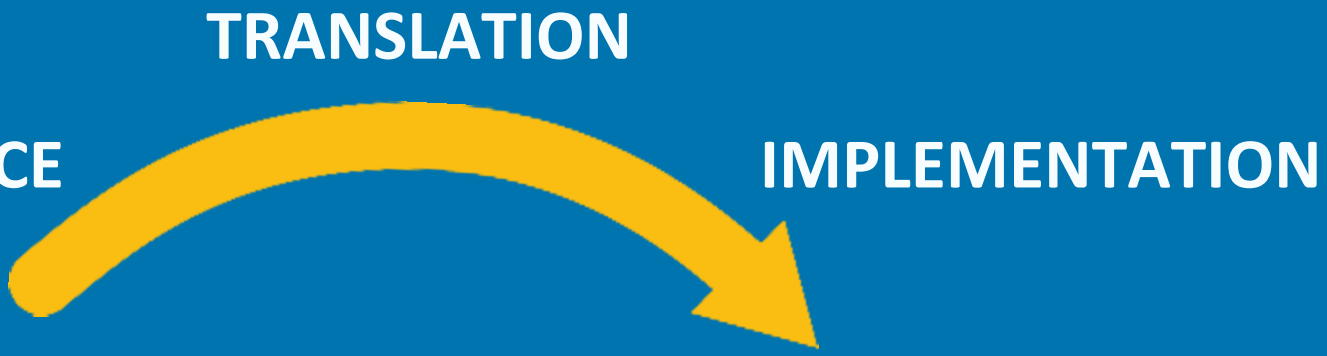
Can We Keep Up with Changing Estuaries?
Moving from science to action in San Francisco Bay

Letitia Grenier
Association of State Wetlands Managers

May 29, 2019

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

What We Do



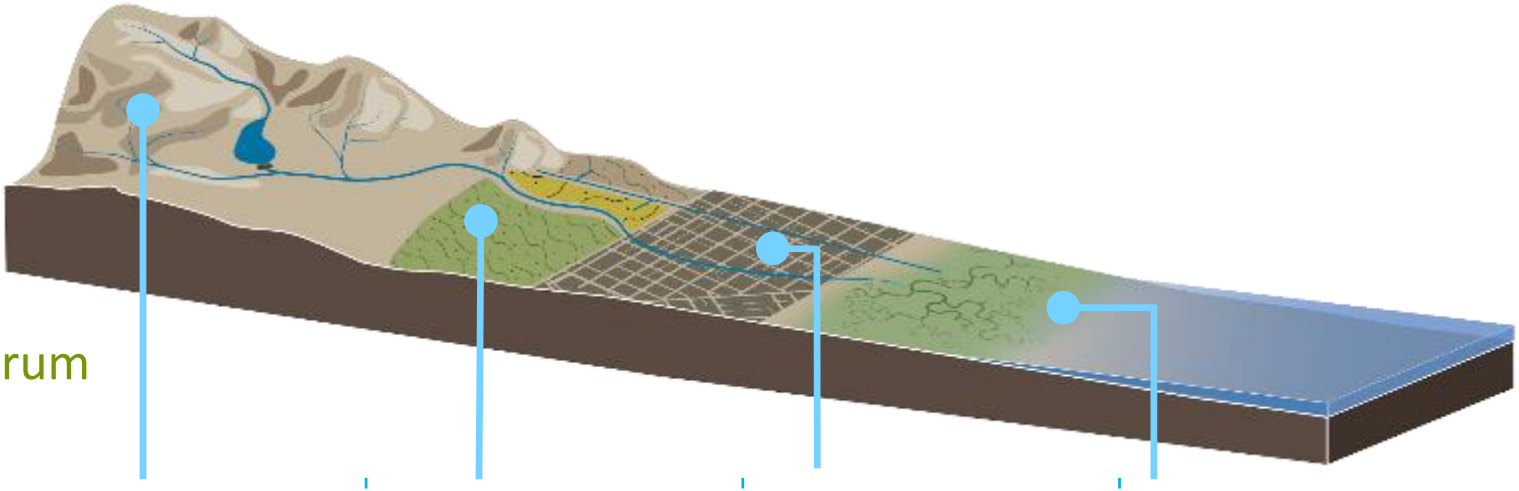
Science: Draw on cutting-edge science from across disciplines

Translation: Turn science into usable local guidance, visions, tools

Implementation: Facilitate integrated actions via partnerships and planning

WORKING WITH NATURE

across the land-use spectrum

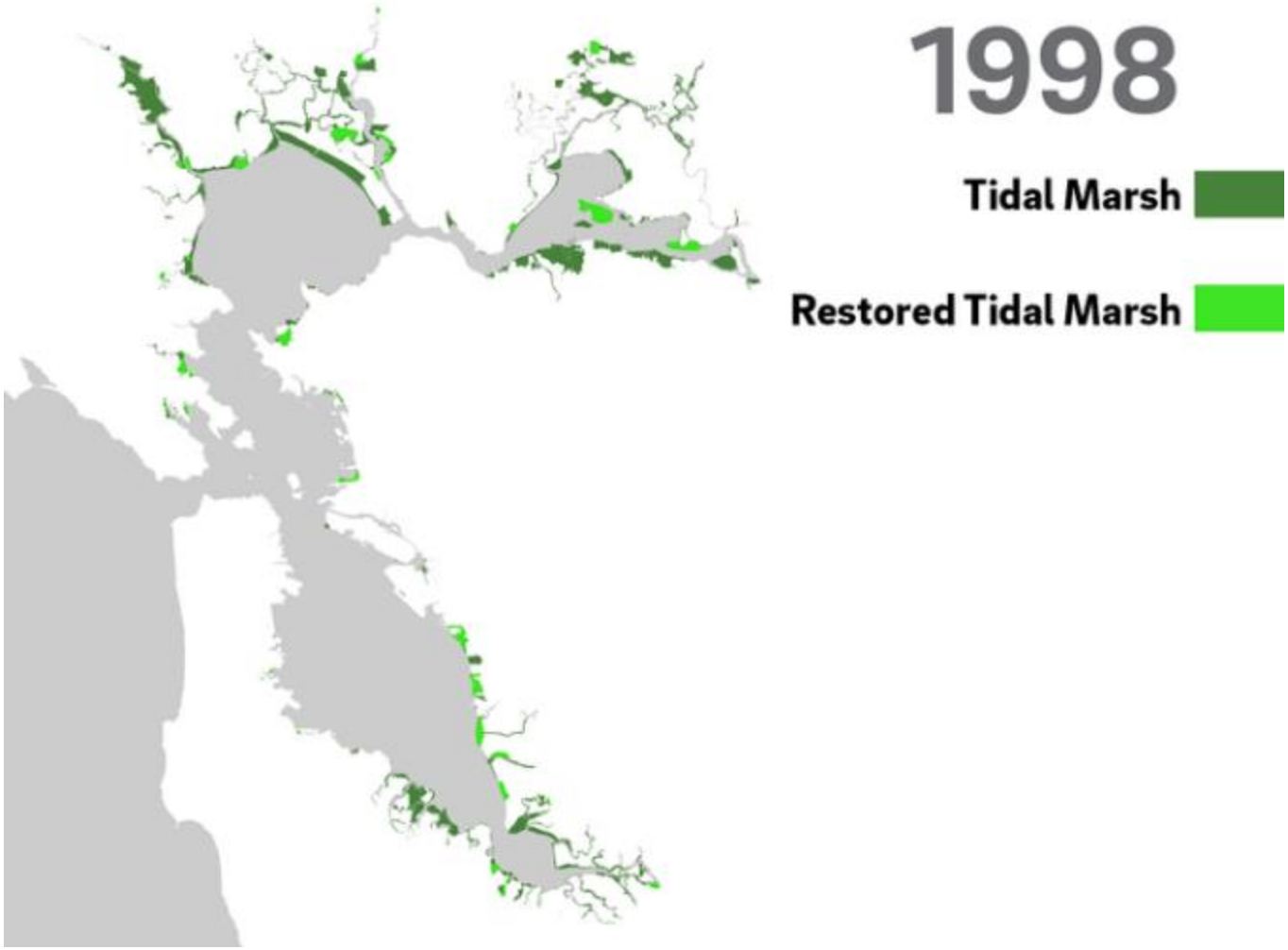


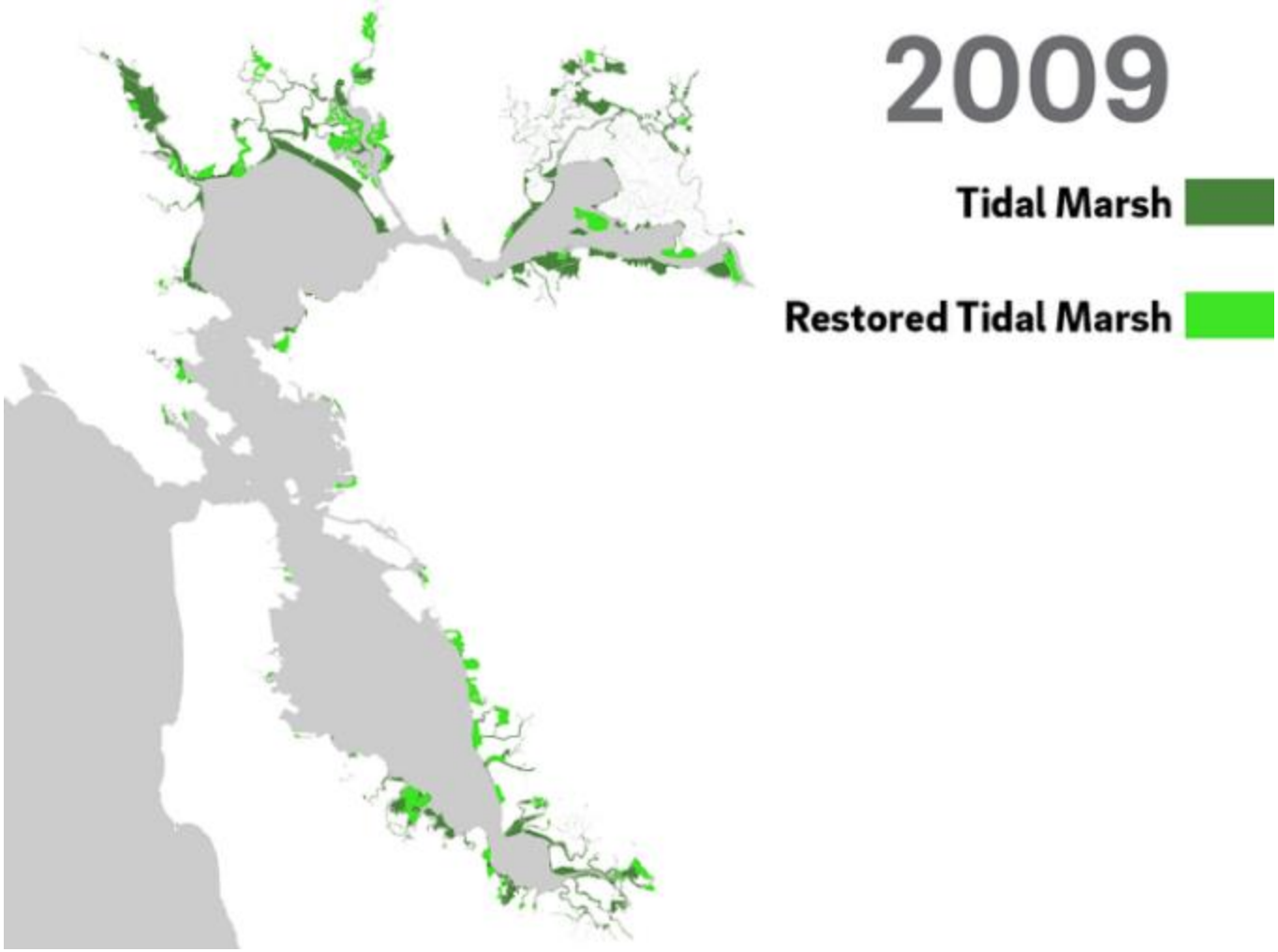
	WILDLANDS	AGRICULTURE	URBAN	SHORE
Nature-Based Solutions	Habitat conservation and restoration Prevent development Emulate fire disturbance	Wildlife-friendly agriculture Creek corridor restoration Prevent development	Native plant urban forest Mitigate barriers to wildlife movement Creek realignment	Marshes Beaches Hybrid shorelines
Resulting Ecosystem Services	Water capture Carbon sequestration Manage wildfire risk Biodiversity	Water infiltration Habitat connectivity Pollination Biodiversity	Flood peak reduction Water quality benefits Sediment transport Biodiversity	Shoreline protection Carbon sequestration Water quality benefits Biodiversity

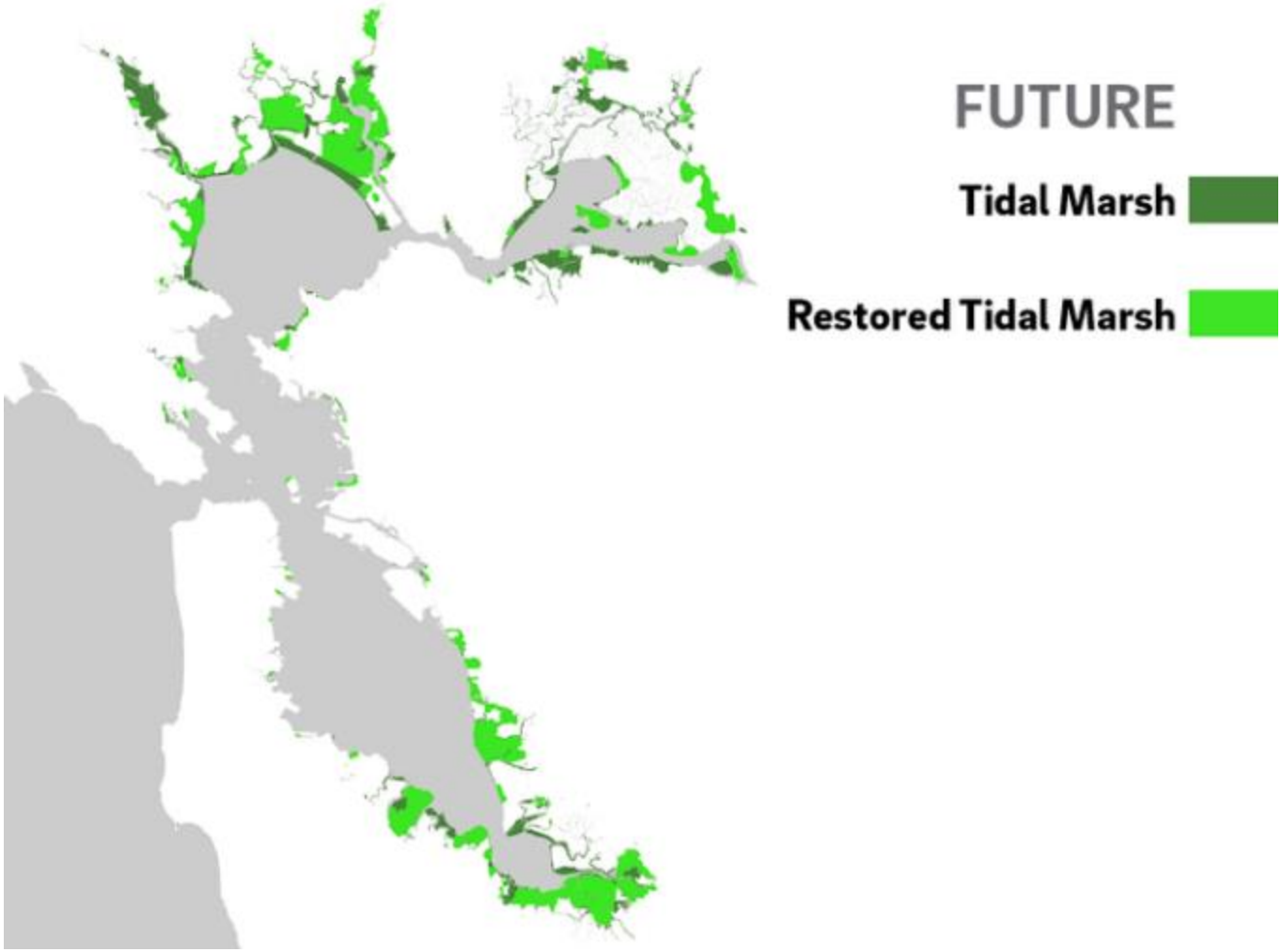
Goals Projects

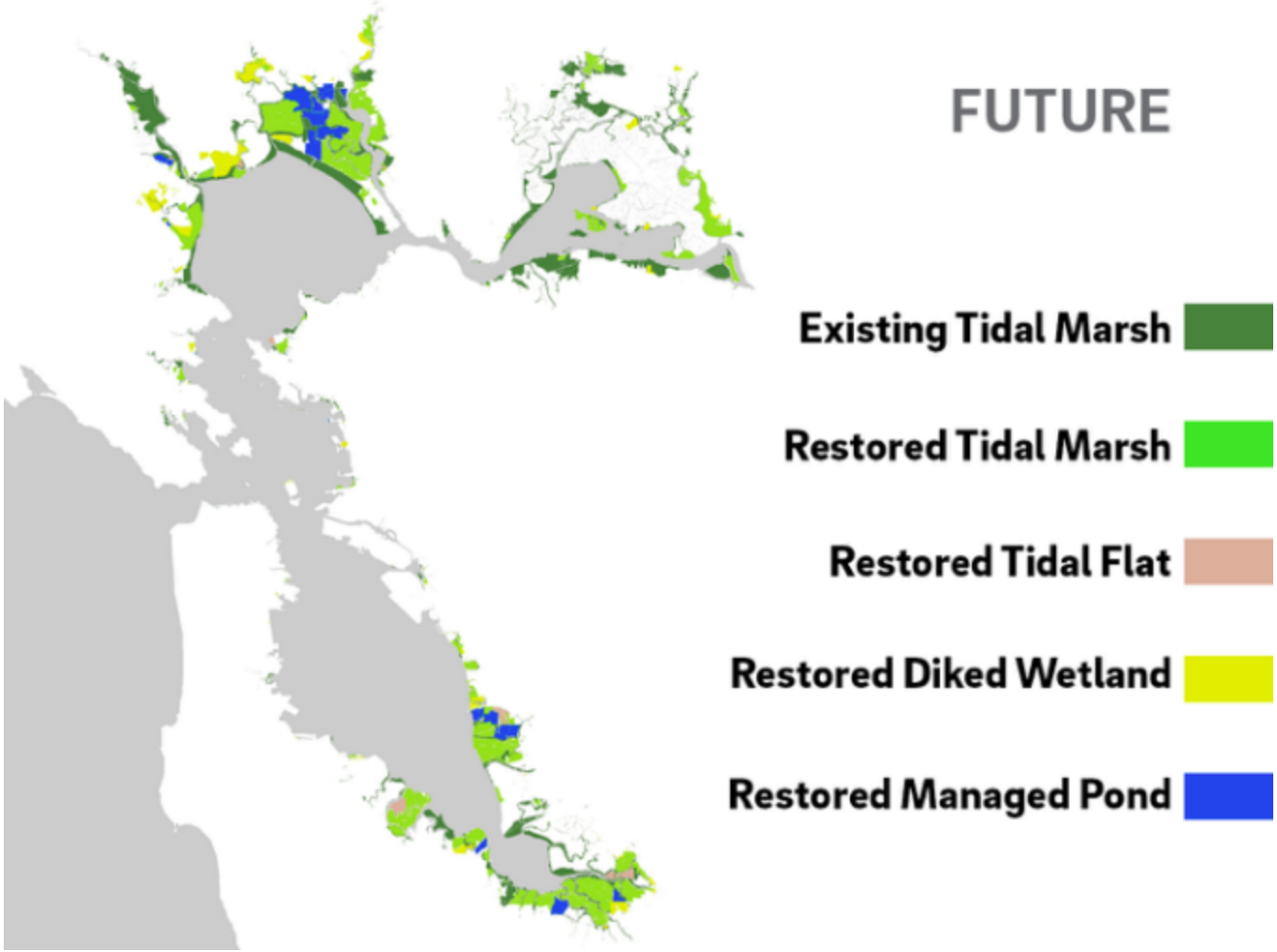
1800

Tidal Marsh

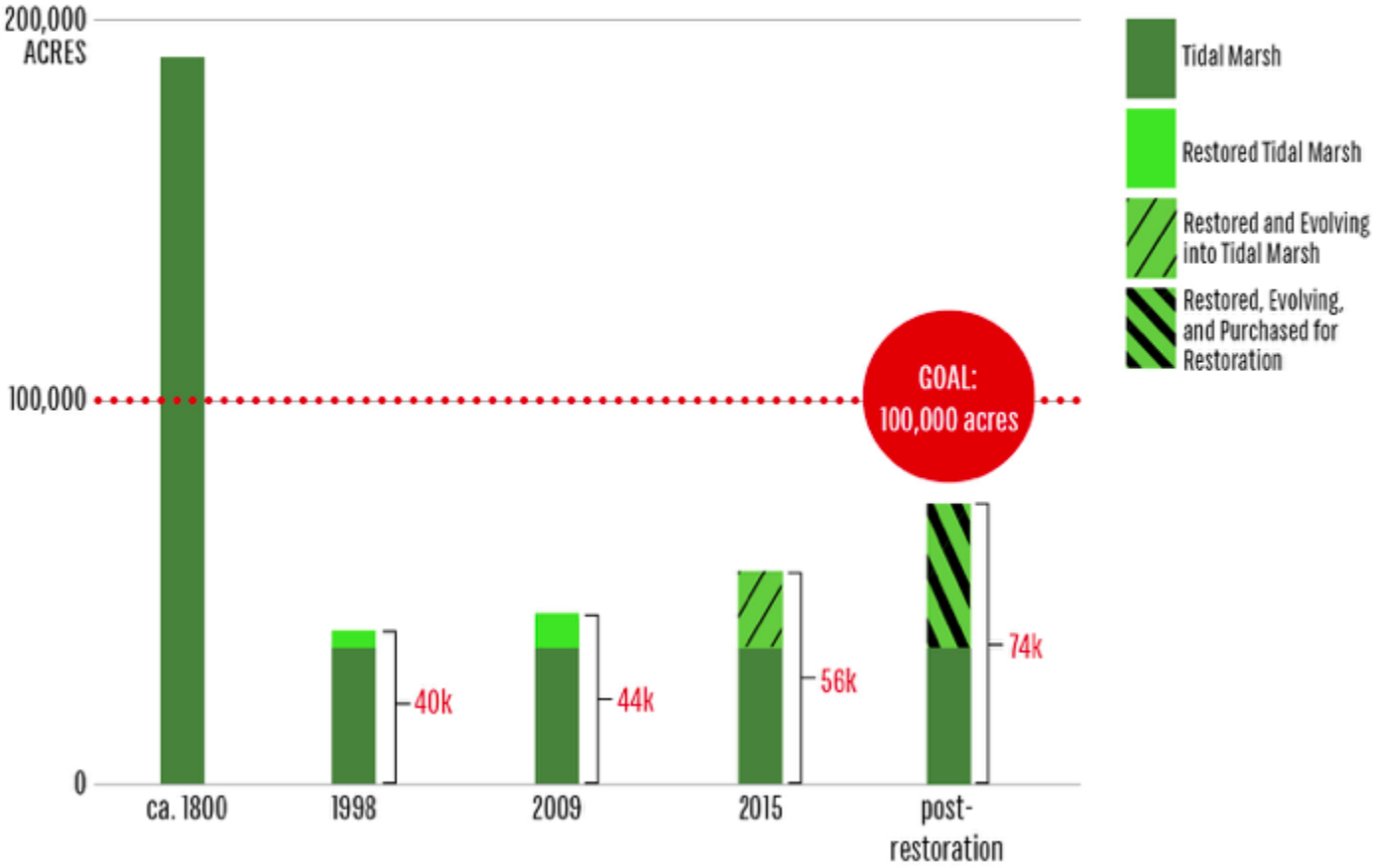

1998
Tidal Marsh
Restored Tidal Marsh


2009
Tidal Marsh
Restored Tidal Marsh


FUTURE
Tidal Marsh
Restored Tidal Marsh


FUTURE
Existing Tidal Marsh
Restored Tidal Marsh
Restored Tidal Flat
Restored Diked Wetland
Restored Managed Pond

TIDAL MARSH *restoration*



MEASURING THE IMPACT
of the Baylands Goals

LARGEST RESTORATION PROJECT

grew from 350 acres to 15,000 acres

WRITTEN INTO POLICY

Water Board, BCDC, SCC, SFBJV, etc.

DRAMATIC INCREASE IN FUNDING

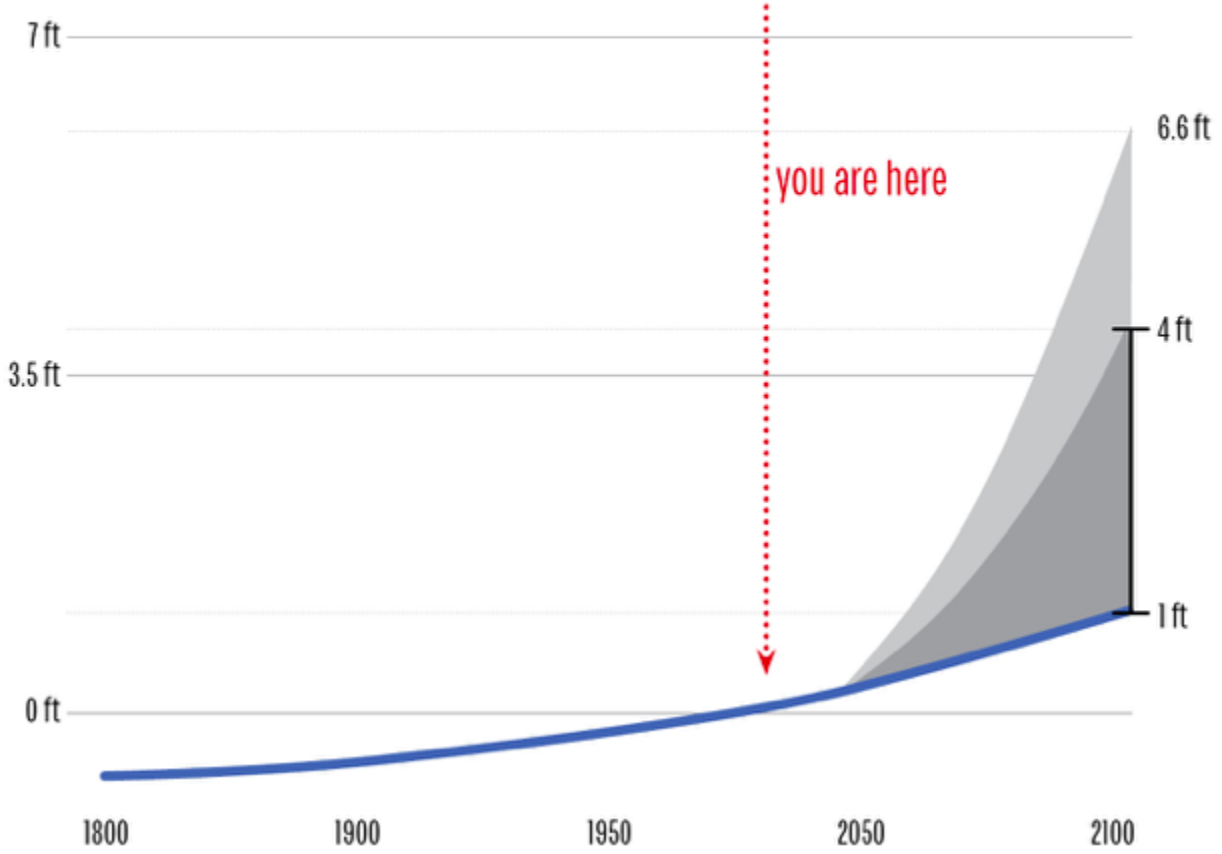
SBSP, Prop 50, Restoration Authority

INSPIRED OTHER GOALS PROJECTS

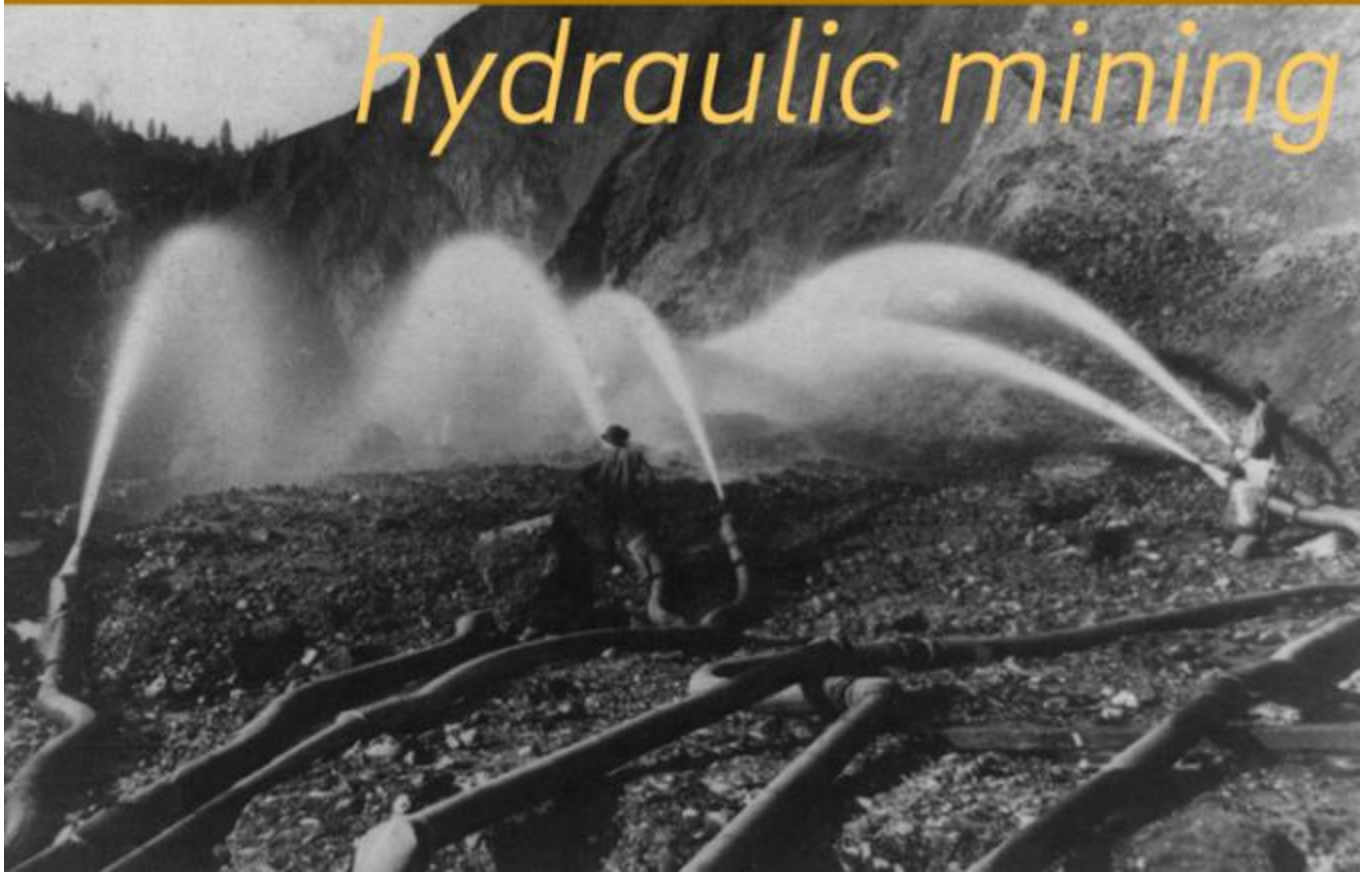
Uplands, Subtidal

GLOBAL SEA LEVEL *change* SINCE 1800

Courtesy 3rd National Climate Assessment, 2014

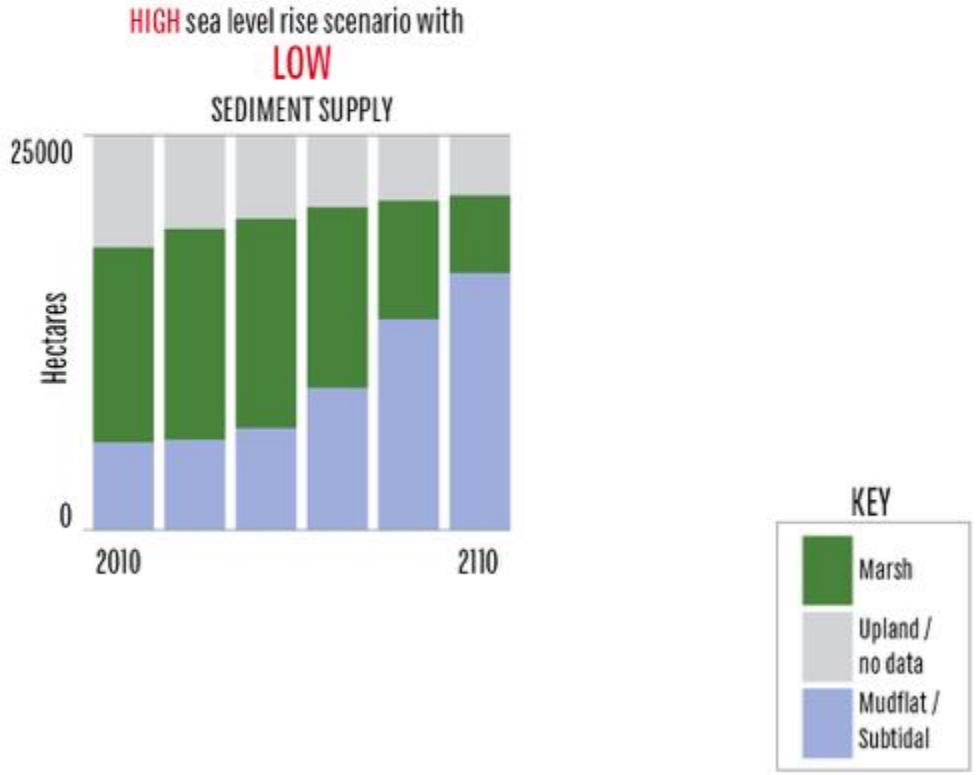


SEDIMENT SUPPLY



THE FUTURE OF MARSHES DEPENDS ON *sediment supply*

Courtesy Stralberg et al. 2011



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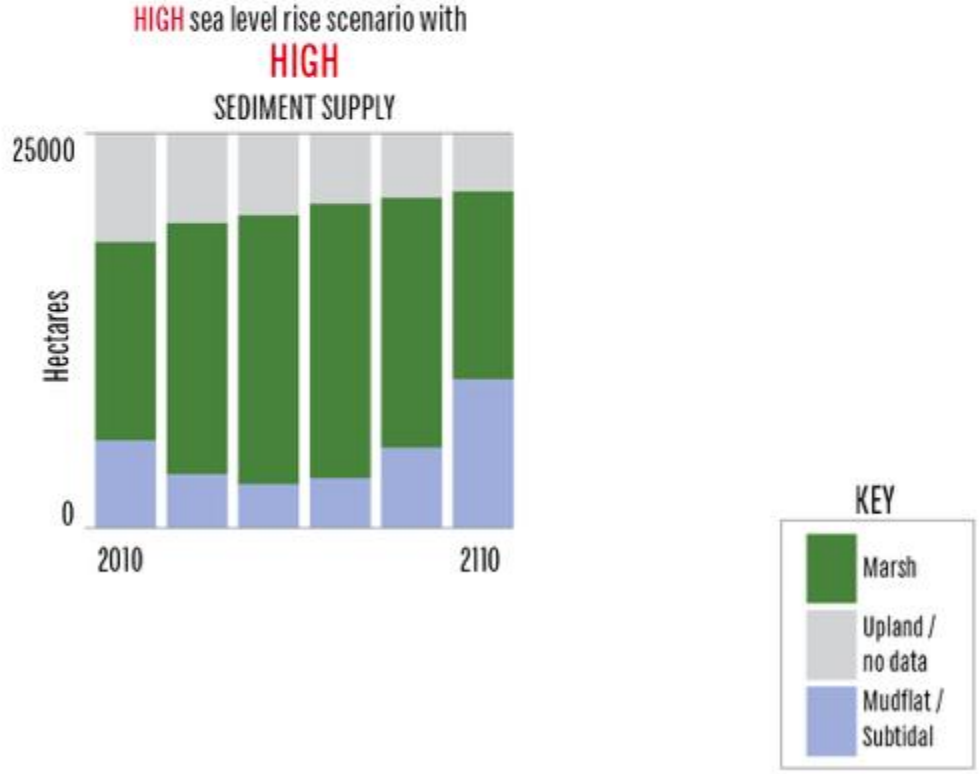
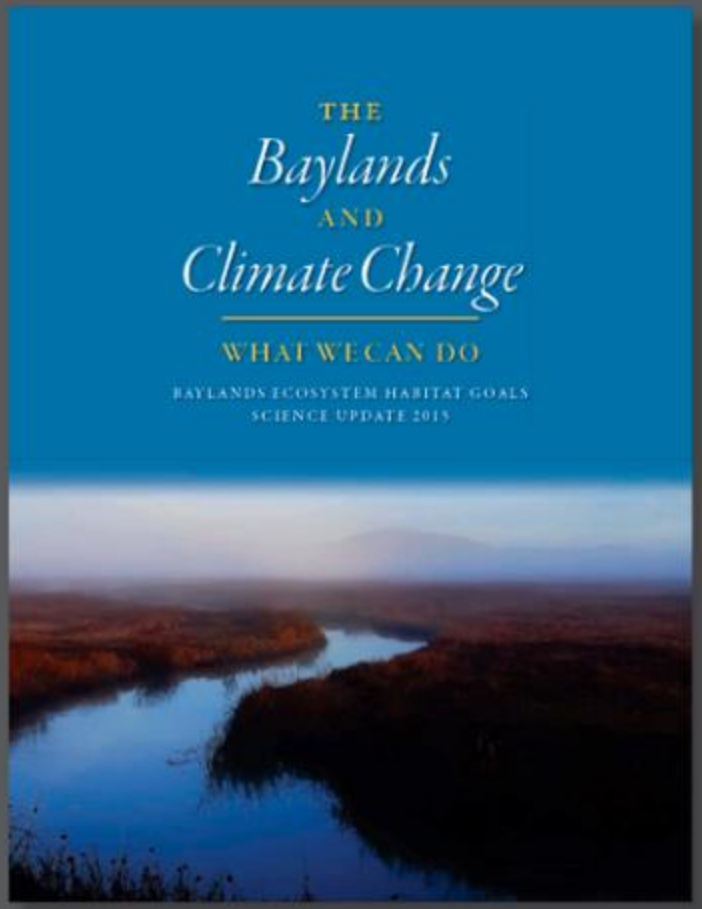


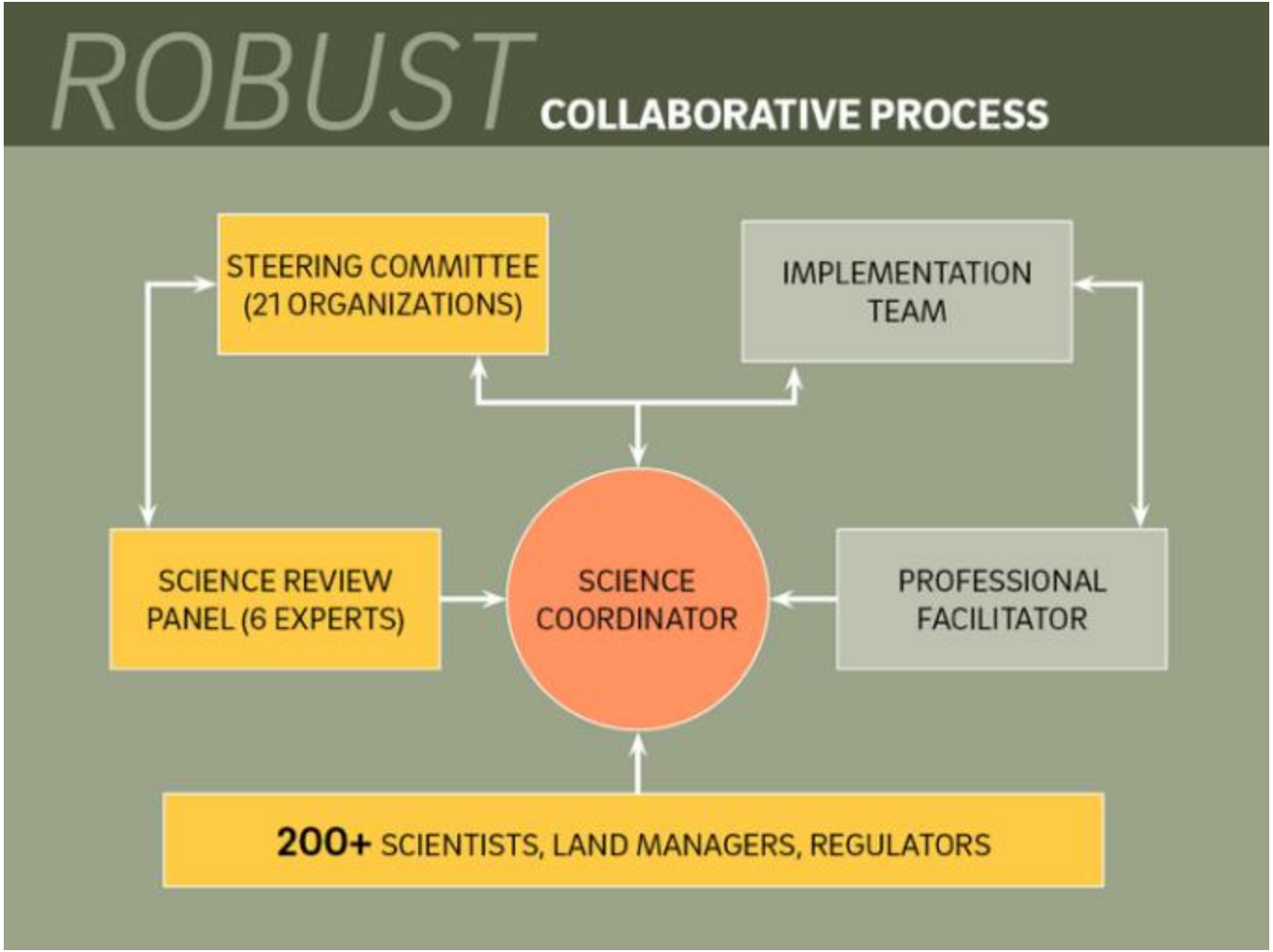


State of California
Coastal Conservancy

BAY AREA ECOSYSTEMS CLIMATE CHANGE CONSORTIUM

BAYLANDS GOALS 2015

- Science synthesis
- Effect of future change, especially climate and sediment supply, on the Baylands
- Goal is healthy ecosystem, providing a resilient shore for people and wildlife
- Recommendations and landscape visions for the next century

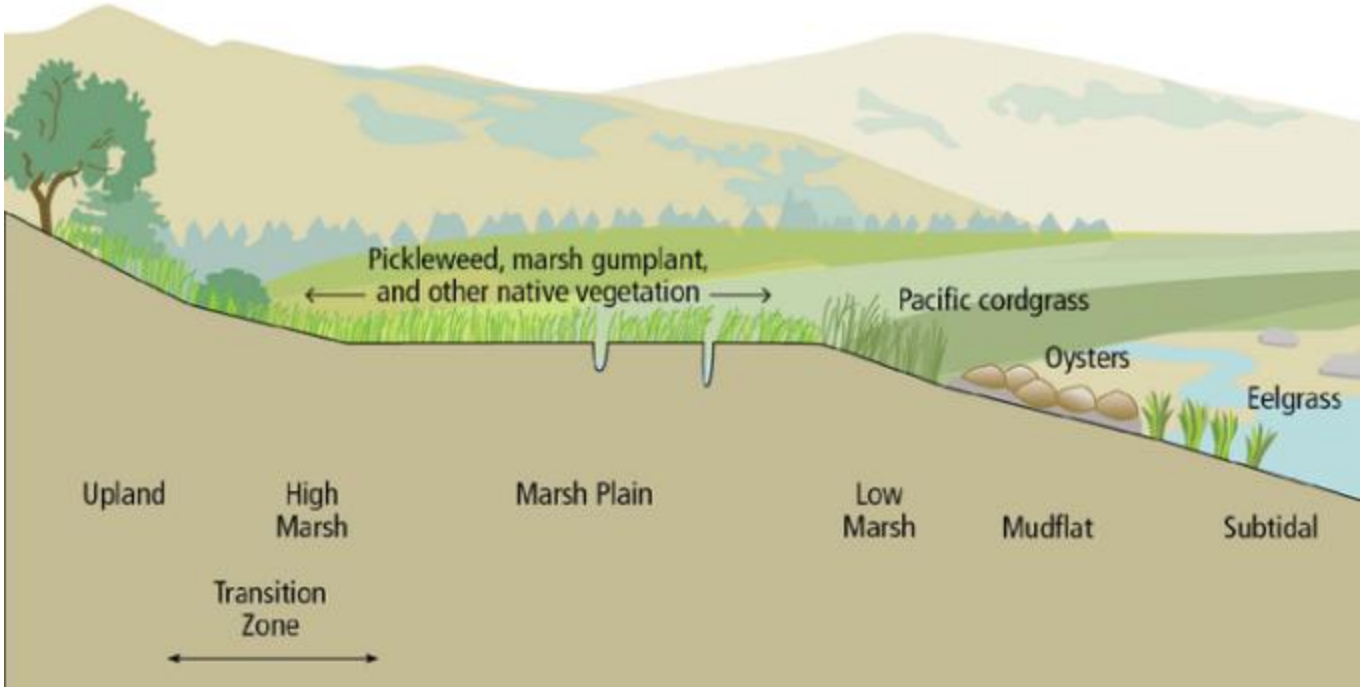

ROBUST
COLLABORATIVE PROCESS
STEERING COMMITTEE (21 ORGANIZATIONS)
IMPLEMENTATION TEAM
SCIENCE REVIEW PANEL (6 EXPERTS)
SCIENCE COORDINATOR
PROFESSIONAL FACILITATOR
200+ SCIENTISTS, LAND MANAGERS, REGULATORS

STEERING COMMITTEE

Resource management, regulatory, restoration organizations

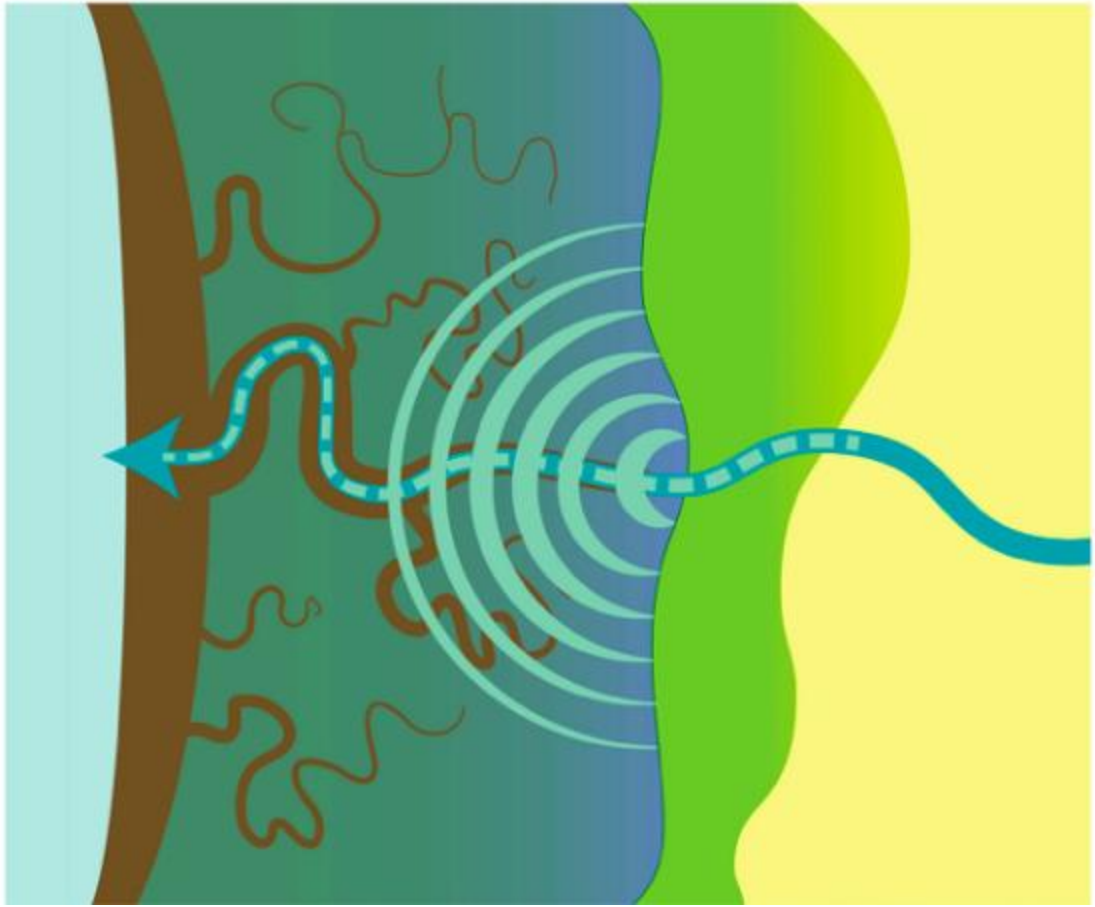
Coastal Conservancy	***Sam Schuchat, Chair (Nadine Peterson)***
Delta Conservancy	*Kristal Davis-Fadtke*
Delta Stewardship Council	*Marina Brand*
EBRPD	*Brad Olson (Chris Barton)*
NOAA	*Becky Smyth (Korie Schaeffer)*
Point Blue	*Grant Ballard (Julian Wood)*
SFEI	*Robin Grossinger (Lester McKee)*
USACE	*Tom Kendall (Fari Tabatabai)*
USEPA	*Sam Ziegler (Luisa Valiela)*
BAFPAA	*Carol Mahoney (C Morrison)*
Water Board	*Andree Greenberg (N Feger)*
USFWS	*Anne Morkill*
BCDC	*Joe LaClair*
DFW	*Carl Wilcox*
DWR	*Erin Chappell*
EBDA	*Michael Connor*
NPS	*Kristen Ward*
SFBJV	*Beth Huning*
SFEP	*Judy Kelly*
Suisun RCD	*Steve Chappell*
URS	*Mike Monroe*

Restore COMPLETE SYSTEMS

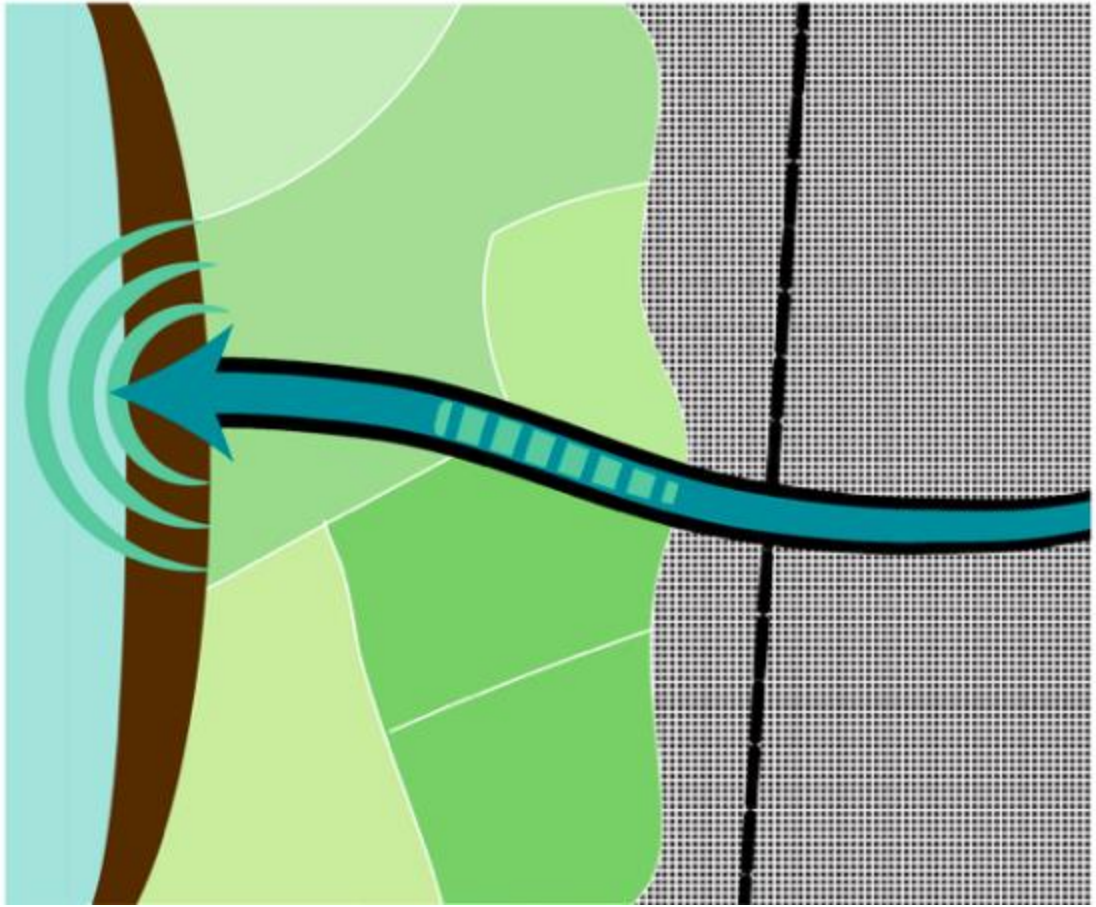


MEANS RESTORING *PROCESSES* NOT JUST PLACES

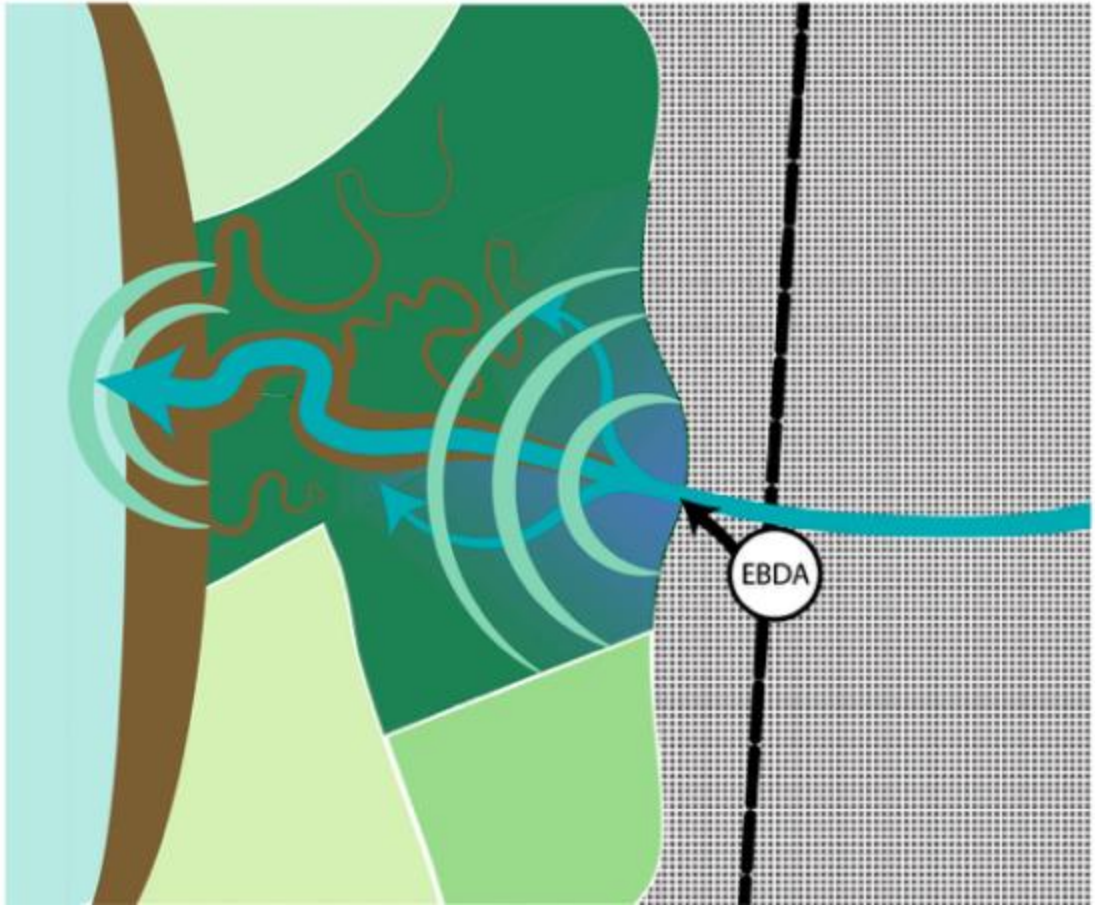
HISTORICAL



MODERN



FUTURE




GUADALUPE SLOUGH
GUADALUPE RIVER
CAPPED
LANDFILL
M
I
H
J
HARVEY
MARSH
PARK
L
G
K
M
SUNNYVALE EAST
HIGHWAY 237
CALABAZAS
SAN TOMAS AQUINO

San Francisco Bay Restoration Authority

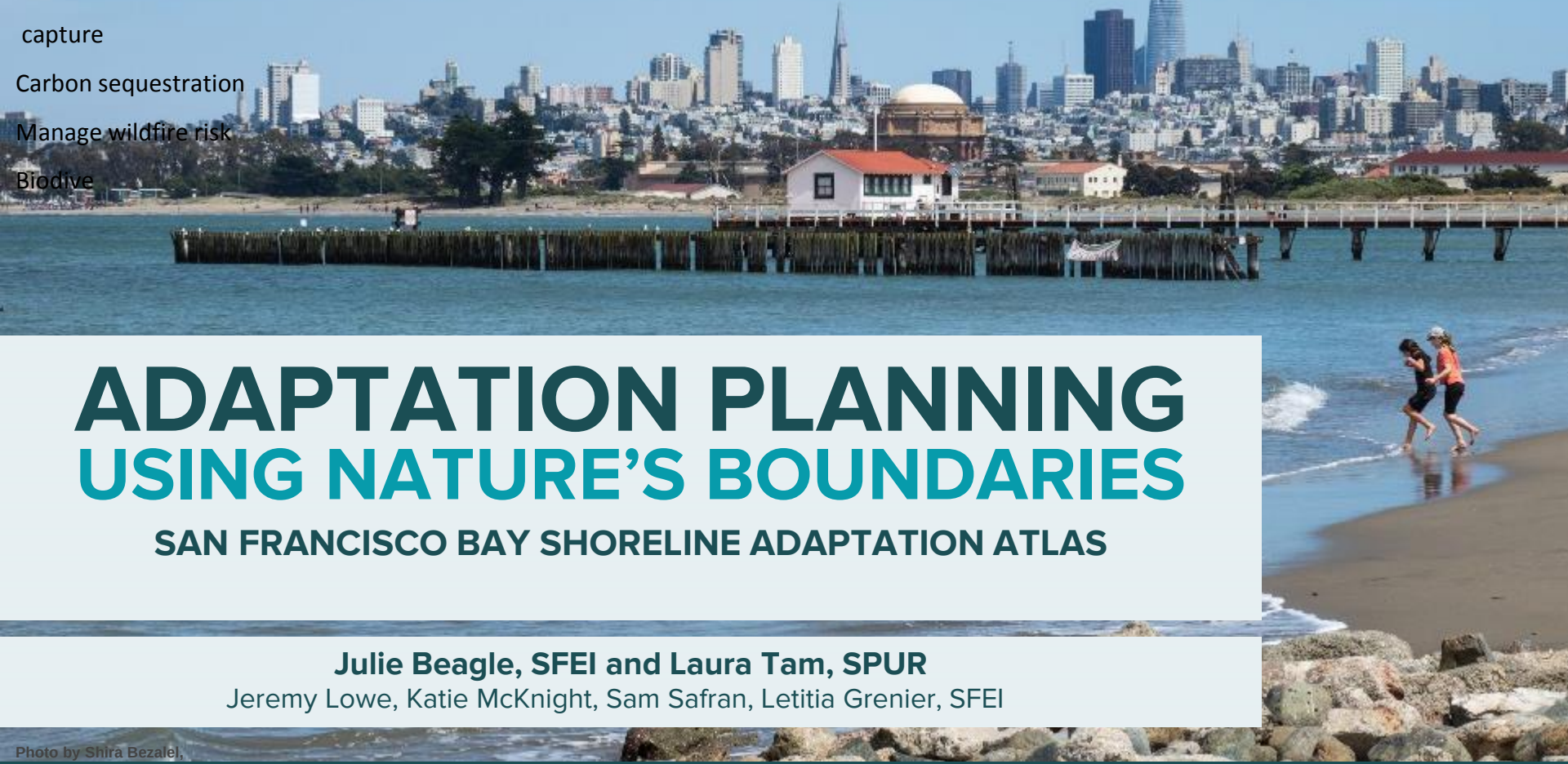
Shoreline Adaptation Atlas

capture

Carbon sequestration

Manage wildfire risk

Biodive



ADAPTATION PLANNING
USING NATURE'S BOUNDARIES
SAN FRANCISCO BAY SHORELINE ADAPTATION ATLAS

Julie Beagle, SFEI and Laura Tam, SPUR

Jeremy Lowe, Katie McKnight, Sam Safran, Letitia Grenier, SFEI

Photo by Shira Bezalel, SFEI

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SPUR

Funding: **S.F. Bay Regional Water Quality Control Board**

With additional funding from the Bernard and Anne Spitzer Charitable Trust, the Marin Community Foundation, the Seed Fund, the Gordon and Betty Moore Foundation, and Google

Sea level rise is happening

Photo by Shira Bezalel, SFEI

Adapting to sea level rise will require big changes

How these changes collectively adapt the shoreline will determine the fate and health of the Bay

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A science-based framework is essential to identify effective adaptation strategies....

...that are appropriate for their particular settings and that take advantage of natural processes.

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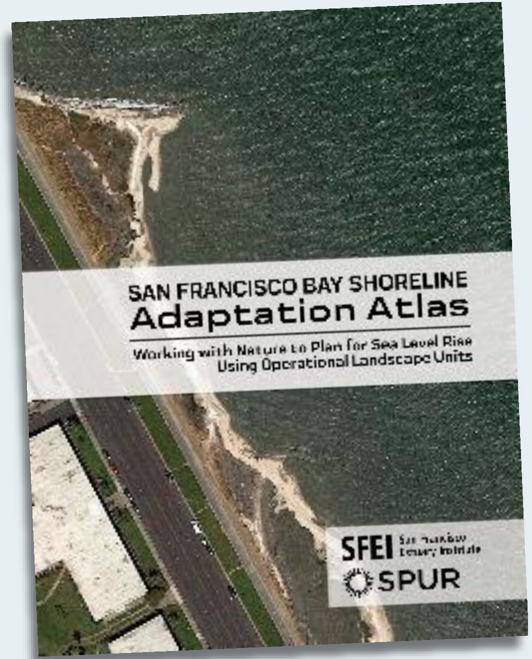
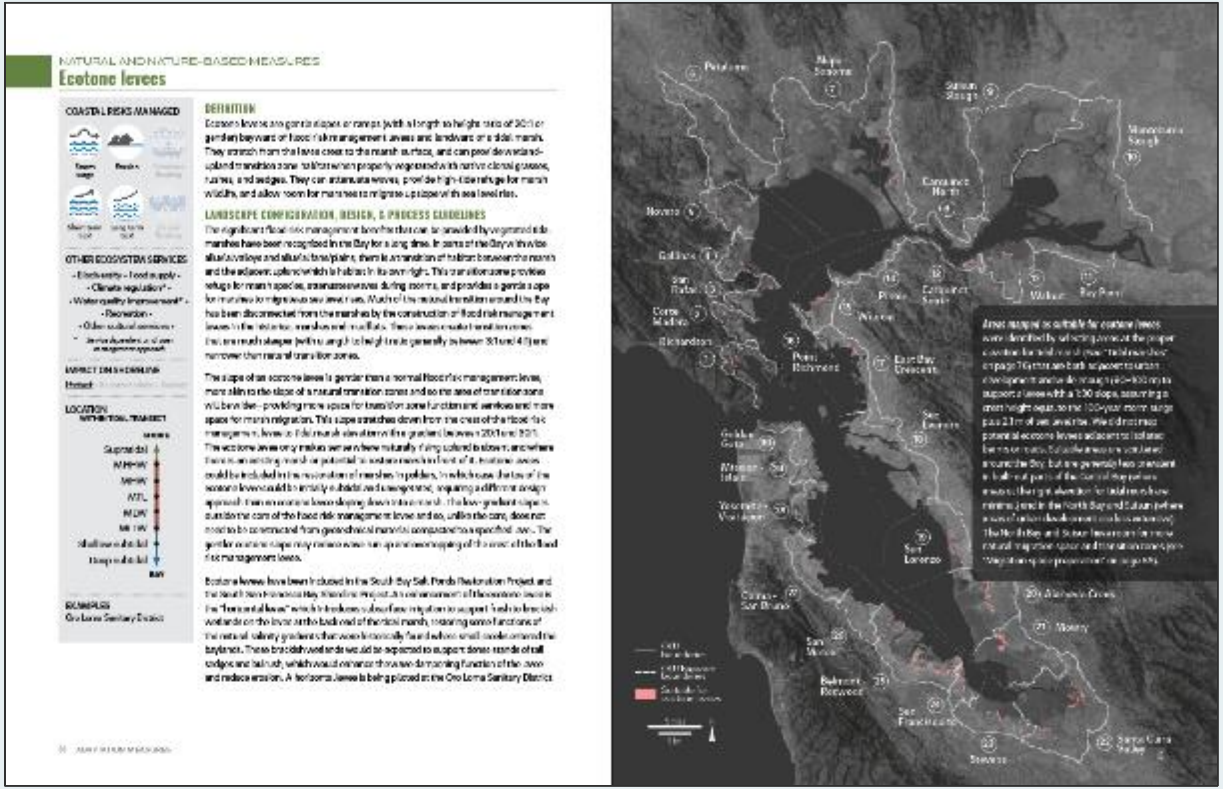
This project helps with filling that gap.





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In this urbanized estuary...

- The Bay and shoreline are **heterogeneous and dynamic**

SFEI

Courtesy of Google Earth

SFEI

Courtesy of Google Earth

SFEI

Courtesy of Google Earth

SFEI

Courtesy of Google Earth

SFEI


Courtesy of U.S. Geological Survey

In this urbanized estuary...

- The Bay and shoreline are **heterogeneous and dynamic**
- There is **no one-size-fits-all approach** for SLR adaptation

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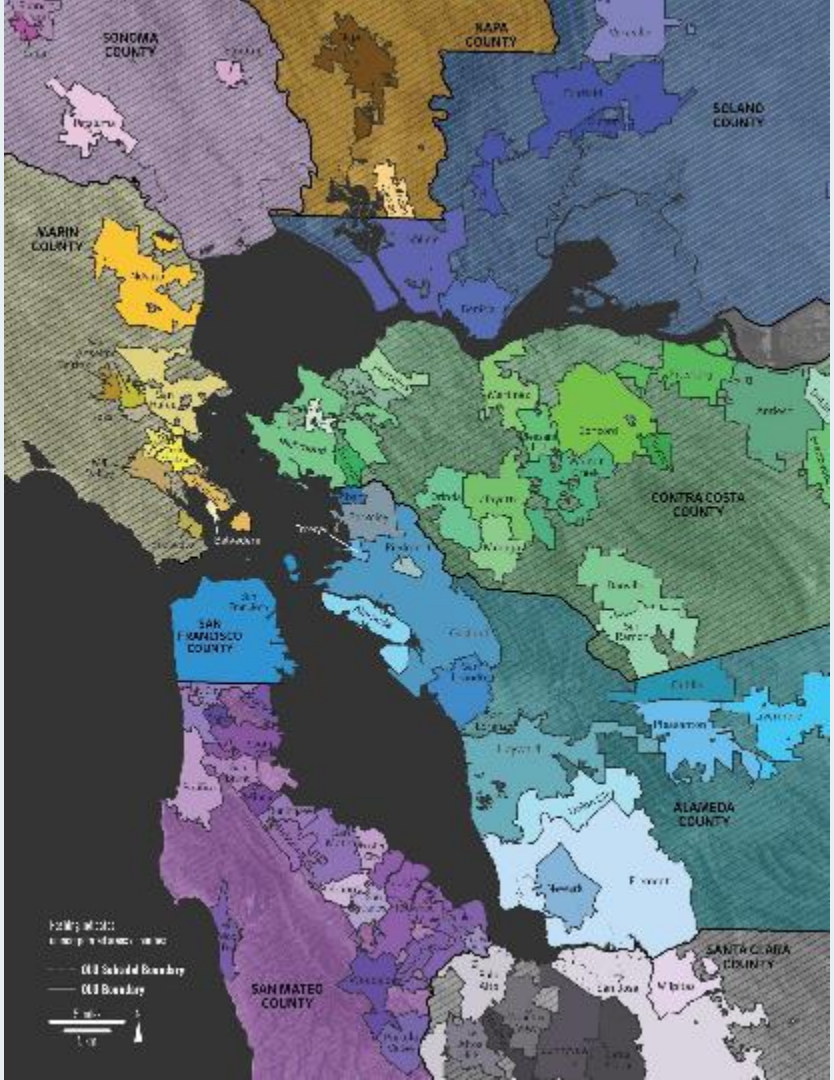
WATERSHED PROCESSES
OCEAN / BAY PROCESSES
ESTUARINE PROCESSES
Courtesy of Google Earth
SFEI

Traditional jurisdictions

- 9 counties
- 101 cities
- Multiple special districts
- Regulatory jurisdictions
- Frontline communities in low-lying areas



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Sea-level rise

will not stop at city boundaries.

SFEI

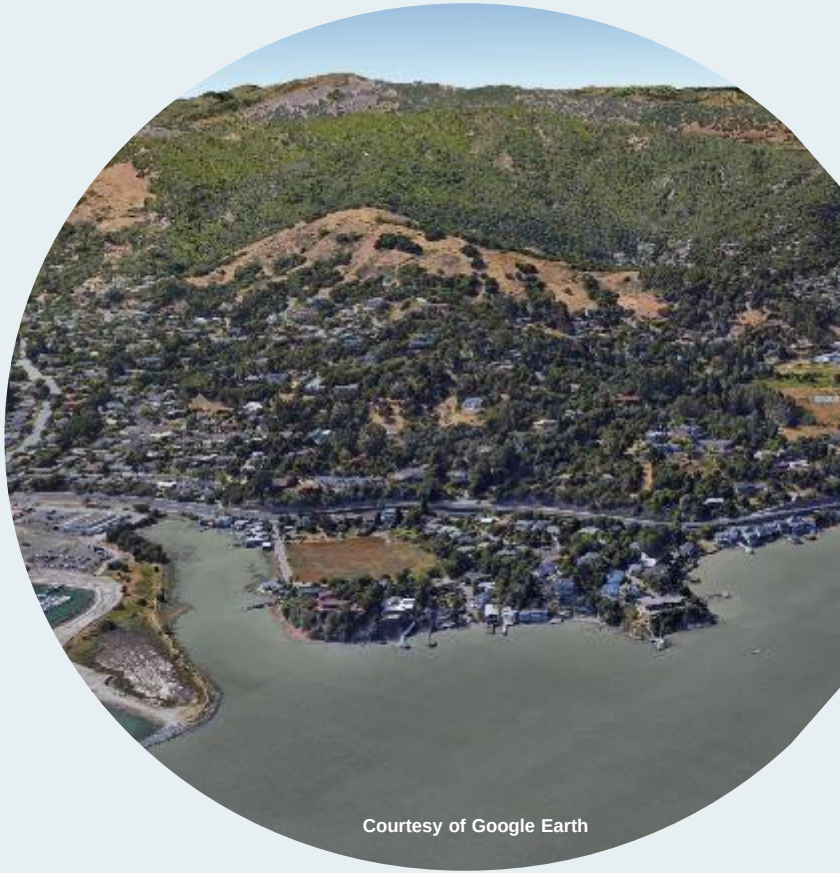
Photo by: Press Democrat

SFEI


SFEI

Addressing this challenge by:

- Dividing up the Bay into manageable units that respond to the **physical and ecological processes**
- Mapping **suitability for nature-based adaptation measures**
- **Integrating across the land-water divide,** and connecting bayside measures with landside measures



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STEP 1

Plan using nature's boundaries

(instead of traditional boundaries)

STEP 2

Identify adaptation measures that could work well in a given place

(and use nature as much as you can)

STEP 3

Use when bringing stakeholders together to envision a resilient future

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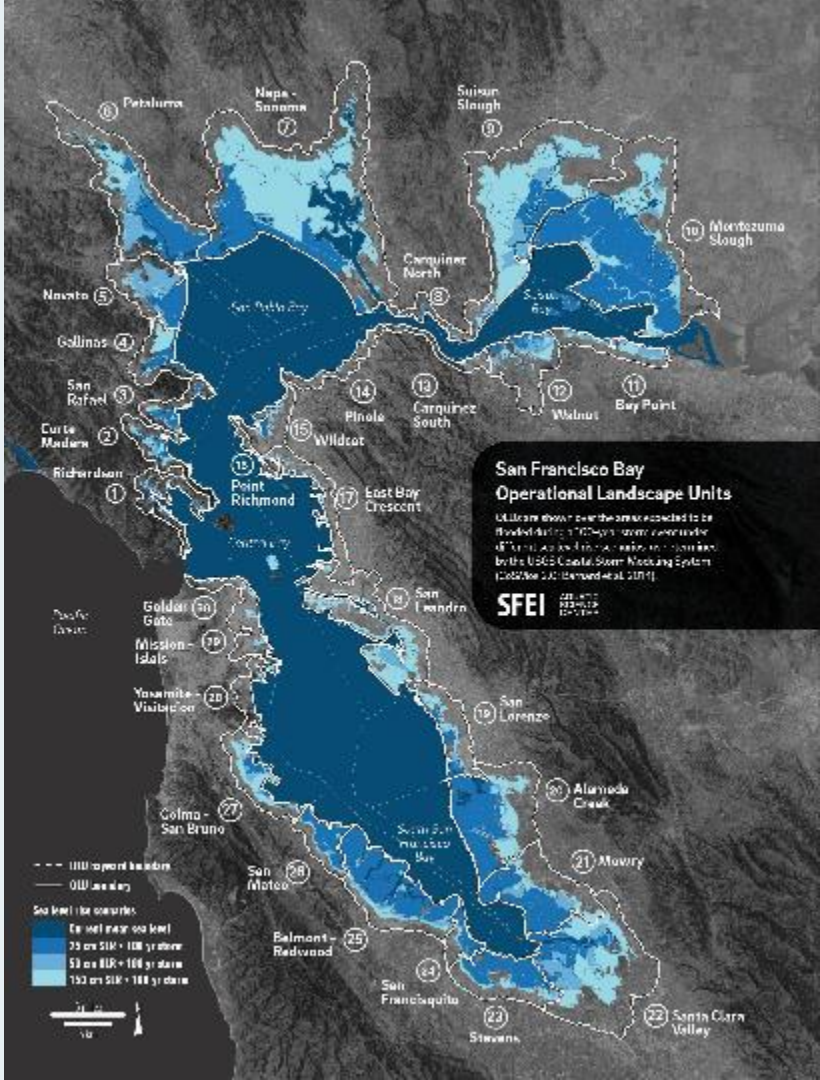
Nature's Boundaries

Operational Landscape Units

Areas with shared geophysical and land use characteristics ***suited for a particular suite of nature-based measures***

- ***Bigger than a project***
- ***Bigger than a City***
- ***Smaller than a County***



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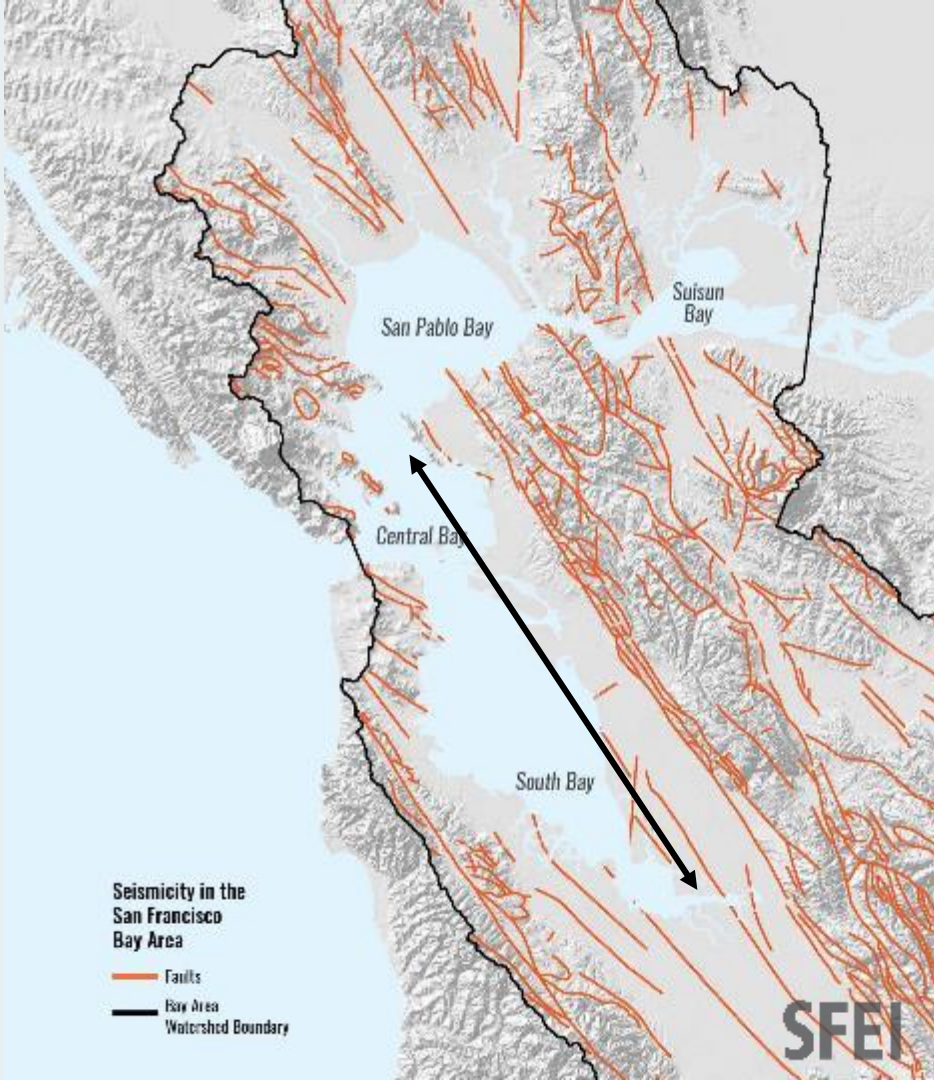
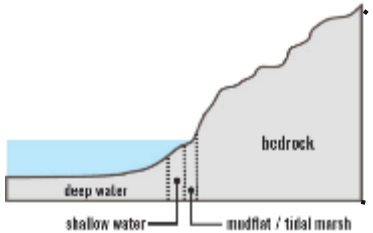
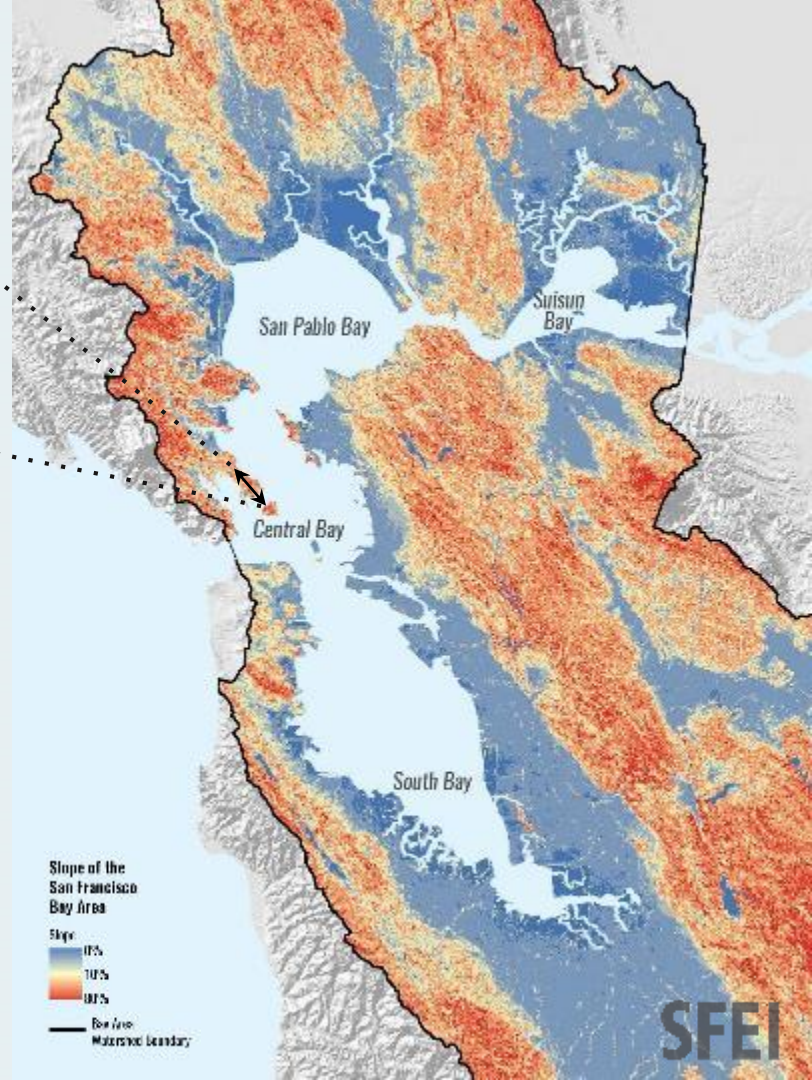
Faults & Topography



Geomorphic types

1 Headlands & small valleys





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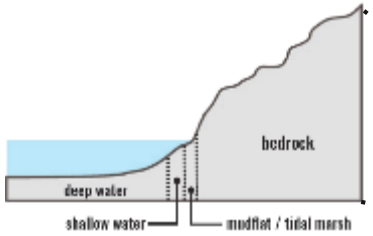
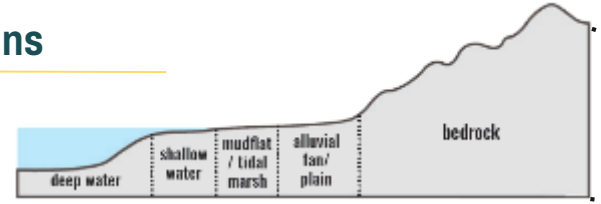
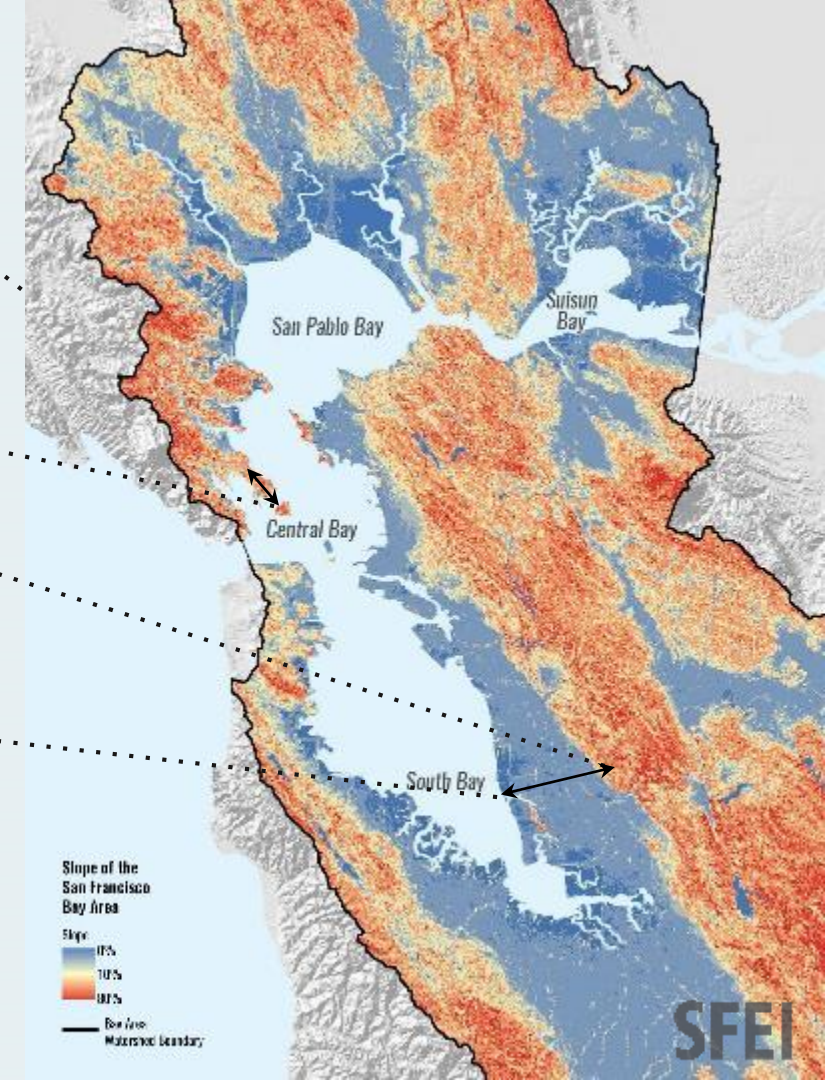


2 Alluvial fans & plains



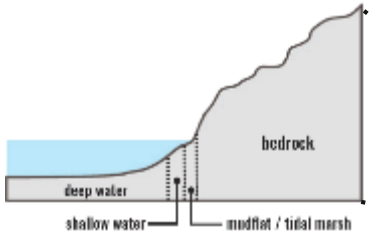


Surficial Geology

USGS

Geomorphic unit types

1 Headlands & small valleys



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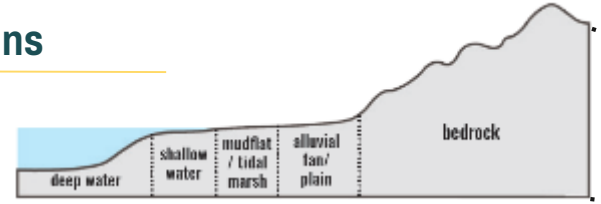
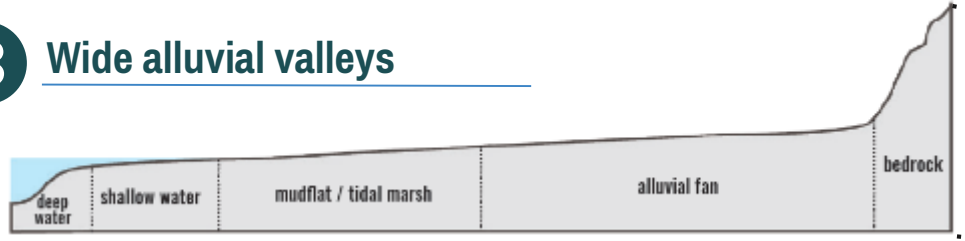
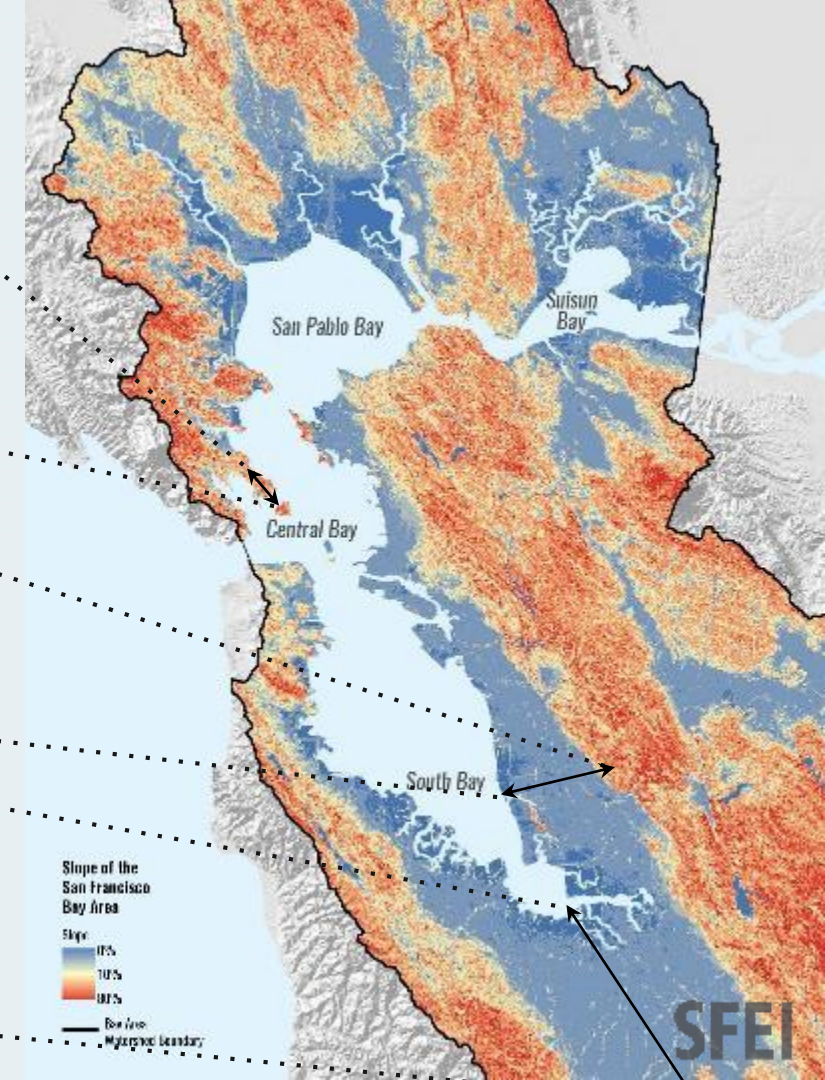


3 Wide alluvial valleys

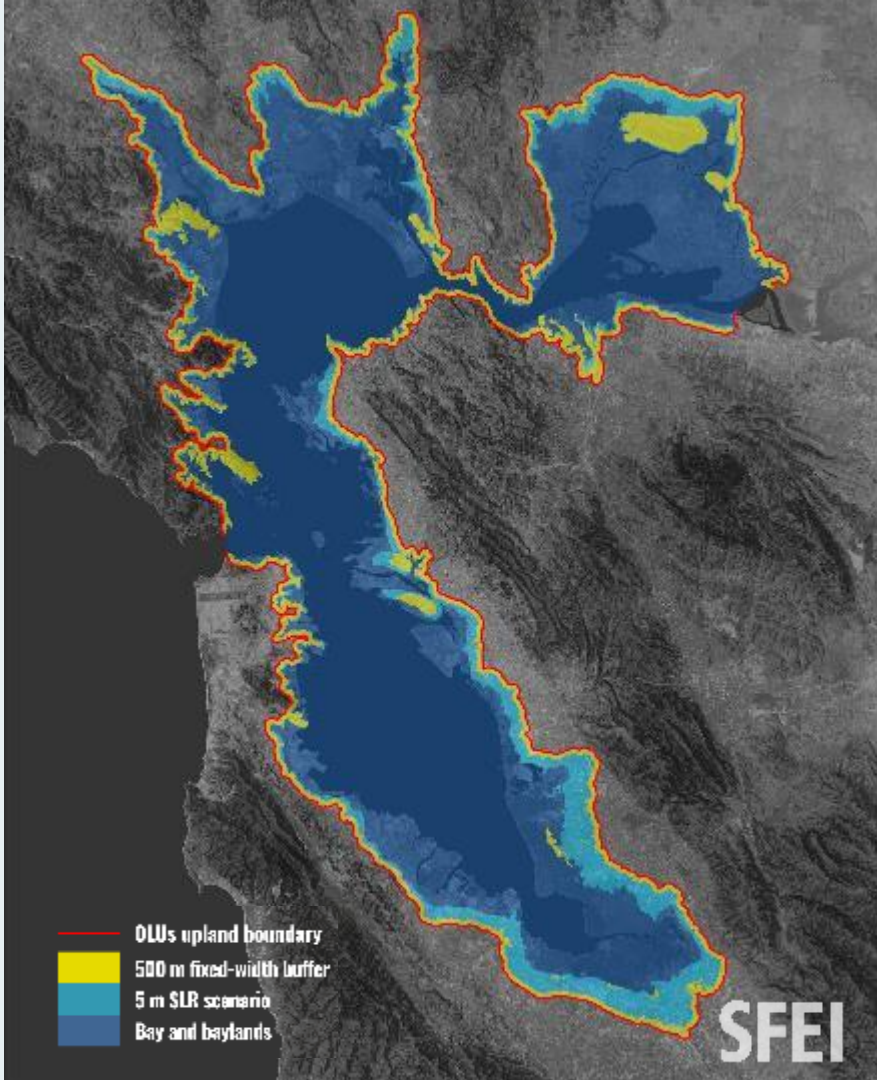





Courtesy of Google Earth
SFEI

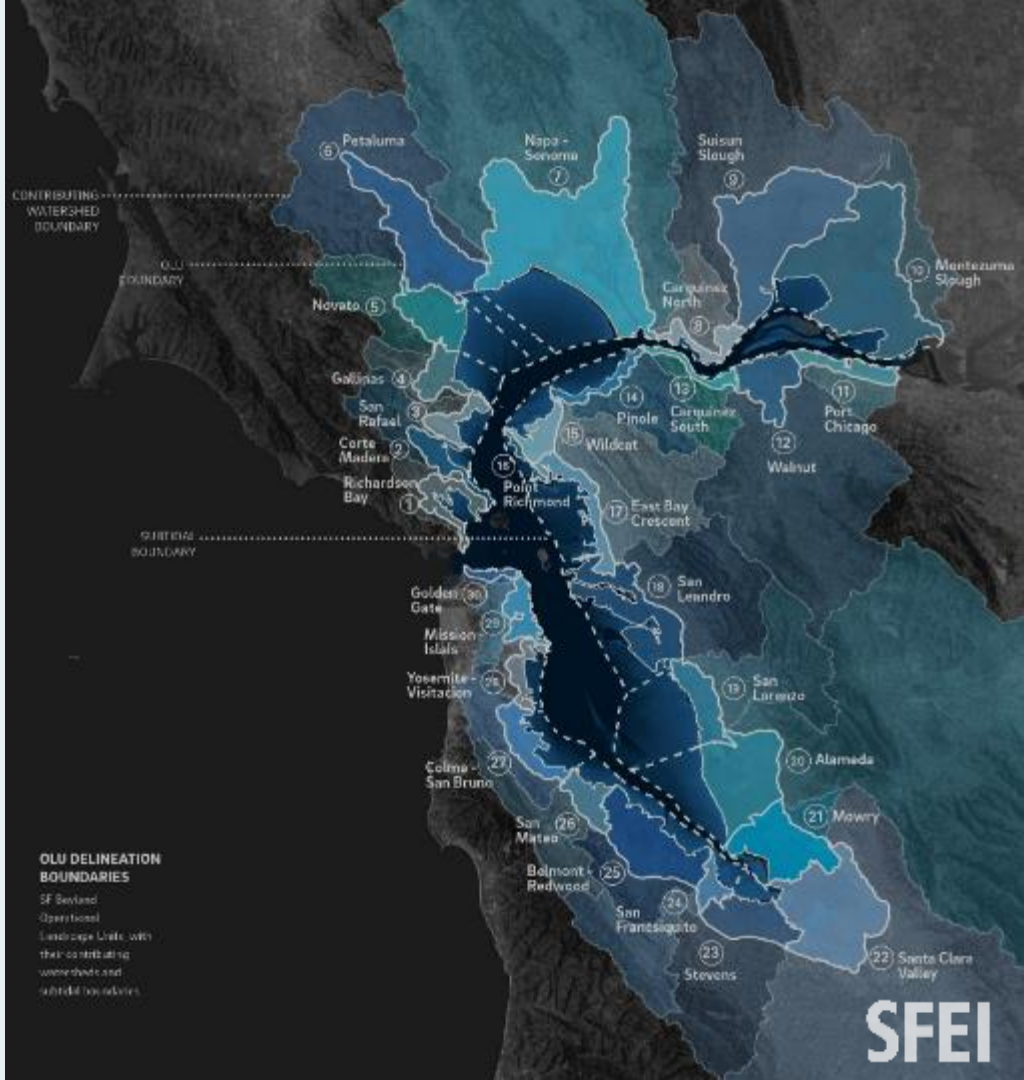
Area of analysis

- Back boundary
  - Baylands + 5 m SLR + transition zone with SLR
- Side boundaries
  - Drainage divides, tidal sheds, sewer sheds



Data inputs

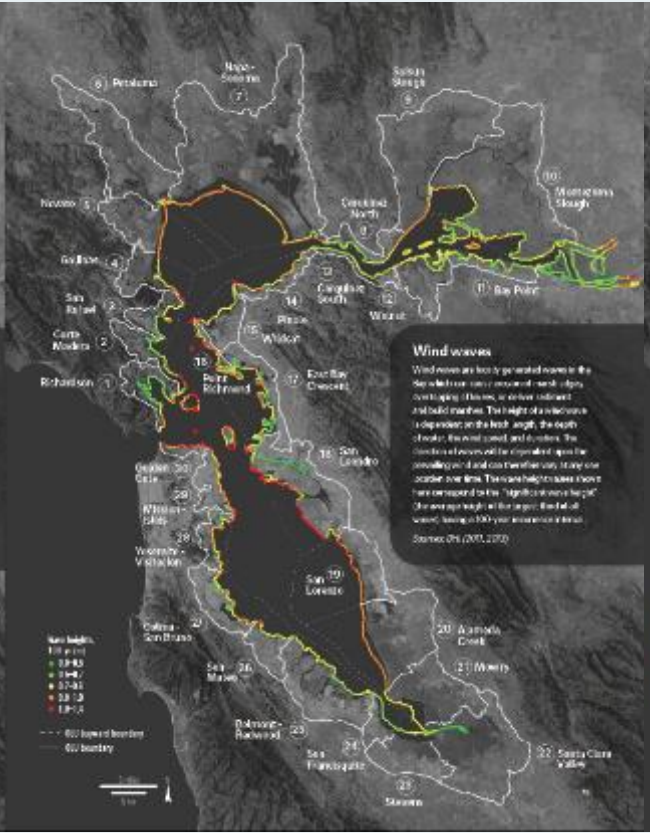
- Defined by geomorphic units & bathymetry
- Characterized by
  - Physical and ecological factors
  - Built environment patterns
  - Key vulnerabilities



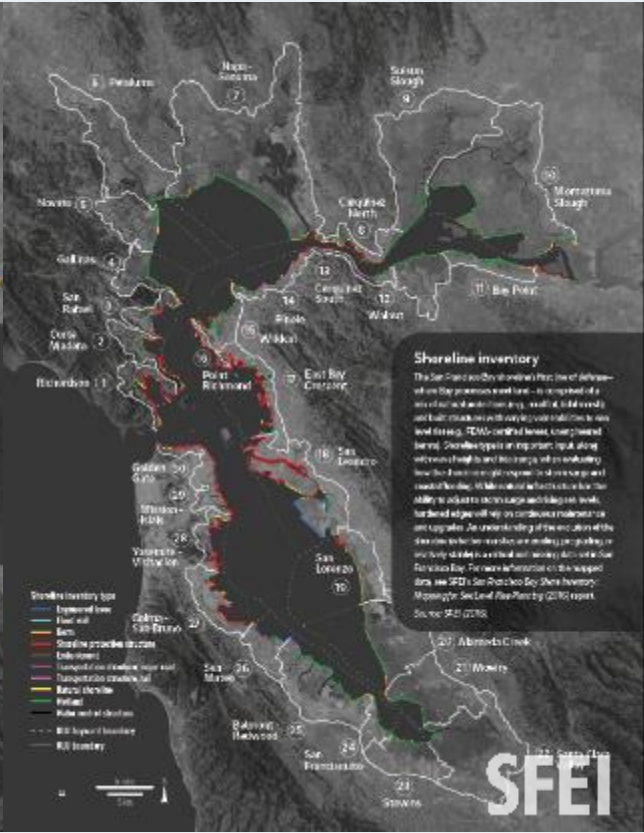
Shoreline characteristics

Tidal range

Wind-wave heights

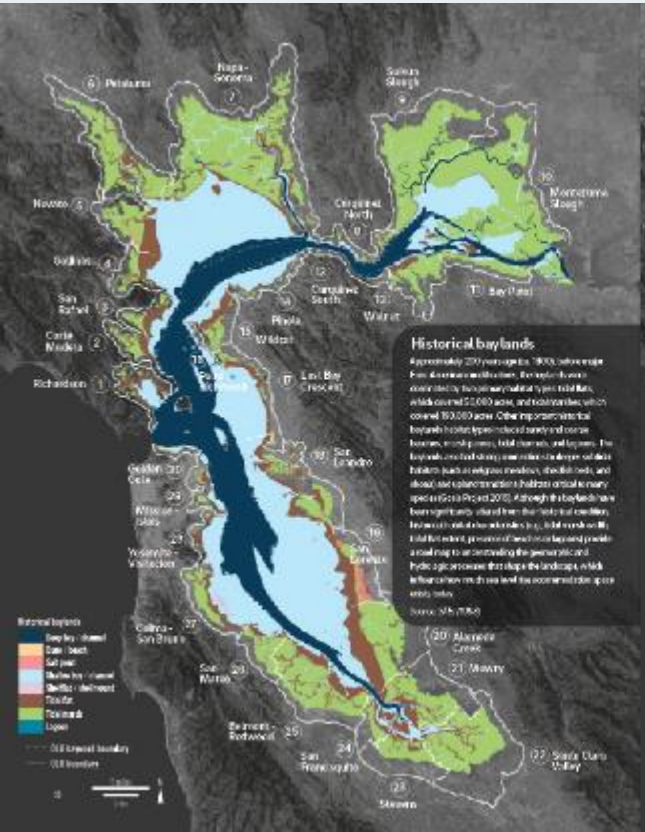


Shoreline composition

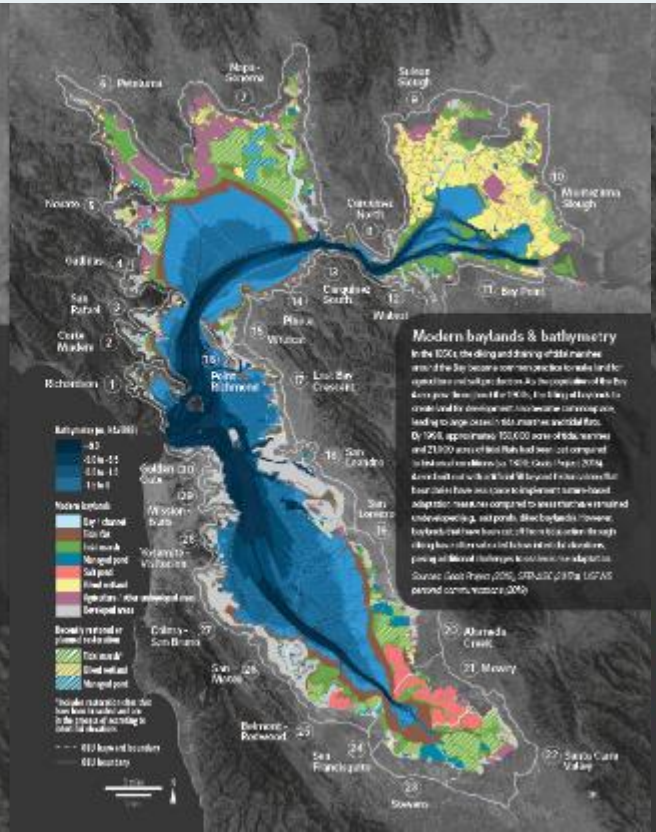


Baylands

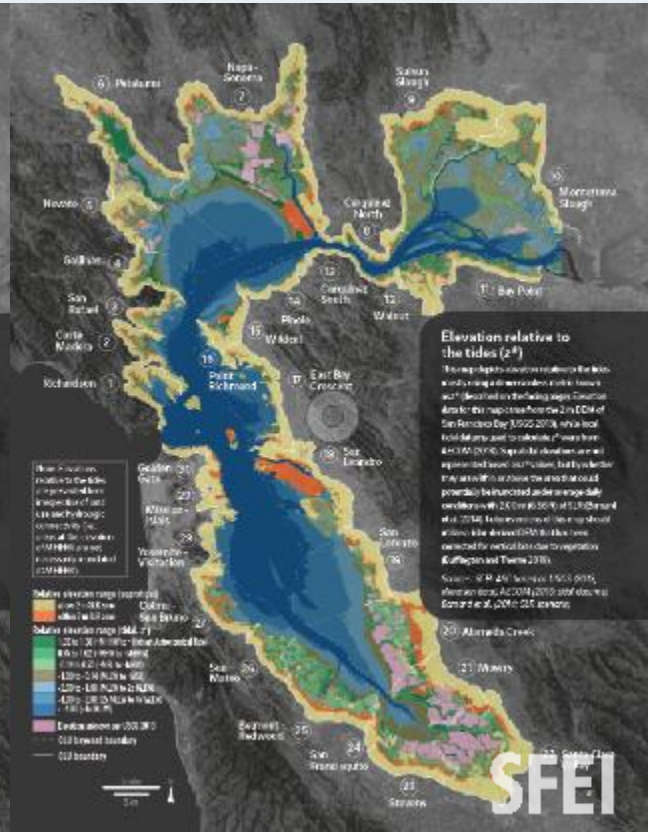
Historical baylands



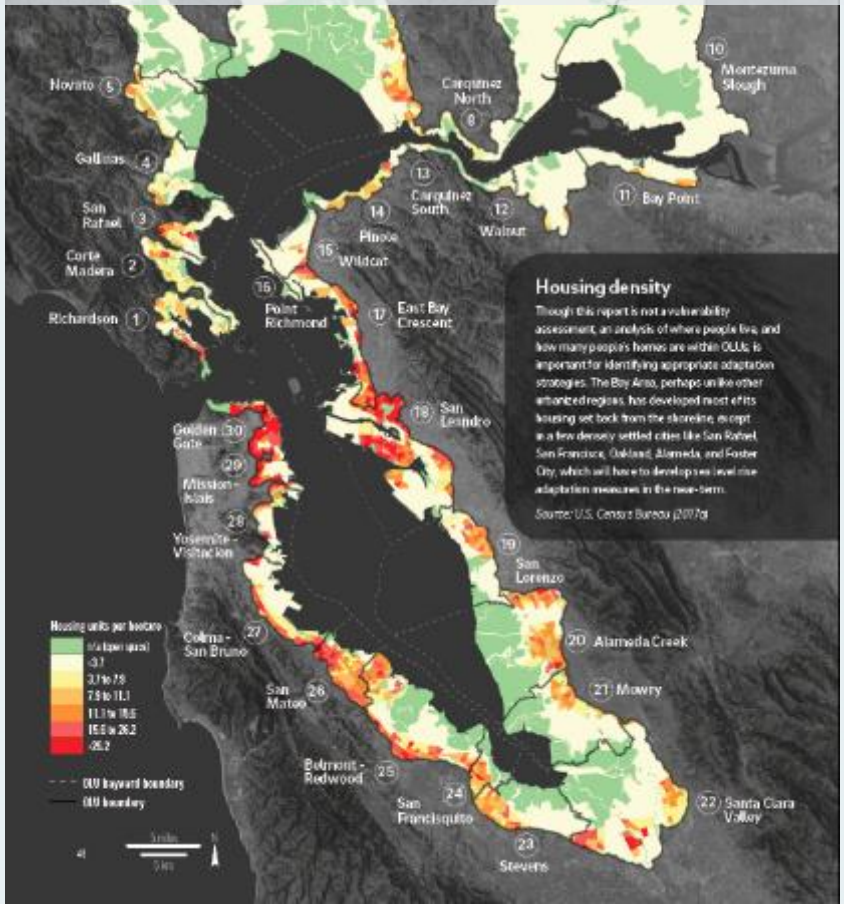
Modern baylands



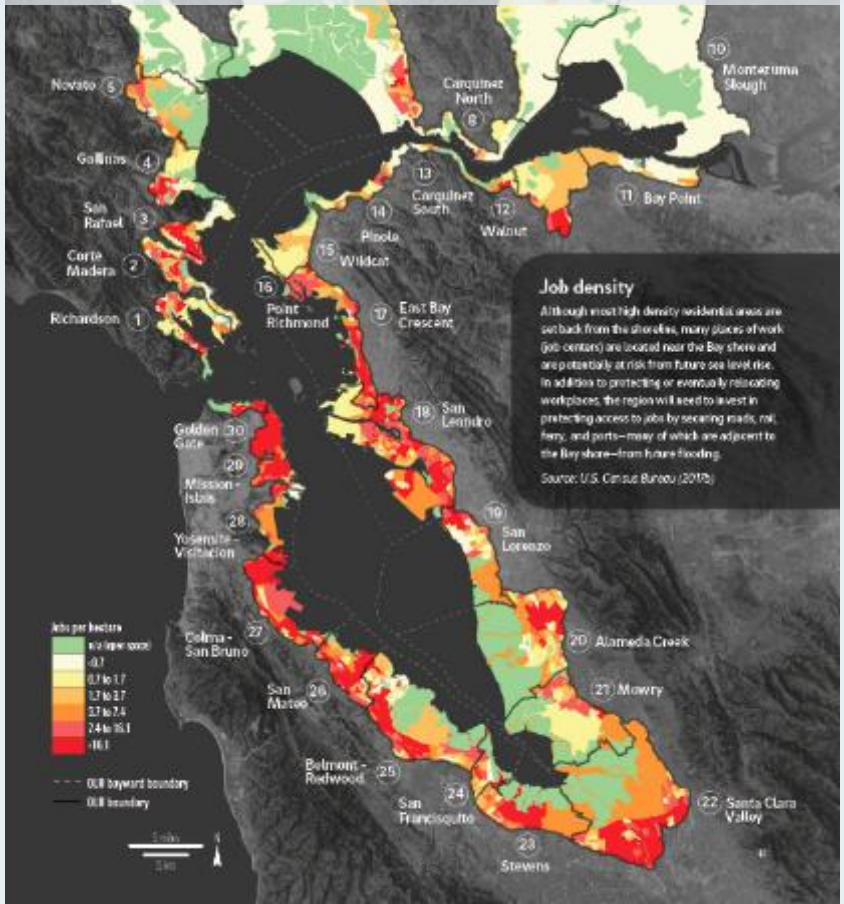
Elevation capital



Housing density



Job density



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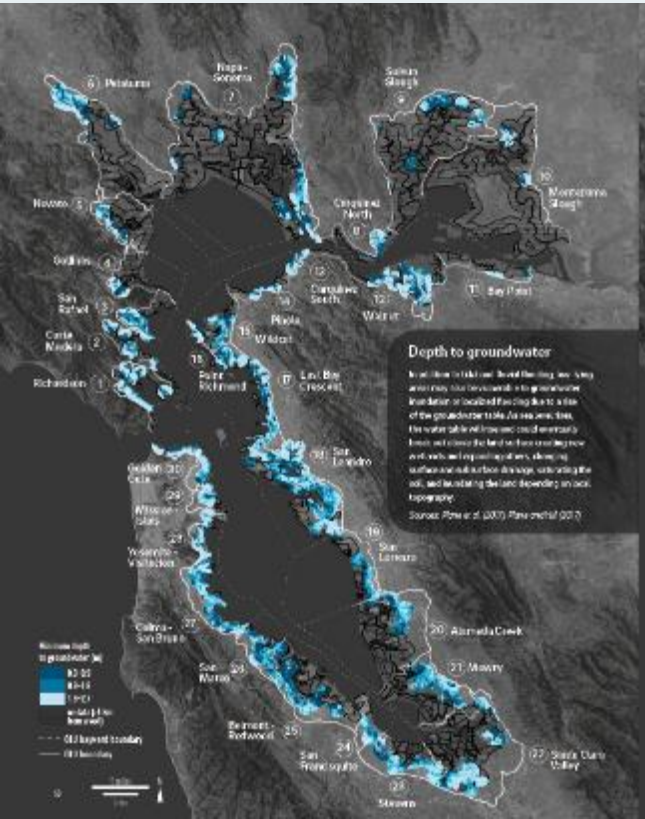
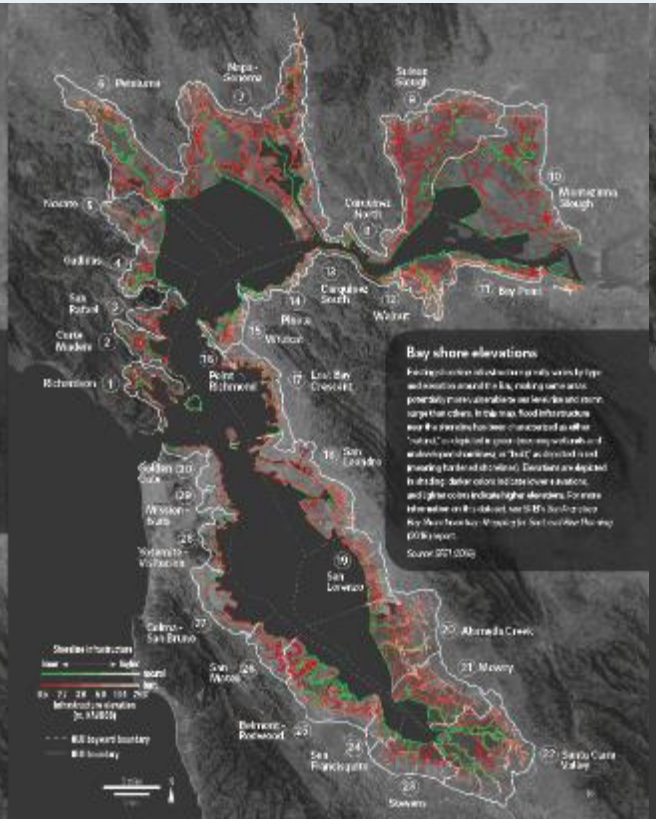
Vulnerability

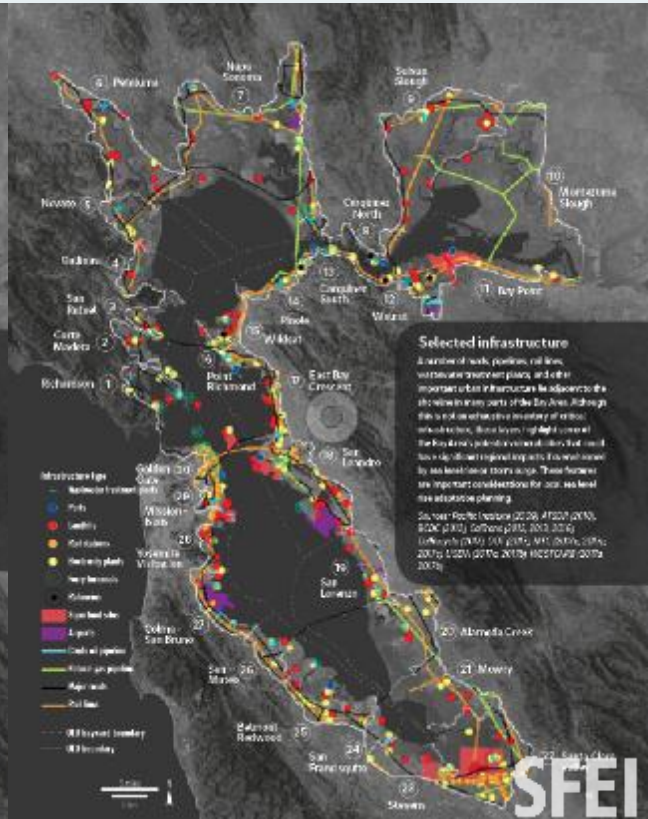
Depth to groundwater



Bay shore inventory



Infrastructure



STEP 1

Plan using nature's boundaries

(instead of traditional boundaries)

STEP 2

Identify adaptation measures that could work well in a given place

(and use nature as much as you can)

STEP 3

Use when bringing stakeholders together to envision a resilient future

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Photo: ESA
SFEI

Wave overtopping

Photo: Mark Taylor

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King tides


Photo: King Tides Initiative
7.12 ft NAVD - King Tide, 2019
Crab Cove Alameda
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Combined flooding: creeks, tides, groundwater

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Pairing problems with nature-based measures

PROBLEM (for example)	CAUSE	EXAMPLE MEASURE
Wave overtopping or erosion of levee with wide foreshore	Large waves reach levee	Marsh, fine beach, horizontal levee
Combined flooding	Loss of floodplain	Retention basins, setback levee
Loss of marsh area	Wave erosion of scarp	Coarse beach, oyster reef
Subsided areas behind levee	Diking and draining of marshes	Reconnect to creeks, warping

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Photo by Shira Bezalel

What are the benefits of nature-based adaptation?

- Multiple benefits
  - Clean water
  - Flood risk management
  - Food web and wildlife
  - Recreation and scenery
- Costs less
- More adaptable over time

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Adaptation measures

Nature-based measures

- Nearshore reefs
- Submerged aquatic vegetation (eelgrass)
- Beaches (sand, cobble, shell)
- Tidal marshes
- Polder management
- Ecotone levees
- Migration space preparation
- Creek-to-bayland reconnections
- Green stormwater infrastructure

Regulatory, financial, policy tools

- Zoning and overlay zones
- Setbacks, buffers, and clustering
- Building codes and building retrofits
- Rebuilding and redevelopment restrictions
- Conservation easements
- Tax incentives and special assessments
- Geologic Hazard Abatement District
- Transfer of Development Rights
- Buyouts

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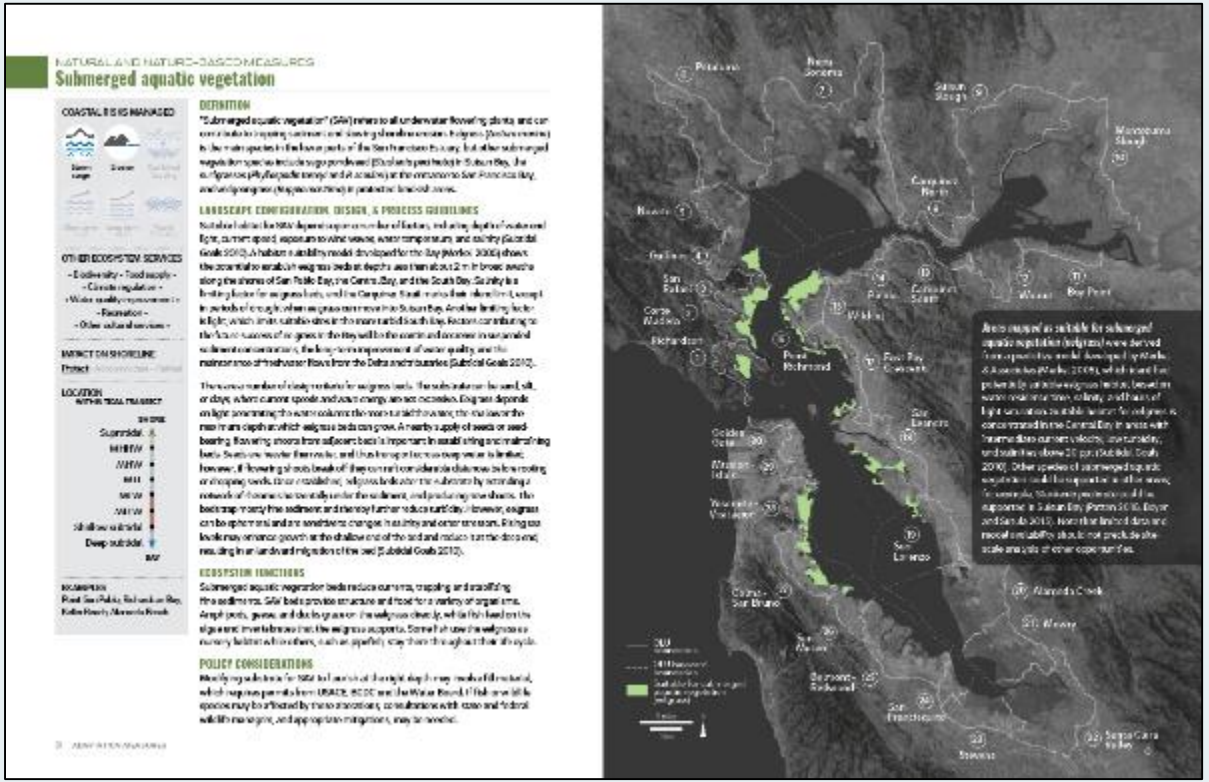
What is in the report



For each measure:

- Landscape configuration and process guidelines
- Ecosystem functions
- Coastal risks managed
- Ecosystem services
- Policy considerations
- Examples

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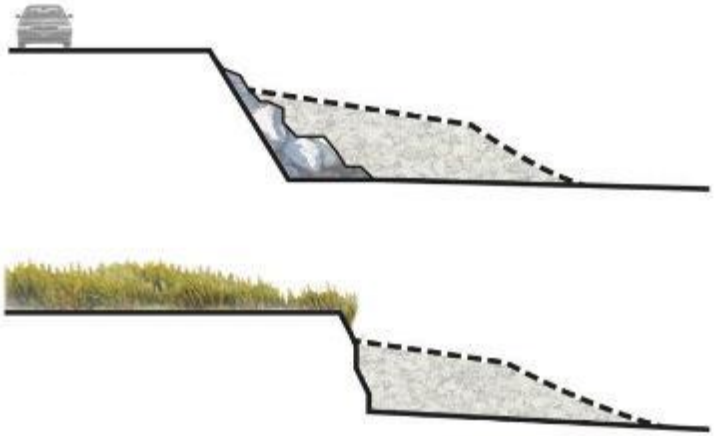
Beaches in S.F. Bay

San Francisco Bay had an estimated **27 miles of beaches** along its shoreline in the 1800s.

Beaches act **as a natural defense against sea level rise** by knocking down waves and protecting infrastructure near the shoreline from erosion.



Arambaru beach enhancement project

Peter Baye, Roger Leventhal

Living shorelines: oyster reefs

Giant Marsh Living Shorelines Project
Marilyn Latta

Coastal storm-surge barriers: tidal marsh & horizontal levee

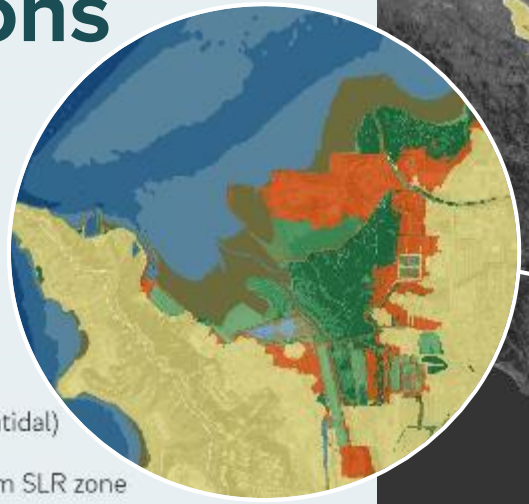
The Horizontal Levee
Courtesy of The Bay Institute

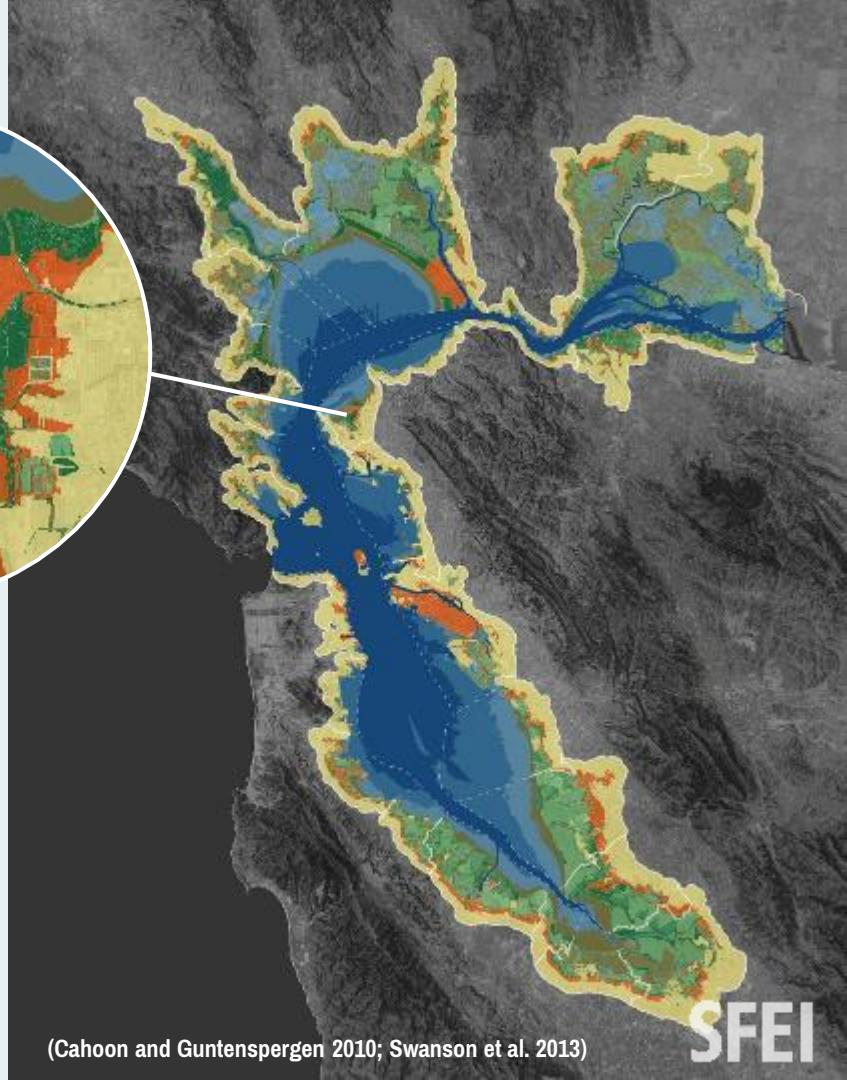
Relative elevations

Compares absolute elevation of land with local water levels & tidal range:

$$z^* = \frac{z - MSL}{MHHW - MSL}$$

MHHW = 1
MSL = 0
MLLW = -1





Elevation range (supratidal)

Upland zone
- above 200 cm SLR zone

Migration space / Transition zone
- within 200 cm SLR zone

Elevation range (tidal, z*)

Tidal marsh zone
- 1.02 to 1.38 (~MHHW to ~HAT)
- 0.75 to 1.02 (~MHW to ~MHHW)
- -0.14 to 0.75 (~MSL to ~MHW)

Unvegetated tidal flat zone
- -1.00 to -0.14 (MLLW to ~MSL)

Subtidal zone
- -1.00 to -2.00 (MLLW to 2x MLLW)
- -2.00 to -4.00 (2x MLLW to 4x MLLW)
- < -4.00 (<4x MLLW)

(Cahoon and Guntenspergen 2010; Swanson et al. 2013)

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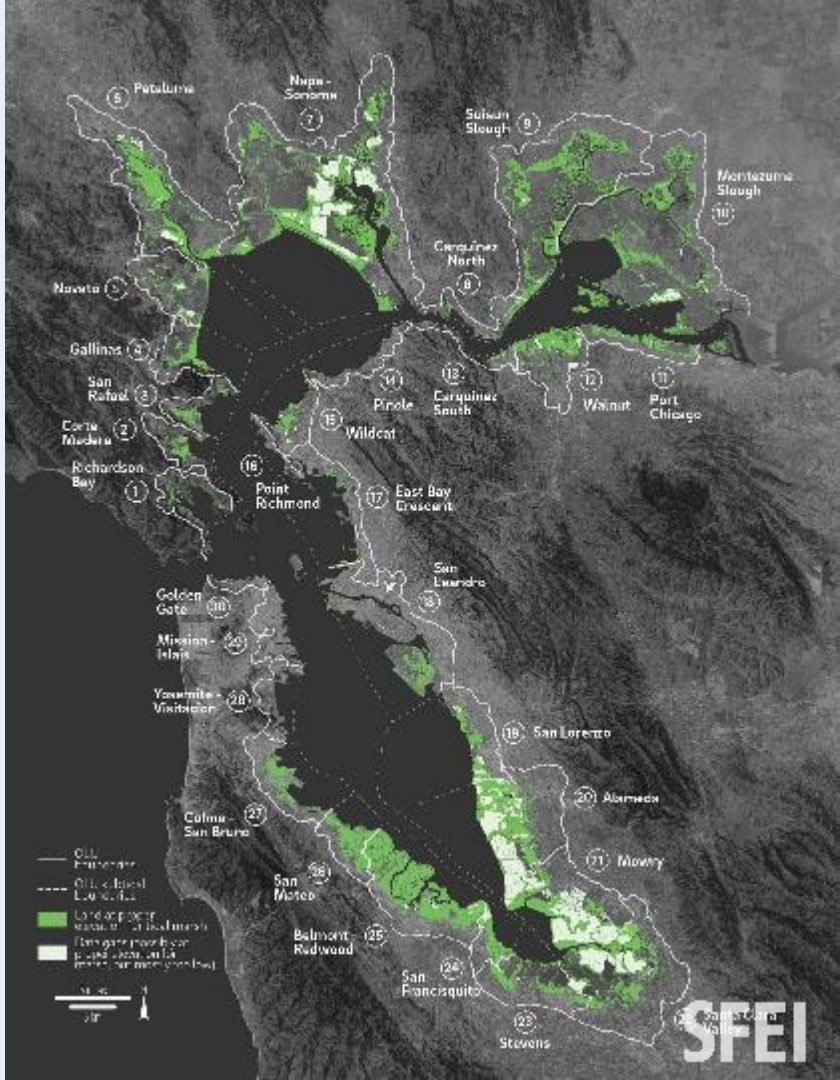
Marsh restoration

Methods:

- Identify areas currently at the right elevation to potentially support tidal marshes using z* (~MSL and ~HAT)
- Assess width of marsh needed to knock 100-year waves down to ~1 ft (0.3 m)



South Bay Salt Pond Restoration Project, 2013

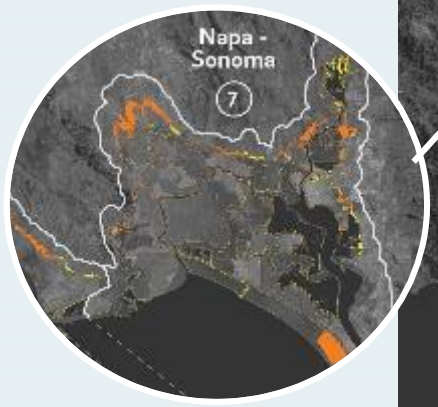
Migration space

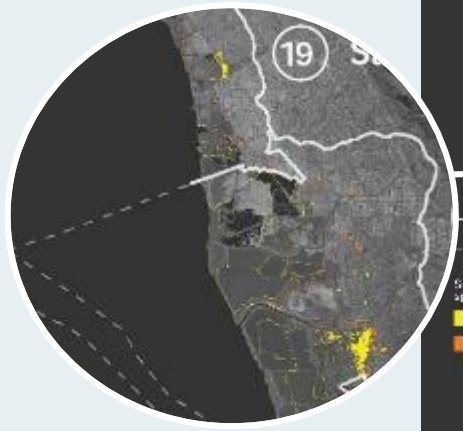
Methods:

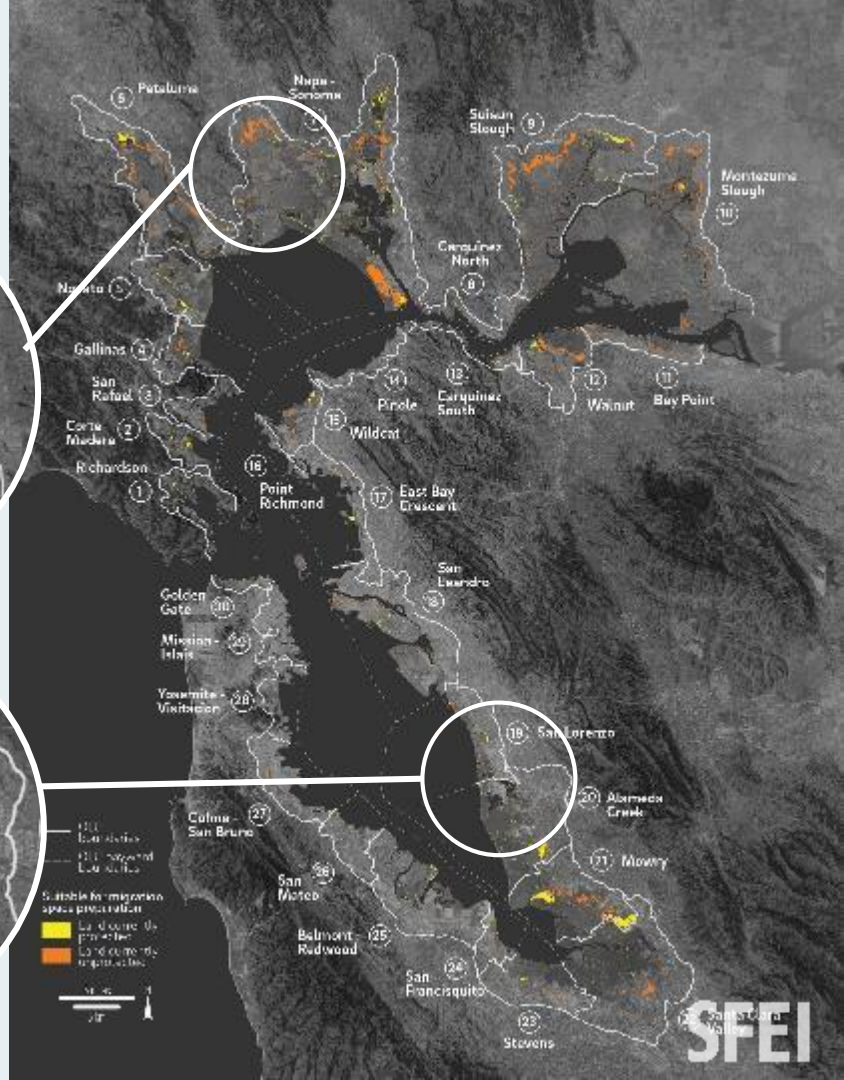
- Identify areas that are above tidal range now, but will be within tidal range in the future (areas where wetlands could migrate)

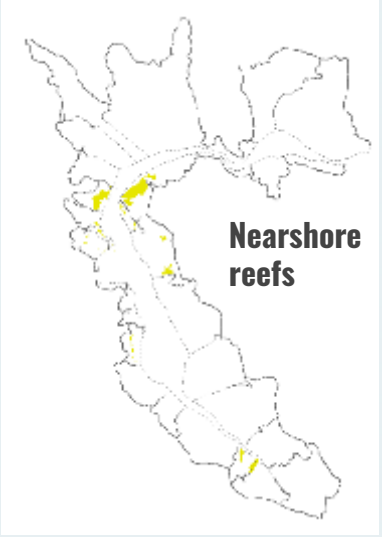
Protected

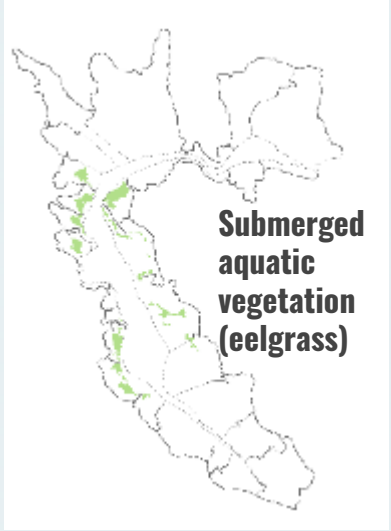
Unprotected







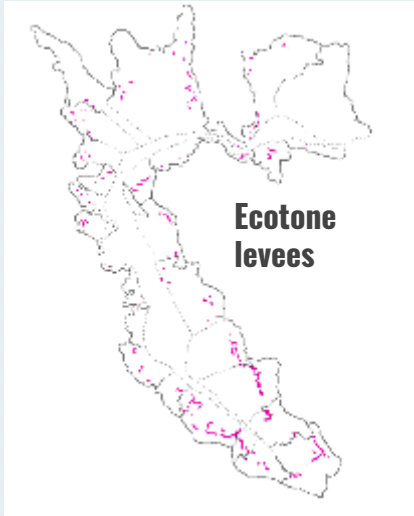

Nearshore reefs

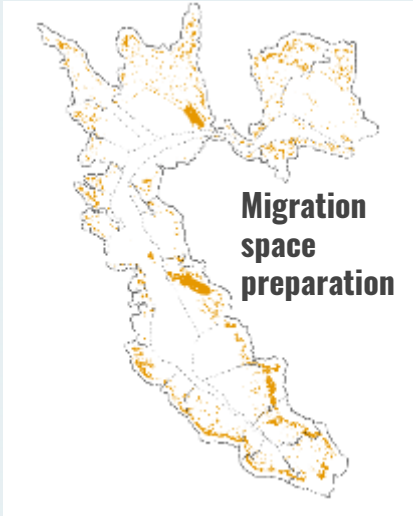

Submerged aquatic vegetation (eelgrass)


Beaches


Tidal marshes


Polder management


Ecotone levees


Migration space preparation

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Suitability

of nature-based measures

Suitability Rating

- Limited suitability
- Some suitability
- High suitability

	Nearshore reefs (p. 93)	Submerged aquatic vegetation (eelgrass) (p. 98)	Beaches (p. 72)	Tidal marshes (p. 76)	Polder management (p. 90)	Ecotone levees (p. 84)	Migration space preparation (p. 86)
1. Richardson	●	●	●	◔	○	◔	○
2. Corte Madera	●	●	●	◔	◔	◔	◔
3. San Rafael	●	●	●	◔	◔	◔	○
4. Gallinas	◔	●	○	●	●	◔	●
5. Novato	○	○	○	●	●	◔	●
6. Petaluma	○	○	○	●	●	○	●
7. Napa – Sonoma	○	○	○	●	●	◔	●
8. Carquinez North	○	○	○	●	○	◔	●
9. Suisun Slough	○	○	○	●	●	◔	●
10. Montezuma Slough	○	○	○	●	●	○	●
11. Bay Point	○	○	○	●	●	◔	●
12. Walnut	○	○	○	●	●	●	●
13. Carquinez South	○	○	○	◔	○	●	●
14. Pinole	●	○	●	◔	○	◔	○
15. Wildcat	●	●	●	●	◔	●	●
16. Point Richmond	●	●	●	○	○	○	○
17. East Bay Crescent	●	●	●	◔	○	●	○
18. San Leandro	○	●	●	◔	◔	○	○
19. San Lorenzo	○	●	●	●	◔	●	◔
20. Alameda Creek	○	○	●	●	●	●	●
21. Mowry	○	○	○	●	●	●	●
22. Santa Clara Valley	○	○	○	●	●	●	●
23. Stevens	◔	○	○	●	●	◔	◔
24. San Francisquito	●	○	○	●	◔	●	◔
25. Belmont - Redwood	○	○	●	●	●	●	○
26. San Mateo	○	●	●	◔	◔	◔	○
27. Colma - San Bruno	○	●	●	◔	○	◔	○
28. Yosemite - Visitacion	●	●	●	○	◔	○	○
29. Mission - Islais	○	●	●	○	○	○	○
30. Golden Gate	○	○	●	○	○	○	○

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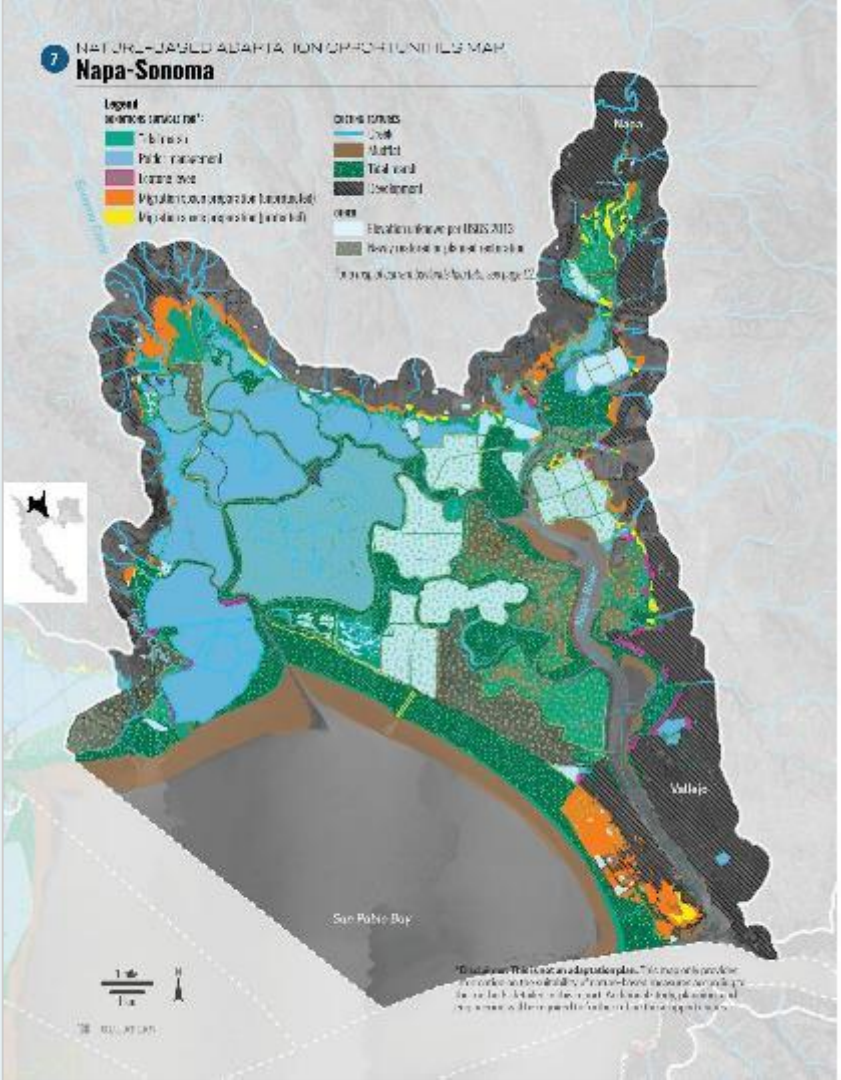


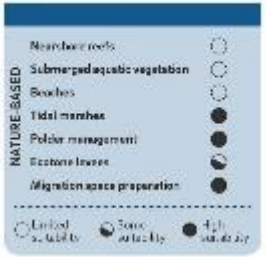
Nature-based Adaptation Measures

Polder management

Marsh Restoration

Migration Space

Creek connections



Aerial view looking downstream of the Napa River towards the Napa-Sonoma wetlands (Photo by WindCountry Media, CC BY 2.0)

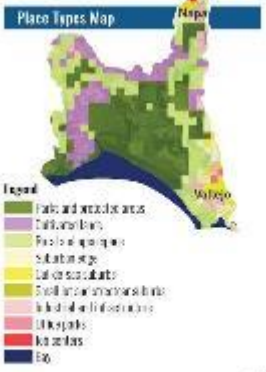
Other Adaptation Opportunities

Acquiring migration space

Easements, buyouts in open/ protected areas

Elevating roadways

Place Types Map



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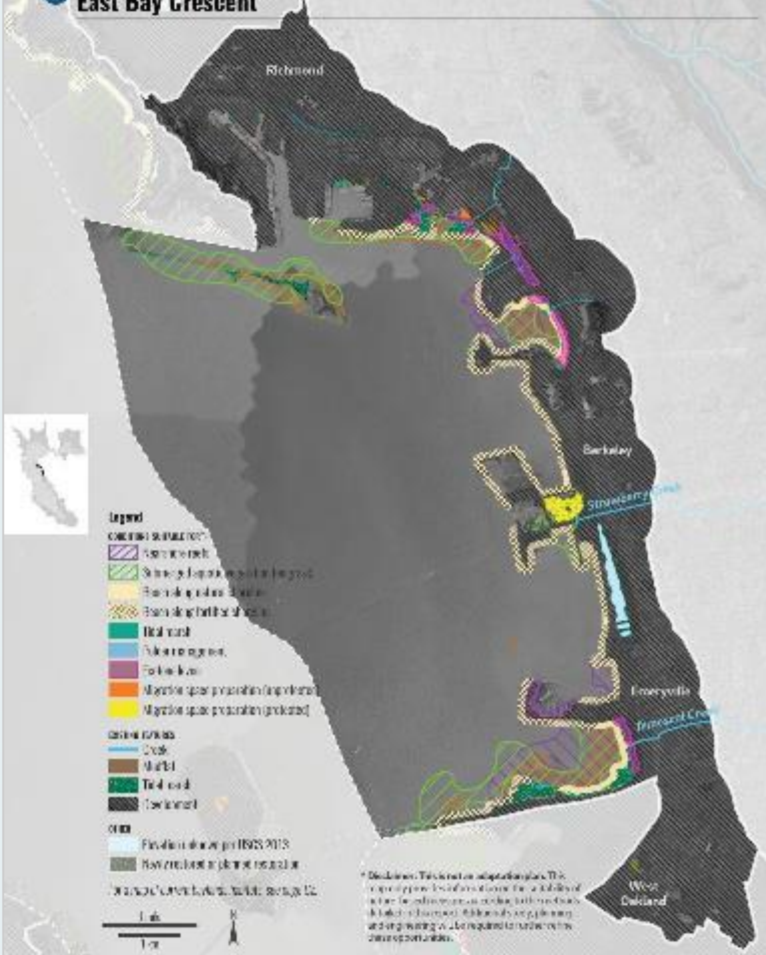
17 East Bay Crescent



Nature-based Adaptation Measures

- Horizontal Levees
- Beaches
- Eel grass
- Nearshore reefs

Selected Measures

NATURE-BASED Selected Measures	Suitability
Nearshore reefs	High suitability
Submerged aquatic vegetation	High suitability
Beaches	High suitability
Tidal marshes	Some suitability
Polder management	Limited suitability
Ecotone levees	High suitability
Migration space preparation	Limited suitability

Highways I-580/I-80 located next to tidal marsh in the East Bay Crescent OLU (Photo by Jay Huang, CC BY 2.0)

Other Adaptation Opportunities

- GHAD
- Transfer of development rights
- Elevating roadways

Place Types Map

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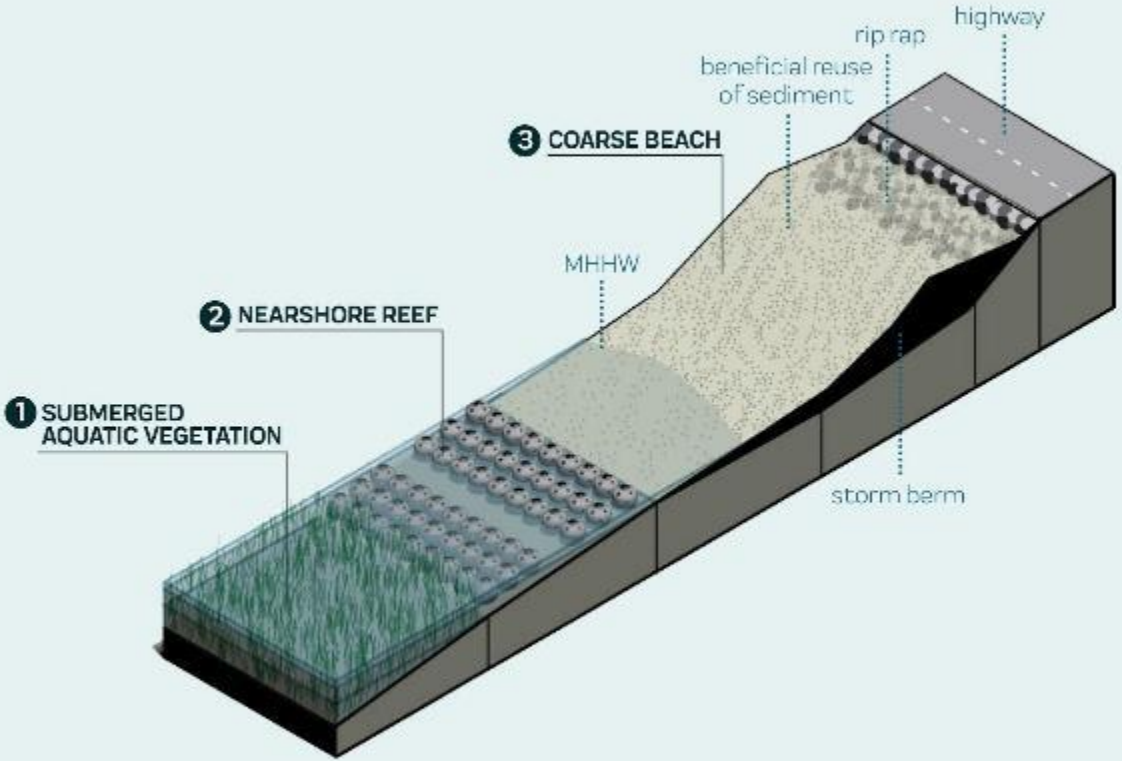
Combining measures



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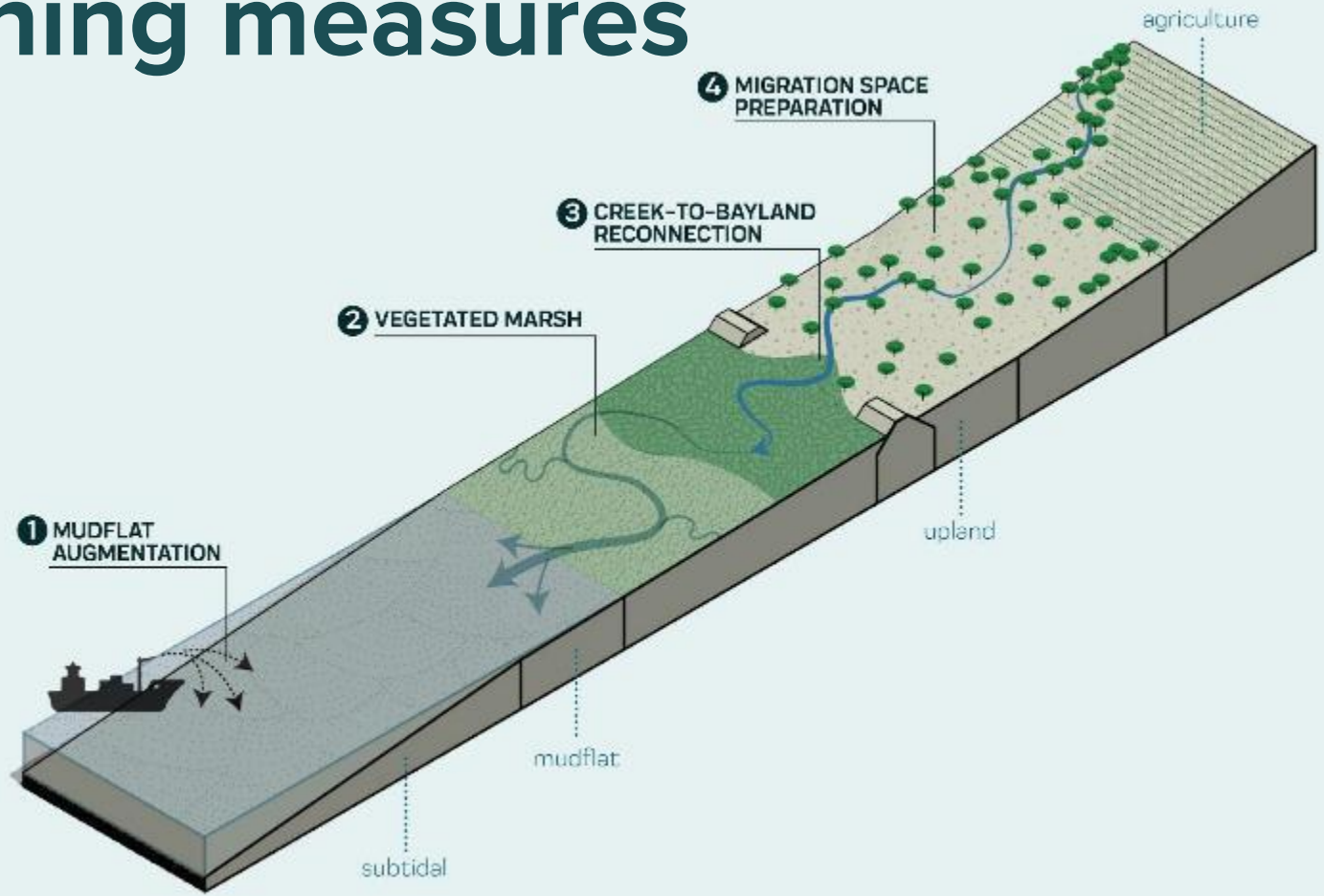
Combining measures



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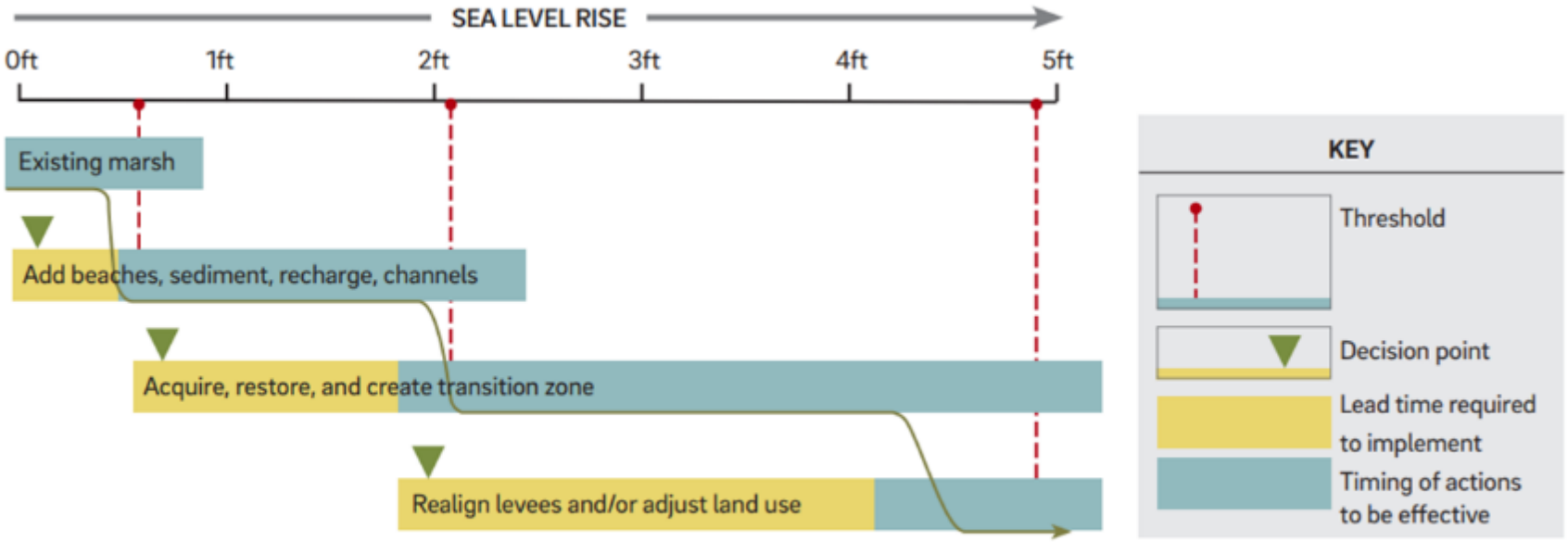
Adaptation pathways



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

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STEP 1

Plan using nature's boundaries

(instead of traditional boundaries)

STEP 2

Identify adaptation measures that could work well in a given place

(and use nature as much as you can)

STEP 3

Use when bringing stakeholders together to envision a resilient future

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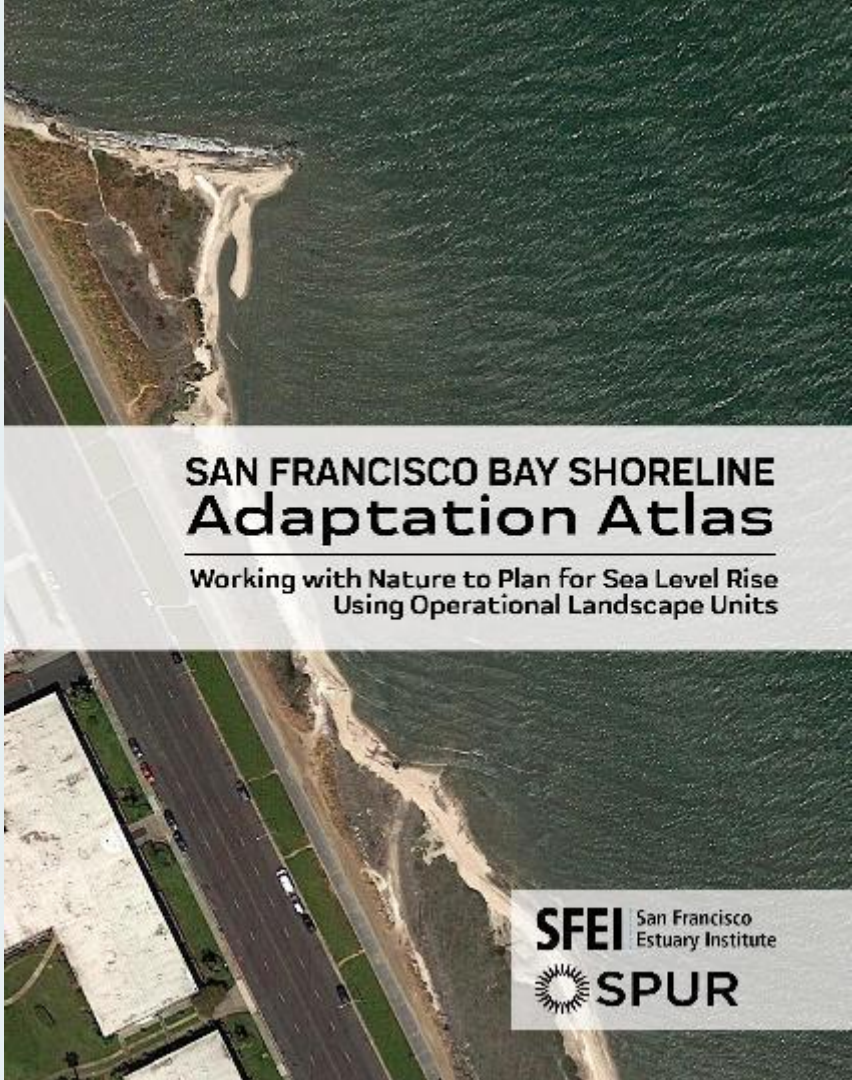
How can this be used?

- As a toolkit to bring together stakeholders around a given shoreline unit
- A resource to assist environmental review and permitting (Bay Conservation Development Commission, Regional Water Board)
- Guidance for developers and project applicants
- Local, regional planners, and communities creating adaptation plans and policies

Who is using this?

- **Bay Conservation Development Commission** for their vulnerability analysis
- **San Mateo** and **Marin Counties** to gather stakeholders, begin adaptation planning, create scenarios of future shorelines
- **Local cities** for adaptation planning



THANK YOU

Goals Projects

- baylandsgoals.org

Adaptation Atlas

- sfei.org/adaptationatlas

Contact

- letitia@sfei.org

SFEI AQUATIC SCIENCE CENTER

SPUR

Funded by: **S.F. Bay Regional Water Quality Control Board**

With additional funding from the Bernard and Anne Spitzer Charitable Trust, the Marin Community Foundation, the Seed Fund, the Gordon and Betty Moore Foundation, and Google

When the water crosses over (the horizontal levee)

- What is the landscape like in the **‘dry land’** part of the OLU?
- What are the **land uses** that may be potentially **inundated?**
- What is the **‘menu’** of available **structural, policy, financial, and regulatory** measures?

Courtesy of Google Earth

Courtesy of Google Earth

SFEI

Courtesy of Google Earth

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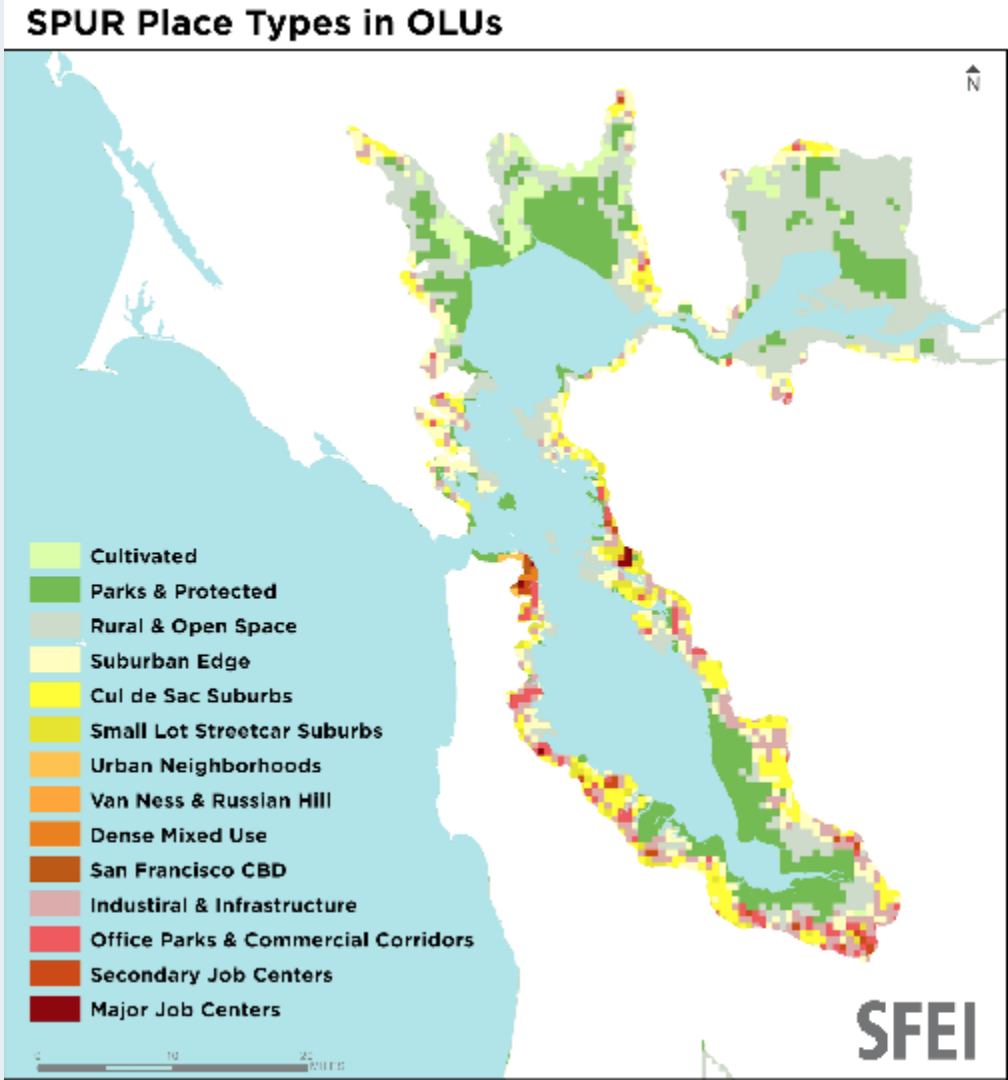
Place-types index

Five factors in characterizing land uses as place-types:

- Intersection density
- Permeability
- Housing unit density
- Job density
- Land use mix

Open space categories additionally classified using CPAD, NLCD



Open space

Urban neighborhoods

Secondary job centers

Suburban edge

Office parks and commercial

Dense mixed use

Adaptation measures

Nature-based measures

- Nearshore reefs
- Submerged aquatic vegetation (eelgrass)
- Beaches (sand, cobble, shell)
- Tidal marshes
- Polder management
- Ecotone levees
- Migration space preparation
- Creek-to-bayland reconnections
- Green stormwater infrastructure

Regulatory, financial, policy tools

- Zoning and overlay zones
- Setbacks, buffers, and clustering
- Building codes and building retrofits
- Rebuilding and development restrictions
- Conservation easements
- Tax incentives and special assessments
- Geologic Hazard Abatement District
- Transfer of Development Rights
- Buyouts

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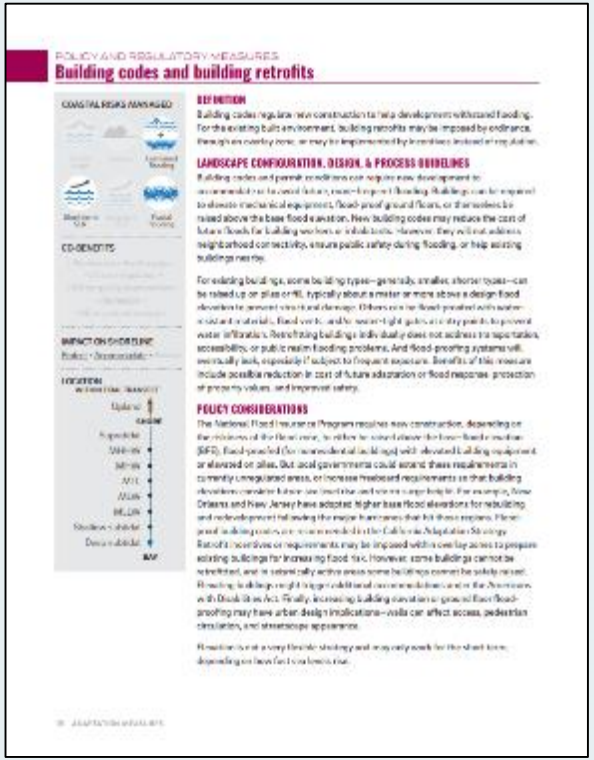
Regulatory, financial, & policy tools

- We convened landscape architects, building engineers, and urban designers to vet suitable flood control strategies by place-type
- We used this information to suggest planning and policy measures for specific OLUs based on their land use mix, and the sequence of place-types in a transect from the shoreline landwards



POLICY AND REGULATORY MEASURES

Building codes and building retrofits

COASTAL RISKS MANAGED

CO-BENEFITS

IMPACT ON SHORELINE

LOCATION

DEFINITION

Building codes regulate new construction to help development withstand flooding. For the existing built environment, building retrofits may be imposed by ordinance, through a overlay zone, or may be implemented by incentives (reduced insurance premiums).

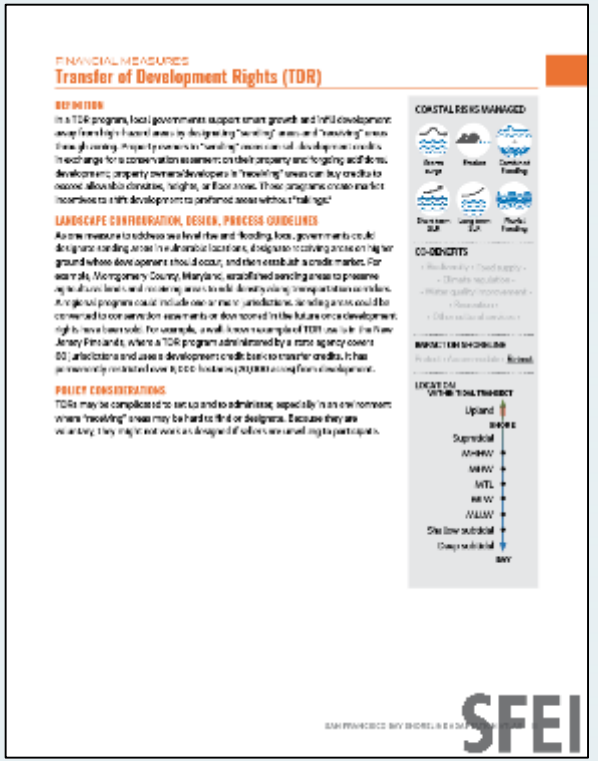
LANDSCAPE CONFIGURATION, DESIGN, & PROCESS GUIDELINES

Building codes and permit conditions can require new development to accommodate or be raised above future, more frequent flooding. Buildings can be required to elevate mechanical equipment, flood-proof ground floors, or themselves be raised above the base flood elevation. New building codes may reduce the cost of future floods for building owners or inhabitants. However, they will not address neighborhood connectivity, ensure public safety during flooding, or help existing buildings near risk.

For existing buildings, some building types—generally, smaller, shorter types—can be raised up on piles or fill, typically about a meter or more above a design flood elevation to prevent structural damage. Others can be flood-proofed with water-resistant materials, flood vents, and/or water-tight gates and dry panels to prevent water infiltration. Retrofitting buildings individually does not address the vegetation, accessibility, or public realm flooding problems. And flood-proofing systems will eventually leak, especially if subject to frequent exposure. Benefits of this measure include possible reduction in cost of future relocation or flood response, protection of property values, and improved safety.

POLICY CONSIDERATIONS

The National Flood Insurance Program requires new construction, depending on the riskiness of the flood zone, to either be raised above the base flood elevation (BFE). Flood-proofed (for non-residential buildings) with elevated building equipment or elevated on piles. But local governments could extend these requirements in currently unregulated areas, or increase freeboard requirements on their building elevations considering future sea level rise and storm surge height. For example, New Orleans and New Jersey have adopted higher base flood elevations for rebuilding and redevelopment following the major hurricanes that hit those regions. Flood-proofing policies are recommended in the California Adaptation Strategy. Rates of incentives or requirements may be imposed with a overlay zones to prepare existing buildings for increasing flood risk. However, some buildings cannot be retrofitted, and in seismically active areas some building cannot be safely raised. Elevating buildings might trigger additional requirements under the Americans with Disabilities Act. Finally, increasing building elevations in general flood-proofing may have urban design implications—walls can affect access, pedestrian circulation, and streetscape appearance.



FINANCIAL MEASURES

Transfer of Development Rights (TDR)

DEFINITION

In a TDR program, local governments support smart growth and infill development away from high hazard areas by designating "sending" areas and "receiving" areas through zoning. Property owners in "sending" areas can sell development credits in exchange for a conservation easement on their property and forgoing additional development; property owners/developers in "receiving" areas can buy credits to exceed allowable densities, heights, or floor areas. These programs create market incentives to shift development to preferred areas without "takings."

LANDSCAPE CONFIGURATION, DESIGN, PROCESS GUIDELINES

As one measure to address sea level rise and flooding, local governments could designate sending areas in low elevation locations, designate receiving areas on higher ground where development should occur, and then create a credit market. For example, Montgomery County, Maryland, established sending areas to preserve agricultural uses and receiving areas to add density along transportation corridors. A regional program could include one or more jurisdictions, including areas could be connected to conservation easements or downzoned in the future once development rights have been sold. For example, a well-known example of TDR use is the New Jersey Pinelands, where a TDR program administered by a state agency covers 60 jurisdictions and uses a development credit bank to transfer credits. It has permanently restricted over 9,000 hectares (23,000 acres) from development.

POLICY CONSIDERATIONS

TDRs may be complicated to set up and to administer, especially in an environment where "receiving" areas may be hard to find or designate. Because they are voluntary, they might not work in a designed if sellers are unwilling to participate.

COASTAL RISKS MANAGED

CO-BENEFITS

IMPACT ON SHORELINE

LOCATION WITHIN TDR TRANSECT

Upland

BEACH

Supratidal

AHHW

MHW

MTL

MLW

MLLW

Shallow subtidal

Deep subtidal

BAY

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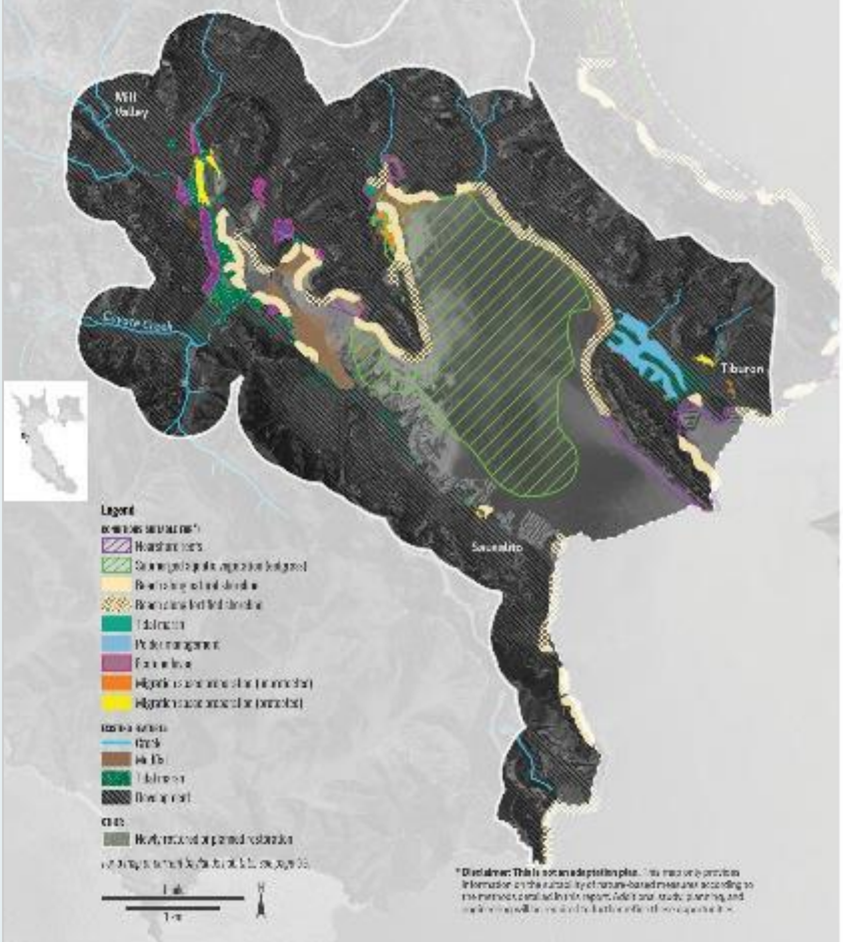
1 NATURE-BASED ADAPTATION OPPORTUNITIES MAP

Richardson



1 RICHARDSON

Nature-based Adaptation Measures

Oyster reefs

Horizontal Levees

Beaches

Eelgrass

Creek connections

Selected Measures

NATURE-BASED	Suitability
Nearshore reefs	High
Submerged aquatic vegetation	High
Beaches	High
Tidal marshes	Some
Polder management	Limited
Ecotone levees	Some
Migration space preparation	Limited

Limited suitability · Some suitability · High suitability

Housing along Sausalito's shoreline in Richardson OLU (Photo by Shira Bezalel, SFEI)

Other Adaptation Opportunities

Easements, buyouts in open/ protected areas

Not intensifying development, elevating roads, buildings, re-zoning

Place Types Map

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Next Steps

- Continuing to improve the science and fill data gaps
- Get data online in an interactive map
- Working with communities across the Bay to help apply and translate this work

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