Sediment and Beneficial Reuse Commissioner Working Group

May 19, 2023

Project Team: Maya McInerney, Brenda Goeden, Erik Buehmann, Pascale Soumoy, Jaime Lopez

San Francisco Bay Conservation and Development Commission

San Francisco Bay Regional Sediment Management

Agenda

1. Welcome and Project Updates
2. Overview of San Francisco Bay Sediment Transport System
3. Tidal Marsh Sediment Supply and Transport
4. Stakeholder Process
5. Public Comments
6. Adjournment

Photo: Hamilton Wetlands

Project Goal

To increase beneficial reuse of sediment and soil for wetland habitat restoration, resilience, and sea level rise adaptation in the SF Bay Area.

Where have we come from?

- Fill for Habitat (BPA 1-17)
- Previous Working Group meeting topics:

January

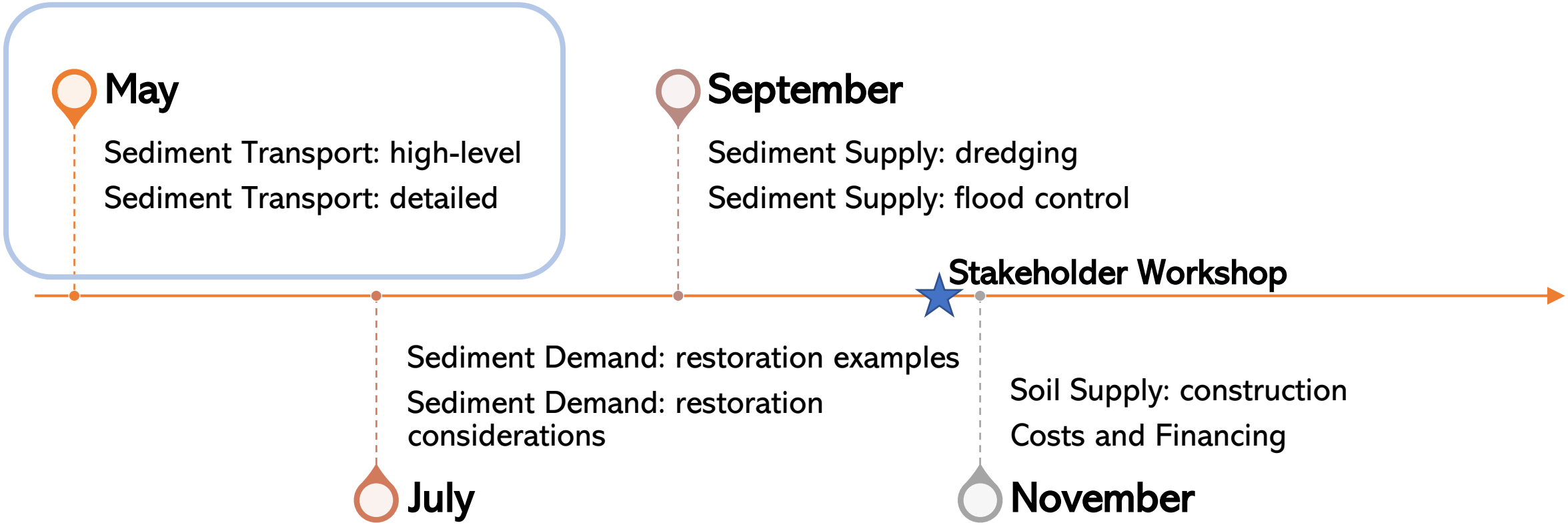
- EPA Project Grant
- Sediment and Soil in SF Bay Region
- Existing related Bay Plan Policies Affecting Beneficial Reuse

March

- Bay Plan Amendment Process
- Project Workplan
- Project Direction and Goals

Photo: Newark Slough courtesy of King Tides Project

Where are we going?



Discussion

- Is there any other topic that you think might be missing from our briefings?

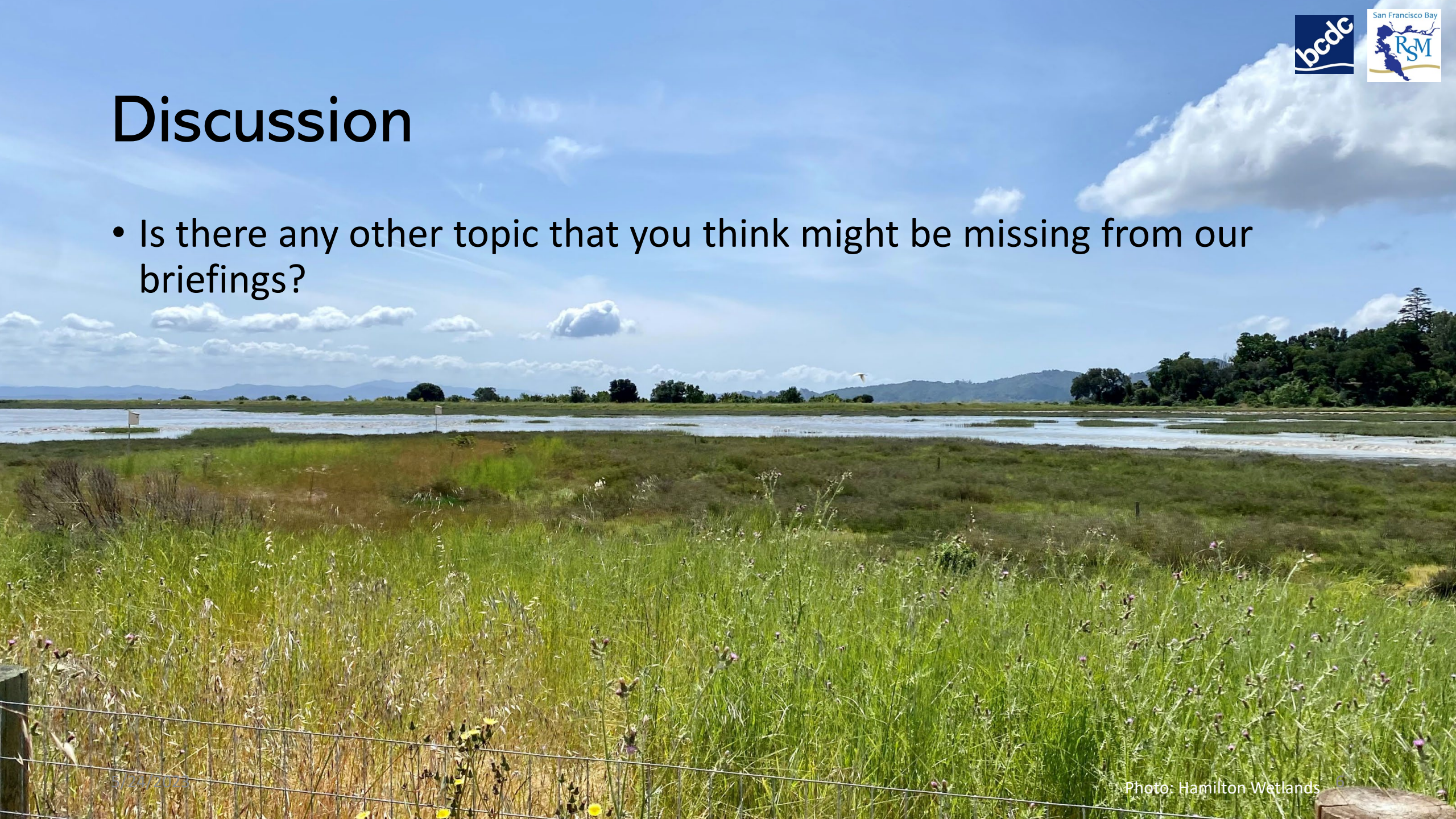


Photo: Hamilton Wetlands

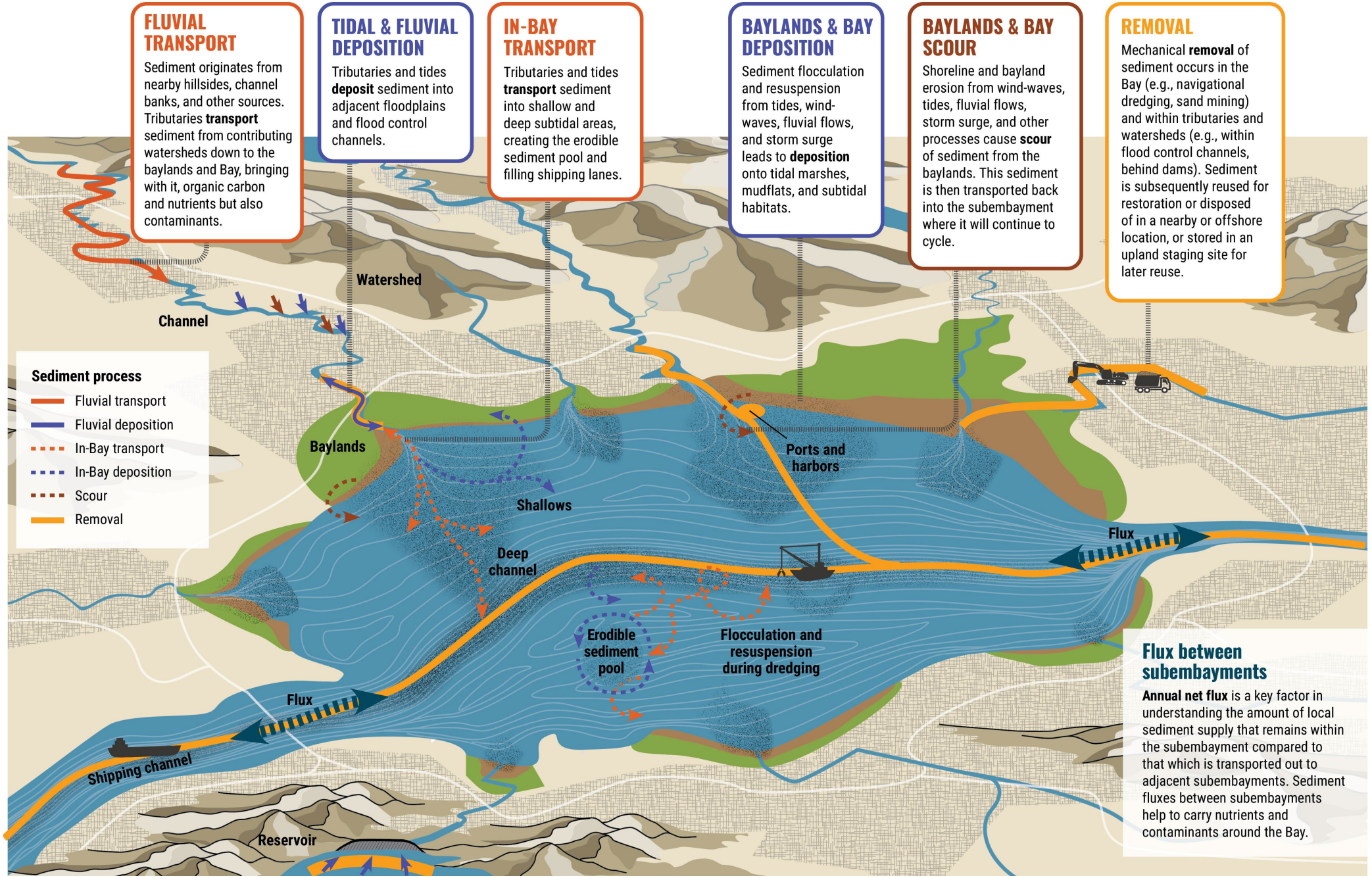
San Francisco Bay Geomorphology and Sediment Transport Overview

Brenda Goeden, Sediment Program Manager
San Francisco Bay Conservation and Development Commission
Commissioner Sediment and Beneficial Reuse Working Group
May 19, 2023

Making San Francisco Bay Better

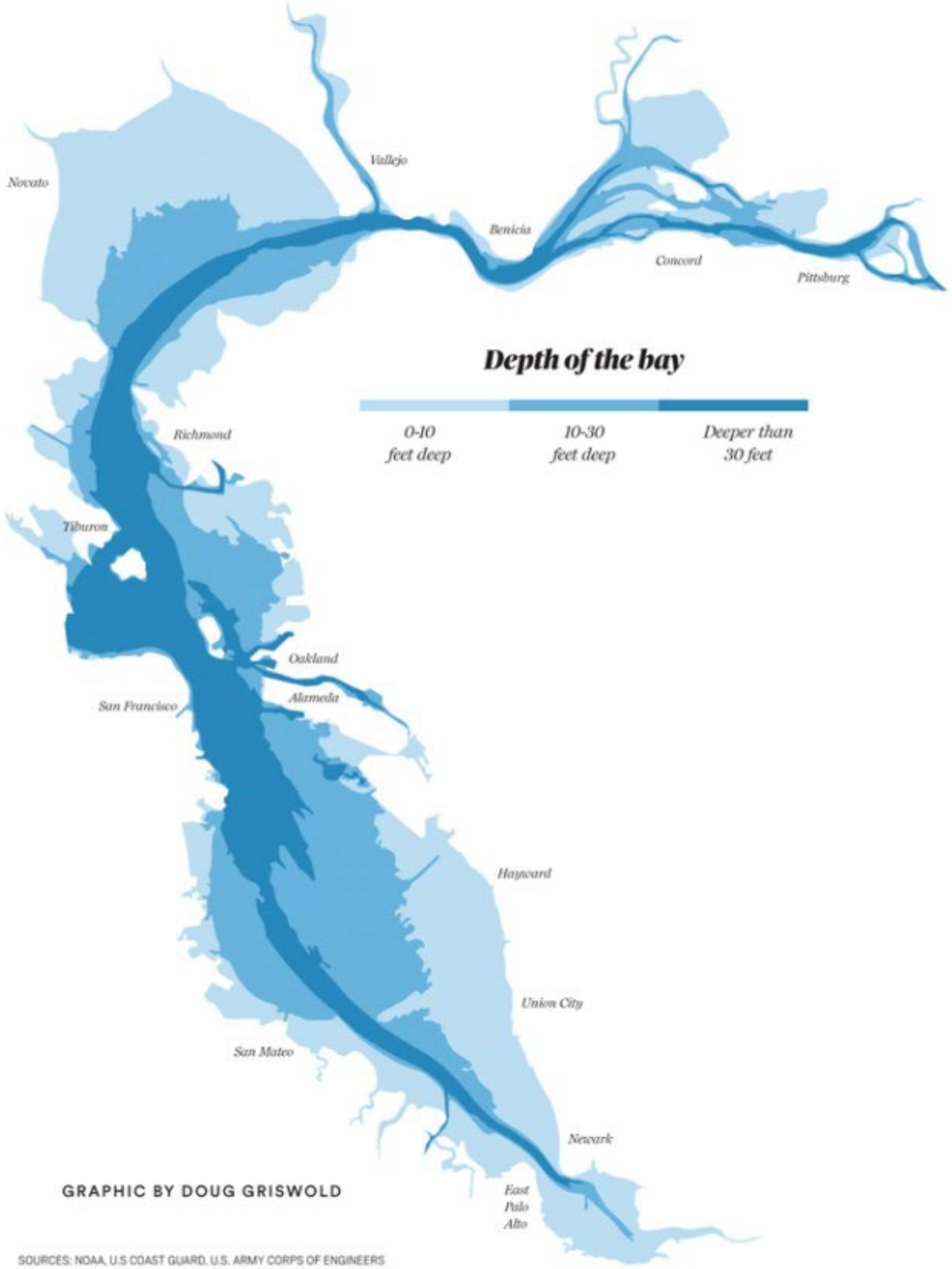
San Francisco Bay Area

- 550 square miles
- 6.8 million people (2020 Census)
- 9 Counties, 54 Cities
- Hundreds of flood control channels and watershed
- 6 Bridges
- 17 Federal channels
- 5 Ports
- 7 Refineries/oil
- terminals
- 100 + marinas and berthing areas



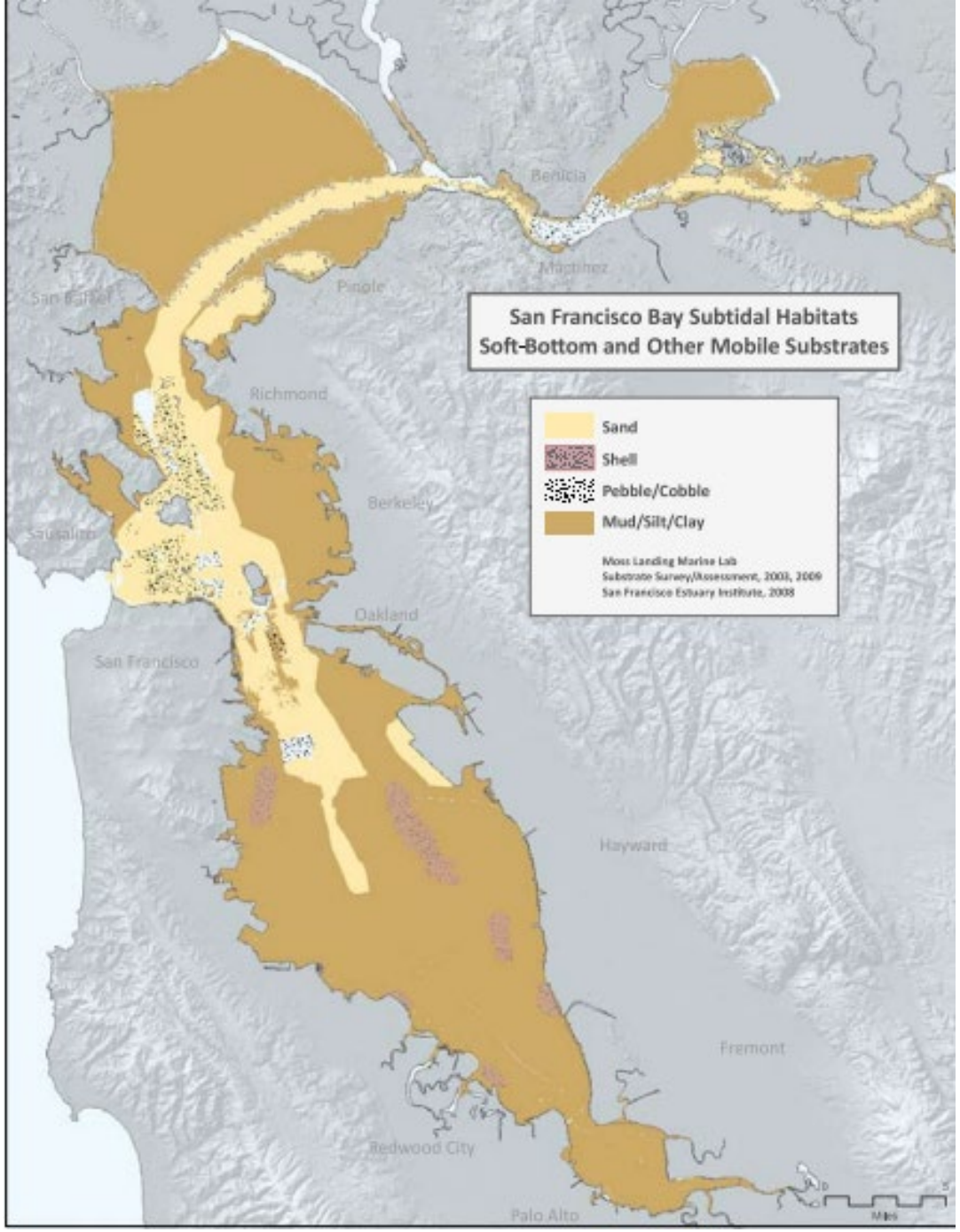
SFEI, Fine Grain Sediment Conceptual Model, in preparation


North Bay
Suisun Bay
The Delta
Central Bay
South Bay
Lower South Bay

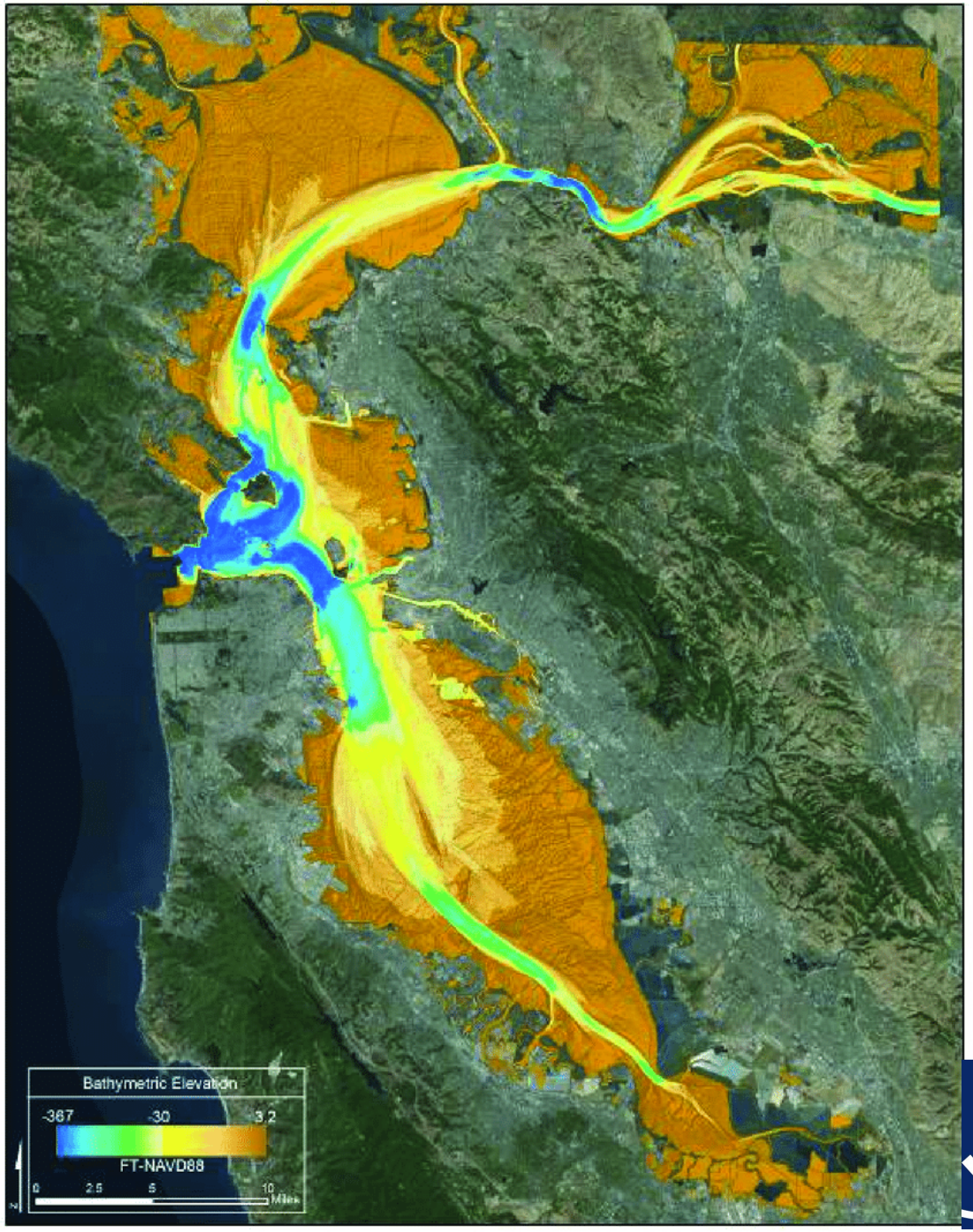


San Francisco Bay Geomorphology and Bathymetry

- Deep water channels
- “Pinch Points” constraining water and sediment flow
- Broad, shallower shoals
- Wide and shallow intertidal mudflats
- Tidal wetlands
- Sand and gravel beaches

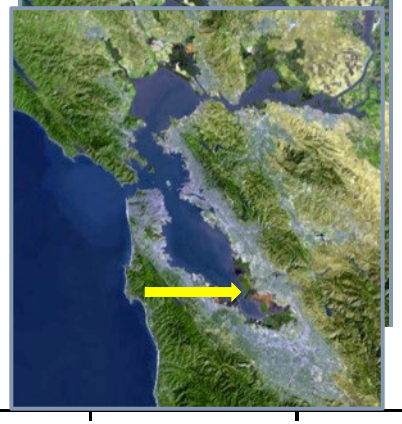


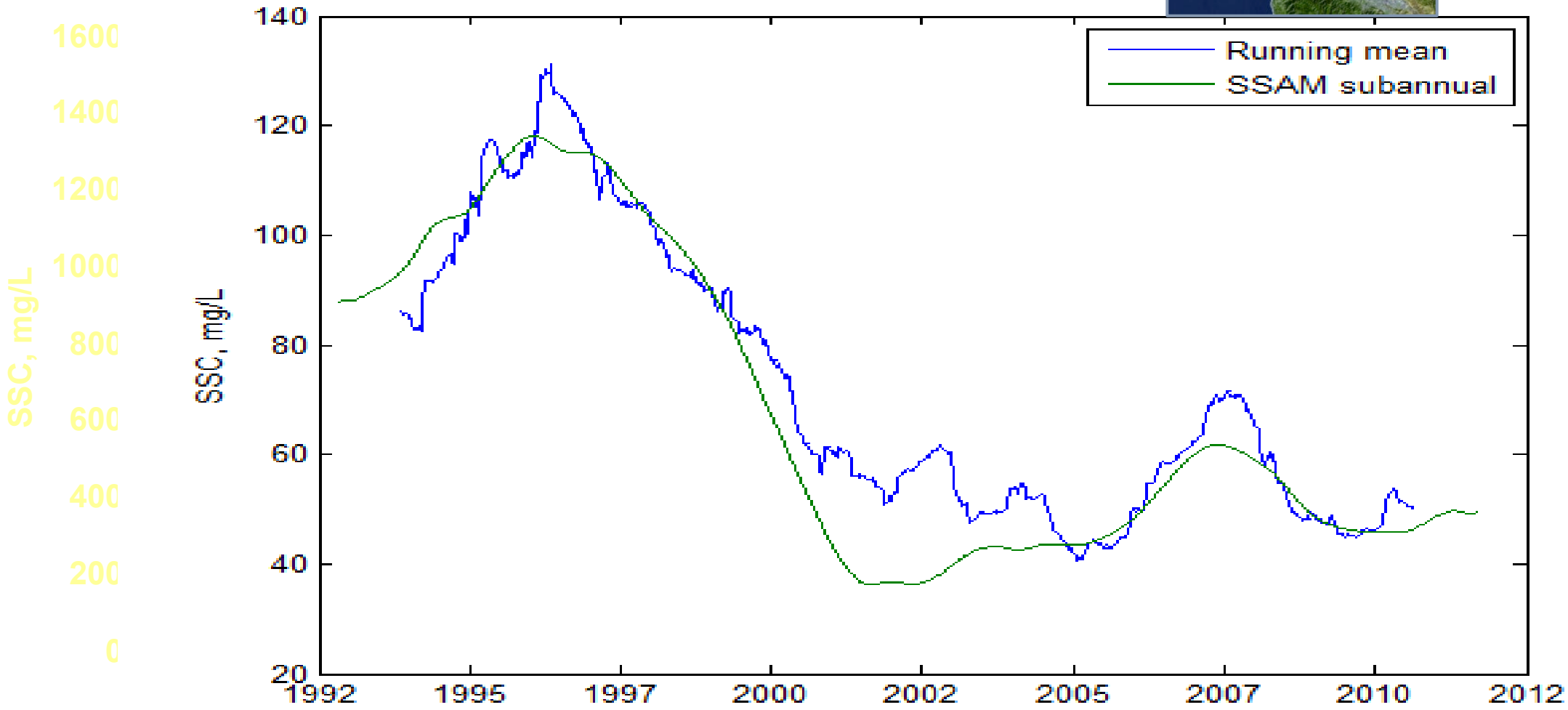
Subtidal Habitat Goals, 2010



AECOM 2016

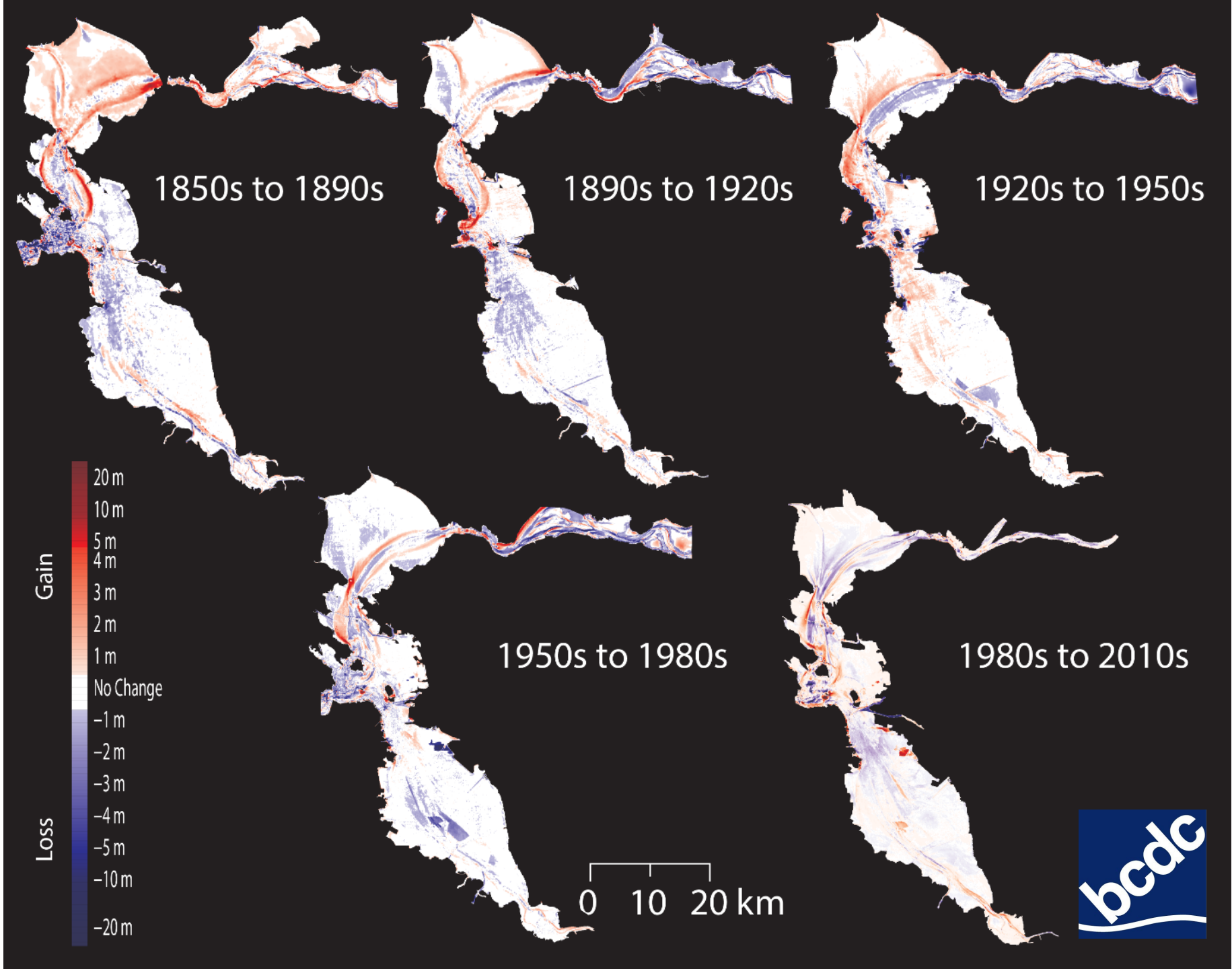
Decline in Suspended Sediment Supply from the Delta



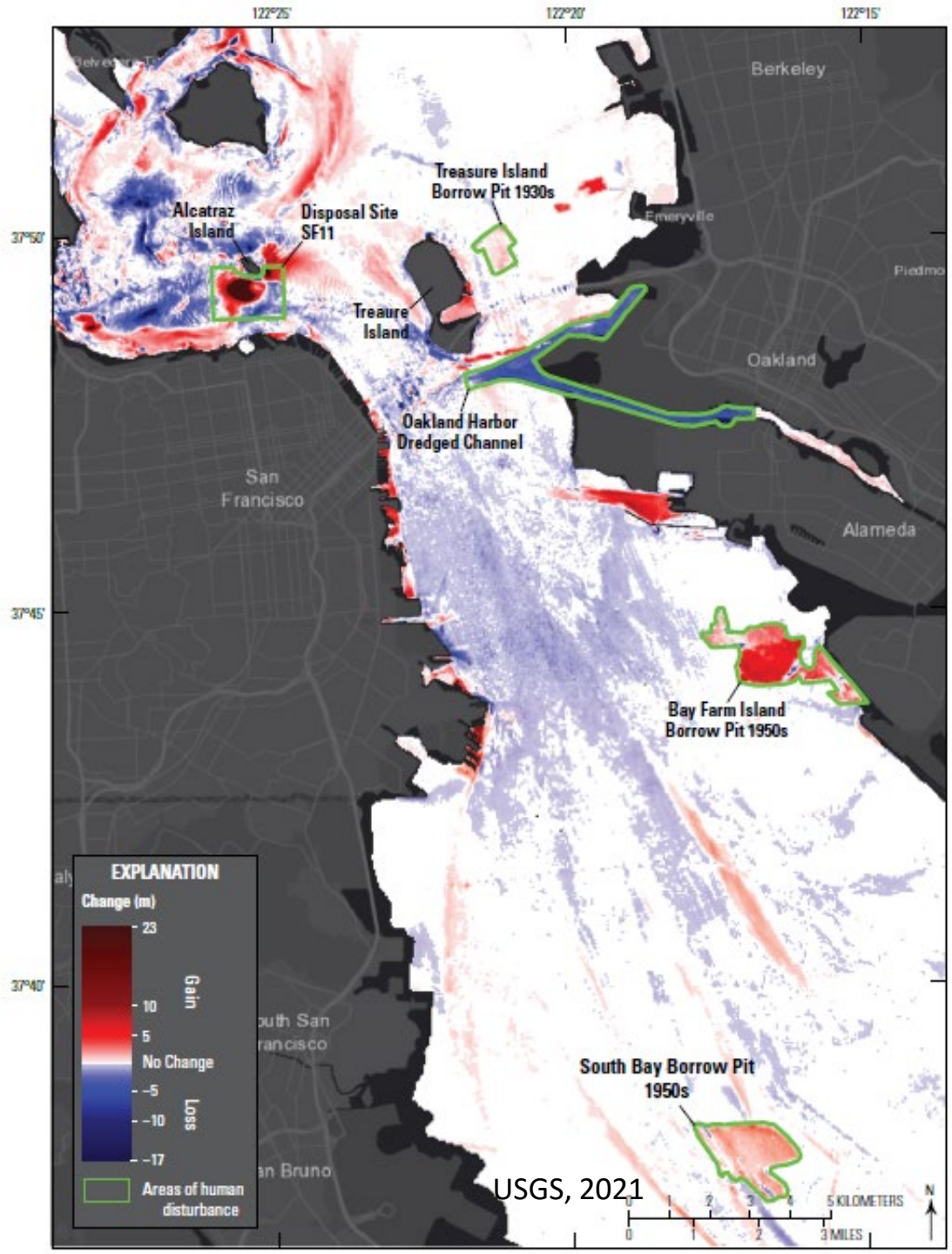


Changes to Bay Bathymetry

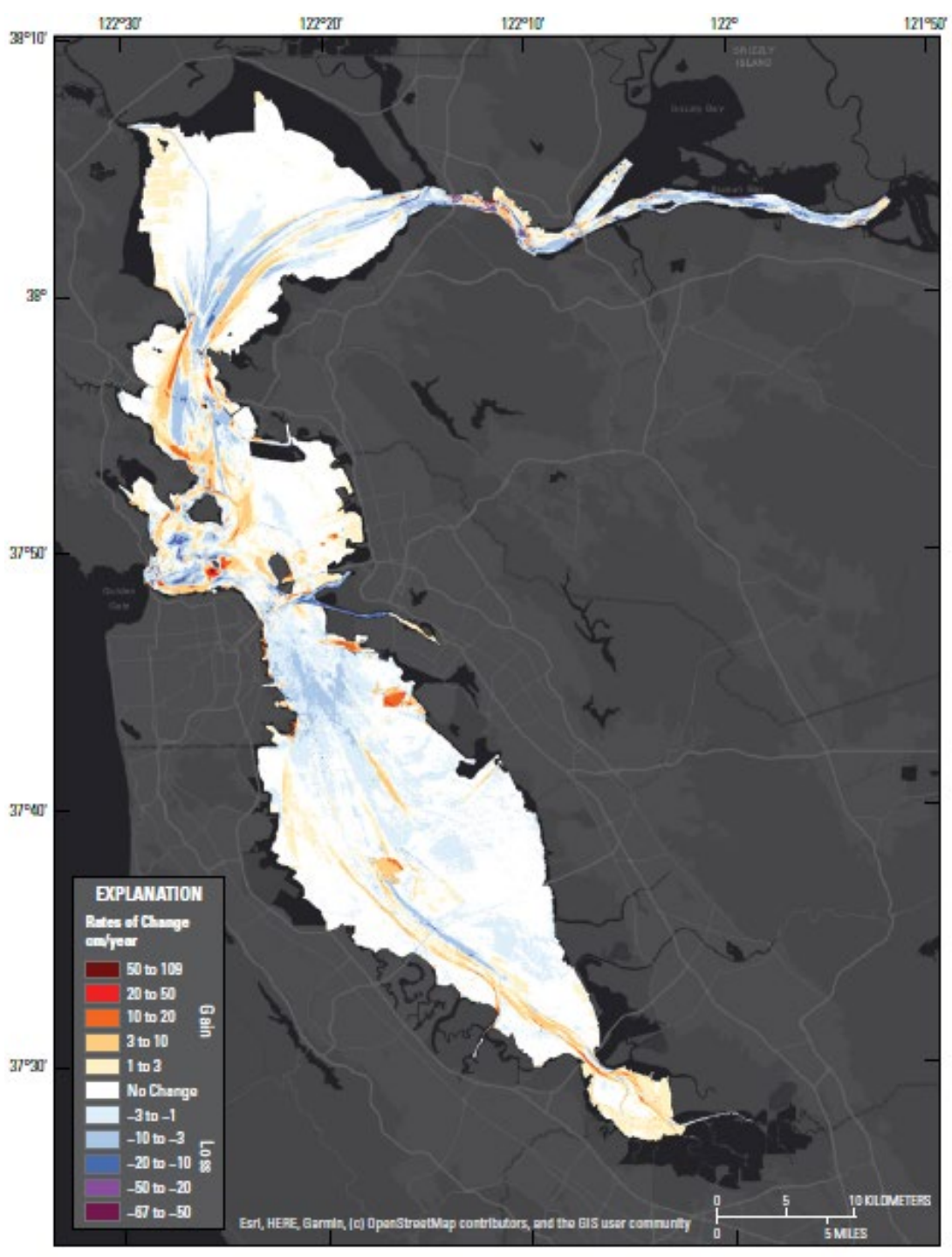
Red = sediment gains
Blue = sediment loss



Jaffee, B., et.al., USGS, 2021



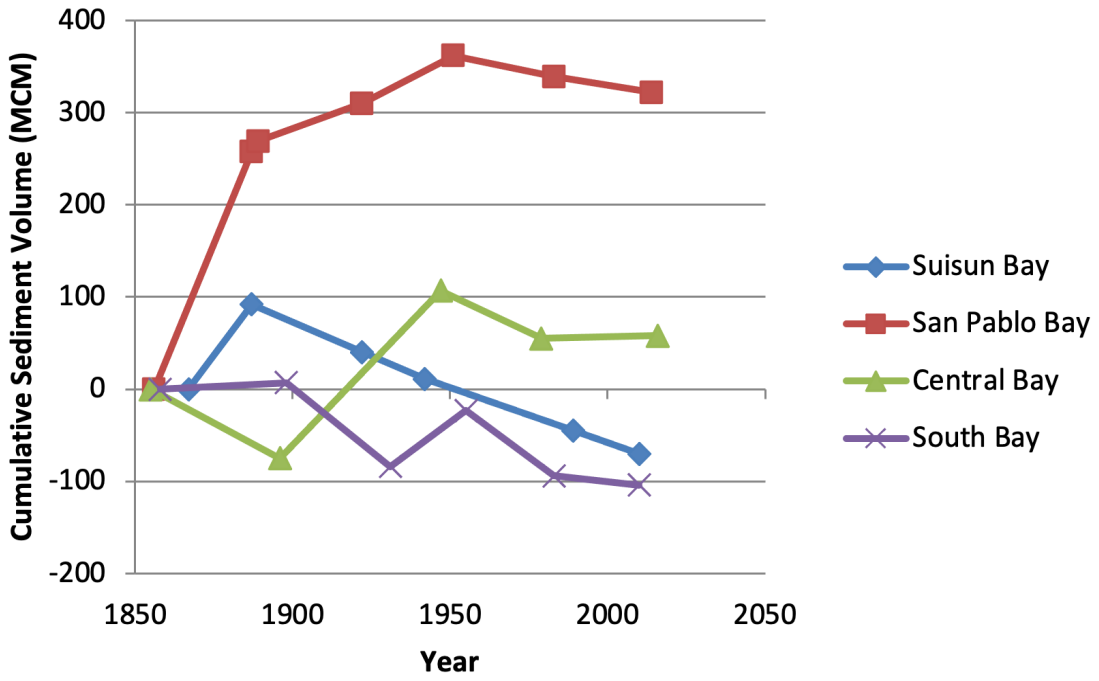
USGS, 2021



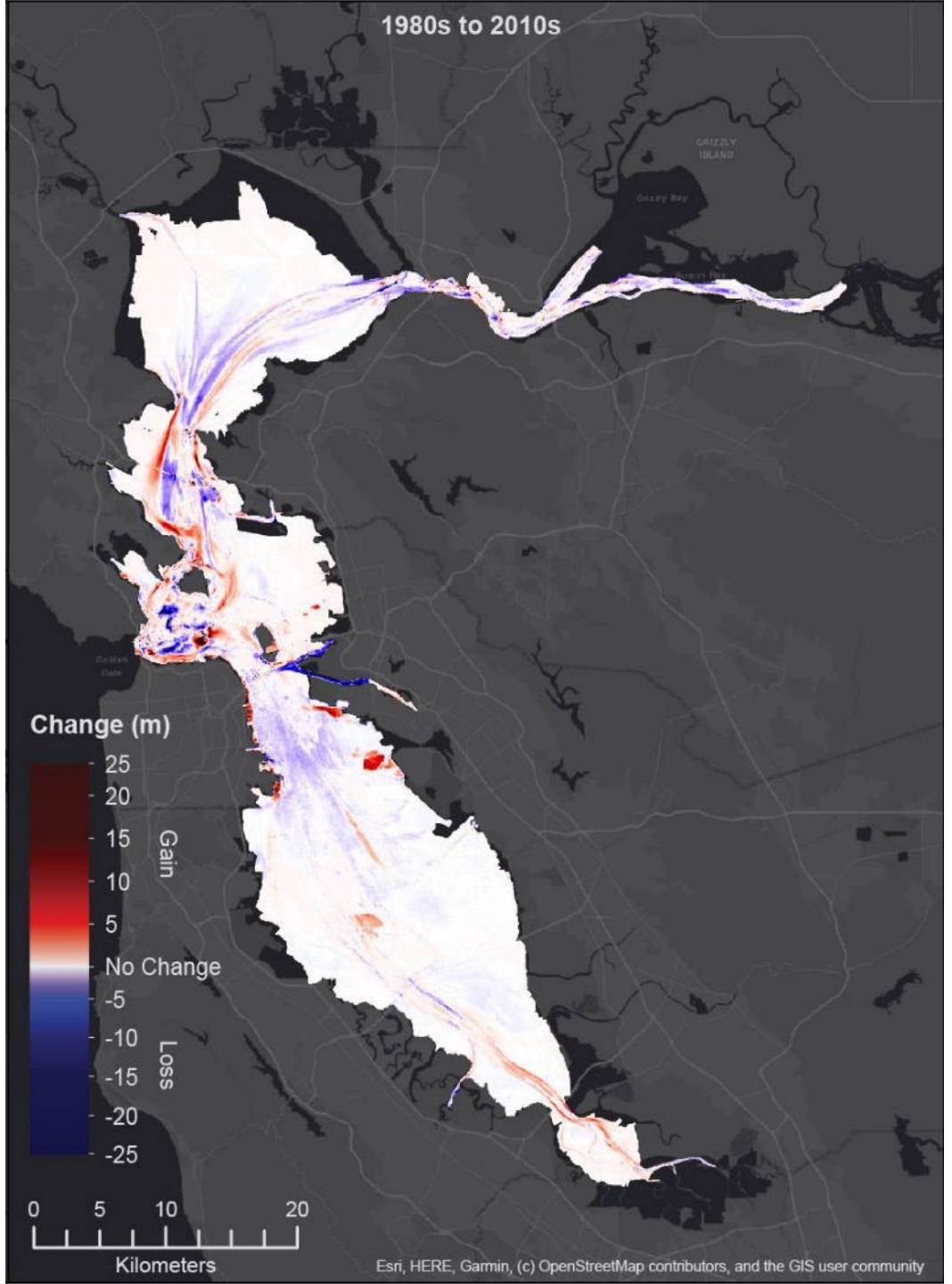
Jaffee, B. et.al., USGS, 2021

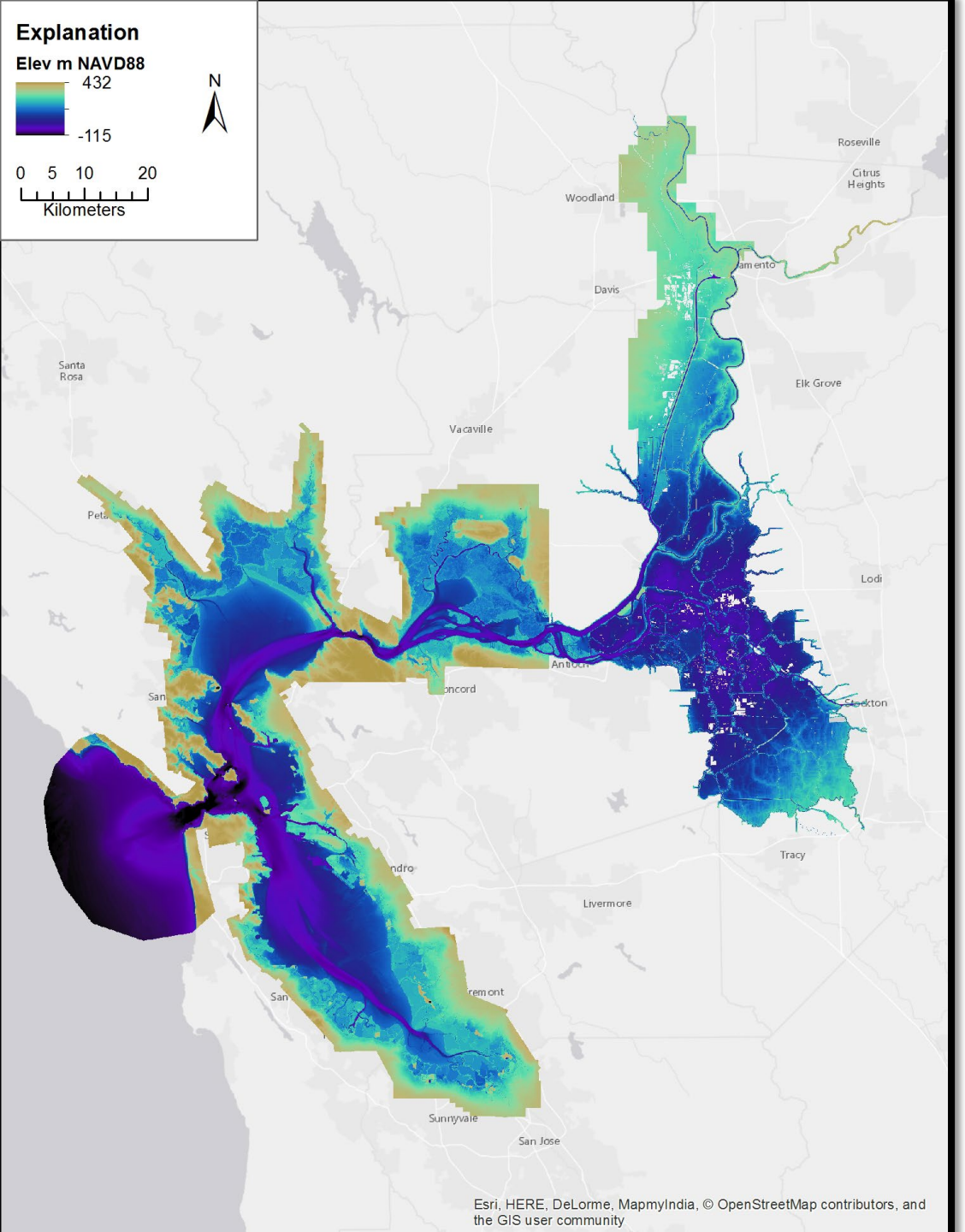
Changes in Bay Sediment Volume

Overall: Approximately 25 MCM loss
San Pablo Bay: 17 MCM loss
Central Bay: 3 MCM gain
South Bay: 10 MCM loss



Jaffee, B. et.al., USGS, 2021




Explanation
Elev m NAVD88
432
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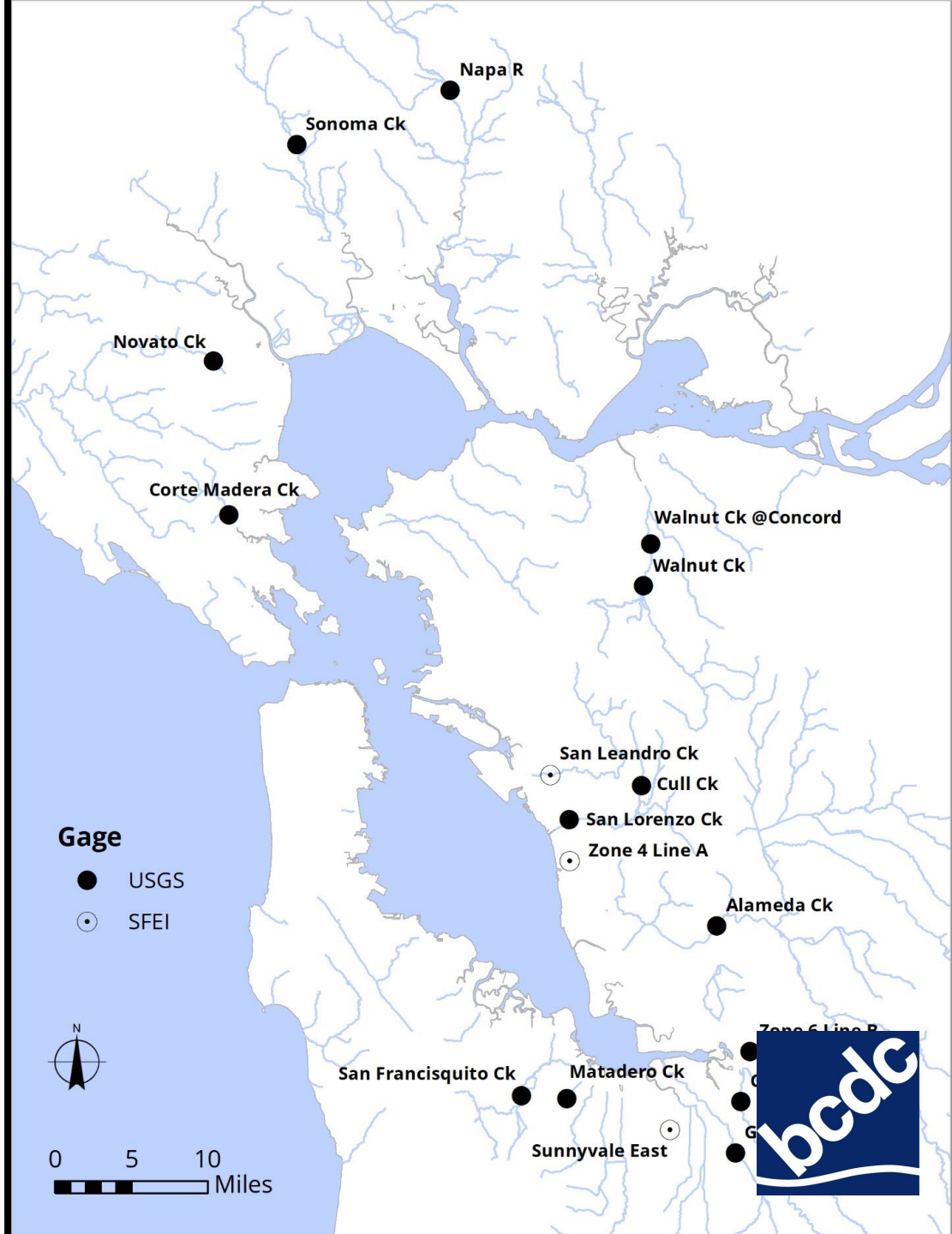
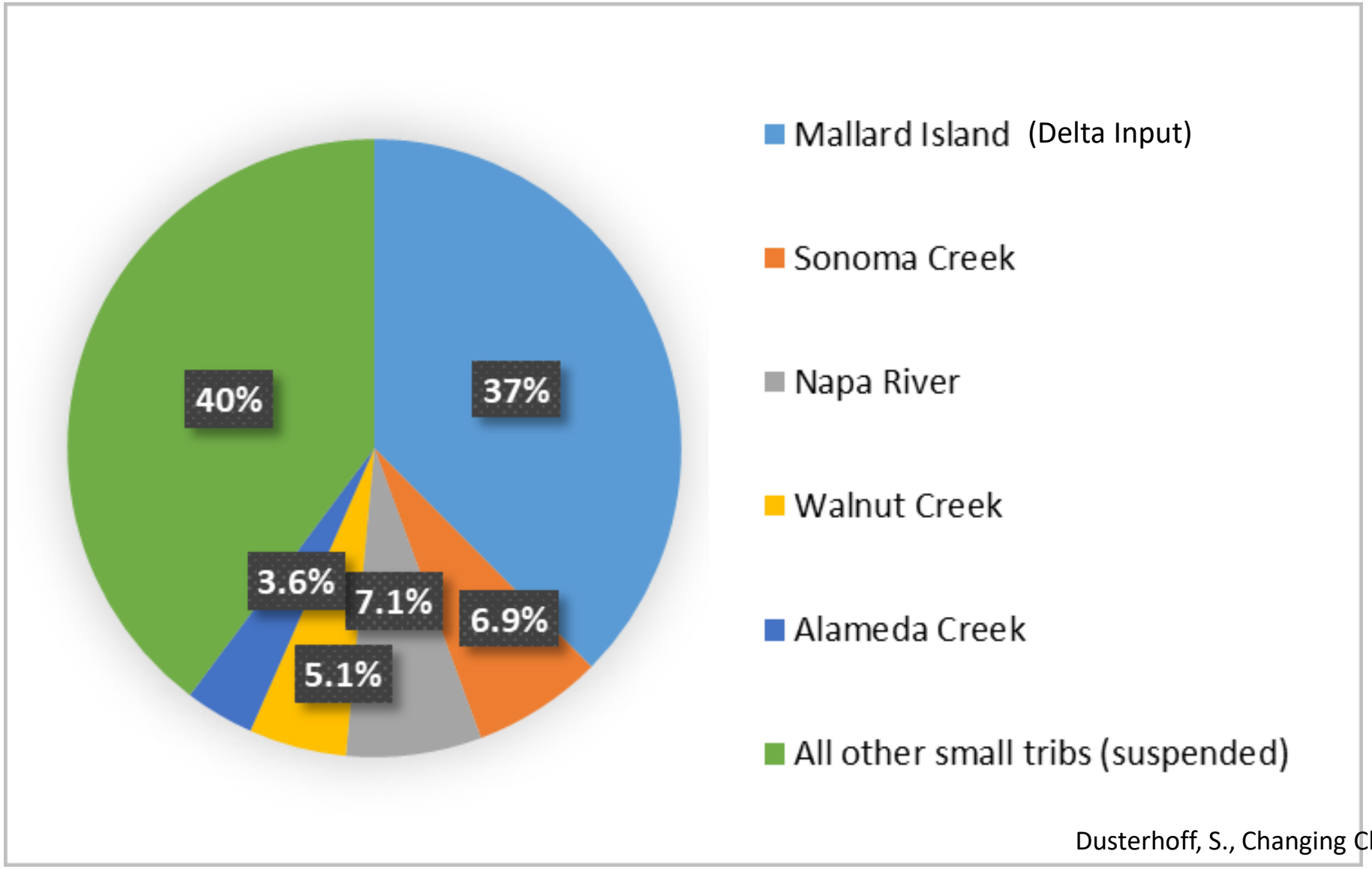
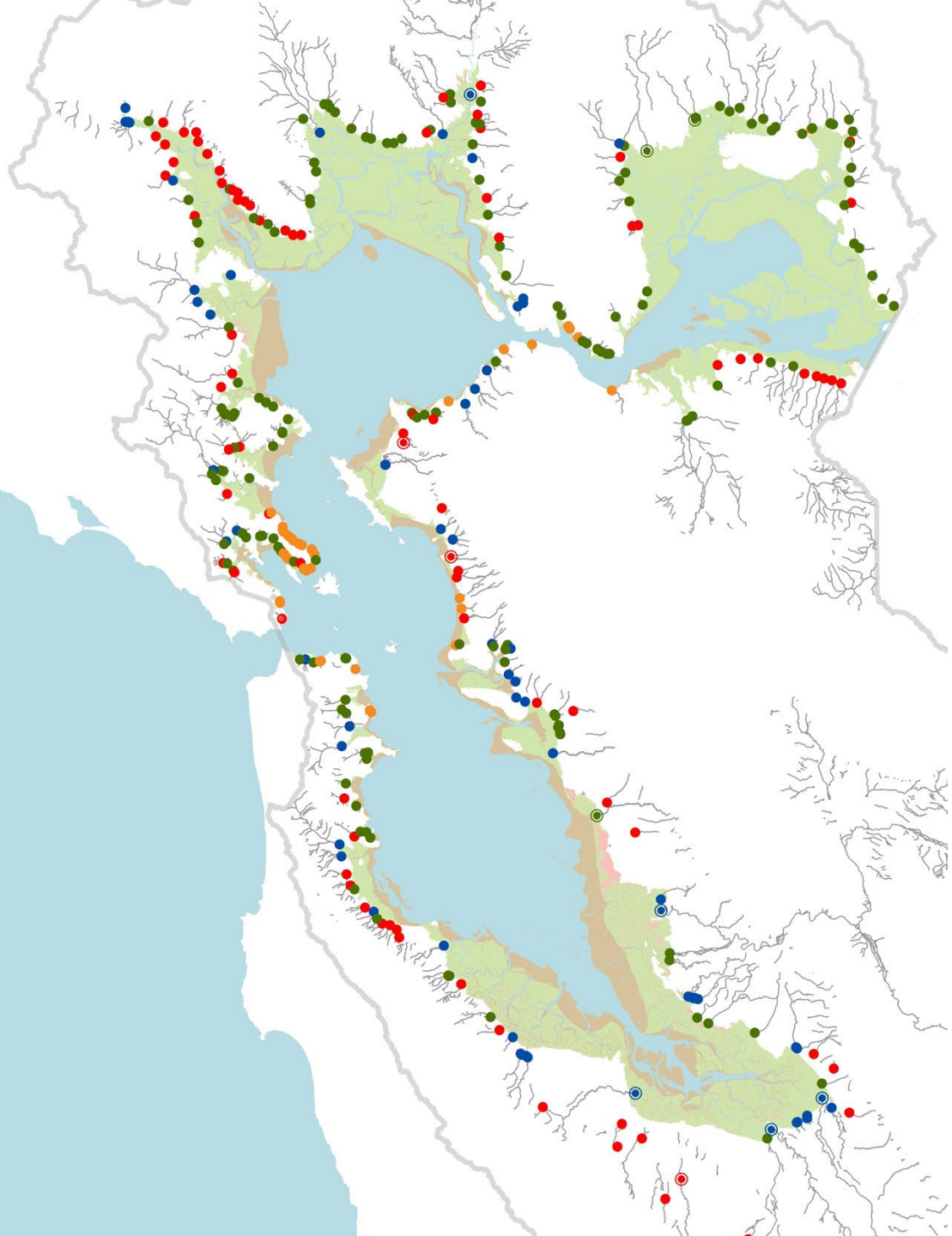
N
0 5 10 20
Kilometers
Roseville
Citrus Heights
Woodland
Davis
Santa Rosa
Elk Grove
Vacaville
Lodi
Antioch
Tracy
Livermore
Sunnyvale
San Jose
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

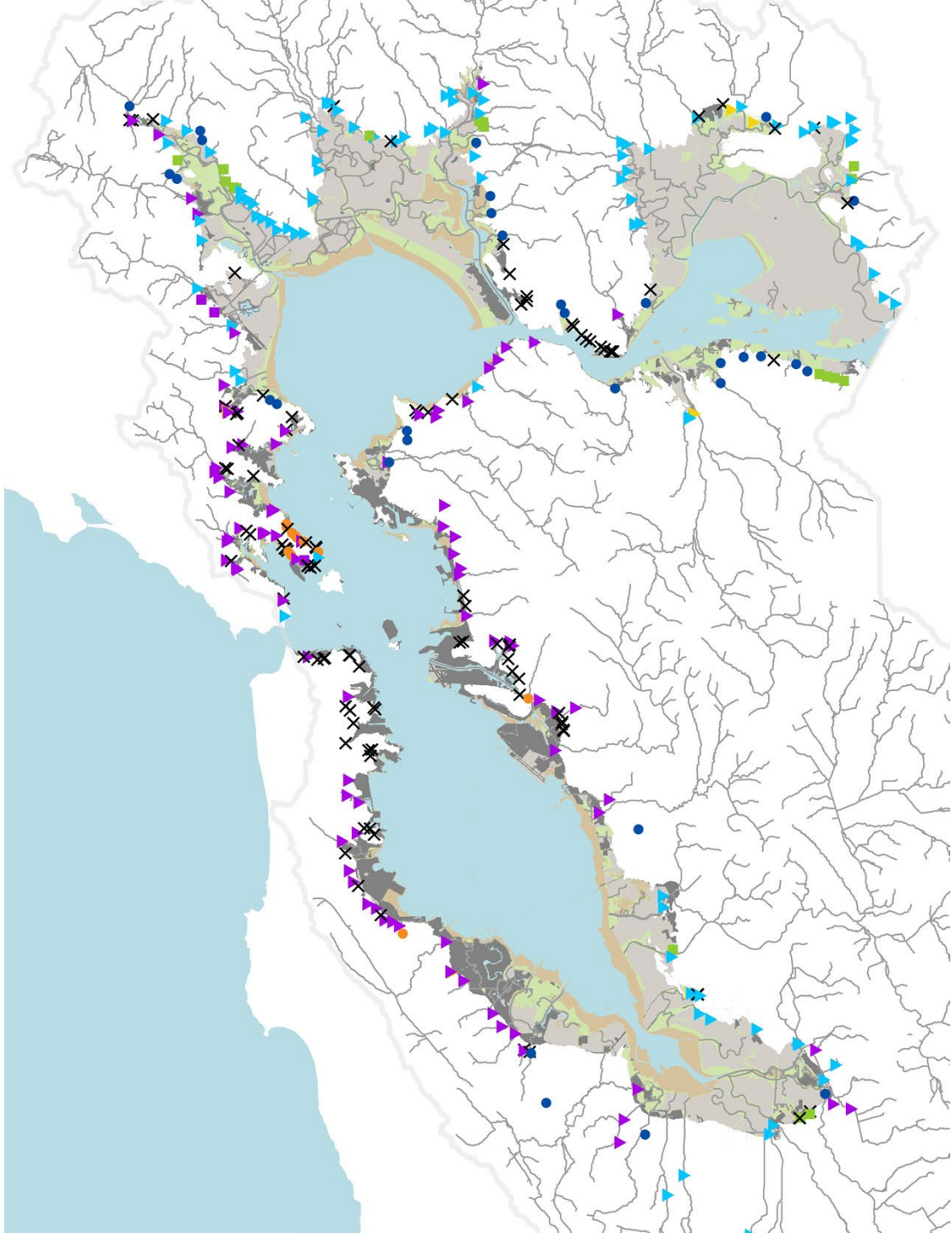

Napa R
Sonoma Ck
Novato Ck
Corte Madera Ck
Walnut Ck @Concord
Walnut Ck
San Leandro Ck
Cull Ck
San Lorenzo Ck
Zone 4 Line A
Alameda Ck
San Francisquito Ck
Matadero Ck
Sunnyvale East
Gage
USGS
SFEI
N
0 5 10
Miles
bcdc

Suspended Sediment Supply



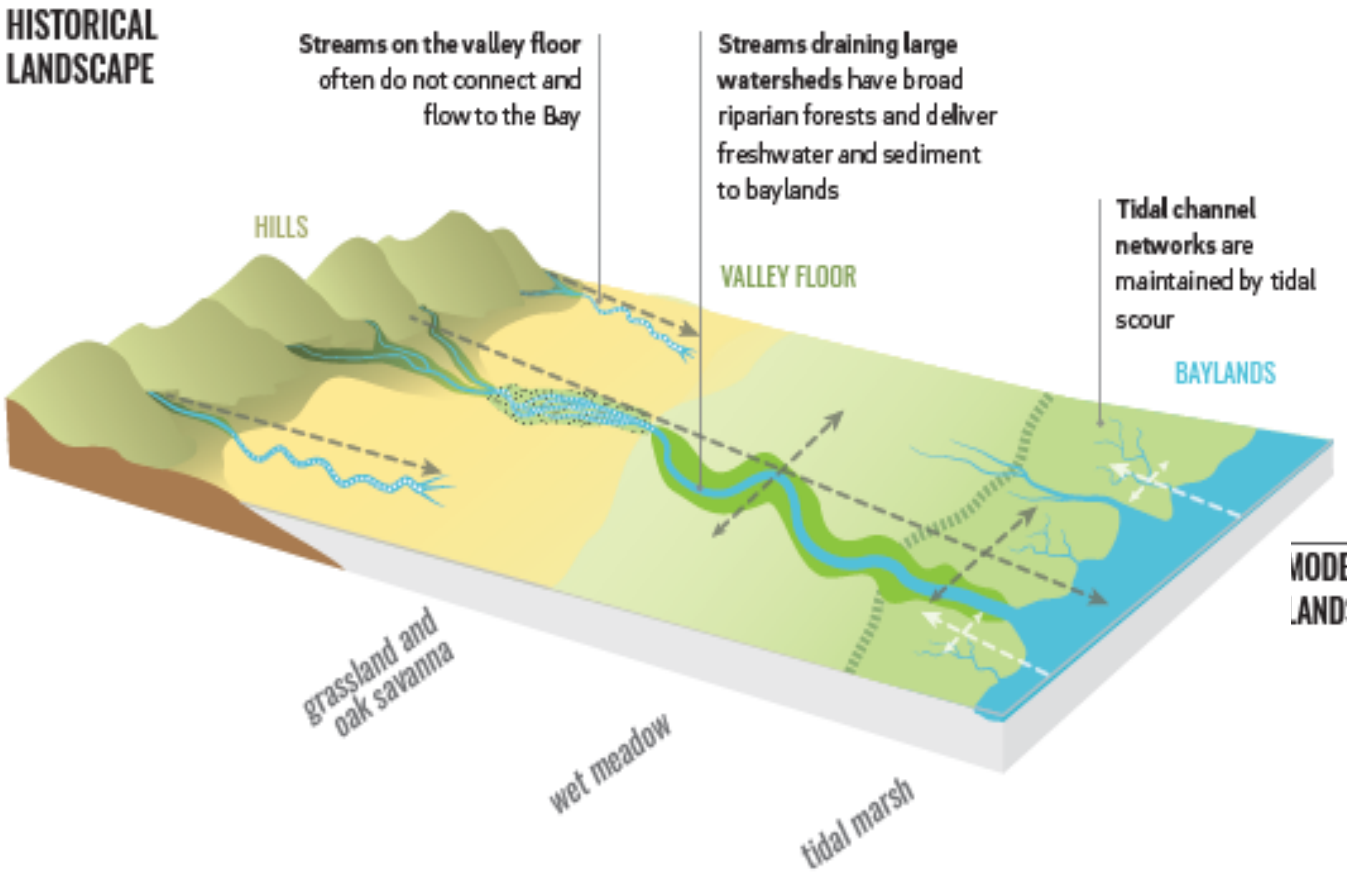
Dusterhoff, S., Changing Channels Report, SFEI, 2017

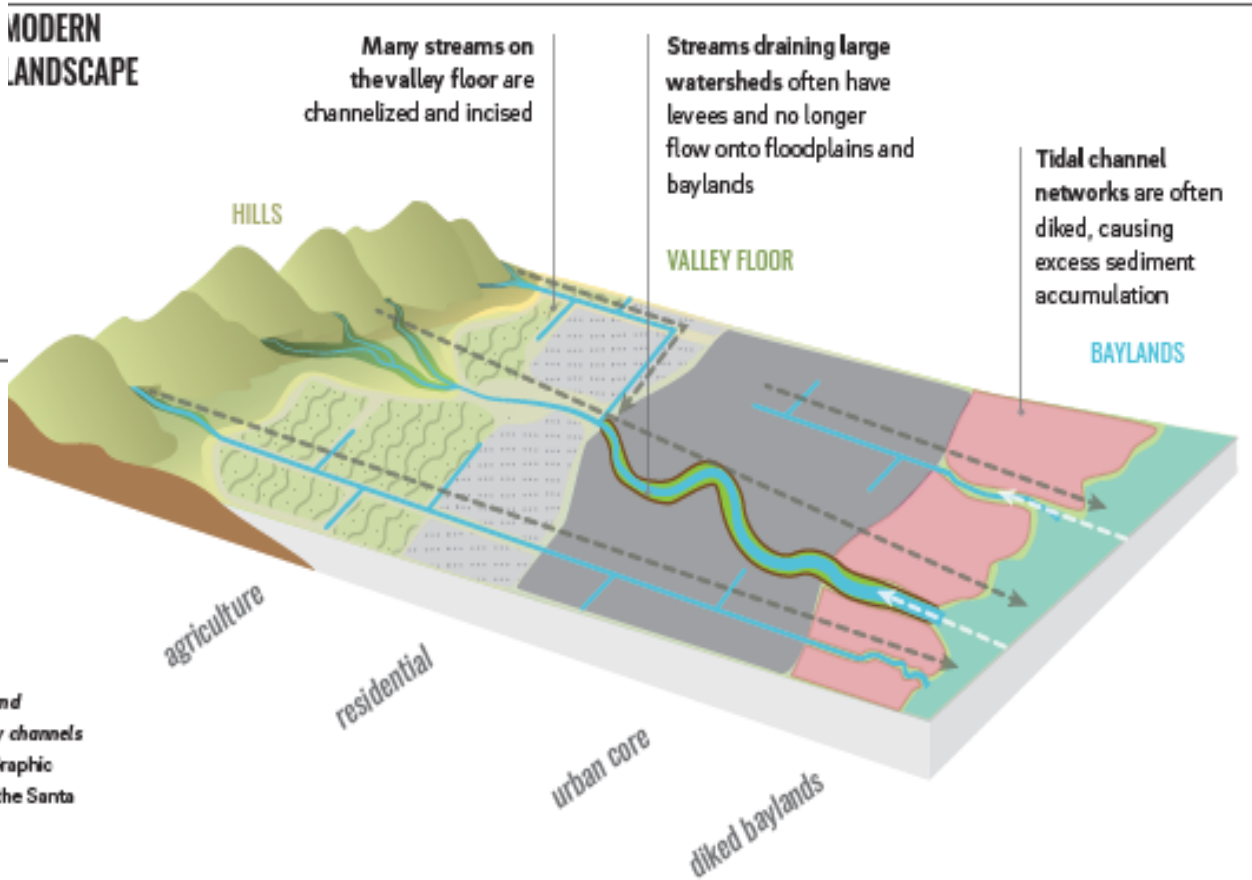




Dusterhoff, S.,
Changing Channels
Report, SFEI, 2017

SFEI, Fine Grain Sediment Conceptual Model, in preparation

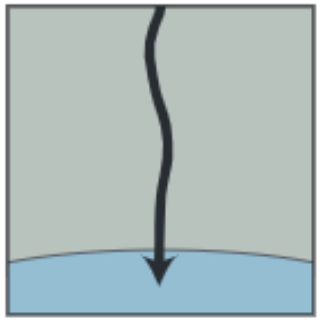




HYDROLOGY
- Intermittent
- Perennial

PHYSICAL PROCESS
- Stream flow (water, nutrients, sediment)
- Tidal flow (water, nutrients, sediment)

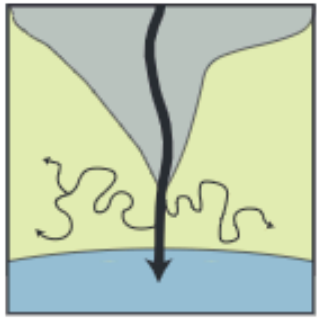
Conceptual model of historical and contemporary dynamics of many channels draining to San Francisco Bay. Graphic developed in coordination with the Santa Clara Valley Water District.



Connected to the Bay

Channels entered directly into the Bay without passing through baylands (i.e., mudflats, tidal marshes, tidal-terrestrial transition zones).

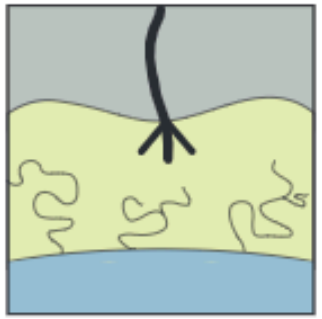
Example: Hilarita Drainage (Marin County)



Connected to a tidal marsh channel with natural levee

Channels reached tidal marshlands and merged into a tidal channel network.

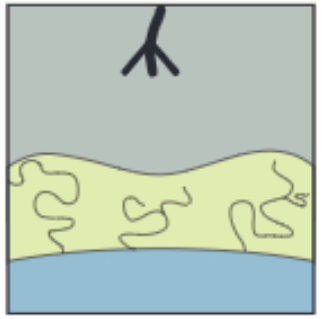
Example: San Leandro Creek (Alameda County)
Example with levee: Guadalupe River (Santa Clara County)



Drains onto a tidal marshland with natural levee

Channels entered tidal marshlands and dissipated without connecting to a larger tidal channel network.

Example: Belmont Creek (San Mateo County)
Example with levee: San Lorenzo Creek (Alameda County)



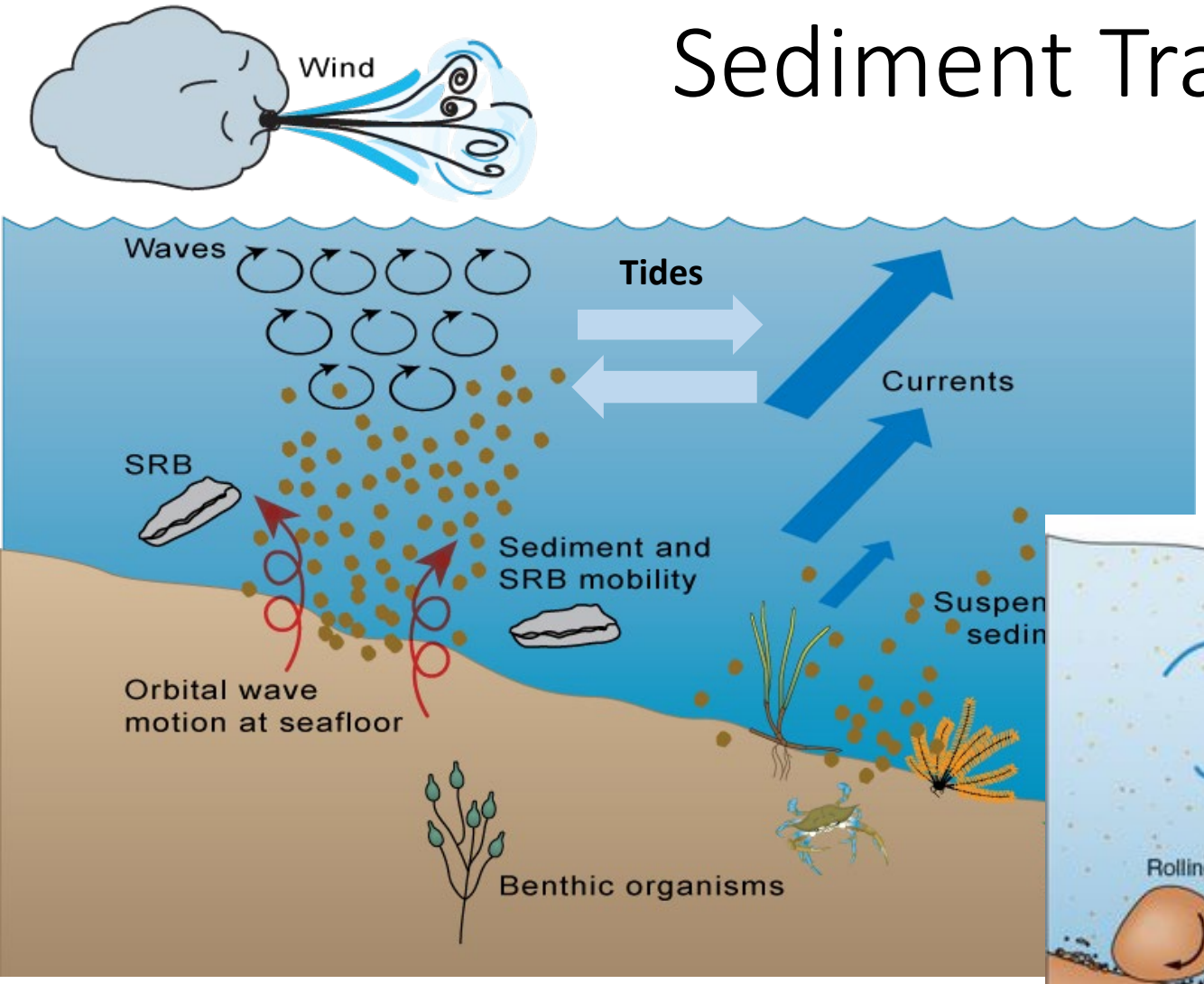
Disconnected on alluvial plain with natural levee

Channels dissipated on alluvial plains or freshwater wetlands prior to reaching the baylands.

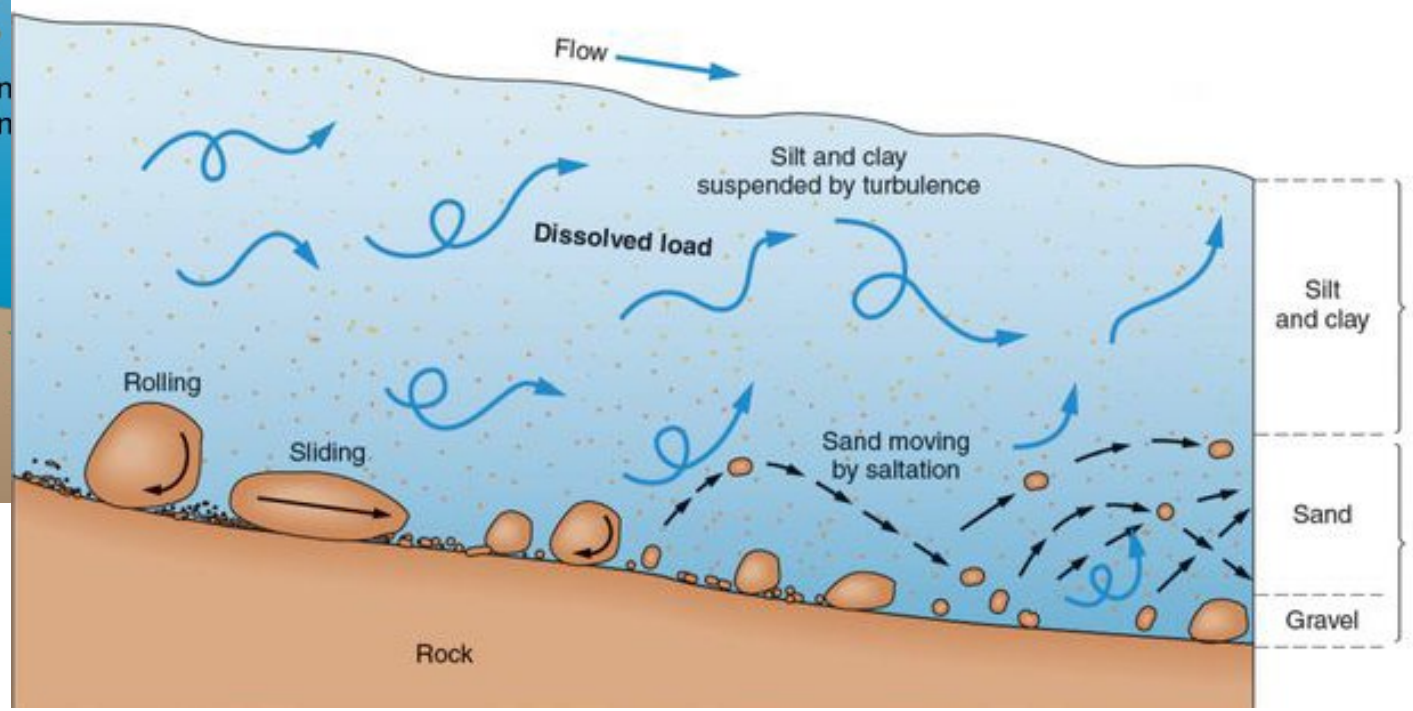
Example: Adobe Creek (Santa Clara County)
Example with levee: Stevens Creek (Santa Clara County)

Dusterhoff, S., Changing Channels Report, SFEI, 2017

Sediment Transport Mechanisms

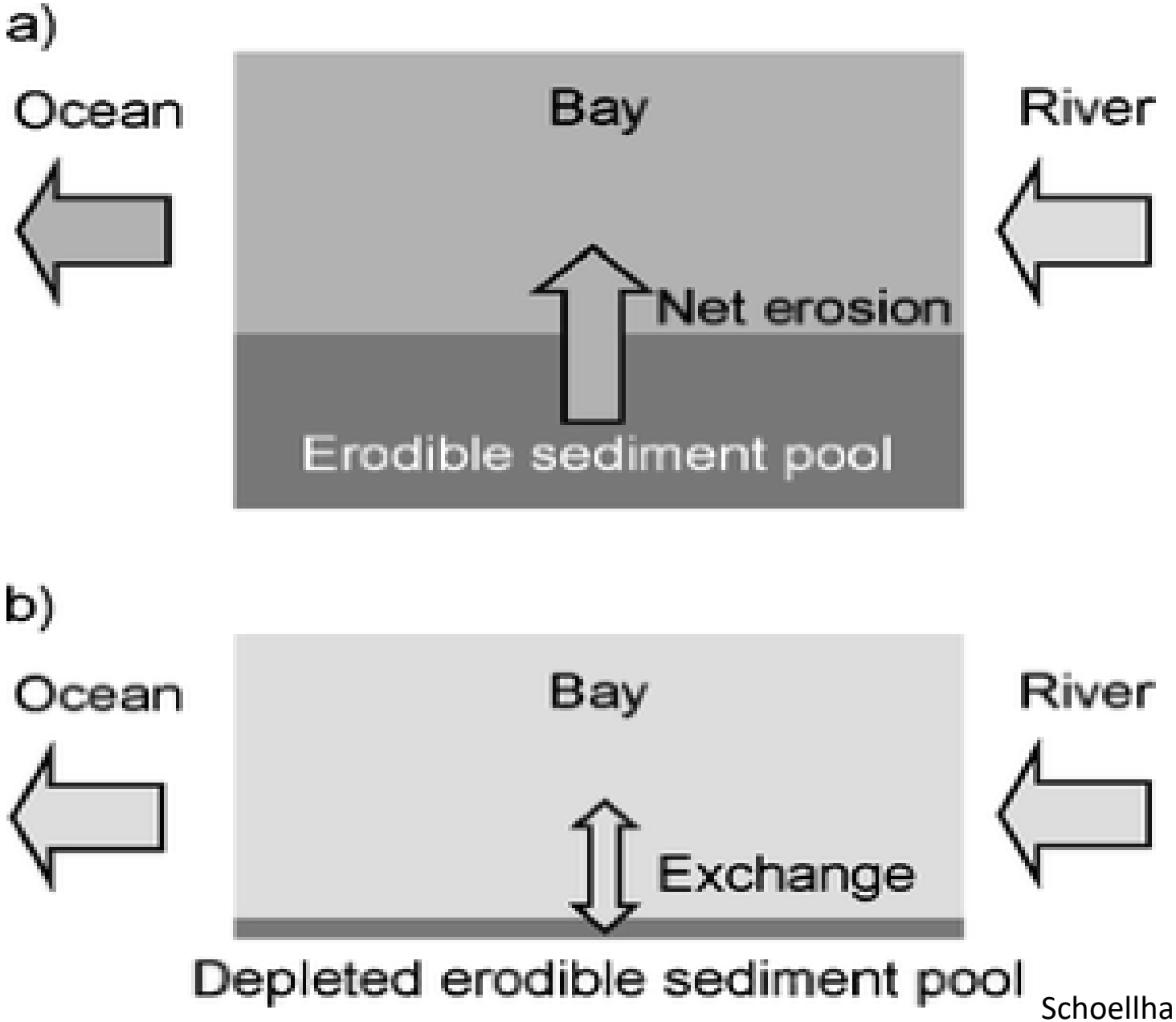


Plant, N. USGS 2012



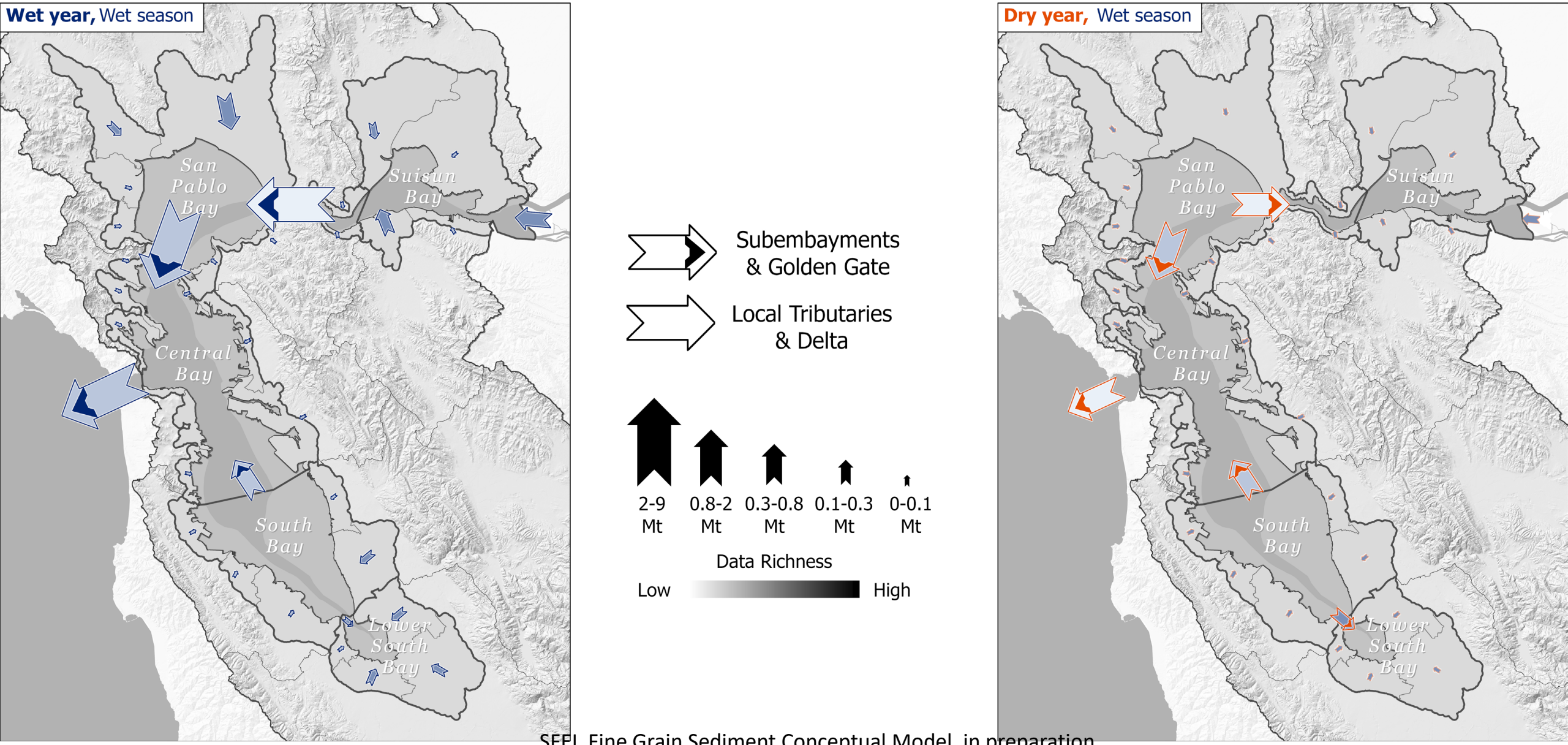
WorldRivers

Erodible Sediment Pool



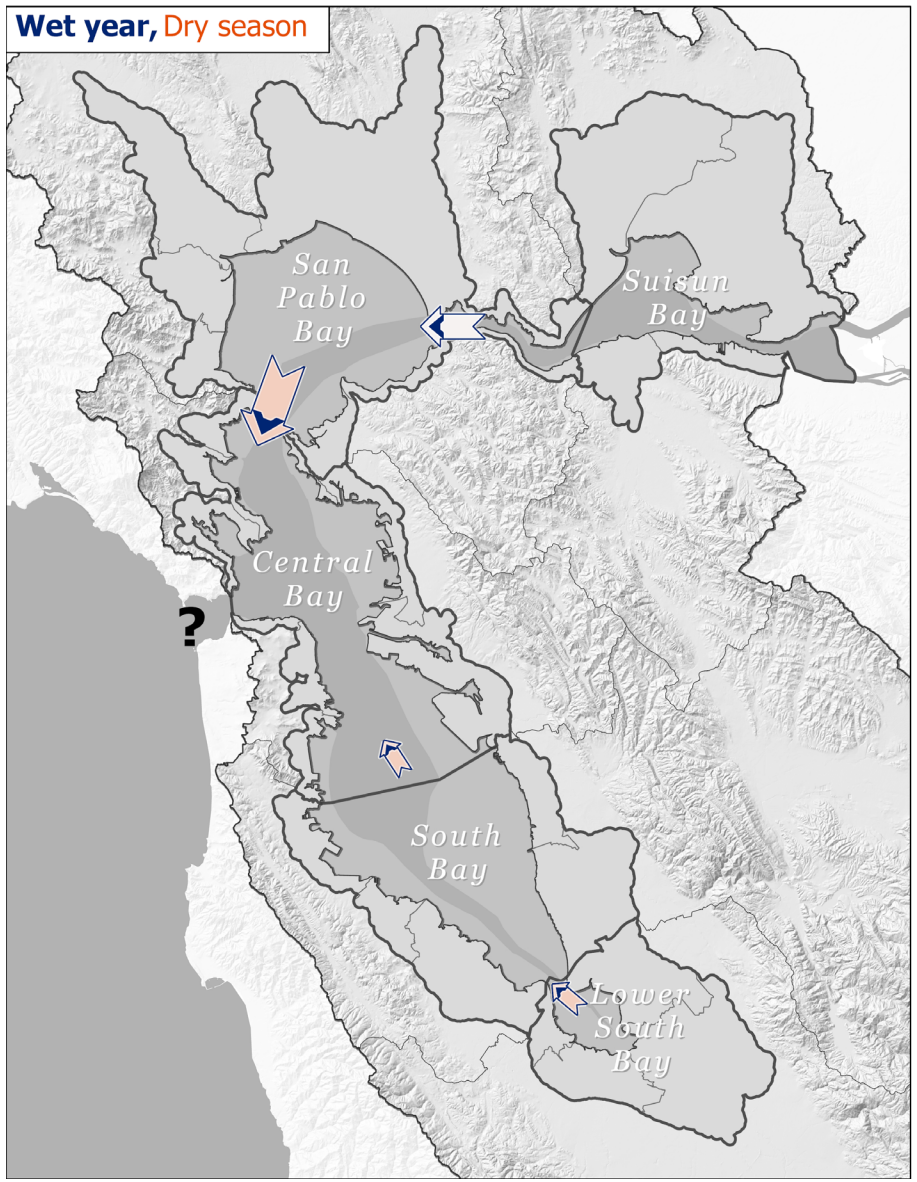
Schoellhamer, D. 2011

Current conditions (Avg. Net Flux) - **Wet Season**



SFEI, Fine Grain Sediment Conceptual Model, in preparation

Current conditions (Avg. Net Flux) - Dry Season



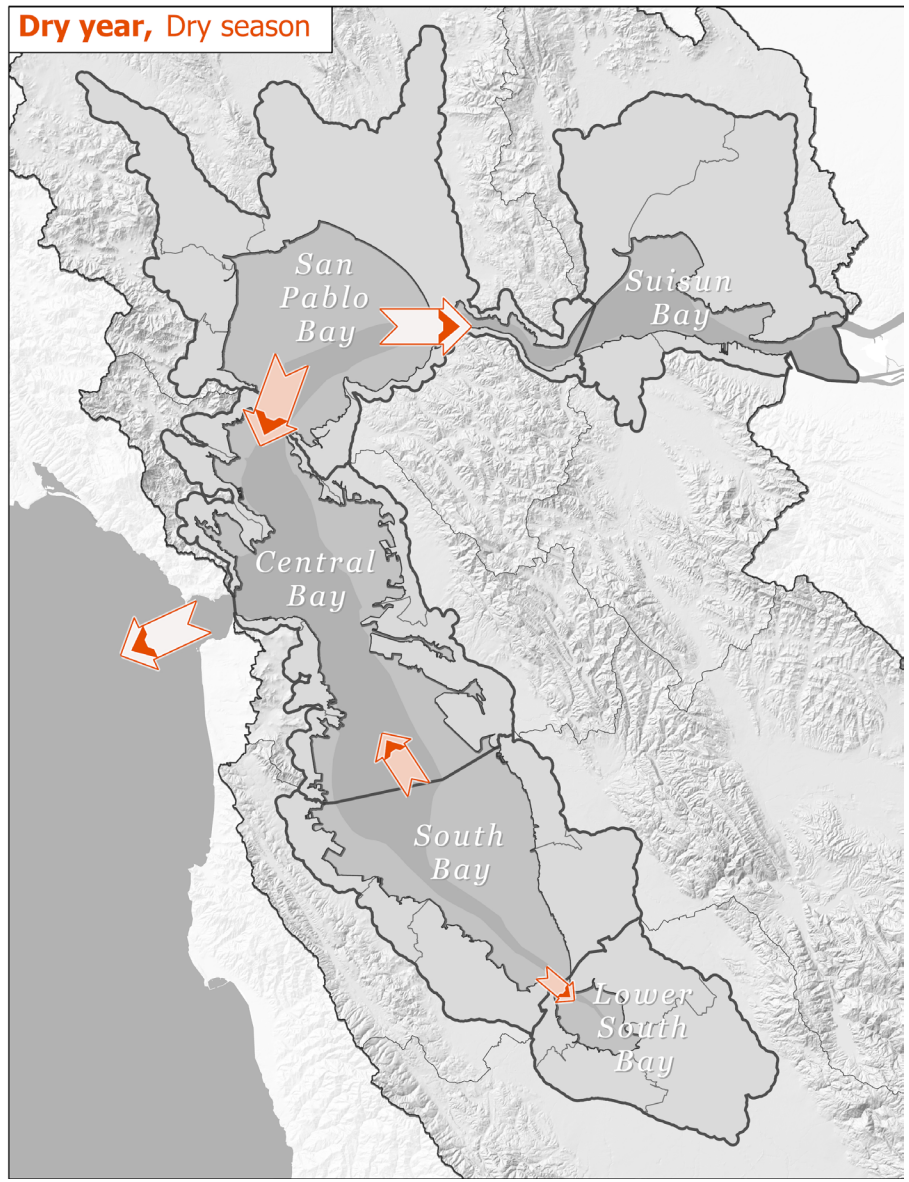
Subembayments & Golden Gate

Local Tributaries & Delta

2-9 Mt | 0.8-2 Mt | 0.3-0.8 Mt | 0.1-0.3 Mt | 0-0.1 Mt

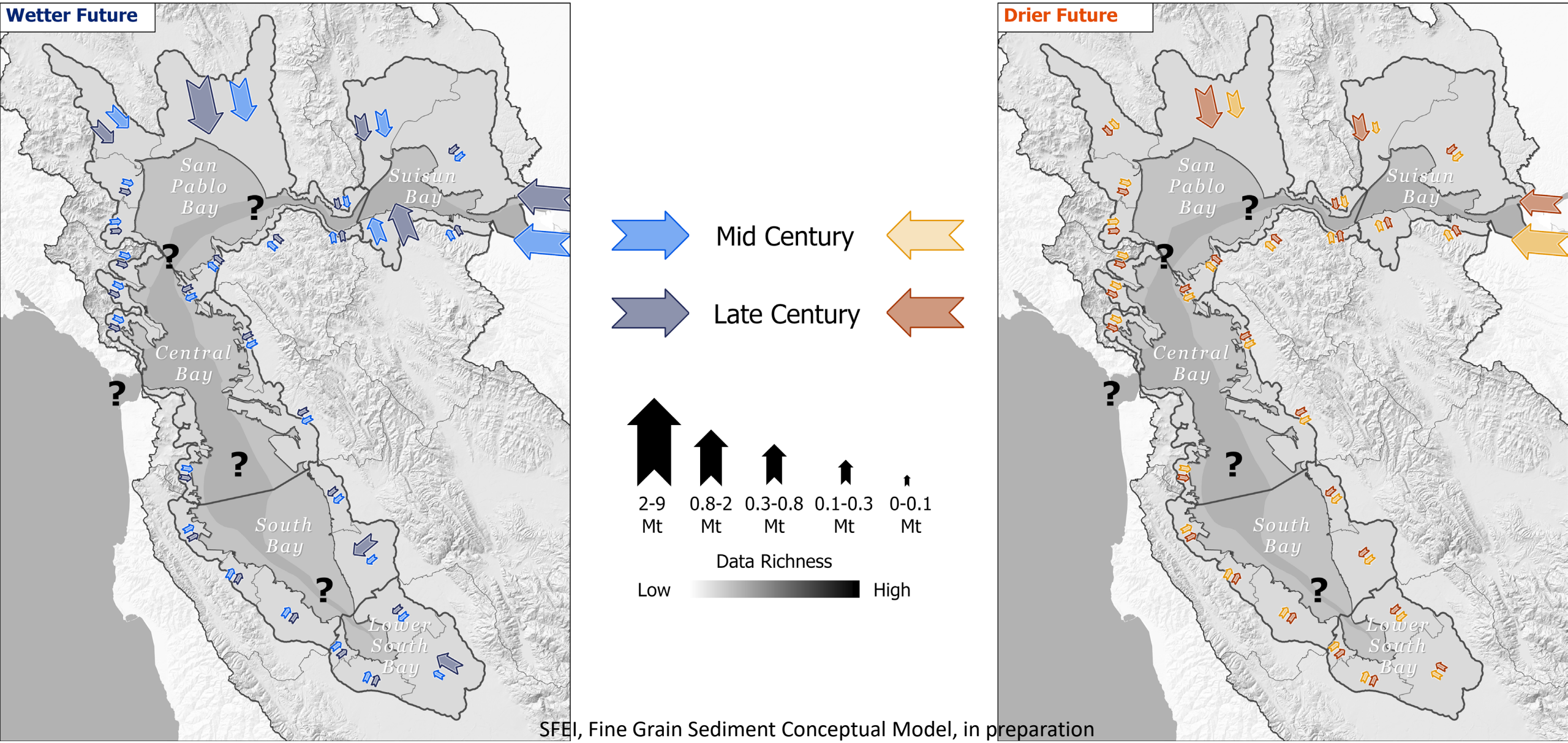
Data Richness

Low — High



SFEI, Fine Grain Sediment Conceptual Model, in preparation

Future conditions (Avg. Net Annual Flux)



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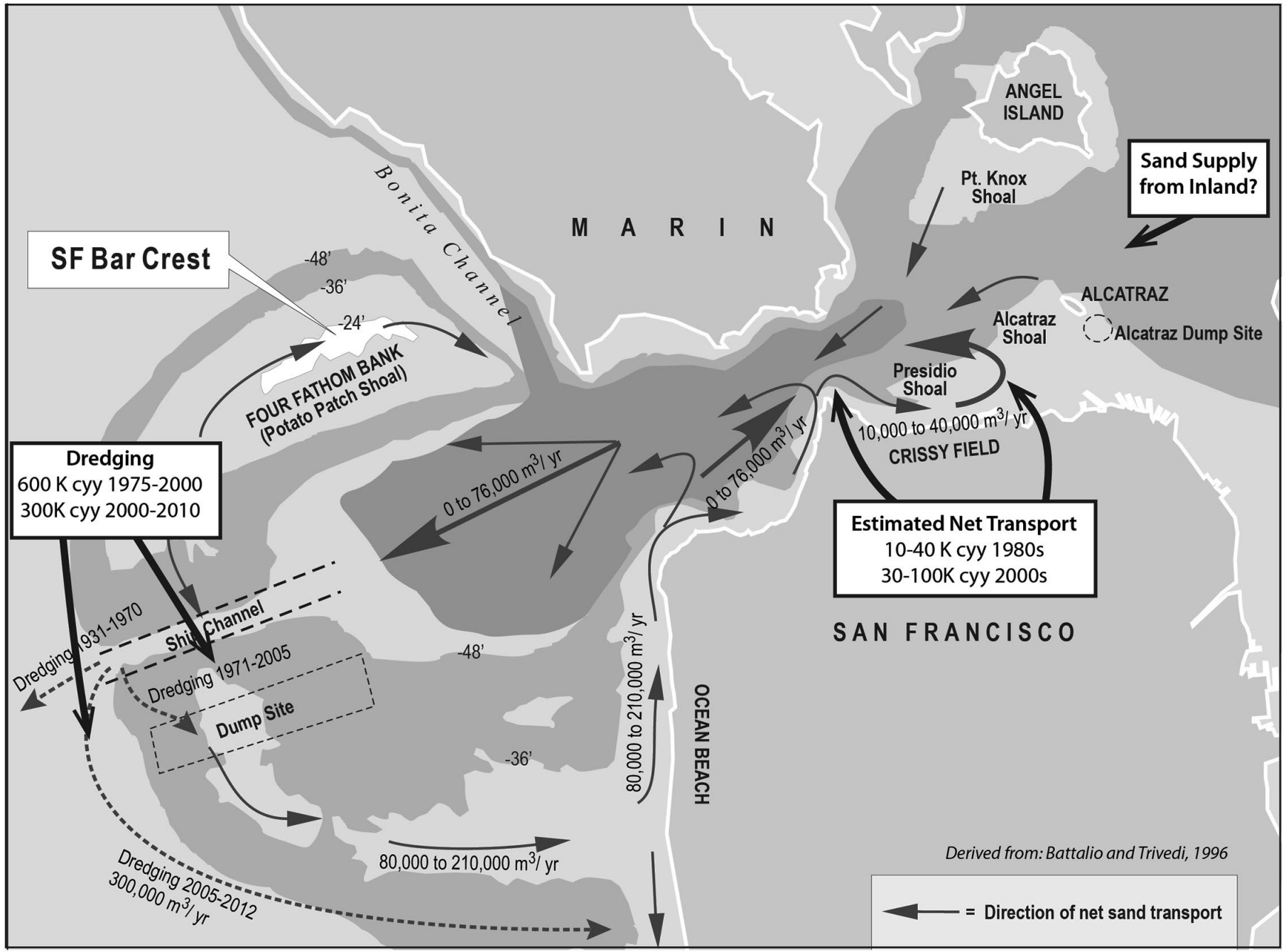
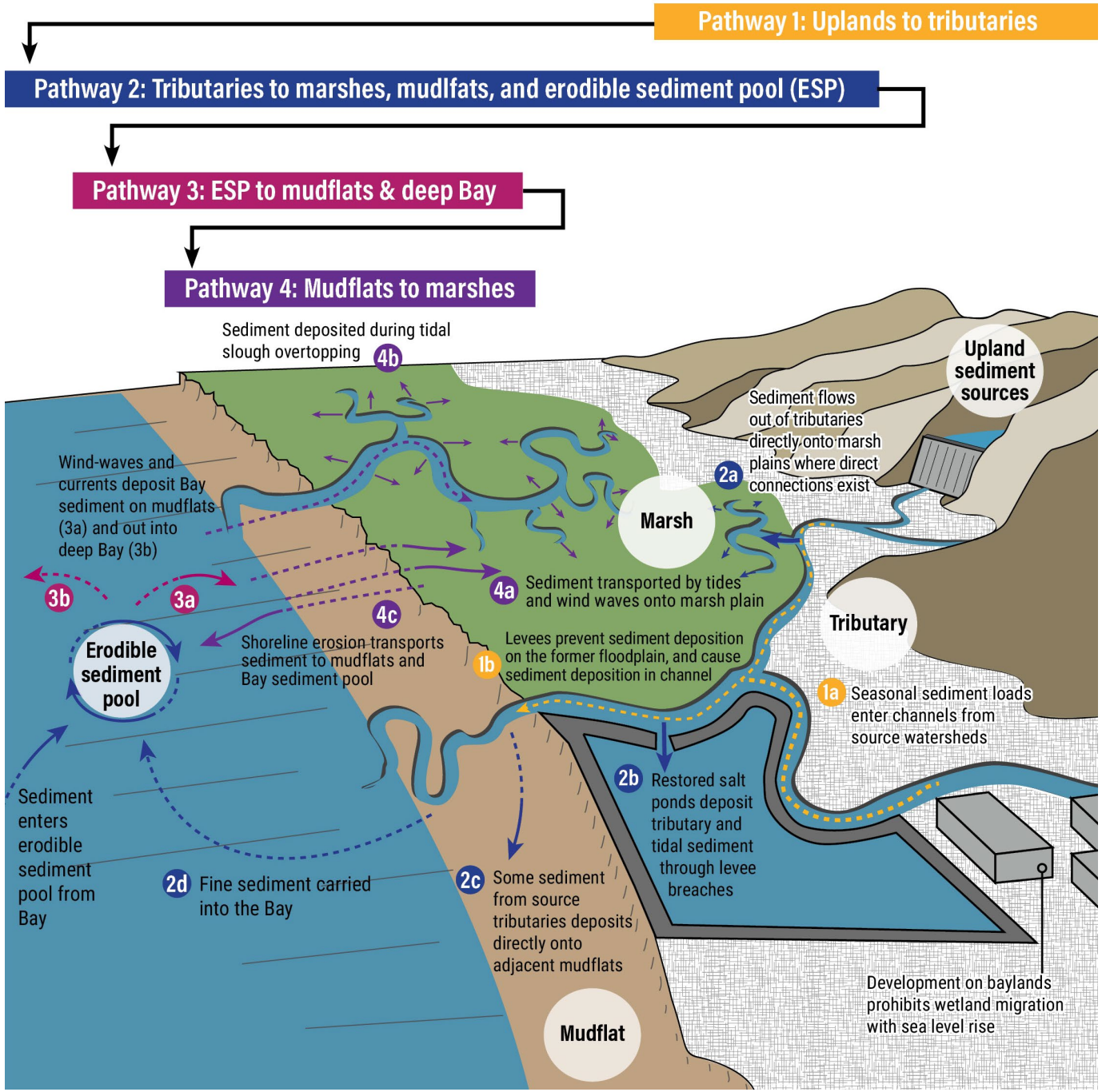


Battalio, B. 2014

Sediment Transport Mechanisms to Marshes



SFEI, Fine Grain Sediment Conceptual Model, in preparation

Sediment supply to San Francisco Bay salt marshes

Jessie Lacy USGS PCMSC

USGS science for a changing world

May 19, 2023

Salt marsh in San Francisco Bay

- Provides critical habitat to fish, birds, and plants
- Protects coastal communities and infrastructure by damping waves

Marshes and other shallow water habitats are particularly threatened by sea-level rise

Sediment accretion allows marshes to maintain elevation as sea level rises

The sediment that accumulates in marshes is a combination of organic matter, from plants, and mineral sediment

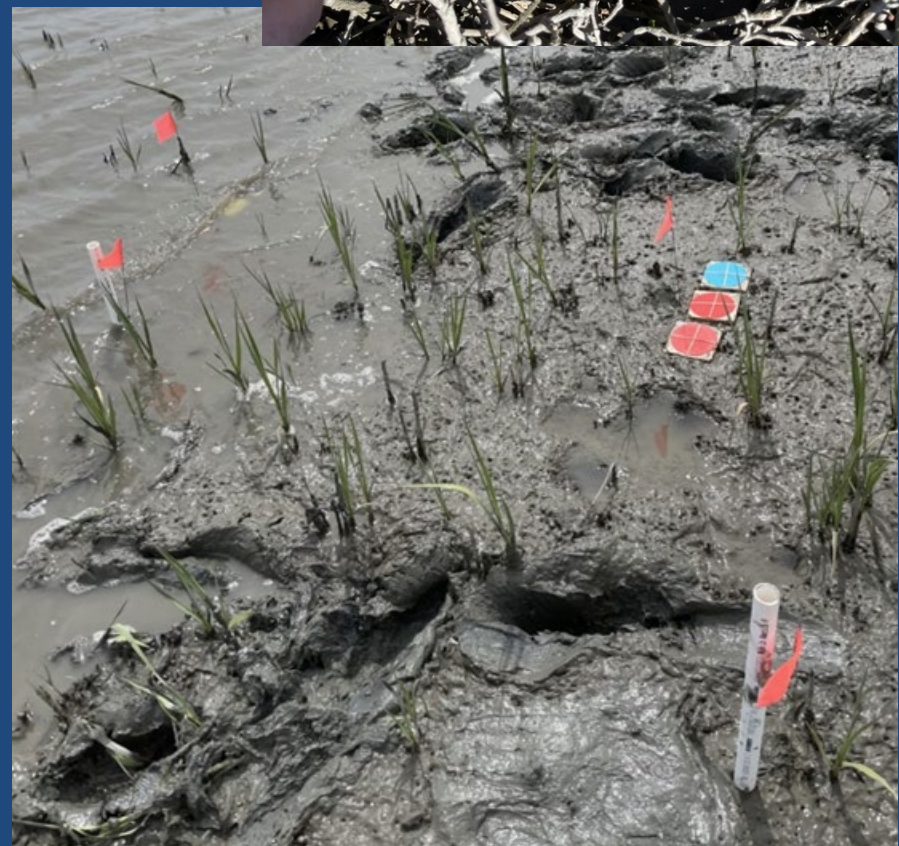
San Francisco Bay salt marsh sediment is predominately (~90%) mineral, originating from bay shallows or local tributaries

Particle size is very fine (mud)

Very few SF Bay marshes are still connected to local tributaries

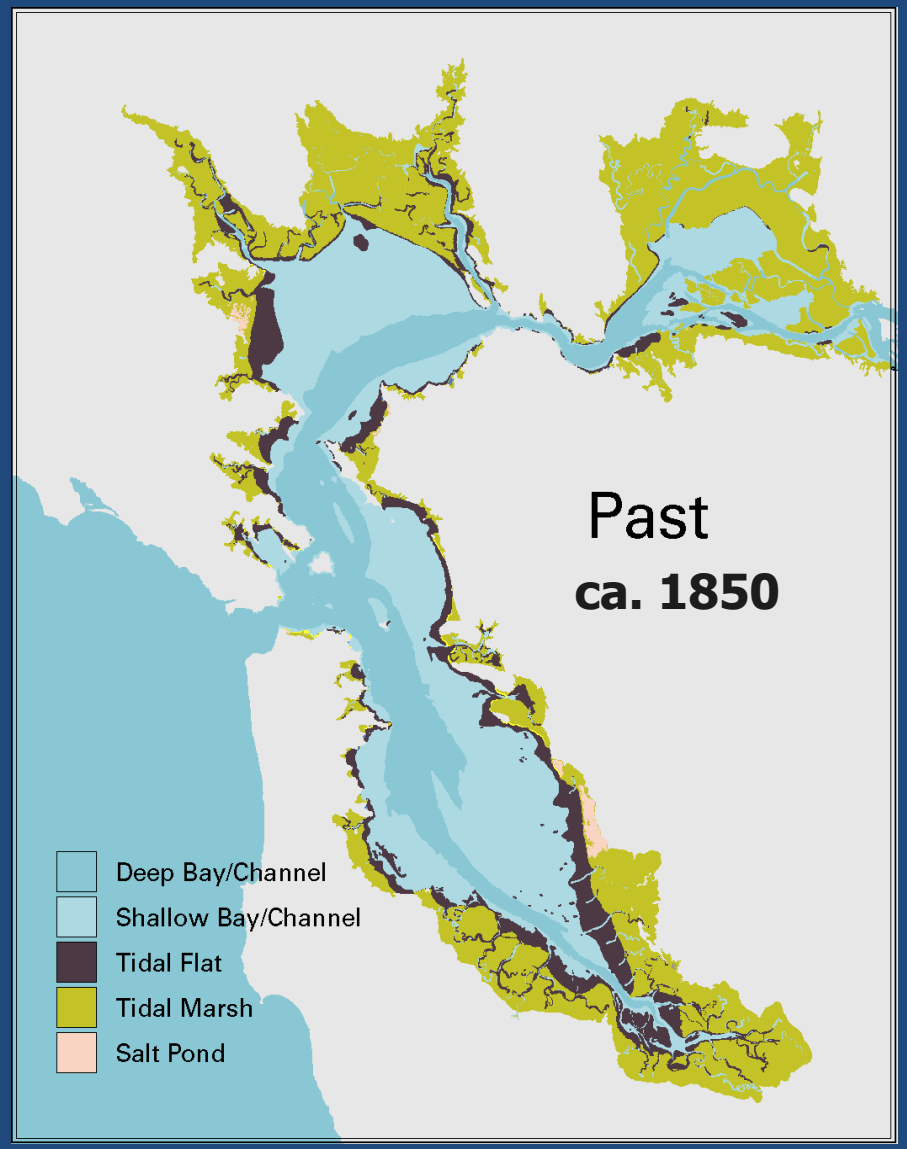
Bay sediment (mud) is crucial!!

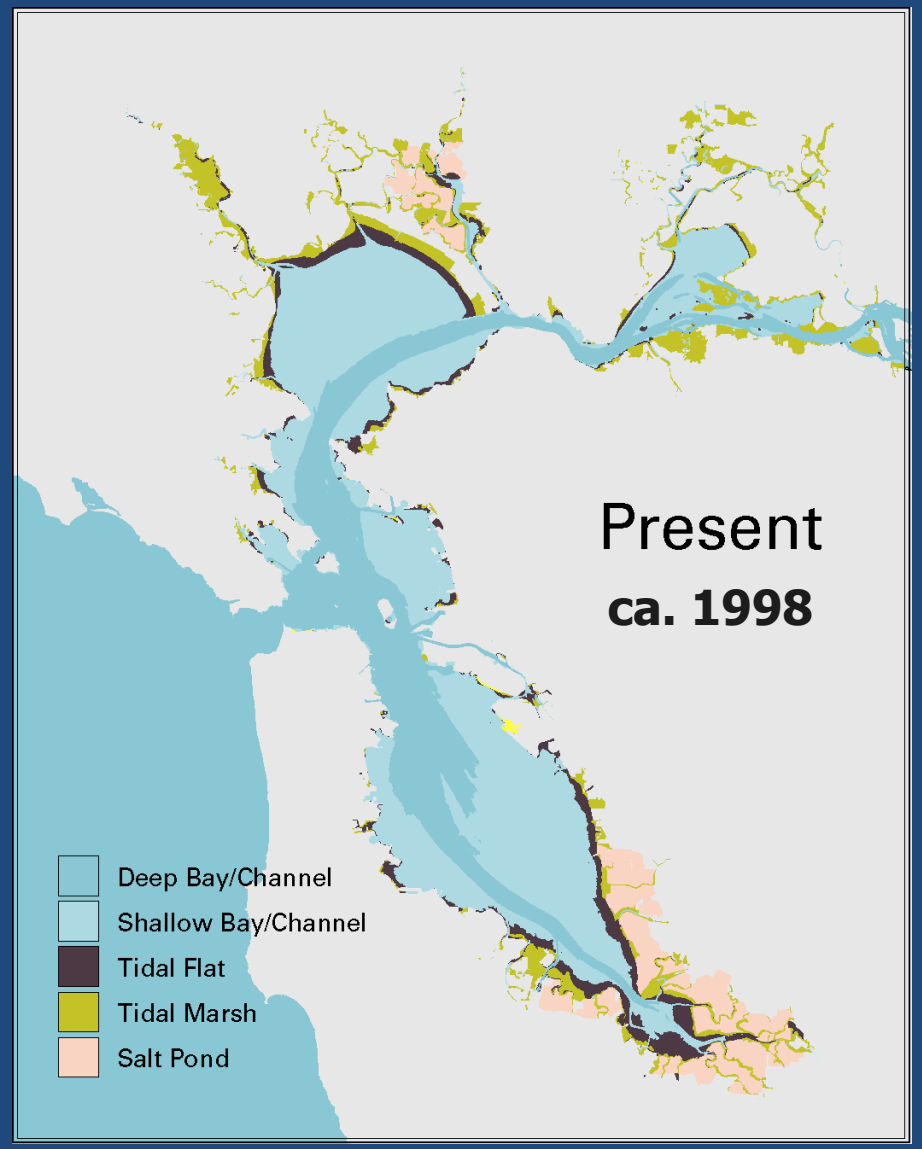
Sediment supply and SSC in the Bay is decreasing



In San Francisco Bay, 90% of tidal marsh was lost in the 19th and 20th centuries due to diking, draining, and filling

Large scale restoration now underway





15,100 acres
2003 acquisition

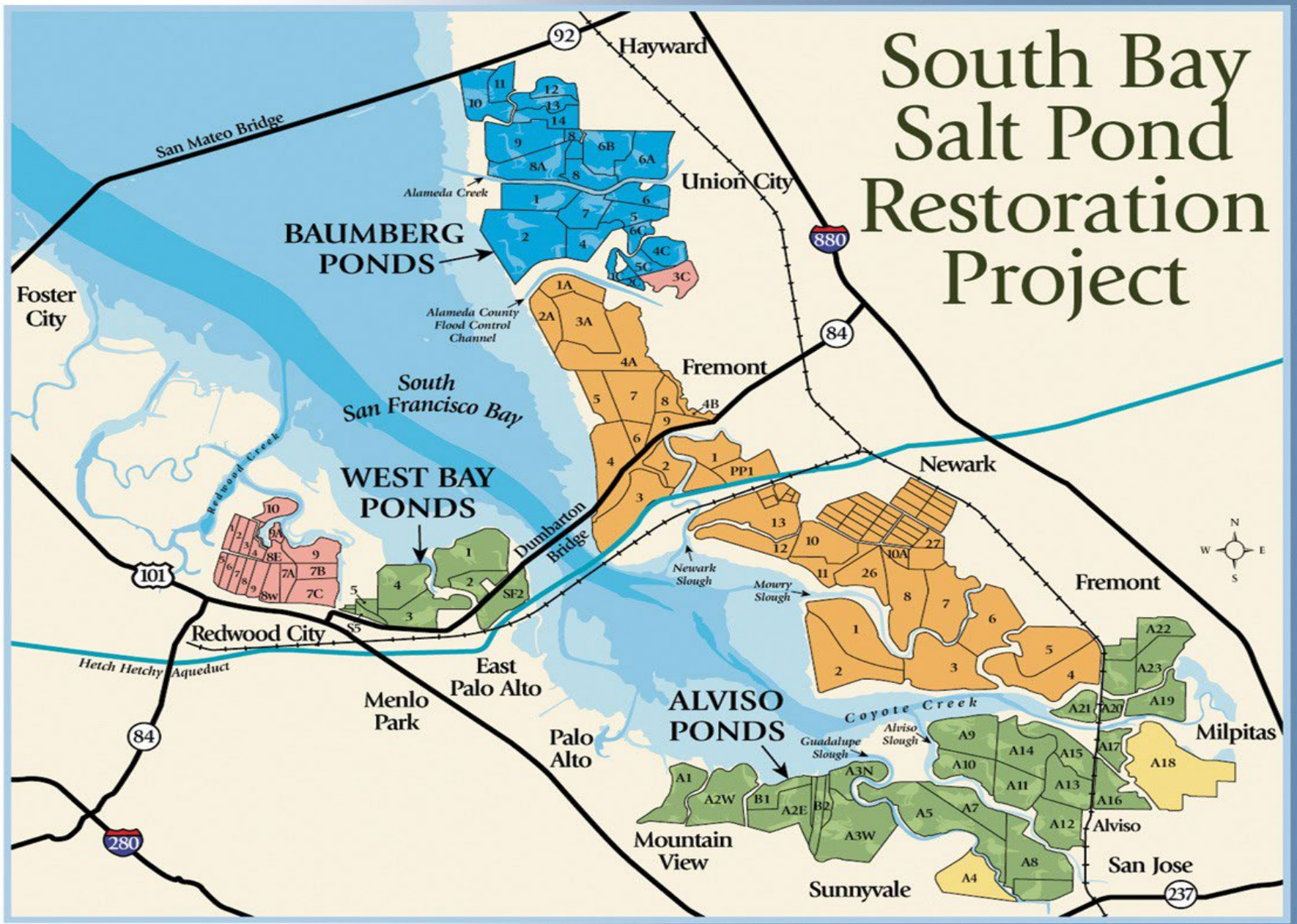
Goals

- Habitat restoration
- Flood protection
- Public access

Salt ponds are subsided

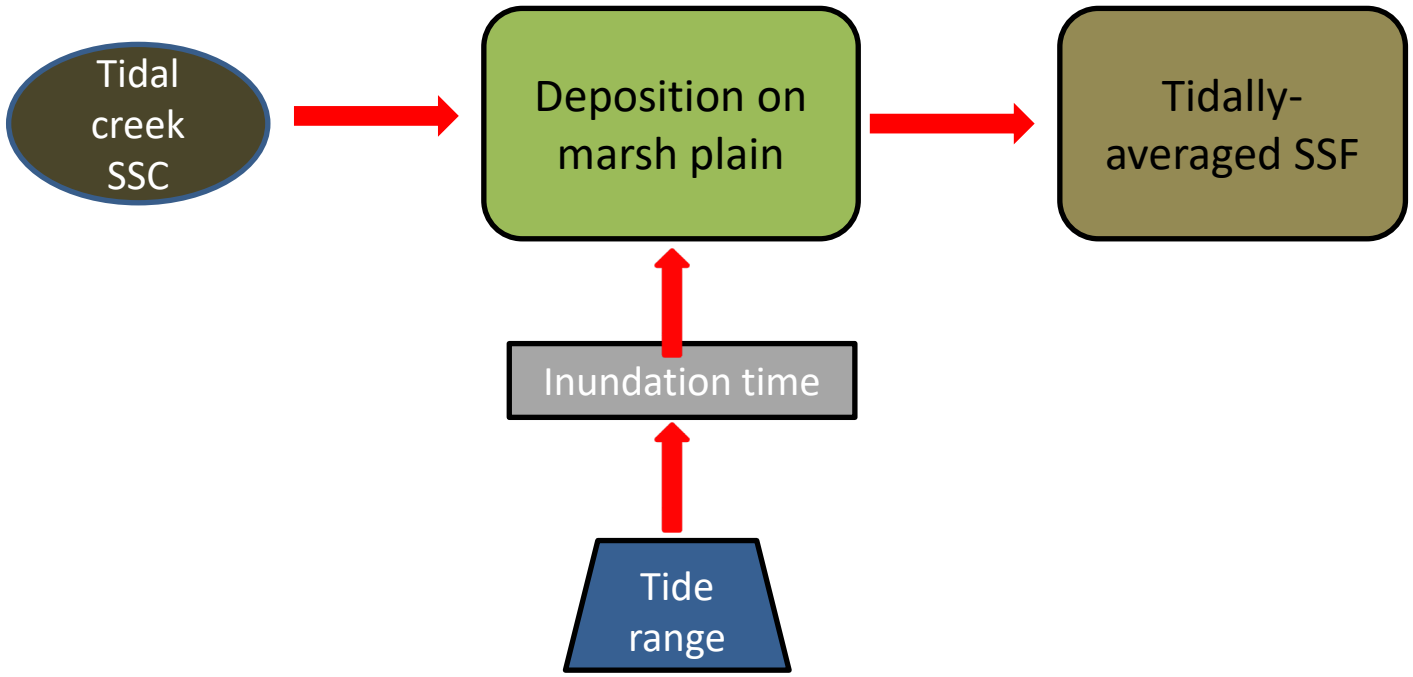
Accumulation has proceeded quickly

New sediment sink in the system




Suspended sediment from the Bay gets to marshes
• through tidal creeks
• across bay-marsh edge

Primary marsh supply process: sediment-laden water carried into marsh on flood tide, sediment settles out, and water with lower suspended-sediment concentration (SSC) exits during ebb tide.

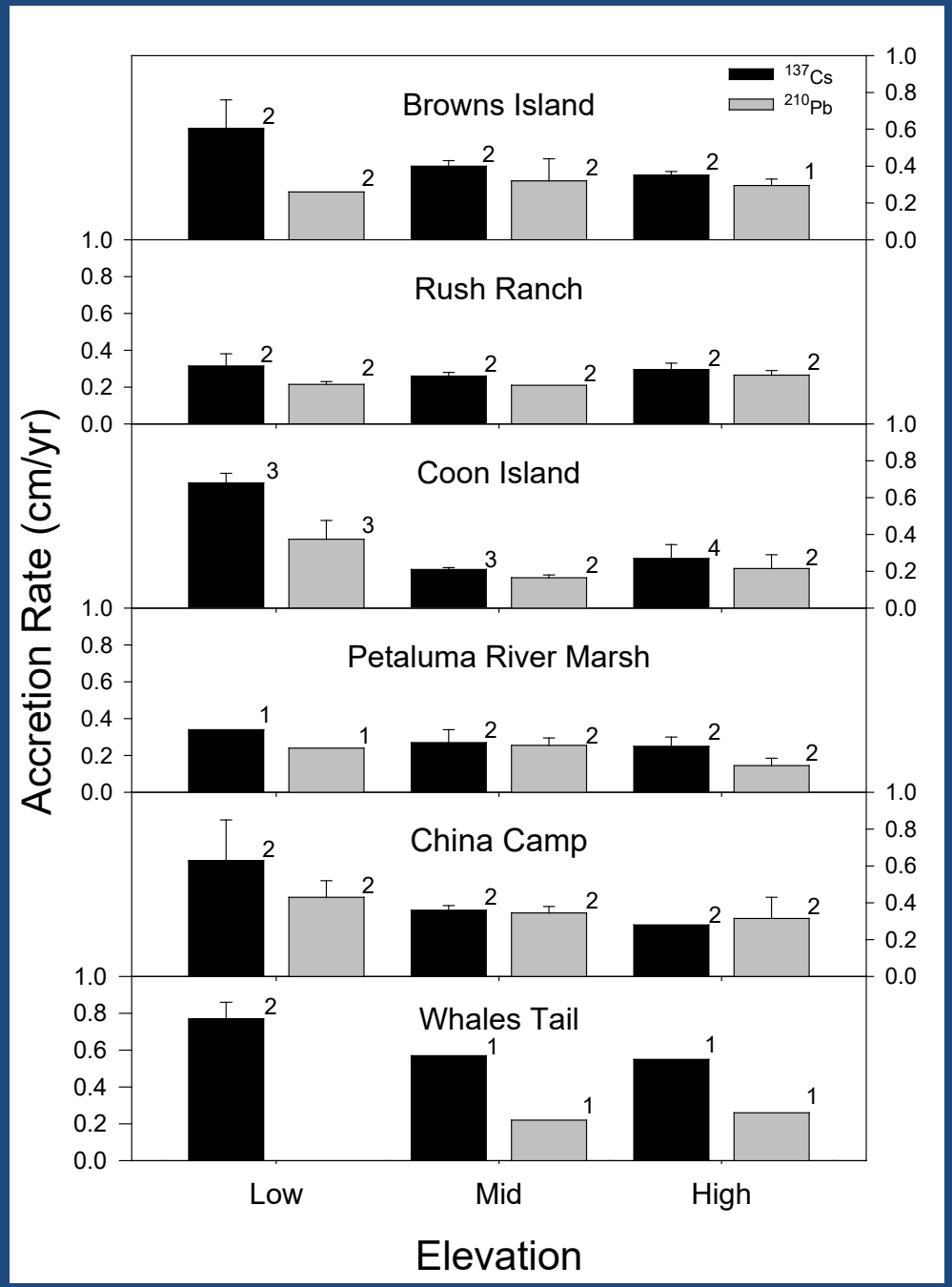


Accretion is typically greater at lower than higher elevations in a marsh

- San Francisco Bay tide range is about 2 to 2.5 m
- Salt marsh is relatively high in the tidal frame (close to MHHW).
- Marshes are only inundated for multiple hours during spring tides

King tides are important times for sediment delivery

China Camp marsh during King tides



Accretion in natural SF Bay marshes is more than adequate to keep up with recent sea-level rise (2 mm/yr)

- Average rates of accretion 2.9 – 6.3 mm/yr
- 37 dated cores using both ^{137}Cs and ^{210}Pb

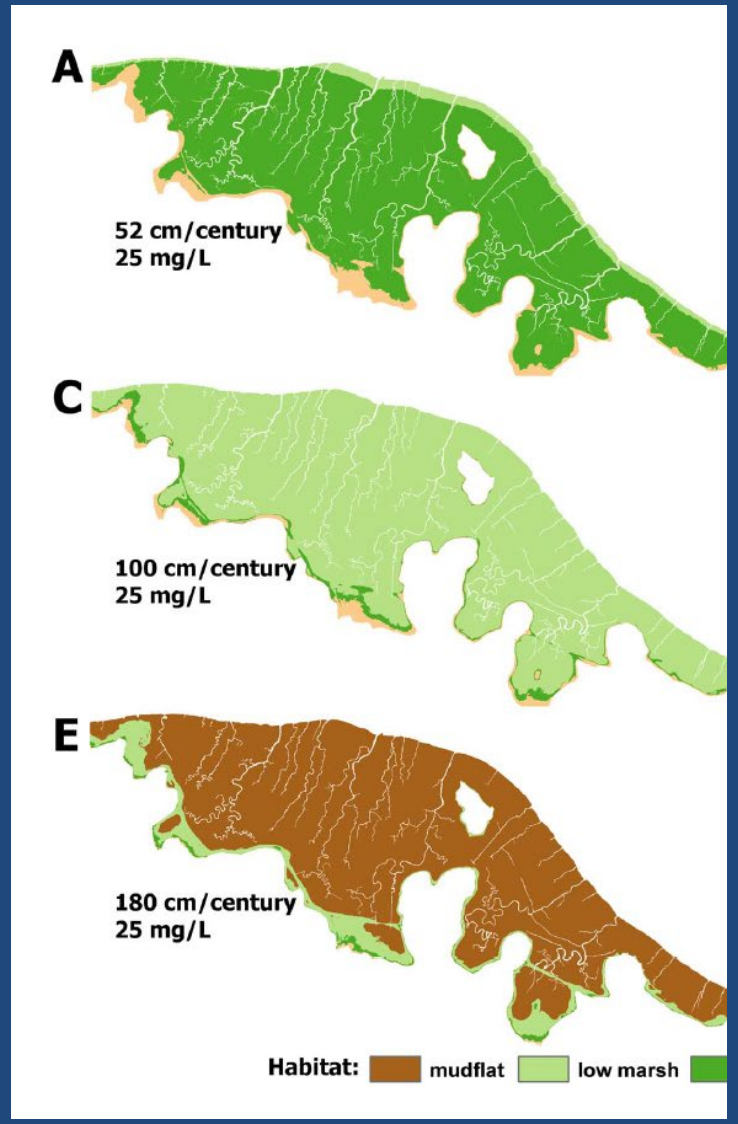
(Callaway et al., 2012)

As the rate of sea-level rise increases, accretion may not be able to keep pace, resulting in more inundation than marsh vegetation can tolerate: *marsh drowning.*

Elevation-based models of marsh evolution predict this process:

Indicate that many SF Bay marshes may be drowned by sea-level rise in the next century

Results depend strongly on
- rate of SLR
- magnitude of sediment supply



China Camp predictions, MEM
Schile et al. (2014)

Whale’s Tail marsh in South San Francisco Bay

Measuring lateral erosion

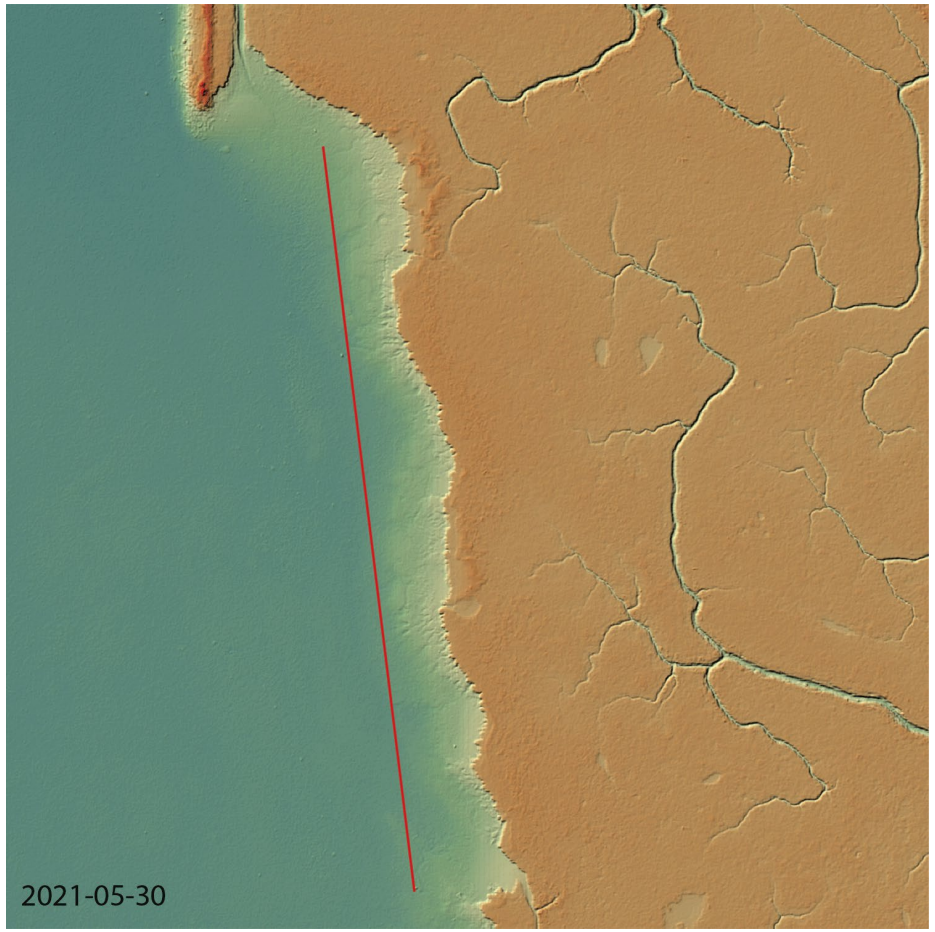
- Collected high-resolution imagery from an airplane at low tide
  - May 2021
  - Sept 2021
  - Nov 2021
  - Feb 2022
  - May 2022

- Created high-resolution (5cm pixel) digital surface models of the marsh using Structure-from-Motion (SfM) Photogrammetry

Ground control point

Orthographic image 02/10/2022

Marsh edge is clearly eroding



Time Period	Median Retreat Rate (m/yr)	% Marsh Erosional
May 2004 - May 2022 (~decadal)	-1.64	100
May 2021 - May 2022 (1 yr)	-1.46	95.2
May - Sep 2021 (summer)	-2.36	93.5
Sept - Nov 2021 (fall)	-0.35	60.4
Nov 2021 - Feb 2022 (winter)	-0.11	61.4
Feb - May 2022 (spring)	-1.81	94.0

Most erosion in spring and summer: season of daily sea breeze

At Whale's Tail, accretion on the marsh plain is also greater in summer than winter:

- Influence of summer wind waves on suspended sediment concentration in the shallows
- Eroded marsh edge is an additional source of sediment

Sea-level rise can increase marsh edge erosion: deeper water adjacent to the marsh edge allows larger waves to reach the edge

Results from China Camp and Whale's Tail marshes show clear temporal variation in deposition:

- Seasonal (summer > winter)
- Spring tides > neap tides
- Wavy > calm

These results can inform timing of restoration actions and choice of restoration sites

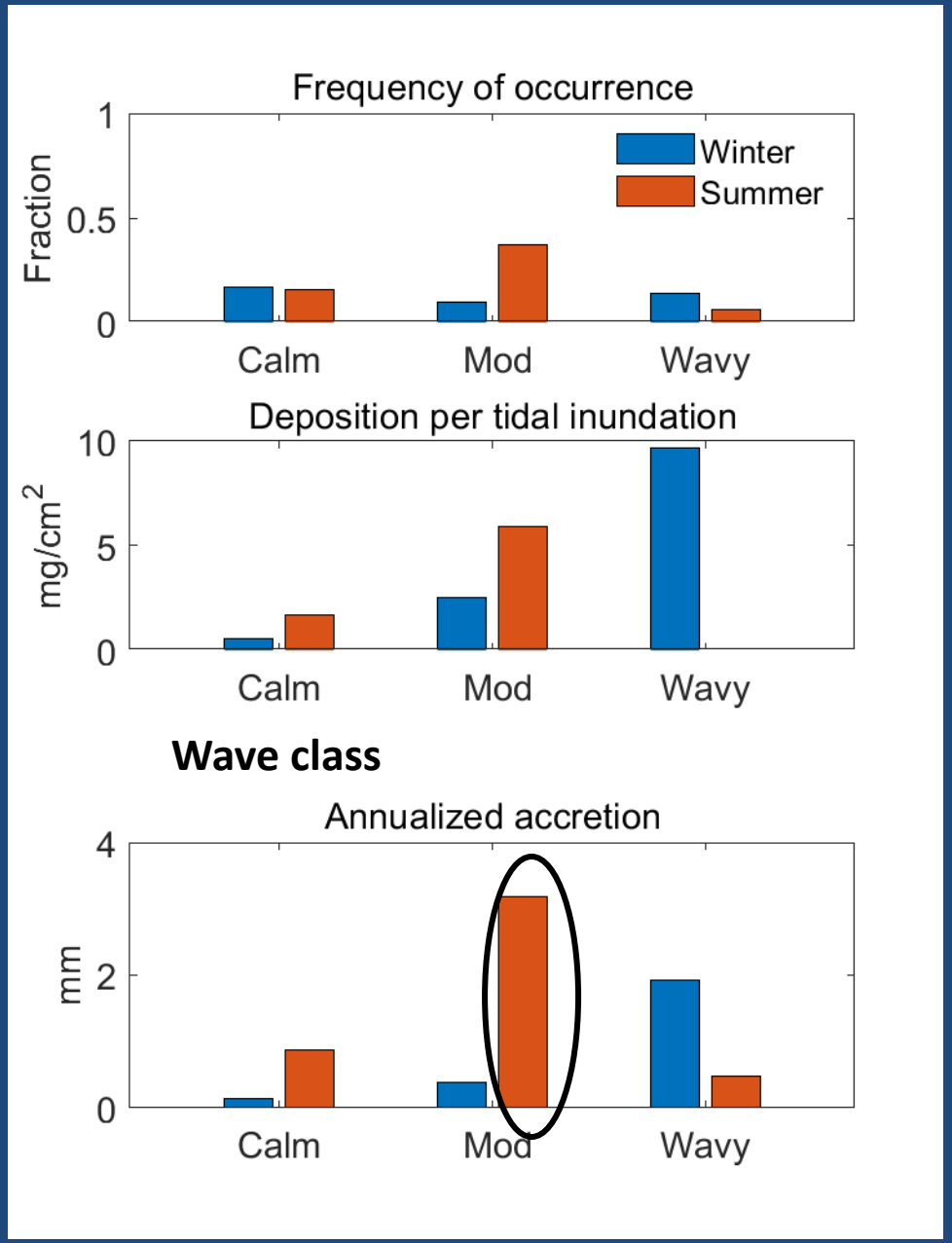
- *Upcoming Strategic Placement project*

How important is wave climate to deposition over the course of a year?

- Depends on frequency of occurrence as well as deposition for each wave class
- results for China Camp pickleweed segment

On an annual basis, moderate waves of summer contribute more to annual deposition than winter storms

Deposition inferred from spatial gradients in SSC

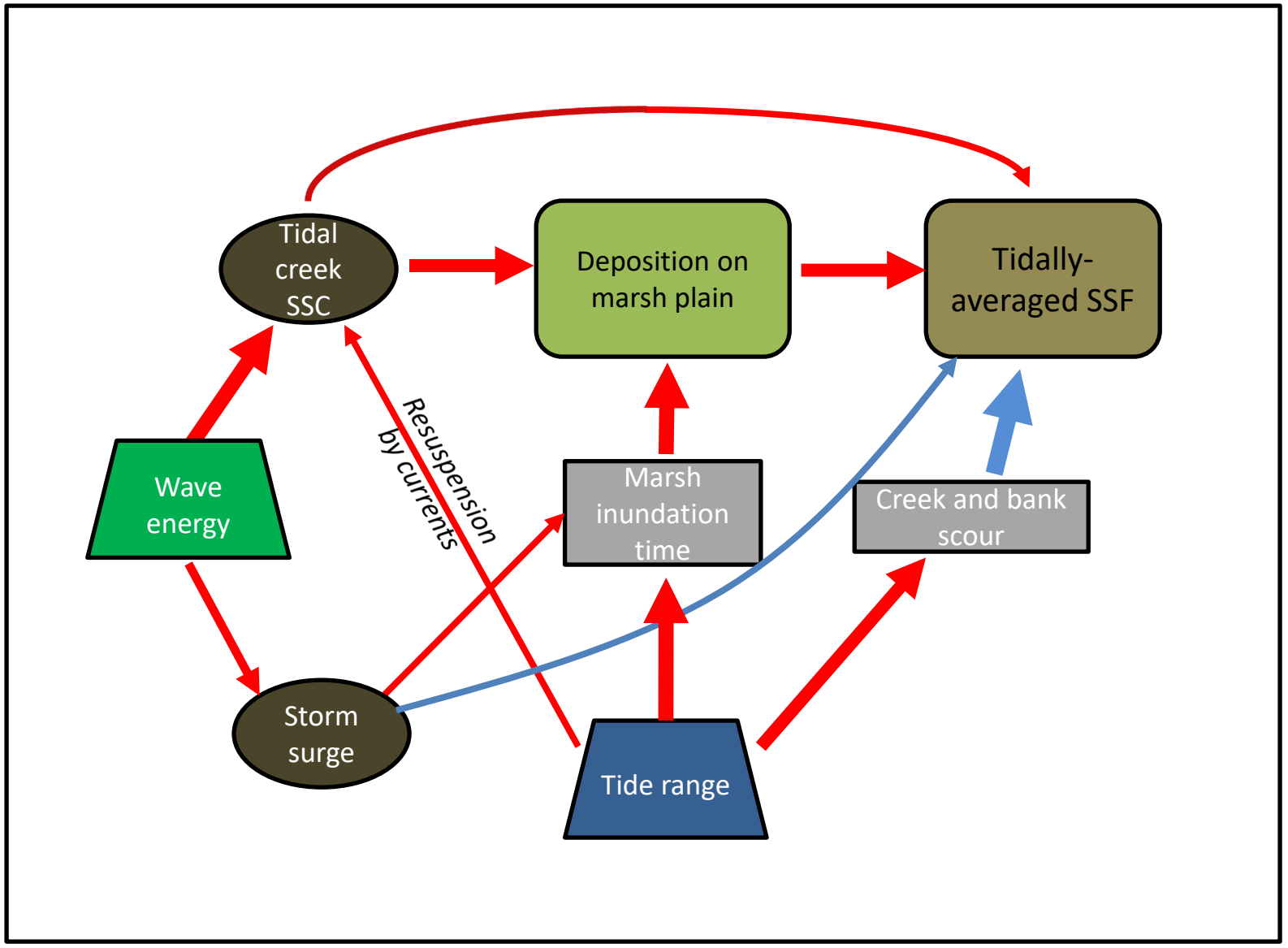


How important is supply across the marsh edge to the marsh sediment budget?

China Camp results:

~24 tons/yr of sediment delivery across 200 m of shoreline (distance between tidal creeks) within 60 m of the marsh edge.

~10 tons/month of import via tidal creeks during moderate tides and 30 to 40 tons of export during the largest spring tides of the year.



Sediment supply varies temporally with conditions in the Bay: tides and waves

SSC in bay shallows

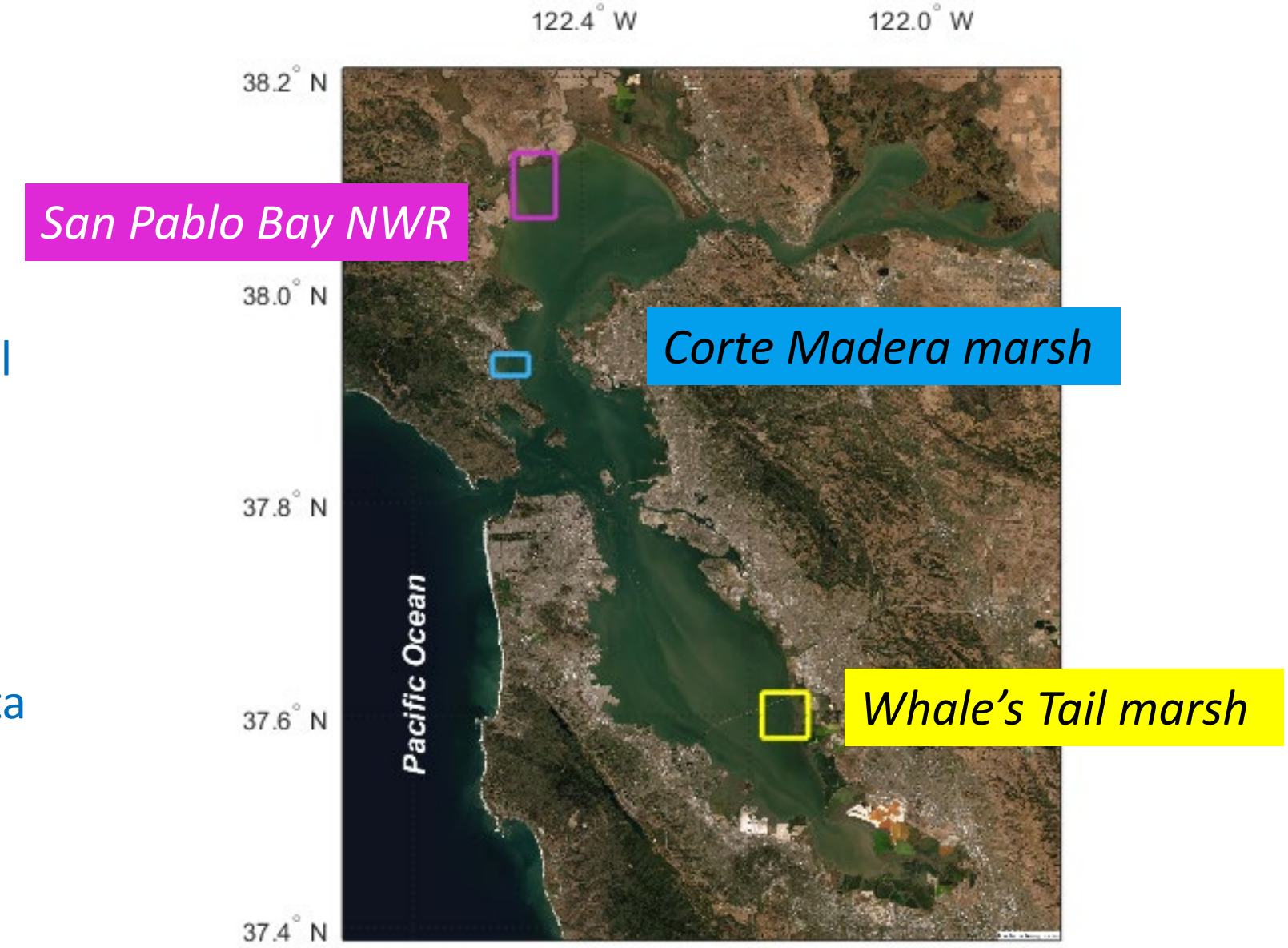
- SSC increases approaching shore
- SSC lower at high than low tide
- SSC increases with wave energy
- Waves account for greater percentage of bed shear stress in shallower water

Characterization of SSC as an input parameter to marsh models should reflect this temporal and spatial variability.

Magnitude and timing of sediment supply and erosion are expected to vary around the estuary, depending on

- Proximity to Delta and local sediment sources
- Wave exposure
- Marsh edge type
- Vegetation type

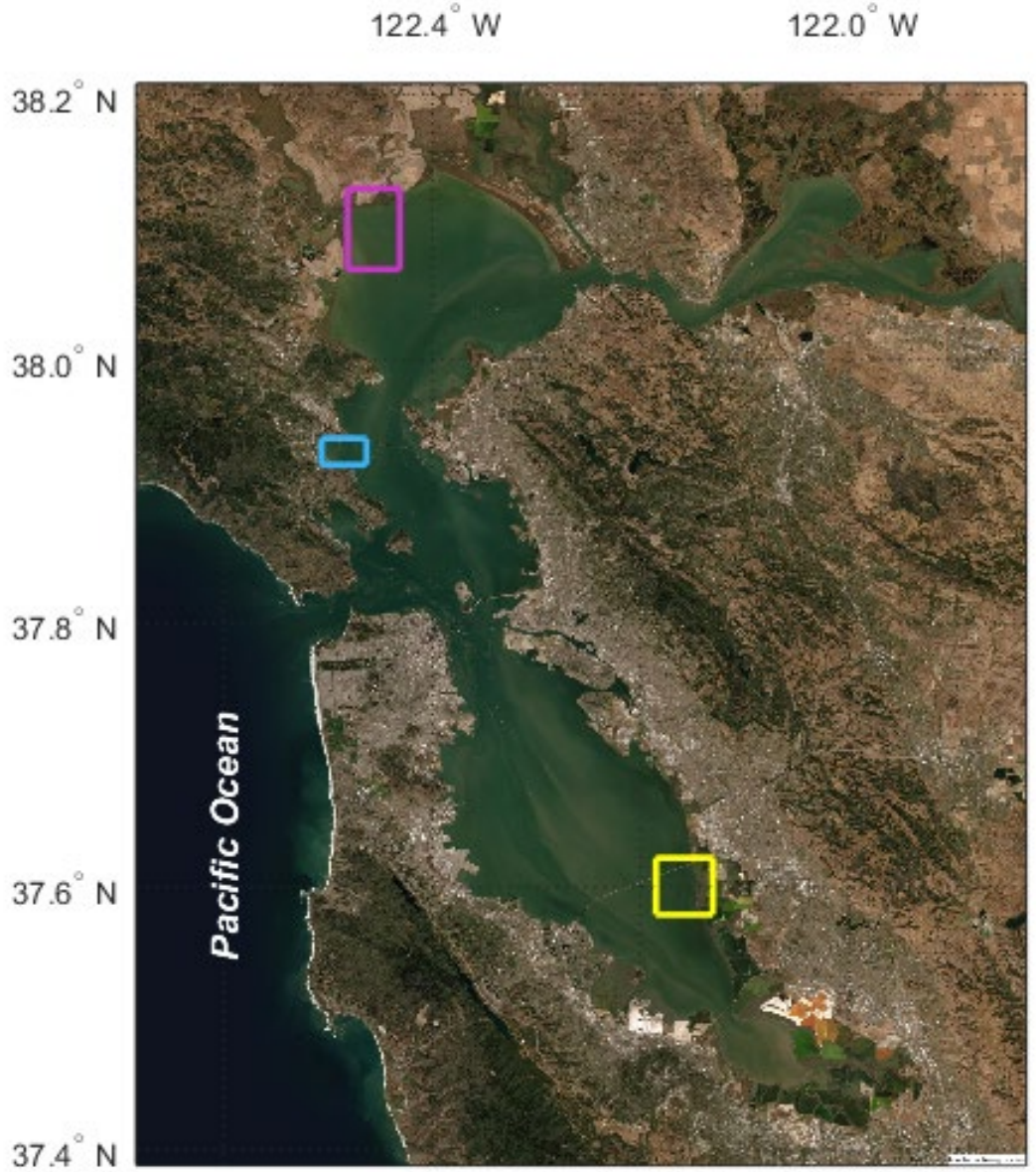
In spring 2022, we started data collection at two more sites (*2022/23 RMP special study*).



Ramped edge, fringing Spartina

Scarped edge ~0.5 m

Scarped edge 1-2 m



Conclusions

Salt marshes must accrete sediment to stay healthy as sea level rises

Primary source is Bay mud, passively transported by tidal inundation

Most SF Bay marshes are keeping up with SLR so far

Marsh loss can occur through drowning or edge erosion

Sediment delivery to marshes varies

- temporally with tide and wave conditions in the Bay
- spatially, based on proximity to sediment sources and other factors


Questions?

Stakeholder Process

Sediment and Beneficial Reuse Project

May 19, 2023

Maya McInerney

San Francisco Bay Conservation and Development Commission

San Francisco Bay Regional Sediment Management

Stakeholder Process

- Identify stakeholders
  - Create email distribution list for stakeholders and interested parties
  - Stakeholder information gathering
- Develop communication strategy
  - Meeting notices
  - Project update/engagement emails

Stakeholder Name
How much does the project affect them? (1,2,3)
What is their most important goal?
How will they contribute?
Best way to manage
Frequency
Comments
Contact info

Stakeholder Process (Continued)

- Pre-workshop meetings with stakeholders
  - Develop outreach presentation
  - Engage with organizations ahead of workshop
- Develop background materials/issue papers
  - Project overview
  - Specific beneficial reuse topics
- Post-workshop meetings with stakeholders
  - Review responsibilities and commitments identified during workshop

Stakeholders

Who's missing?

Federal Government Organizations:
U.S. Army Corps of Engineers
U.S. EPA
NOAA
USGS
U.S. Fish and Wildlife
National Parks Service

State Government Agencies:
California Dept. of Fish and Wildlife
California State Coastal Conservancy
California State Lands Commission
California Coastal Commission
State Water Board
California State Parks
CA Dept. of Boating and Waterways (CSMW)

Regional Government Organizations:
Regional Water Board
SF Bay Conservation and Development Commission

Local Government Agencies:
Cities
Counties
Special Districts (Sanitary/Recreation/etc.)
One Shoreline
Streambed Maintenance Programs
Groundwater Sustainability Agencies

Flood Protection Agencies:
Local Flood Protection Agencies
Bay Area Flood Protection Agencies Assoc.
CHARG

Bay Planning Coalition:
Industry
Sand Miners
Dredgers

Dredgers (not part of Bay Planning Coalition):
Navigation
Permit-holders/Contractors
Dept. of Boating and Waterways

Consultants:
Dredging
Sediment/Water Quality
Restoration

Restoration Community:
SF Bay Restoration Authority
SF Bay Joint Venture
Bay Area Refuges
Refuge/Restoration Non-Profits

Regional Organizations:
San Francisco Estuary Partnership
San Francisco Estuary Authority
San Francisco Estuary Institute
SF Bay Natl Estuarine Research Reserve
SAFER Bay (JPA)
SF Bay Restoration Authority

Non-restoration Non-profits:
Save the Bay
Audubon Society
Nature Conservancy
Sierra Club
Environmental / Social Justice
Community Organizations
San Francisco Baykeeper

Discussion

- What would you add to the communication strategy?
- What changes would you make to the stakeholder list?

Photo: Courtesy of King Tides Project