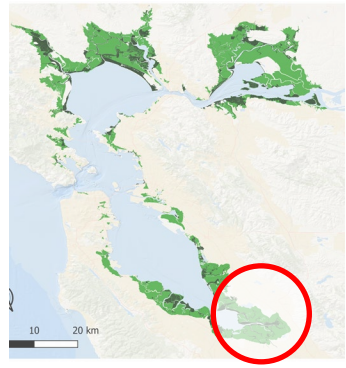


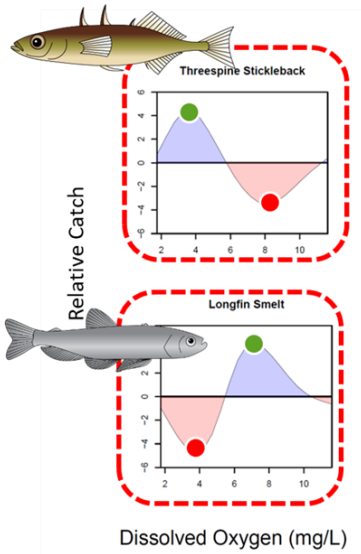
SFEI | AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER



Otter Trawl (nekton)

Sonde (Water Quality)

DO
Temp
Sal



4. FFH Monitoring Studies (OGFL examples)

OGFL FFH Projects

1. **Restoration** (2014-17, 2023-25)
   - *SBSPRP Salt Ponds, ValleyWater*
2. **Endangered Spp** (2015-pres)
   - *DWR LFS Distributions/Broodstock*
3. **Wastewater Effluent** (2016-pres)
   - *SJSCRWF*
4. **Summer Hypoxia** (2021)
   - *SFEI nutrient strategy*
5. **Contaminants** (Hg, 2023-25)
   - *EPA, ValleyWater, Stillwater*
6. **Ben. Use of Dredge** (2023-25)
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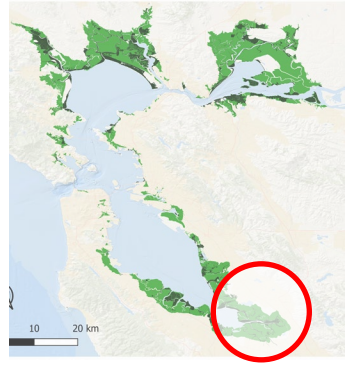
Stillwater Sciences

Valley Water
SANTA CLARA VALLEY WATER DISTRICT



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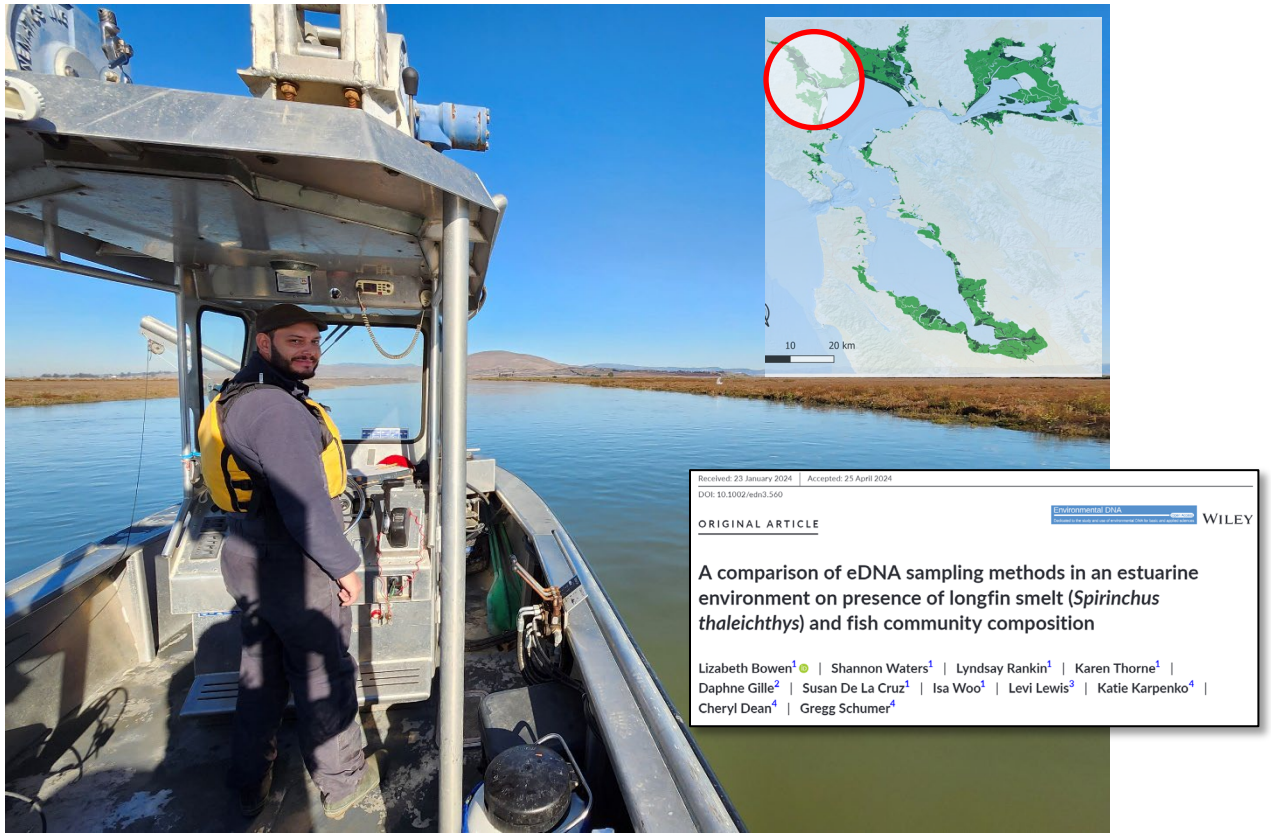
USGS
science for a changing world



Received: 23 January 2024 | Accepted: 25 April 2024
DOI: 10.1002/edn3.560
ORIGINAL ARTICLE
Environmental DNA
WILEY

A comparison of eDNA sampling methods in an estuarine environment on presence of longfin smelt (*Spirinchus thaleichthys*) and fish community composition

Lizabeth Bowen[1] | Shannon Waters[1] | Lyndsay Rankin[1] | Karen Thorne[1] | Daphne Gille[2] | Susan De La Cruz[1] | Isa Woo[1] | Levi Lewis[3] | Katie Karpenko[4] | Cheryl Dean[4] | Gregg Schumer[4]

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3. Past FFH Monitoring (OGFL Reviews)
4. FFH Monitoring Studies (OGFL examples)
5. **FFH Data Integration** (OGFL examples)
6. The Future of Aquatic Wetland Ecology in the SFE

"A society grows great when old men plant trees in whose shade they shall never sit."
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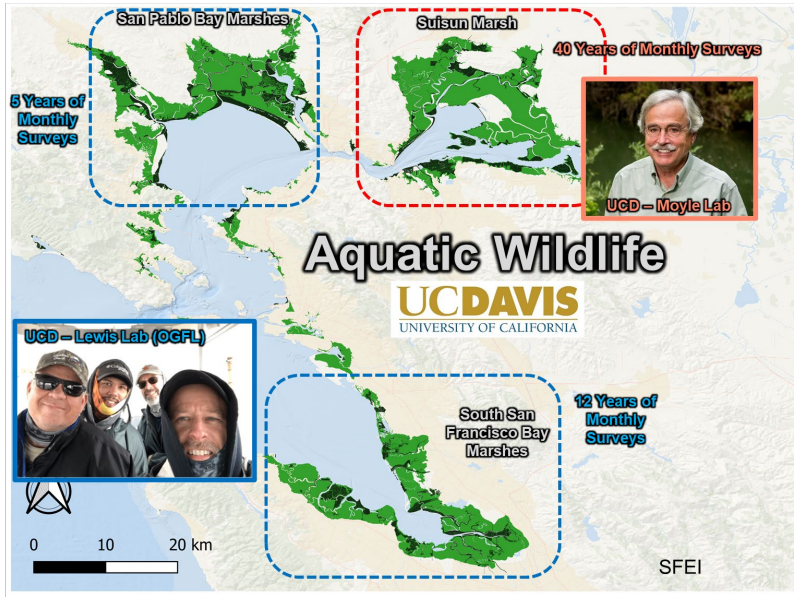
5. Data Integration

(a) Center for Watershed Sciences Incubator Project (2023-2024)

Caroline Newell (L Lewis, M Provost, J Durand)



Spatial Variation:

1. Community Structure
2. Habitat Suitability

Center for Watershed Sciences

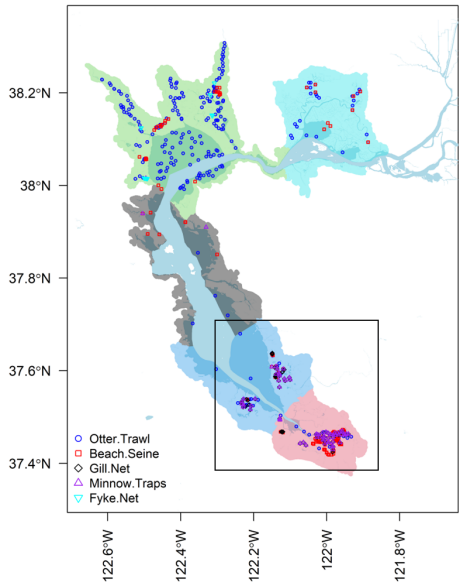
5. Data Integration

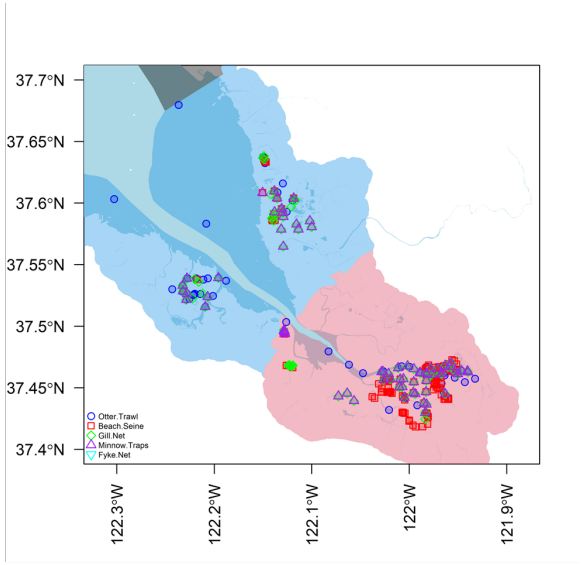
(b) Master database (*repeated*)

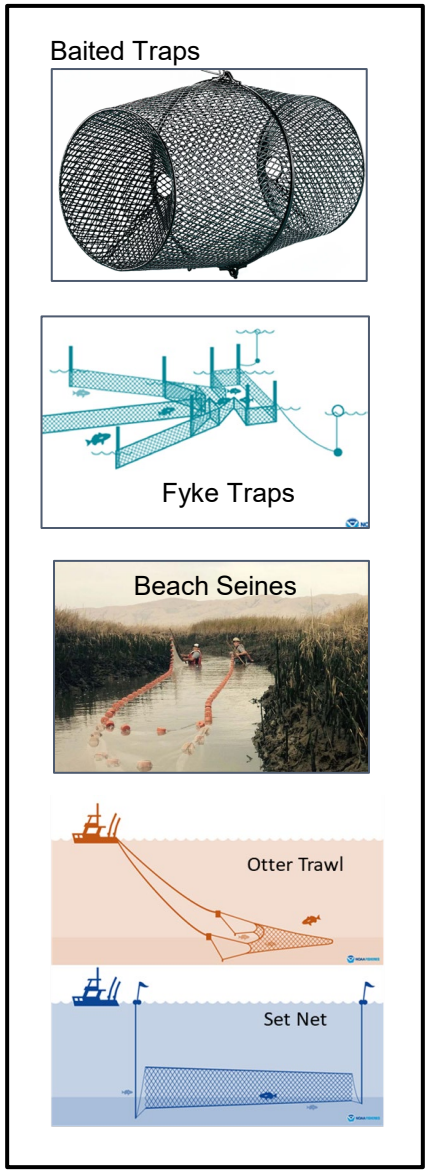
South Bay Salt Pond Restoration Project

- Tow-level catch & env. data
- Incorporation into an online data portal
- Beginning of WRMP FFH database

Project ID	Project Name
PGMTS	USGS Pond Gillnet & Minnow Trap Study
NBOTS	UCD North Bay Otter Trawl & Plankton Study
SBOTS	UCD South Bay Otter Trawl & Plankton Study
AMMBS	UCD Alviso Marsh Mercury Beach Seine Study
CCFNS	SFSU China Camp Fyke Net Study
CCSSM	SFSU China Camp Source or Sink of Mysids
SFEFA	WSU SF Estuary Fish Assemblage Study
SPRFM	HELIX and FISHBIO Sears Point Restoration Fish Monitoring
JSCWC	CCCPWD and Jones & Stokes Chinook in Walnut Creek
HAMRP	Hamilton Wetlands Restoration Project
SFBLS	SCC SF Bay Living Shorelines: Near-shore Linkages Project
SPVFI	SJSU Salt Pond variation and impacts on fish and inverts
SPWQF	USGS Salt Pond water quality impacts on fish assemblages
SBWF	NOAA South Bay wetlands fisheries
FCSPR	UCD Fish Communities response to salt pond restoration
SOGRW	UCD Steelhead Out Migration in Guadalupe R. Watershed
LSSPR	UCD Leopard Shark benefits from salt pond restoration
NACS	UCD Nekton assemblage comparison
SMFMD	UCD Suisun Marsh Fish Monitoring Database
NASP	URS/NOAA Napa Salt Ponds
MALA	WRA Marin Lagoon
SBDA	South Bay Discharge Authority Otter Trawl Study
PEEIR*	UCD Pacific Estuarine Ecosystem Indicator Research Minnow Trap Study*
SFBS*	CDFW San Francisco Bay Study Otter Trawl & Midwater Trawl Study
DJFMP*	USFWS Delta Juvenile Fish Monitoring Program Beach Seine Study*
FRMP*	CDFW Fish Restoration Monitoring Program*







Outline

1. Introduction to FFH in the SFE
2. The WRMP & FFH Monitoring Guidelines
3. Past FFH Monitoring (OGFL Reviews)
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6. The Future of FFH Monitoring in SFE Wetlands

- **Wetland FFH Database/Portal**

Ichthyofaunal Sampling in Brackish and Saline Wetlands of the San Francisco Estuary: *A review with implications for developing an integrated wetland monitoring program*

L. Lewis[1], A. Weber-Stover[2], Z. Duckworth[2], S. Randall[3,4], L. Wang[2], E. Farley[2], M. Williams[2], C. Toms[2]

[1] University of California, Davis
[2] NOAA Fisheries, West Coast region
[3] San Francisco Bay Regional Water Quality Control Board
[4] San Francisco State University

Abstract

Long-term, standardized datasets are integral to understanding the status and dynamics of complex ecosystems. In wetlands, the monitoring of aquatic communities can provide valuable information regarding variation in water quality and ecosystem health, both of which are critical for guiding management and restoration. For example, patterns in the abundance, diversity, and structure of fish communities can be used to assess the responses of wetland ecosystems to human impacts, restoration, and climate change. Such information is critical to the San Francisco Estuary (SFE), where 95% of wetlands have been severely degraded. However, most long-term monitoring of aquatic wetland communities in the SFE has focused on freshwater and low-salinity habitats of the "Upper Estuary" (e.g., the Delta and Suisun Bay). Much less is known about the extensive brackish and saline wetlands throughout the "Lower Estuary", including San Pablo Bay and San Francisco Bay. Nevertheless, the collation and review of numerous short-term studies can provide valuable information to help guide future monitoring, management, and restoration in these ecosystems. Here we conducted a literature review to identify, catalog, and summarize prior and ongoing studies of fishes in brackish and saline tidal wetlands throughout the SFE. Specifically, we explored spatiotemporal patterns in prior monitoring efforts, including the regions and habitats sampled, gears utilized, environmental data collected, and observations of managed species. The results highlight best practices and critical information gaps--key information that will be used to guide future restoration and the establishment of long-term monitoring in wetlands of the lower SFE.

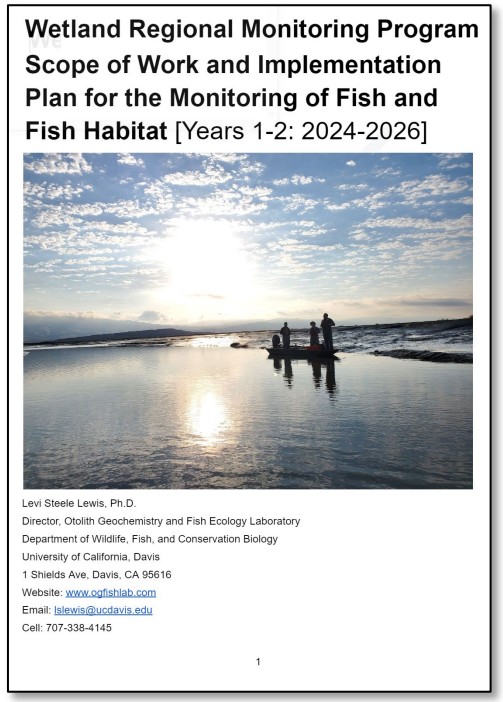
SF ESTUARY Wetlands Regional Monitoring Program

South Bay Salt Pond Restoration Project

- **State of the Estuary Report (Wetland Fishes)**

6. The Future of FFH Monitoring in SFE Wetlands

- **$1.5 Million FFH Y1-2 Implementation**


Wetland Regional Monitoring Program Scope of Work and Implementation Plan for the Monitoring of Fish and Fish Habitat [Years 1-2: 2024-2026]

Levi Steele Lewis, Ph.D.
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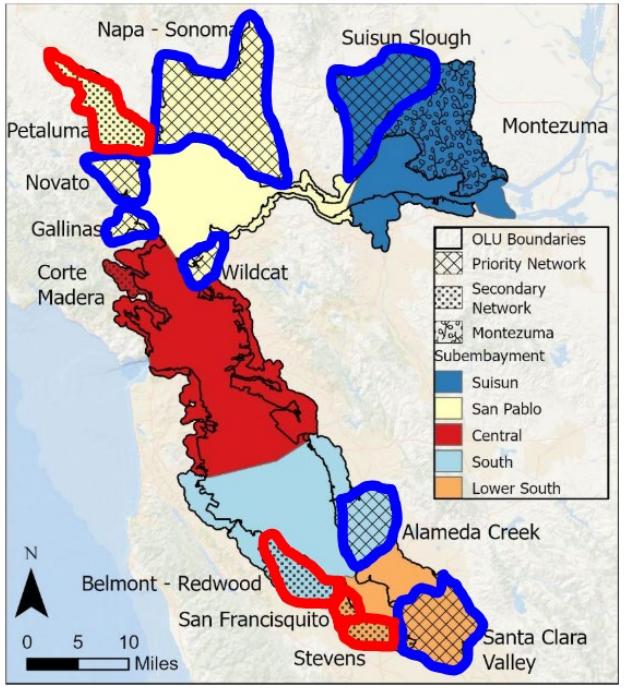

Beneath the Surface, Below the Delta

Expanding our knowledge of aquatic wetland ecosystems across the SFE

Levi S. Lewis

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