Natural and Nature-Based Features (NNBF) Symposium, Santa Cruz, LA

Strategic Sediment Placement in San Francisco Bay

Jeremy Lowe[1]

Jamil Ibrahim[2], Amy Richey[1], Tom Cancienne II[2], Tasmin Brown[2], and Craig Conner[3]

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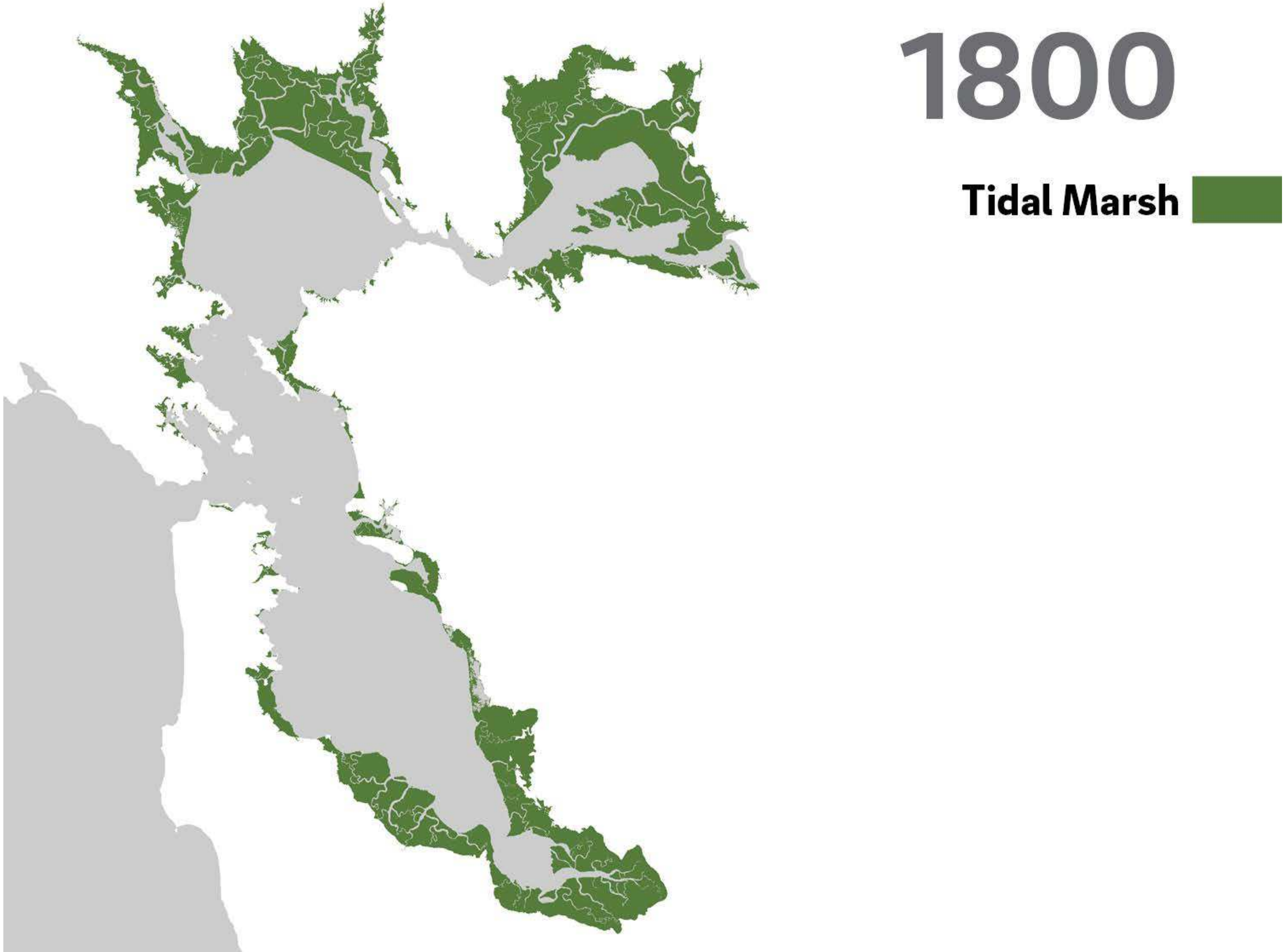
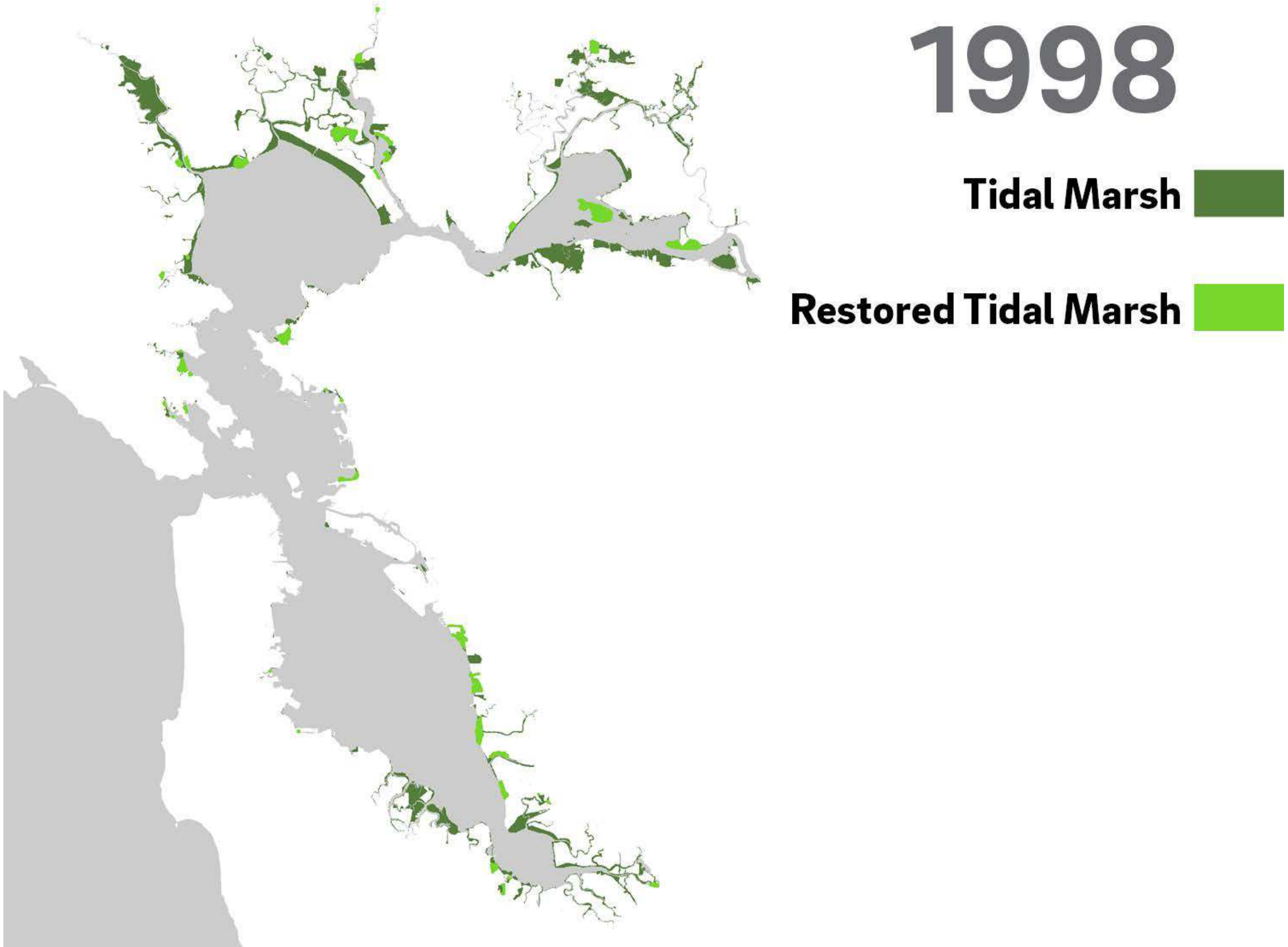
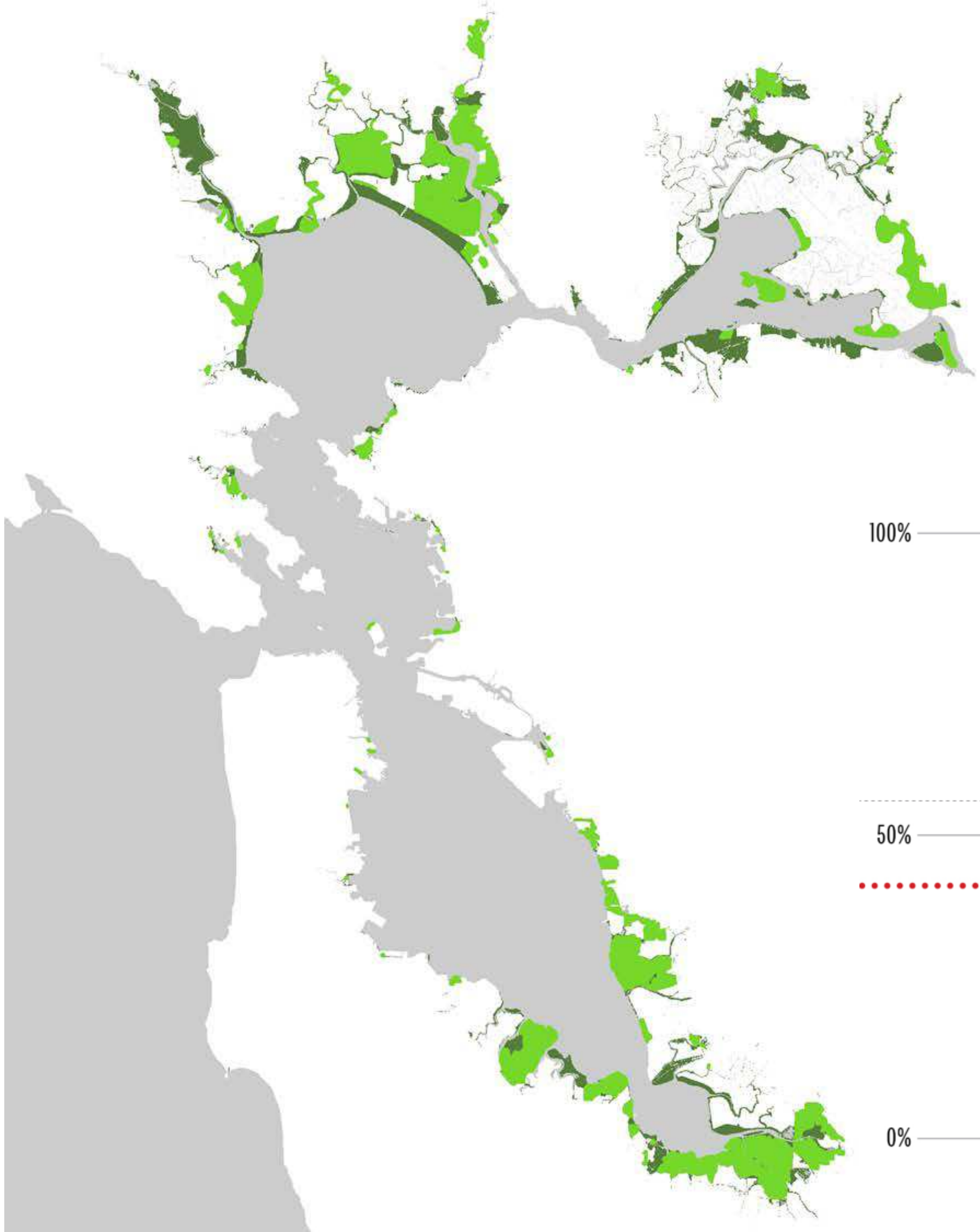
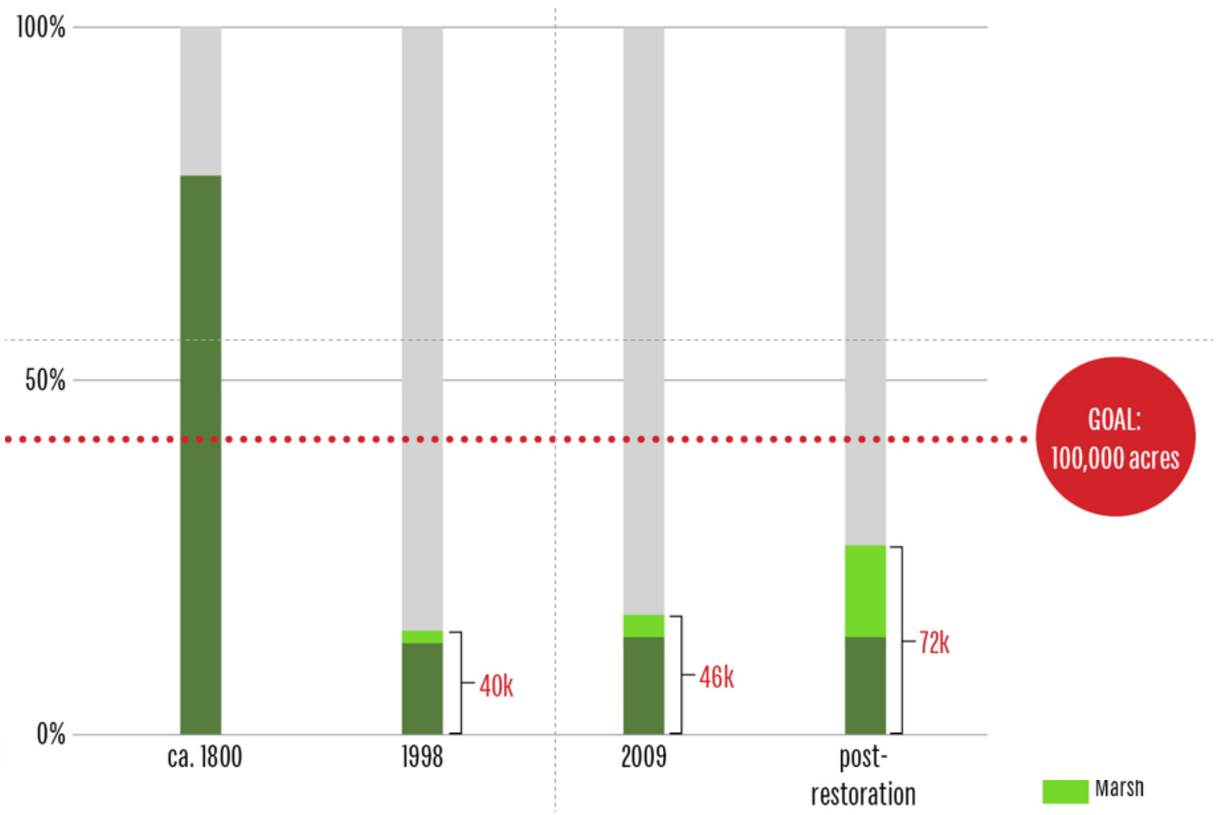

1800
Tidal Marsh


1998
Tidal Marsh
Restored Tidal Marsh

FUTURE



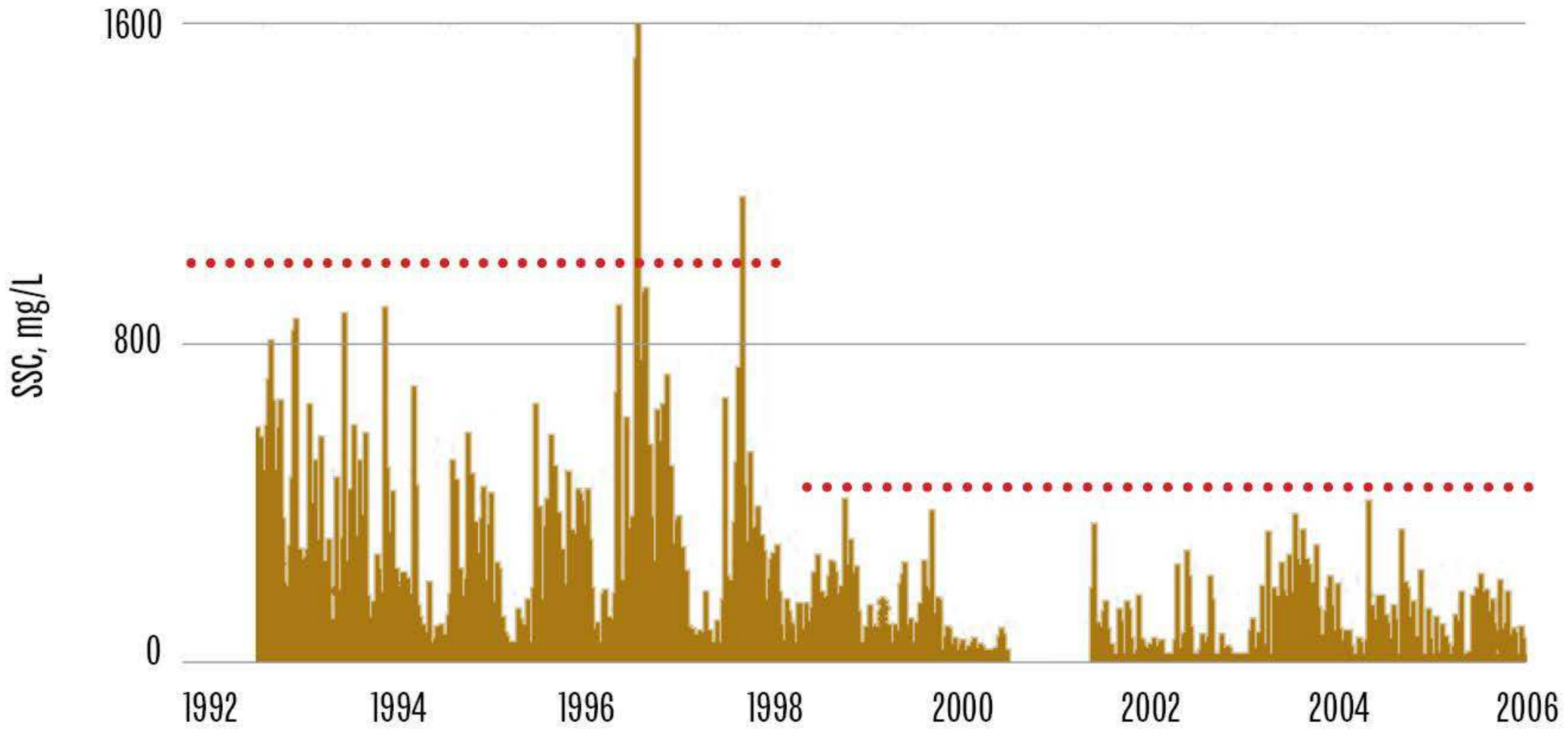
Tidal Marsh
Restored Tidal Marsh



100%
50%
0%
GOAL:
100,000 acres
40k
46k
72k
ca. 1800
1998
2009
post-
restoration
Marsh

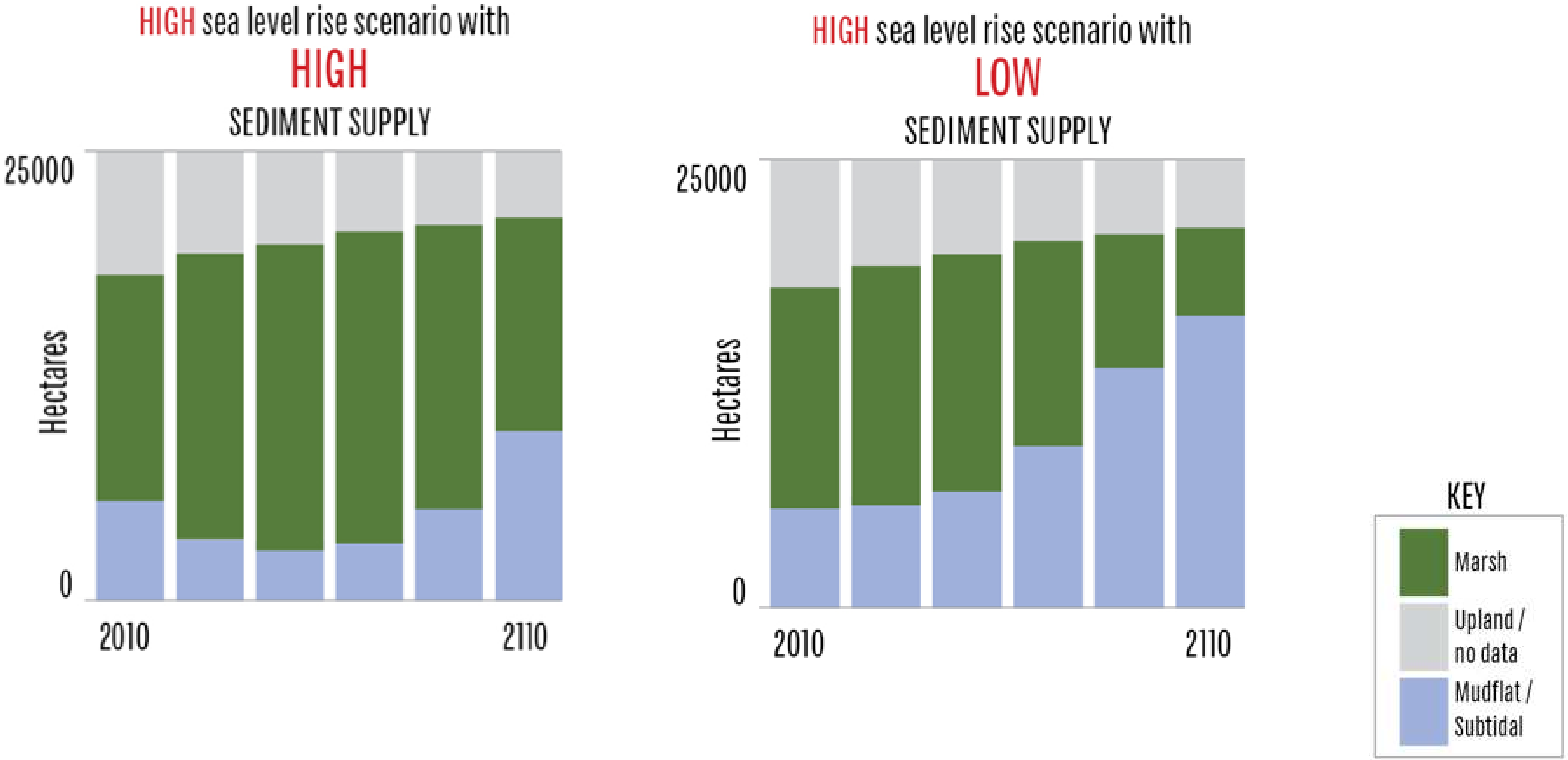
SEDIMENT SUPPLY *reduction*

Courtesy
Dave Schoelhamer
2011

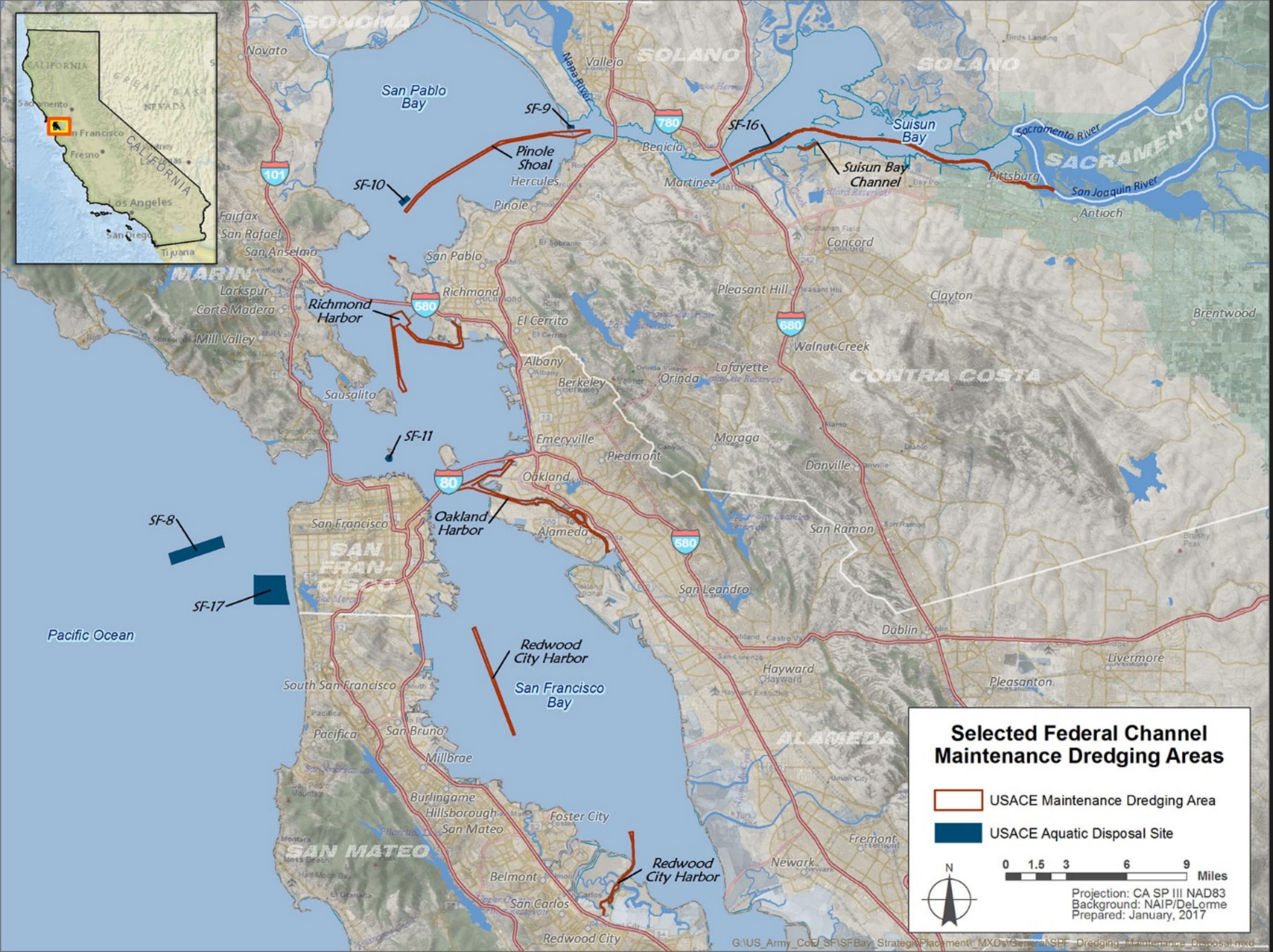


THE FUTURE OF MARSHES DEPENDS ON *sediment supply*

Courtesy Stralberg et al. 2011



Federal Maintenance Dredging and Disposal Areas



Problems and Opportunities

A change in sediment regime, anticipated sea-level rise, and localized erosion could slow restoration efforts and lead to a long-term loss of mudflats and marshes in San Francisco Bay.

Strategic placement techniques may offer one of many possible solutions to the problem of losing mudflats and marshes.

Purpose of Framework

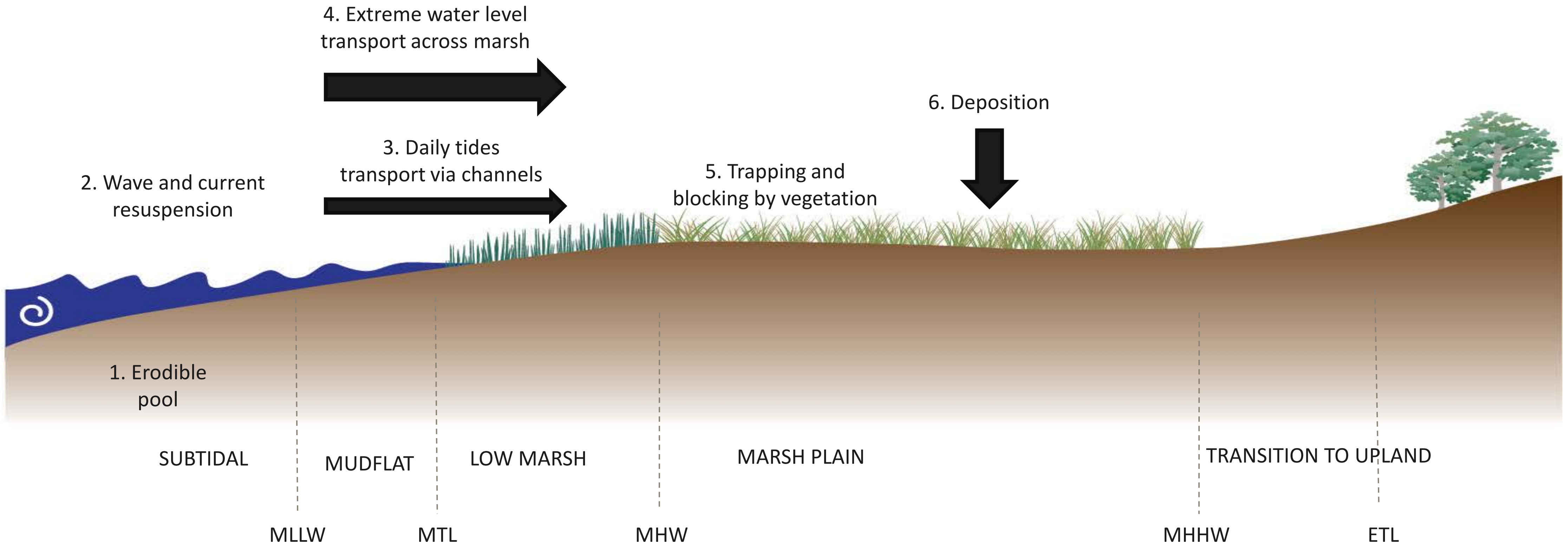
- Review effectiveness and feasibility of the methods for beneficial reuse
- Outline the potential beneficial and adverse effects these methods may have on habitats and biota
- Outline the logistical, regulatory, and equipment needs these approaches would require
- Identify unknowns needing research to reduce uncertainties

Development of Framework

- Two workshops to elicit ideas of stakeholders in engineering, science, dredging, and regulatory communities
- Discussions with individual stakeholders to ID needs and challenges of methods and proposed pilot study
- Independent Review Panel input/comments on early drafts

Thank you to:

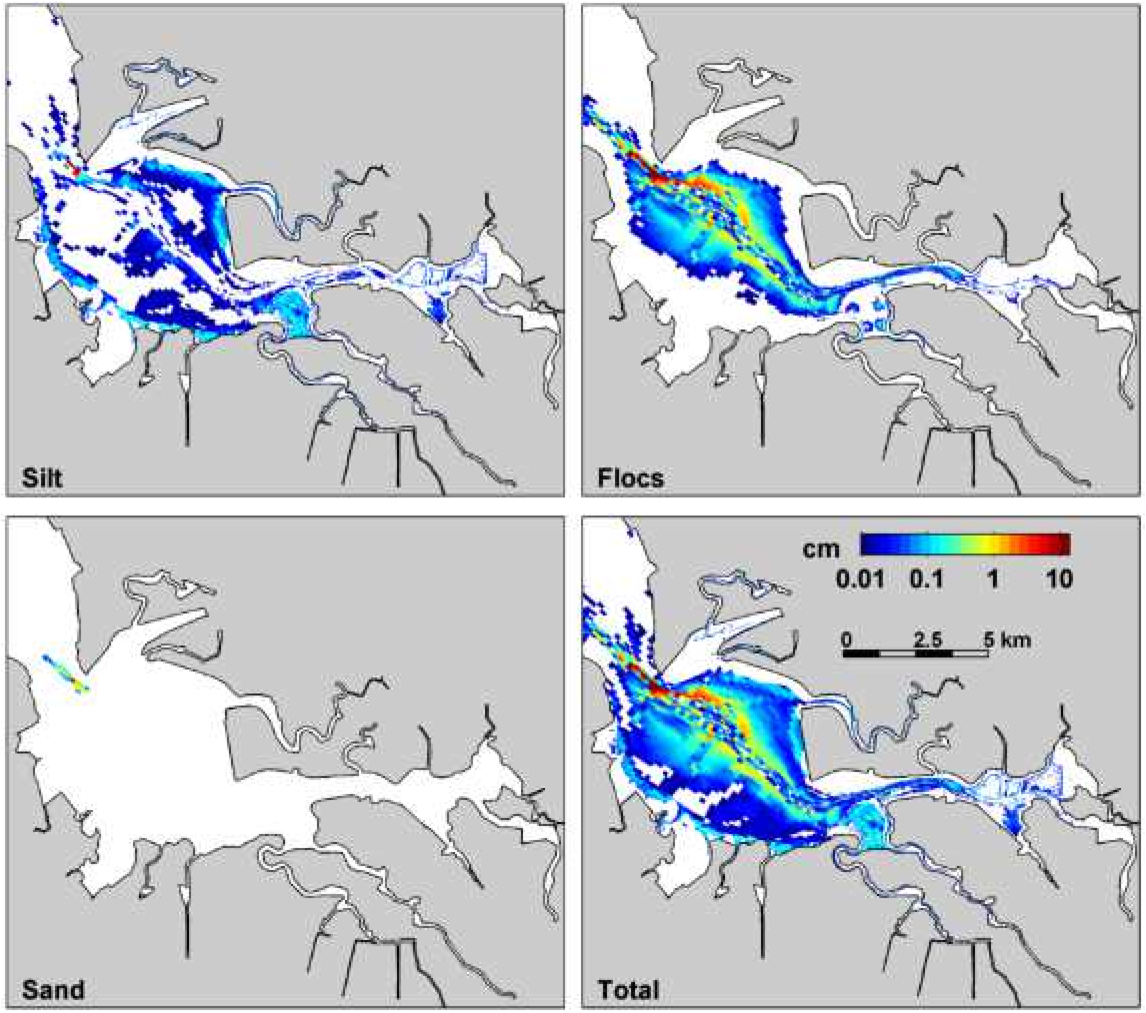
… and others



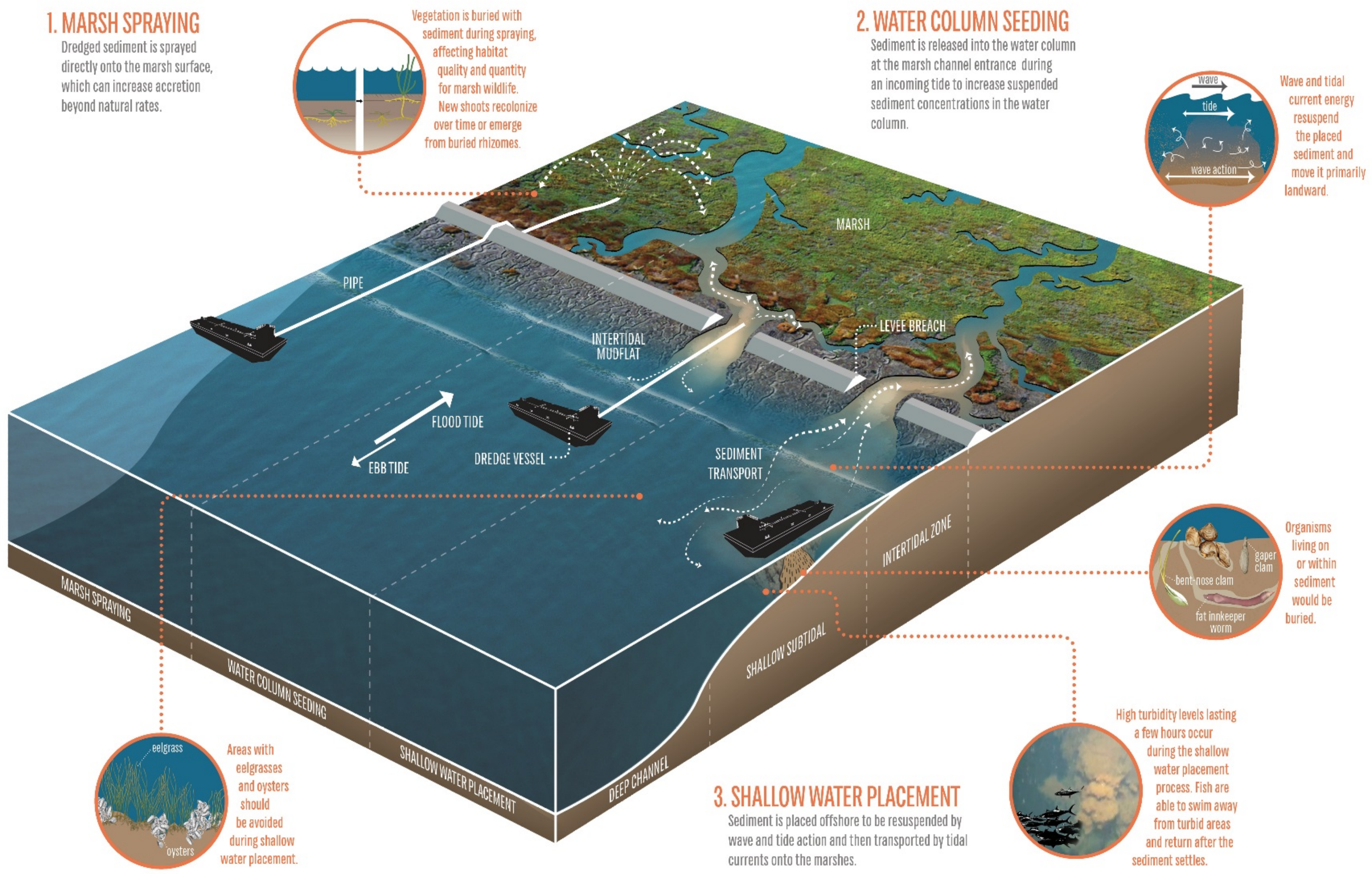
Conceptual Framework for a Method of Strategic Placement of Dredged Sediments

Numerical Modeling

- Bever *et al* (2014) modeled the fate of sediment placed in different parts of the Bay.
- Natural dispersal from open-water placement could be effective in supplying sediment to mudflats, marshes and salt ponds.
- Far South Bay sites were much more effective than dispersive regions in San Pablo Bay.
- Spatial distribution of the predicted bed shear stress may be used to optimize placement sites to maximize erosion and dispersal.



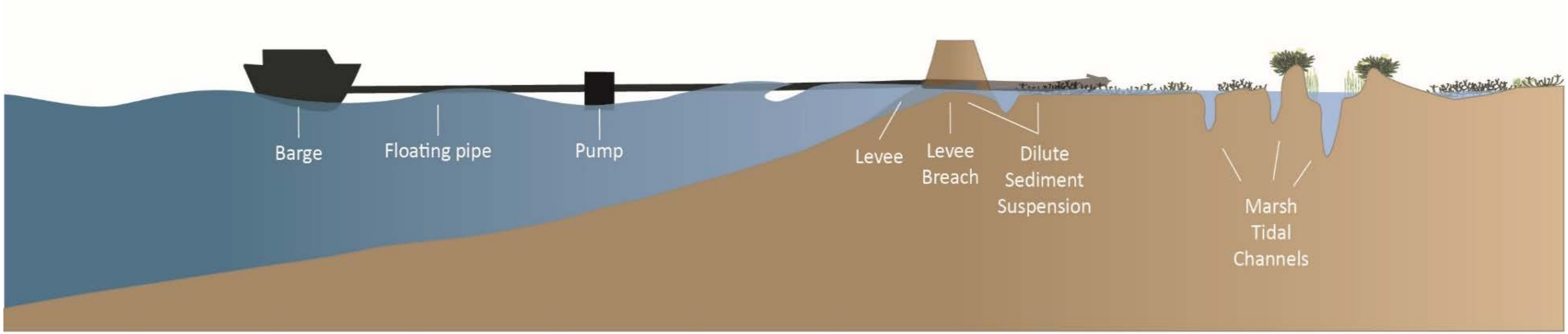
Dredged material deposition thickness, Bever *et al* (2014)


1. MARSH SPRAYING
Dredged sediment is sprayed directly onto the marsh surface, which can increase accretion beyond natural rates.
Vegetation is buried with sediment during spraying, affecting habitat quality and quantity for marsh wildlife. New shoots recolonize over time or emerge from buried rhizomes.
2. WATER COLUMN SEEDING
Sediment is released into the water column at the marsh channel entrance during an incoming tide to increase suspended sediment concentrations in the water column.
wave
tide
wave action
Wave and tidal current energy resuspend the placed sediment and move it primarily landward.
MARSH
PIPE
INTERTIDAL MUDFLAT
LEVEE BREACH
FLOOD TIDE
EBB TIDE
DREDGE VESSEL
SEDIMENT TRANSPORT
INTERTIDAL ZONE
SHALLOW SUBTIDAL
DEEP CHANNEL
MARSH SPRAYING
WATER COLUMN SEEDING
SHALLOW WATER PLACEMENT
gaper clam
bent-nose clam
fat innkeeper worm
Organisms living on or within sediment would be buried.
eelgrass
oysters
Areas with eelgrasses and oysters should be avoided during shallow water placement.
3. SHALLOW WATER PLACEMENT
Sediment is placed offshore to be resuspended by wave and tide action and then transported by tidal currents onto the marshes.
High turbidity levels lasting a few hours occur during the shallow water placement process. Fish are able to swim away from turbid areas and return after the sediment settles.

Shallow Water Placement

- Natural processes, rates are limited, timing and volumes less restricted
- Burial impacts, increase in local SSC
- Uncertainty – efficiency of transport pathway

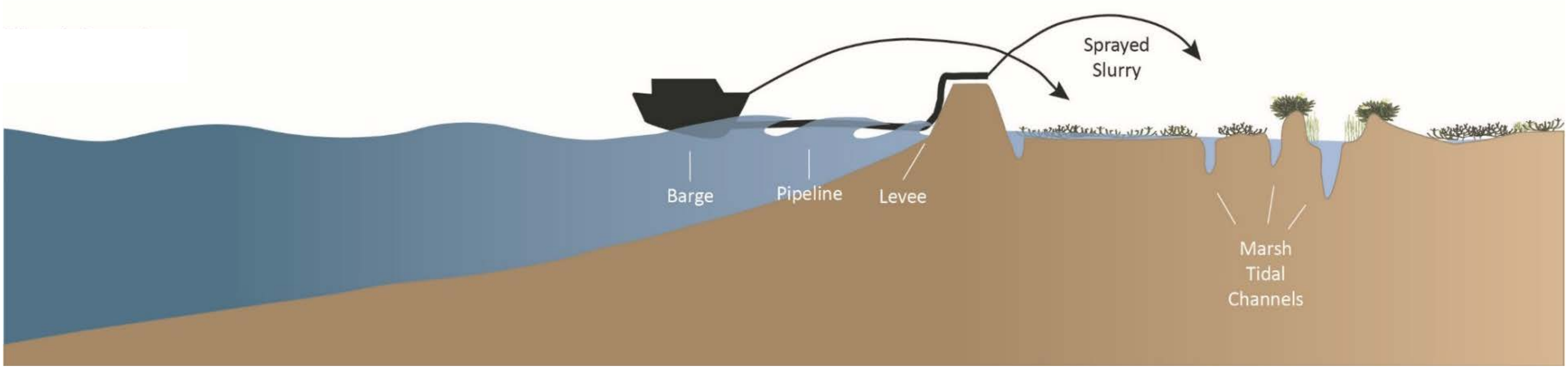
Water Column Seeding



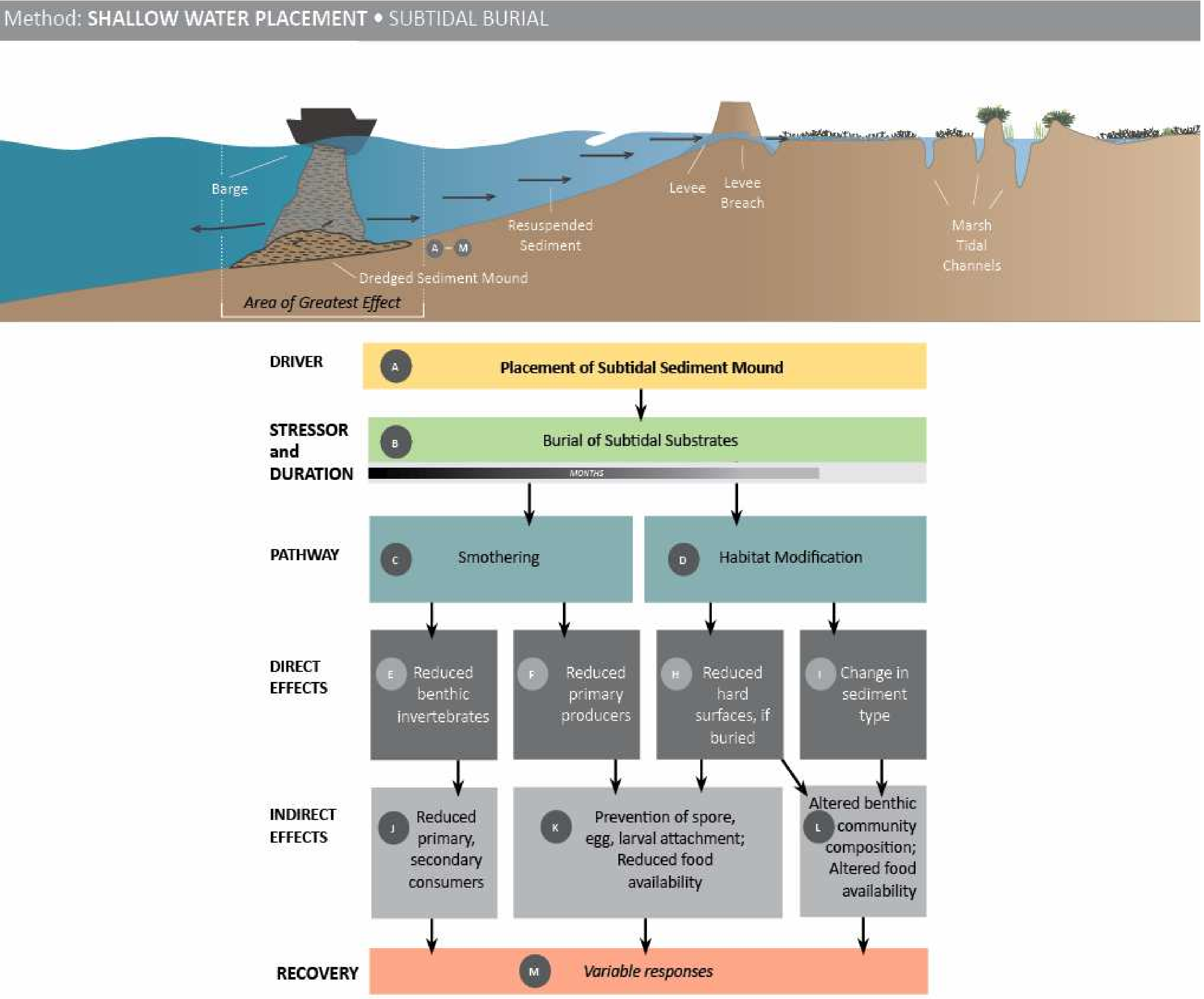
- Increased certainty of placement, less dependent upon wave and tidal energy
- Timing constraints, coupled offloading/accretion
- Uncertainty – timing and volumes of placement

Strategic Placement Methods

Marsh Spraying



- Certainty of placement and timing; tried and tested
- Increasing infrastructure, unnatural rates of accretion and placement
- Uncertainty – burial impact on marsh, recovery time



Example Ecological Effects

- Burial of subtidal surfaces
- Soil texture could be altered
- Direct mortality of plants and animals is possible
- Food web effects possible
- Duration: months

How the Methods Compare: Ecological Effects

Effect	Shallow Water Placement	Water Column Seeding	Spraying
Replication of Natural Rates of Accretion to Mudflats and Marshes Expected	Highest	Somewhat	Lowest
Minimizes Impacts on Subtidal Benthic Community	Lowest	Neutral	Neutral
Minimizes Impacts on Mudflat Community	Neutral	Little	Little
Minimizes Impacts on Water Column Community	Neutral	Lowest	Little
Minimizes Impacts on Vegetated Marsh Community	Neutral	Neutral	Lowest
Minimizes Impacts on Marsh Channel Community	Neutral	Lowest	Lowest
Flexibility of Method in Avoiding Impacts	Somewhat	Somewhat	Somewhat

Program Implementation – A Phased Approach

Pilot Studies

- Form a governance structure to guide the long-term planning and permitting of strategic placement.
- Place small volumes of material in strategic shallow-water and water-column locations.
- Monitor ecological impacts and long term recovery of subtidal benthic, mudflat, and water column communities.
- Refine numerical modeling of fate of placed sediment.
- Go / No-Go decision

Demonstration Projects

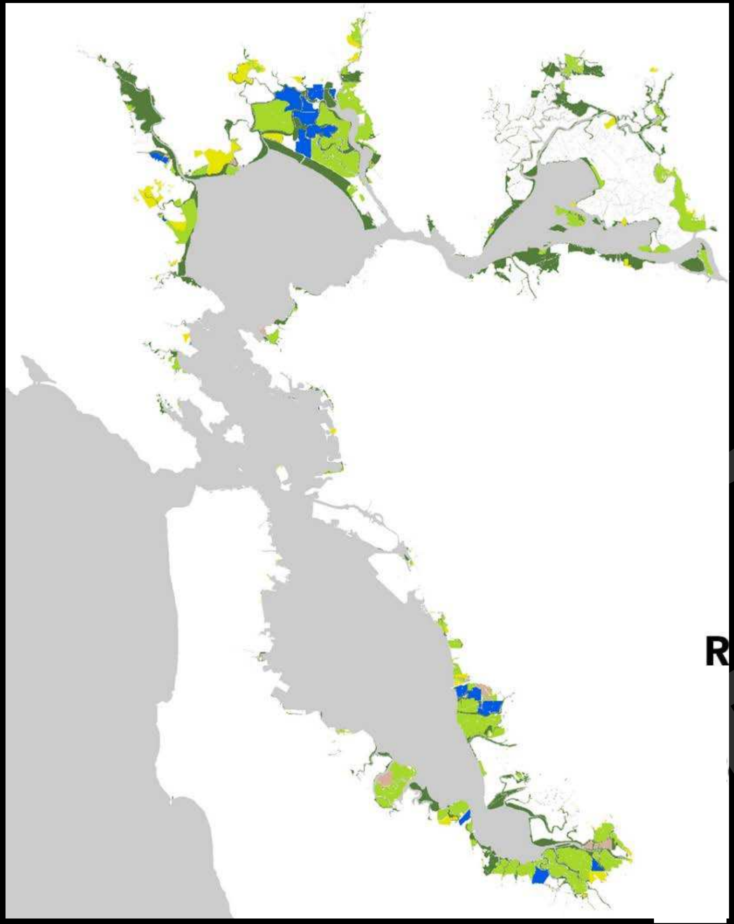
- Place larger volumes of material in strategic shallow-water and water-column locations.
- Measure fate and impacts of sediment over a longer period of time.
- Refine numerical modeling of fate of placed sediment.
- Up to two years of control-site monitoring and one year of post-placement effectiveness ecological monitoring.
- Go / No-Go decision

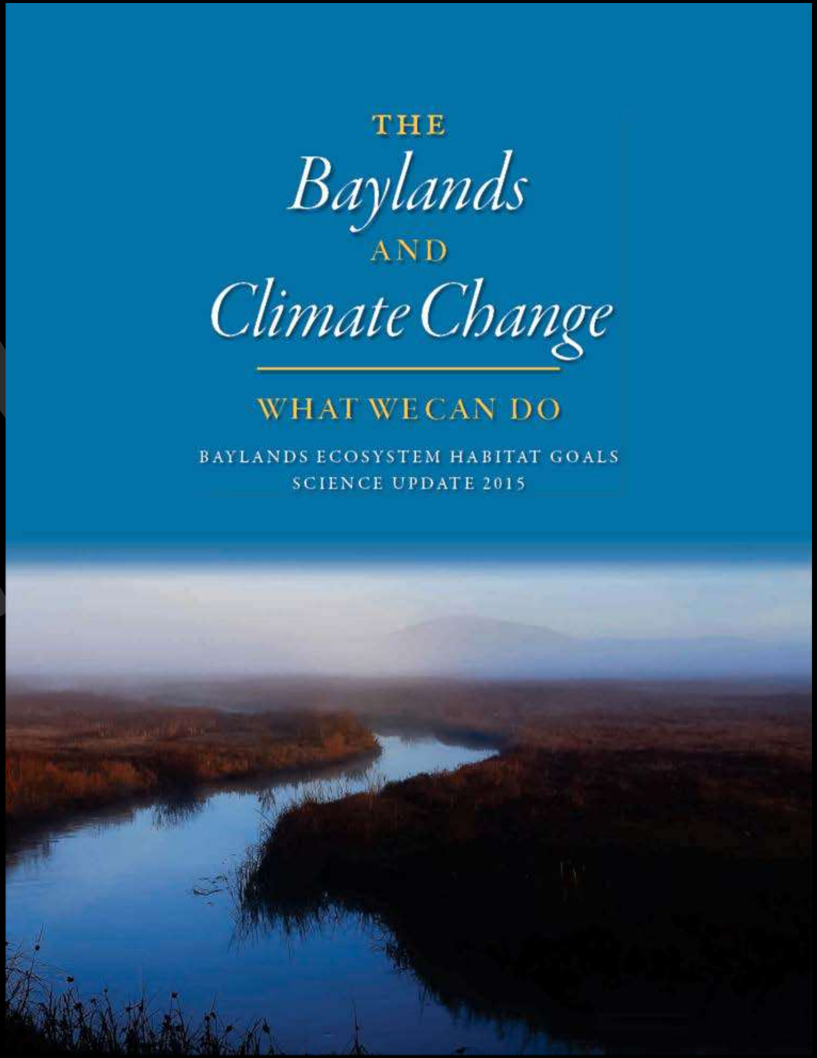

Source: Kathy Boyer

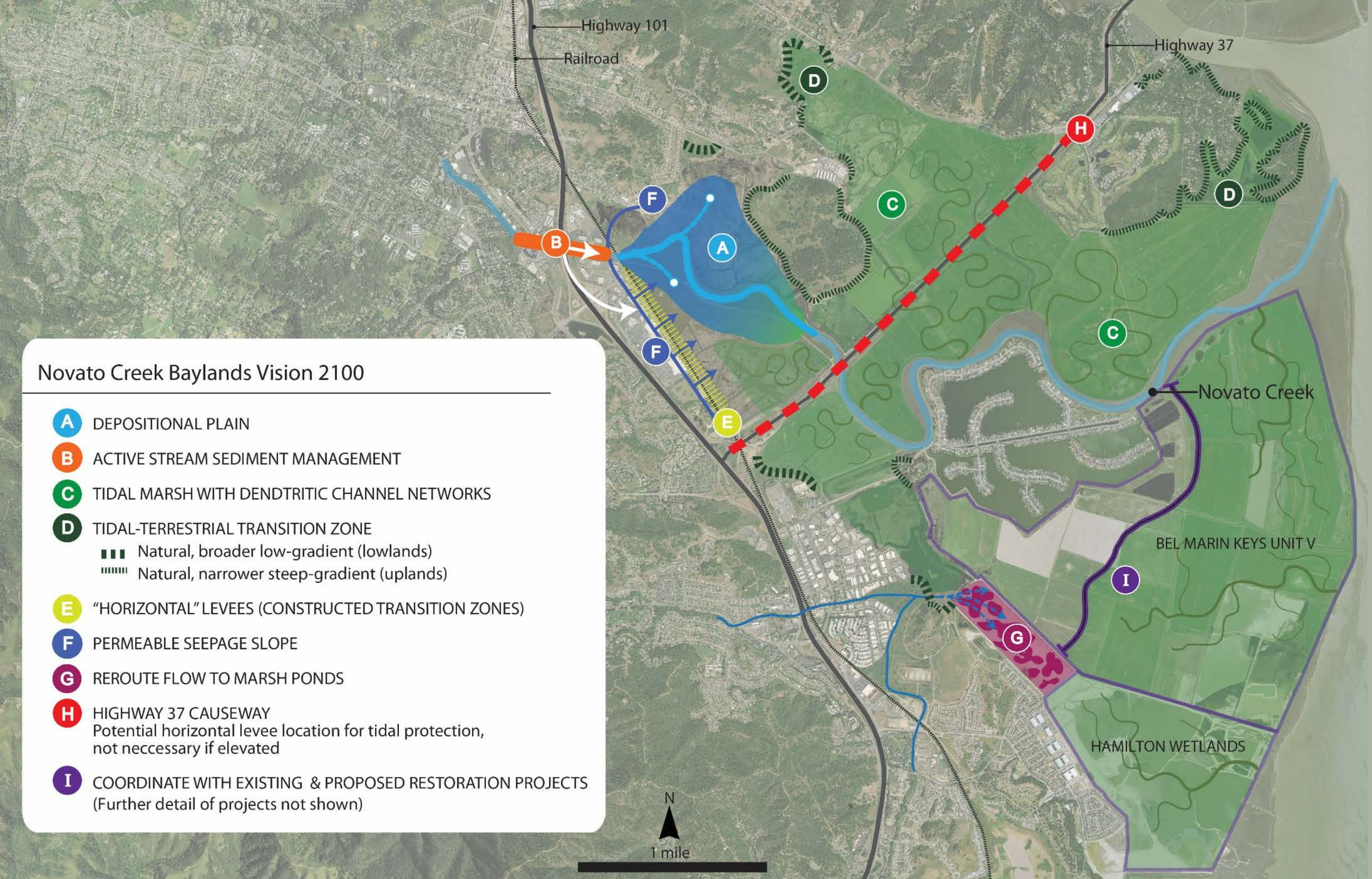

Source: Peter Baye

South Bay Salt Pond
Restoration Project

YES on AA
CLEAN AND HEALTHY BAY





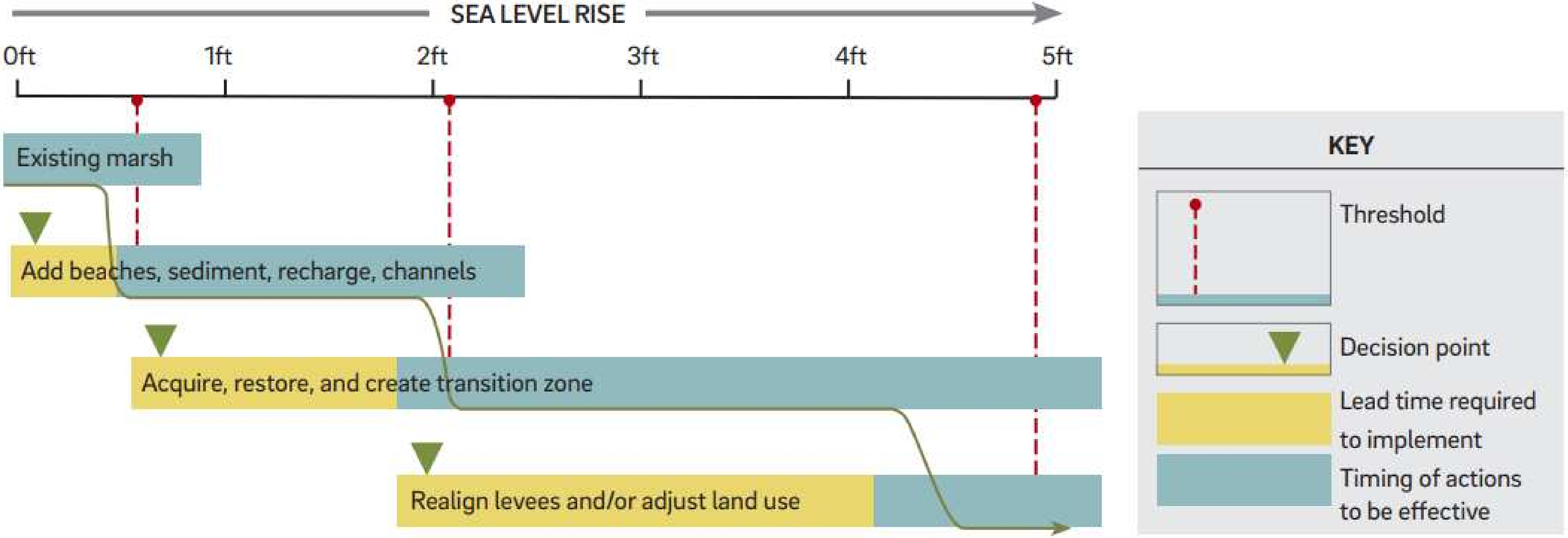

Novato Creek Baylands Vision 2100
A DEPOSITIONAL PLAIN
B ACTIVE STREAM SEDIMENT MANAGEMENT
C TIDAL MARSH WITH DENDTRITIC CHANNEL NETWORKS
D TIDAL-TERRESTRIAL TRANSITION ZONE
Natural, broader low-gradient (lowlands)
Natural, narrower steep-gradient (uplands)
E "HORIZONTAL" LEVEES (CONSTRUCTED TRANSITION ZONES)
F PERMEABLE SEEPAGE SLOPE
G REROUTE FLOW TO MARSH PONDS
H HIGHWAY 37 CAUSEWAY
Potential horizontal levee location for tidal protection,
not neccessary if elevated
I COORDINATE WITH EXISTING & PROPOSED RESTORATION PROJECTS
(Further detail of projects not shown)
Highway 101
Railroad
Highway 37
Novato Creek
BEL MARIN KEYS UNIT V
HAMILTON WETLANDS
N
1 mile

Rationale for Units

1. Processes that govern the shoreline happen at the **Bay scale**.
2. Need to **divide up the Bay** into smaller pieces to manage.
3. Risk of the **wrong type** of actions in the **wrong places**.
4. Opportunity to maximize **multi-benefit, nature-based solutions**.

Measures by Type of Unit

TYPOLOGY		Oysters	Mudflat Augmentation	Beaches	Marsh Restoration	Horizontal Levees	Transition Zone Aquisition	Warping of Polders	Densify Urban Development Away from SLR Zone	Creek Reconnection	Sediment Management	Combined Flooding Abatement	Levees	Super Levees
A	*Wide baylands with more space: Coves with dense urban settlements*	●	●	●	●	●	●	●	●					
A	*Wide baylands with more space: Mixed urban and agricultural creek mouths*		●		●	●	●	●		●				
B	*Narrow baylands with less space: Urban waterfronts beside deep water*	●		●			●							
B	*Narrow baylands with less space: Pocket marshes with shallow water*	●		●	●	●								
C	*Wide baylands with more space: Urban centers*			●	●		●	●						
C	*Wide baylands with less space: Urban centers*			●	●									
D	*Narrow baylands with more space: Urban centers*			○	●	●								
D	*Narrow baylands with less space: Urban centers*	●		●									●	●
E	*Wide baylands with more space: Agricultural fringing, big marshes*				●		●	●		●				
E	*Wide baylands with less space: Urban fringing, big marshes*				●	●	●	●		●				
E	*Wide baylands with less space: Big marshes along a river*				●						●	●		



Conceptual phasing of measures triggered by sea-level rise, rather than a chronological timeline (adapted from Goals Project 2015).

Thank you

Jeremy Lowe
JeremyL@sfei.org
San Francisco Estuary Institute

SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER
4911 Central Ave, Richmond, CA 94804, p: 510-746-7334 f: 510-746-7300