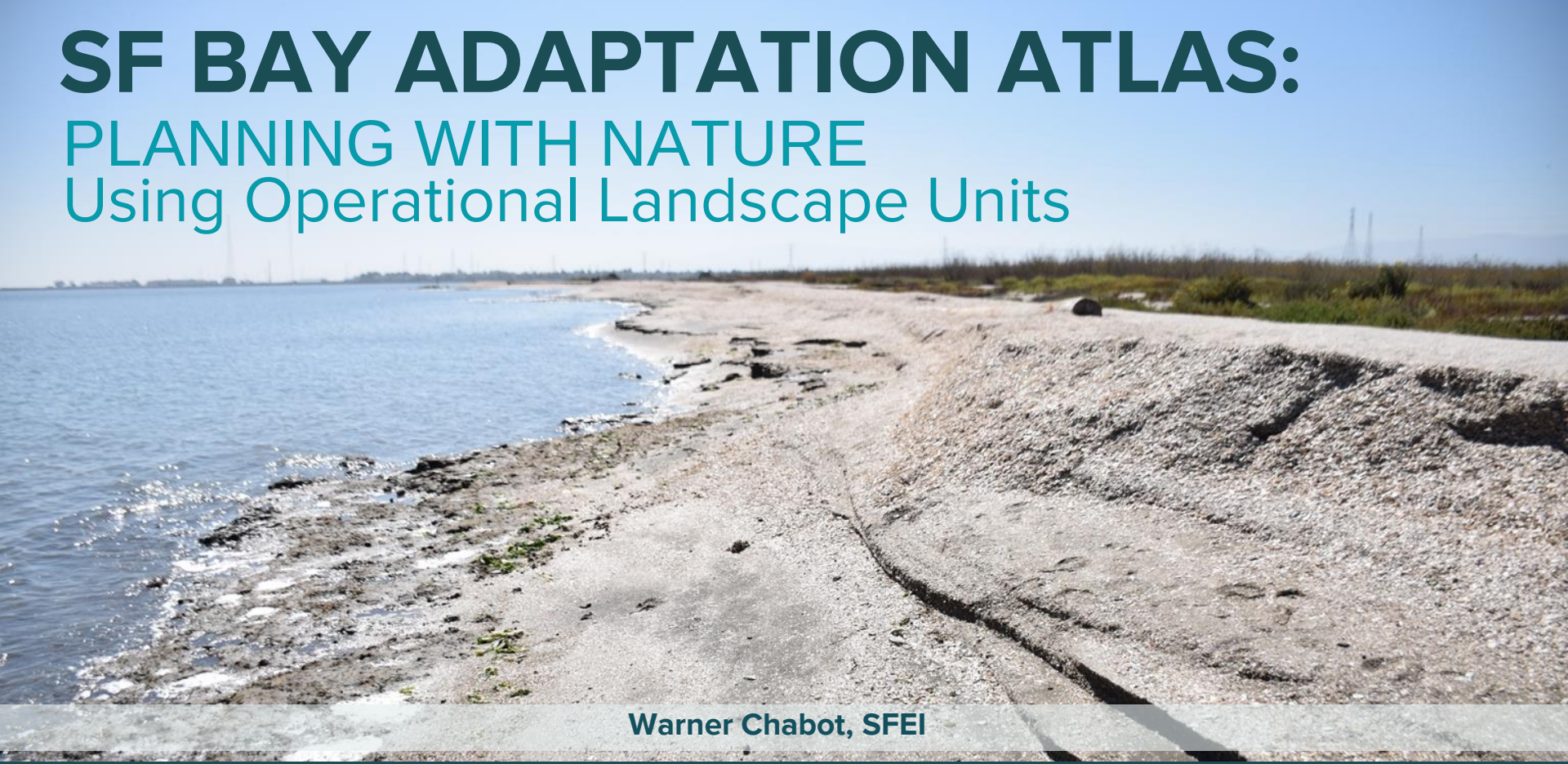
SF BAY ADAPTATION ATLAS:

PLANNING WITH NATURE
Using Operational Landscape Units



Warner Chabot, SFEI

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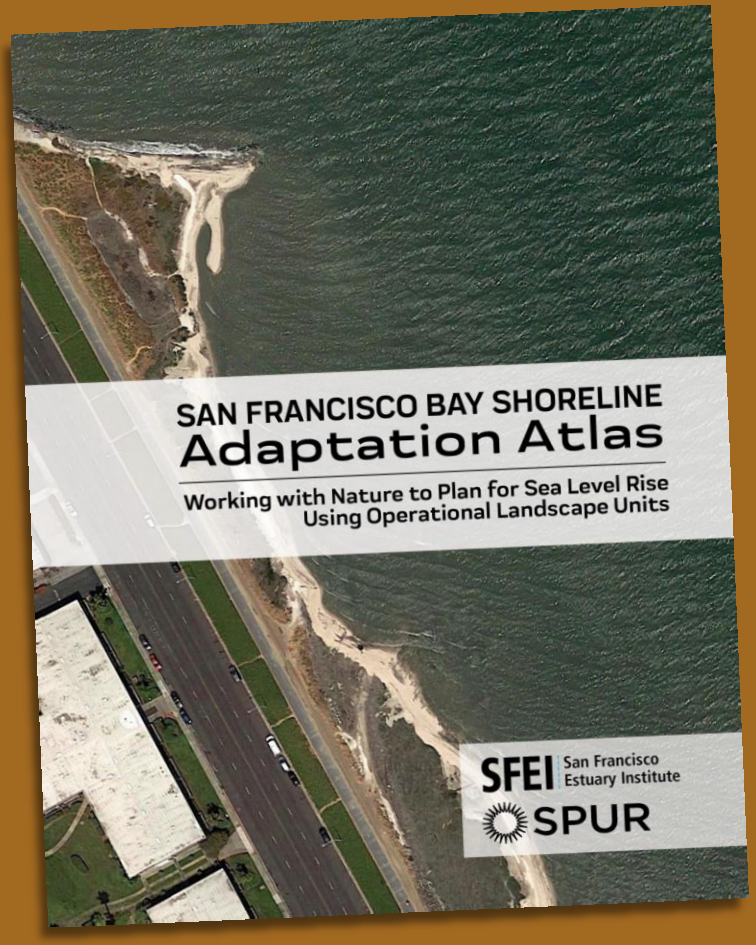
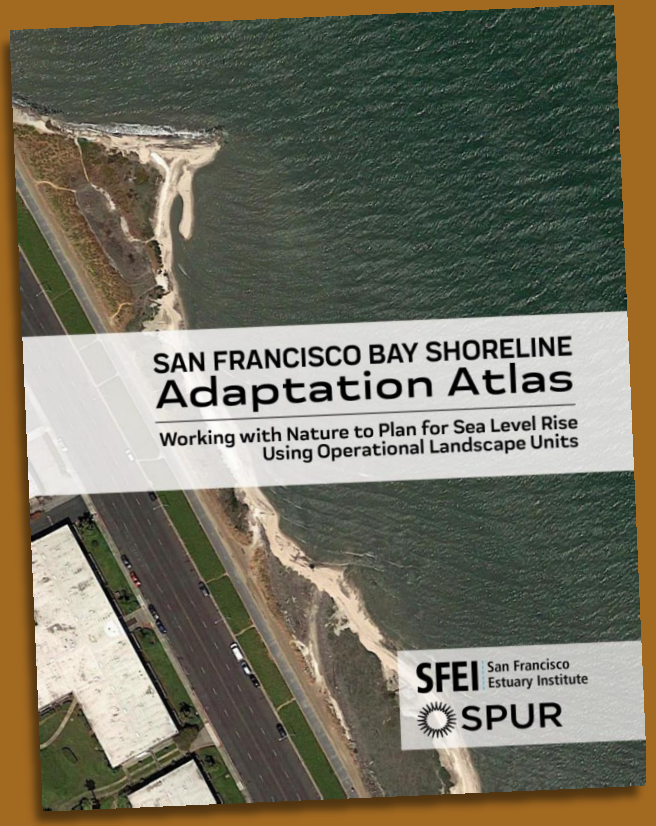
SPUR

- **Adaptation Atlas concept & methods**
- **Nature-based science for climate adaptation**



Adaptation Atlas

- A place-specific framework
- Work with nature to adapt to sea level rise
- Nature-based and hybrid infrastructures
- Less expensive, more effective policy options
- Spans jurisdictions. Allows stakeholders to develop effective adaptation strategies

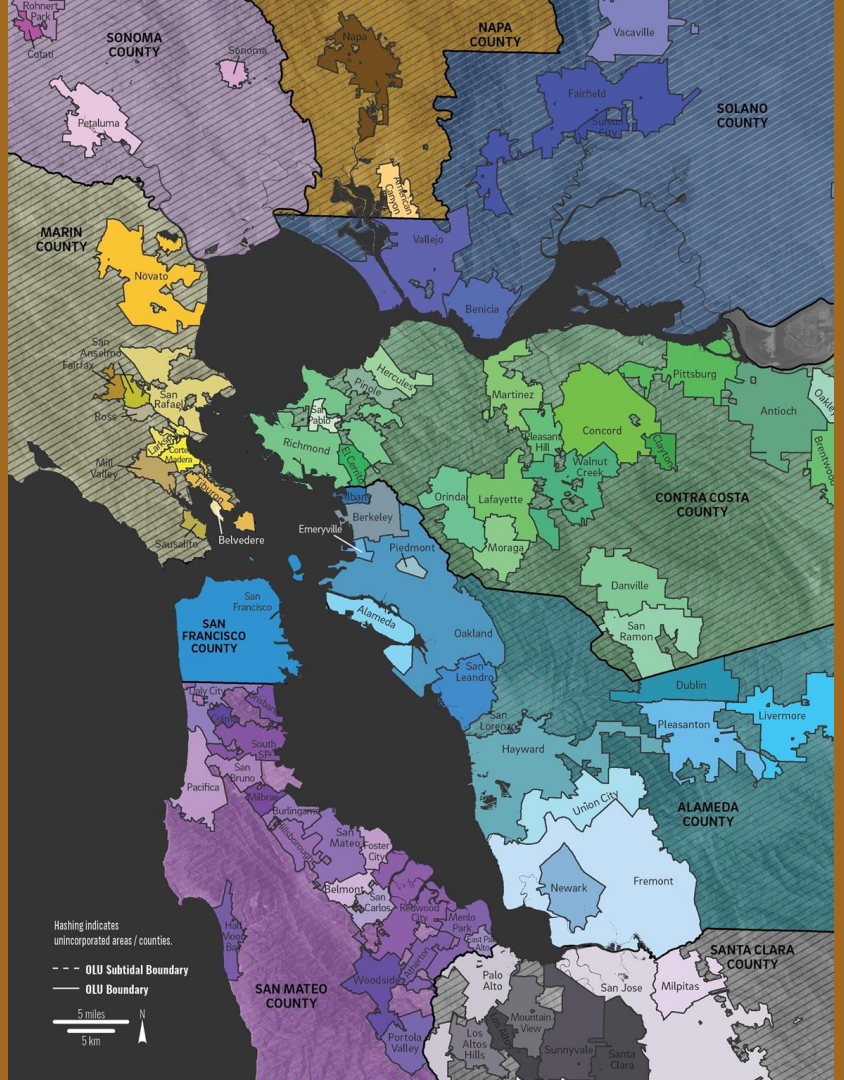


Sea level rise

Won’t stop at city boundaries.

Traditional jurisdictions

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



STEP 1

Plan using nature's boundaries

STEP 2

Find adaptation measures that work in a given place

STEP 3

Bring 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

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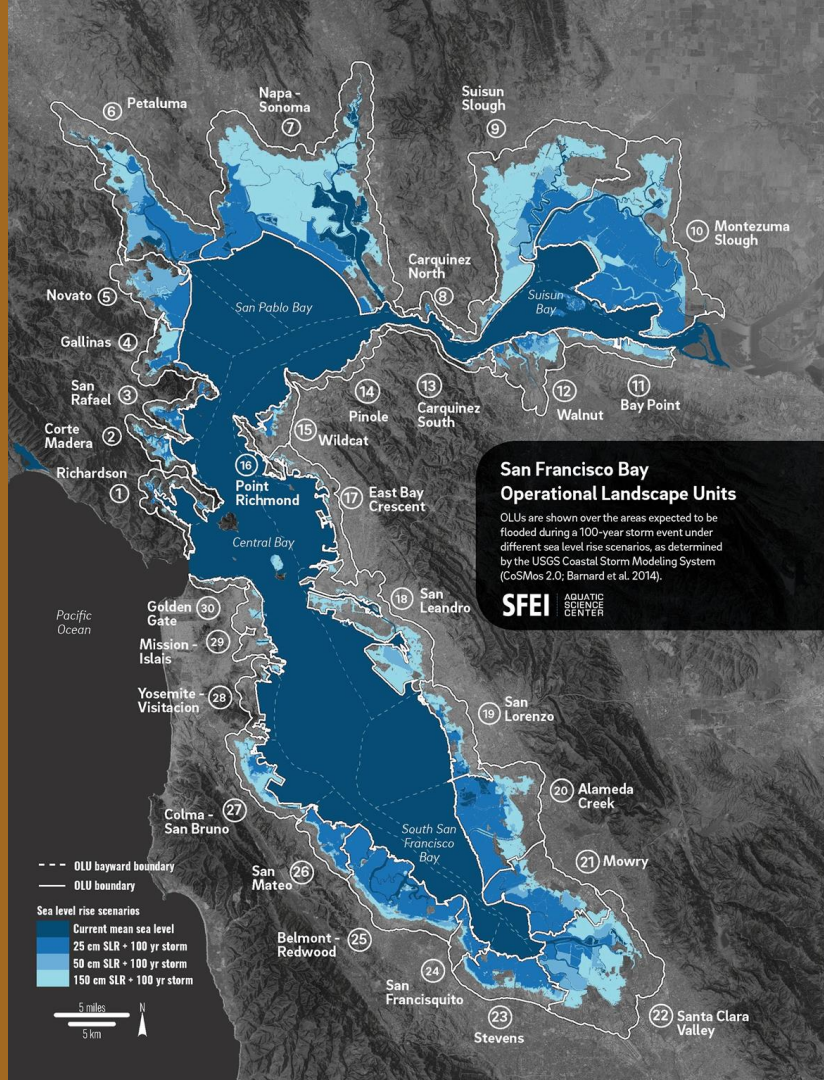
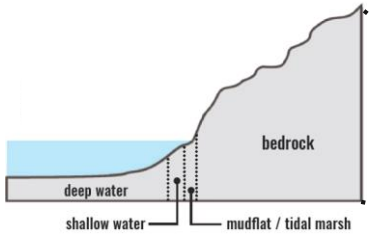
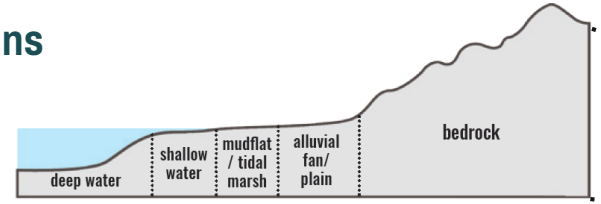


Geomorphic Unit

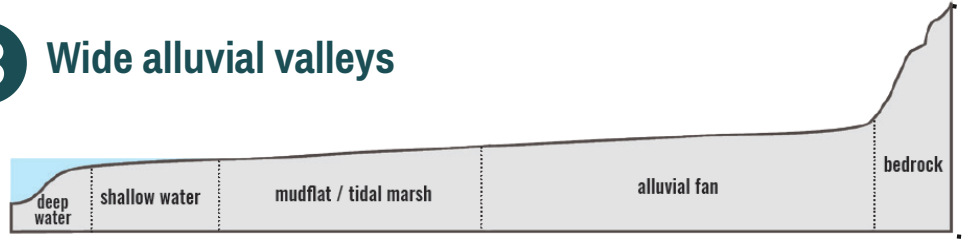
1 Headlands & small valleys

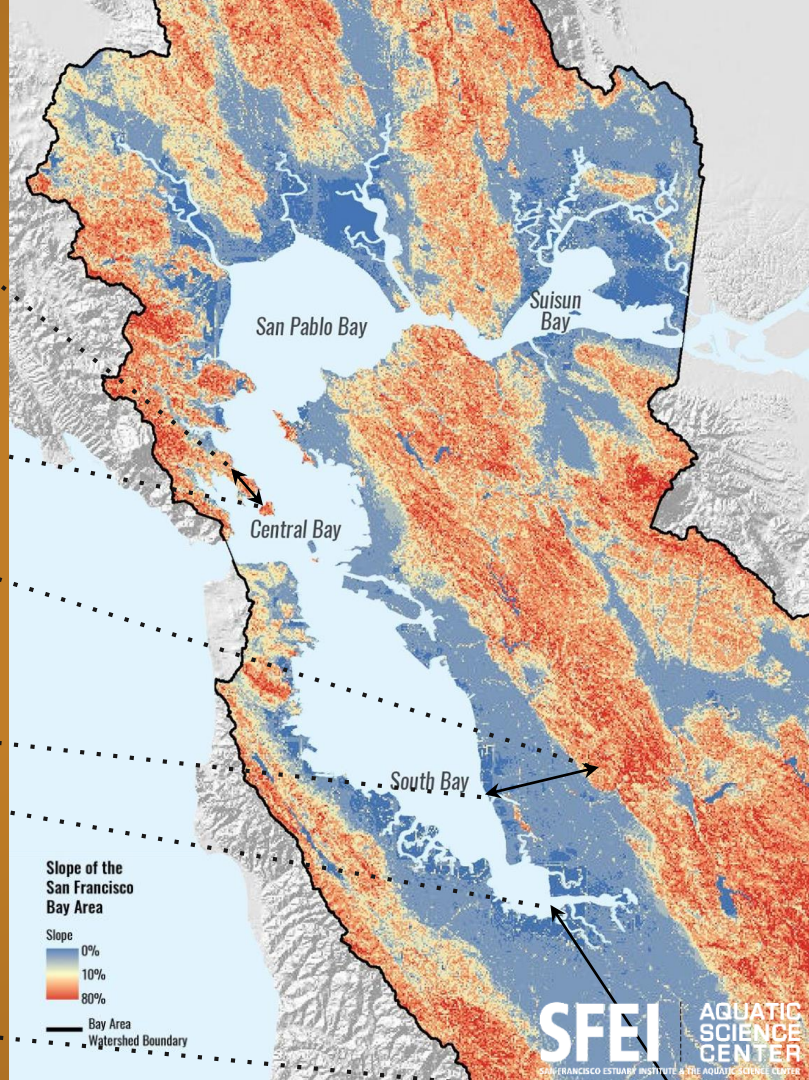


2 Alluvial fans & plains



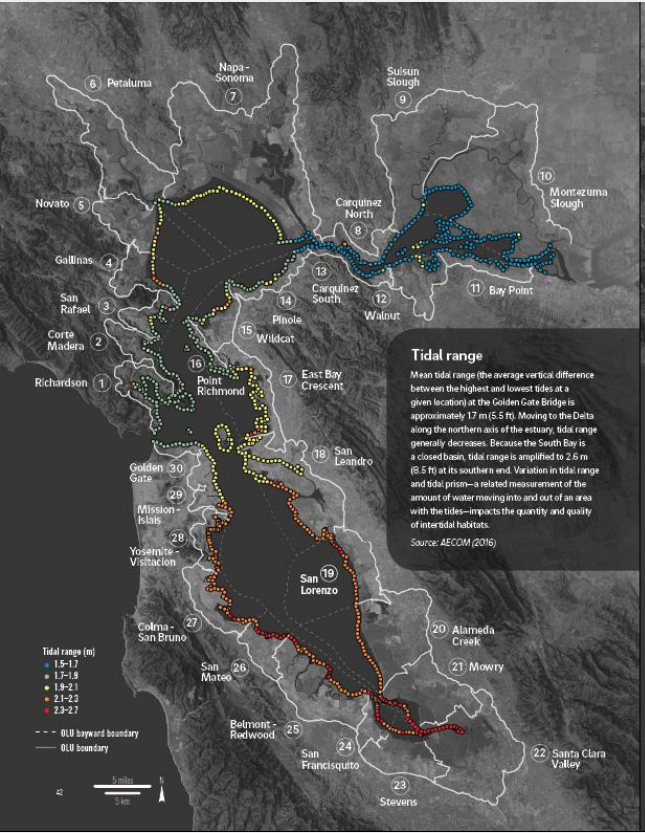
3 Wide alluvial valleys



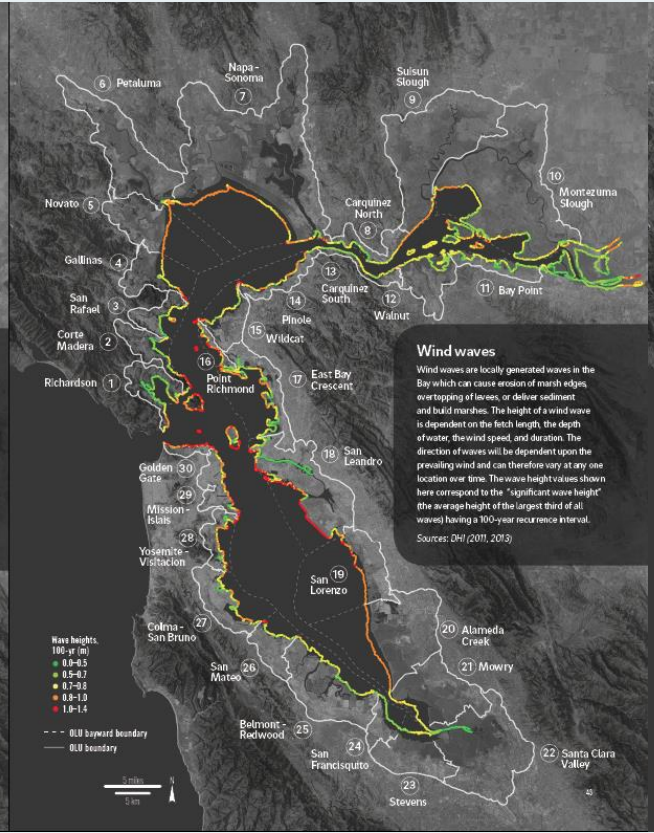


Shoreline characteristics

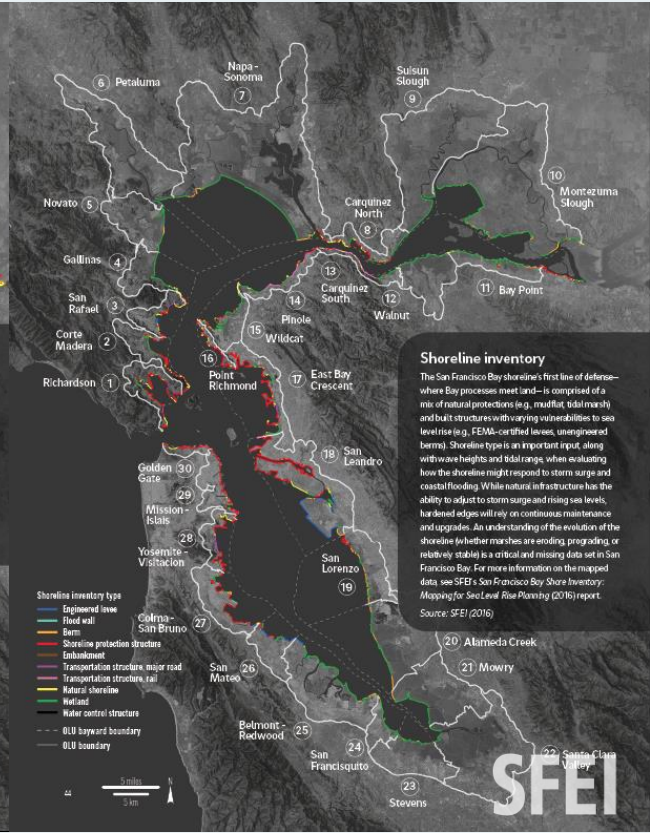
Tidal range



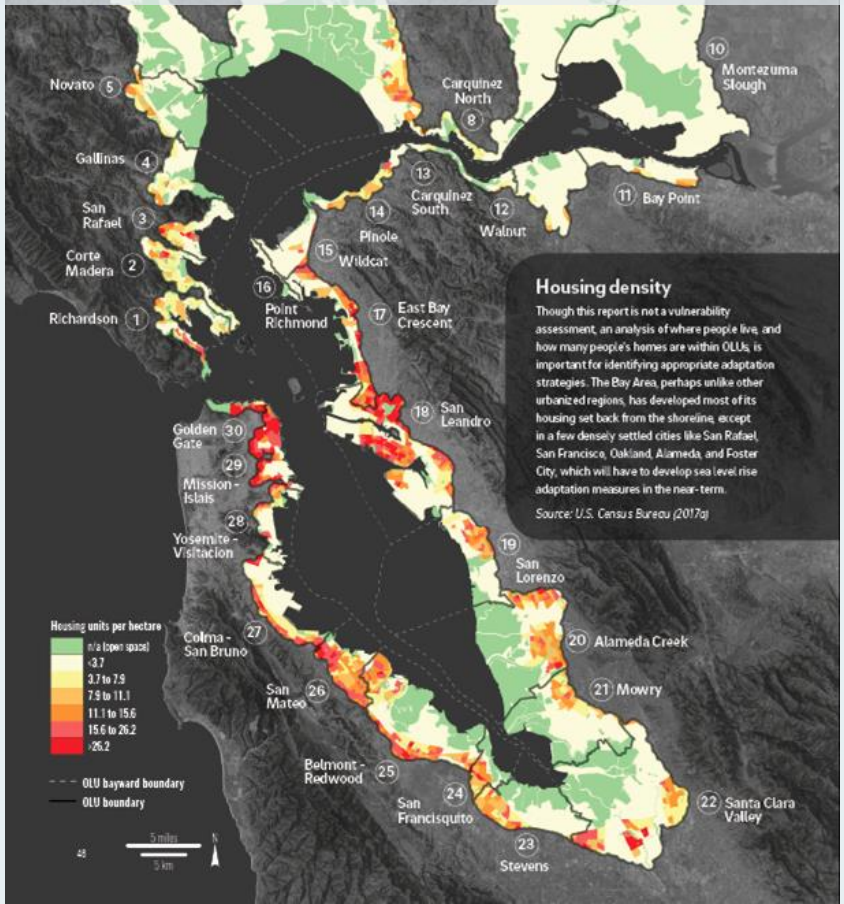
Wind-wave heights



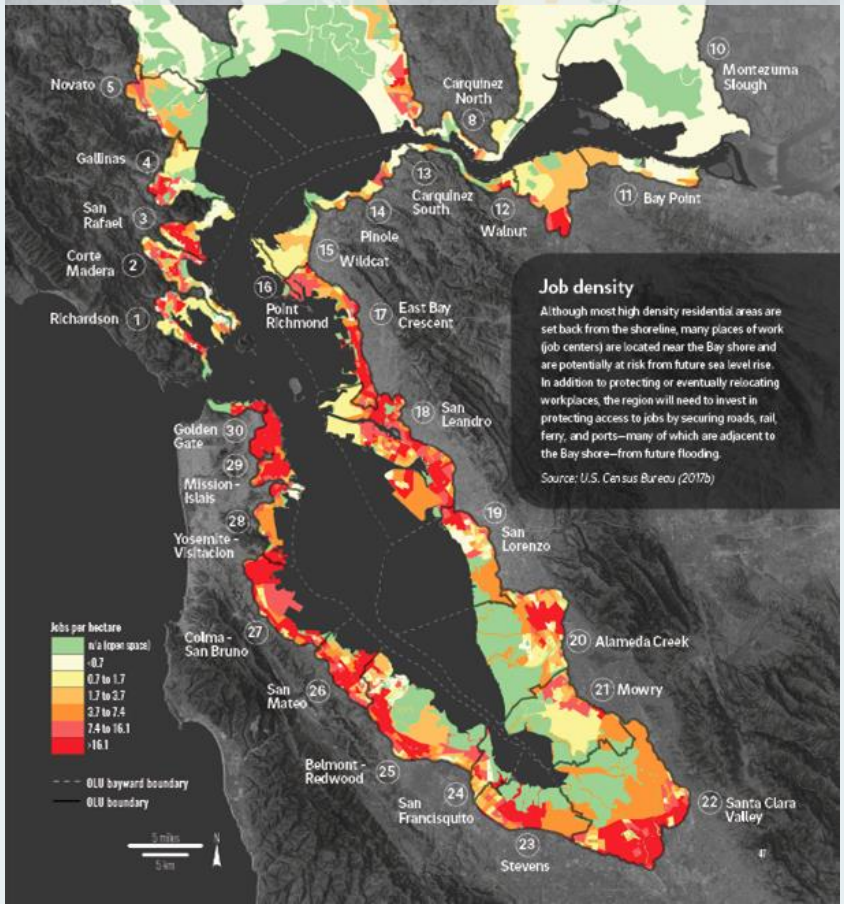
Shoreline composition



Housing density



Job density



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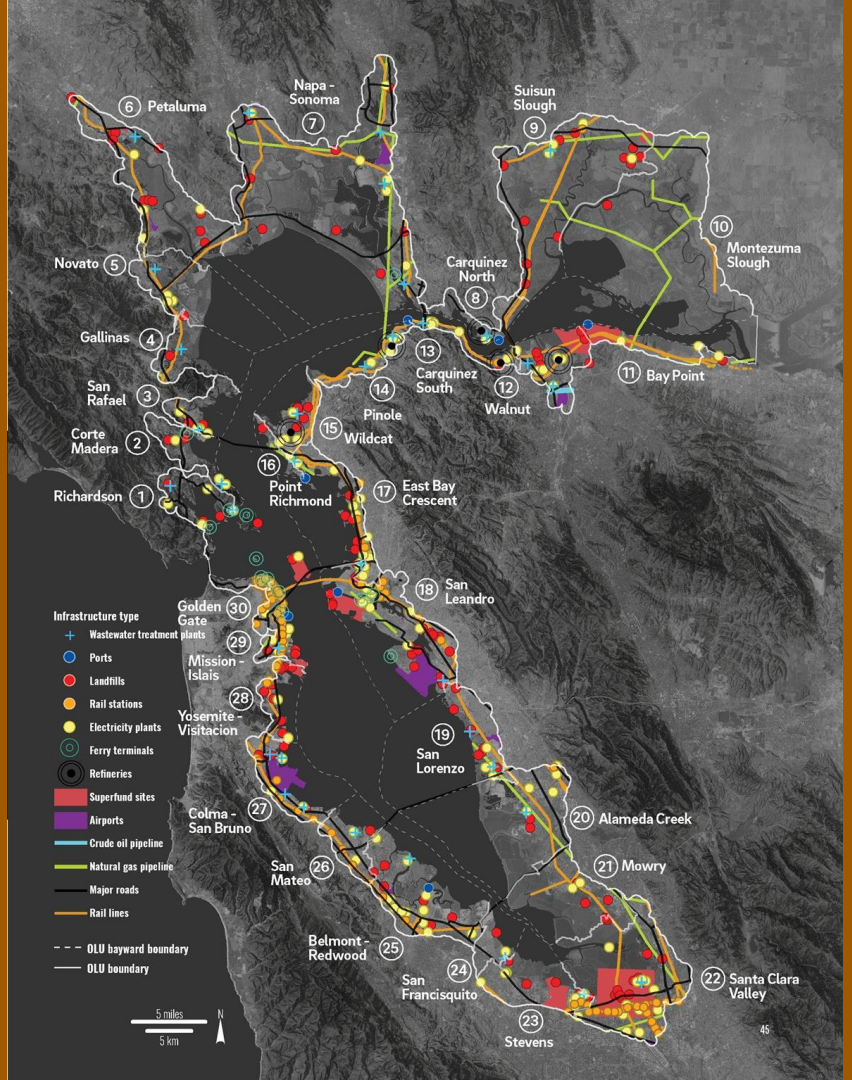
Selected infrastructure

- Ports
- Landfills
- Airports
- Pipelines
- Wastewater plants



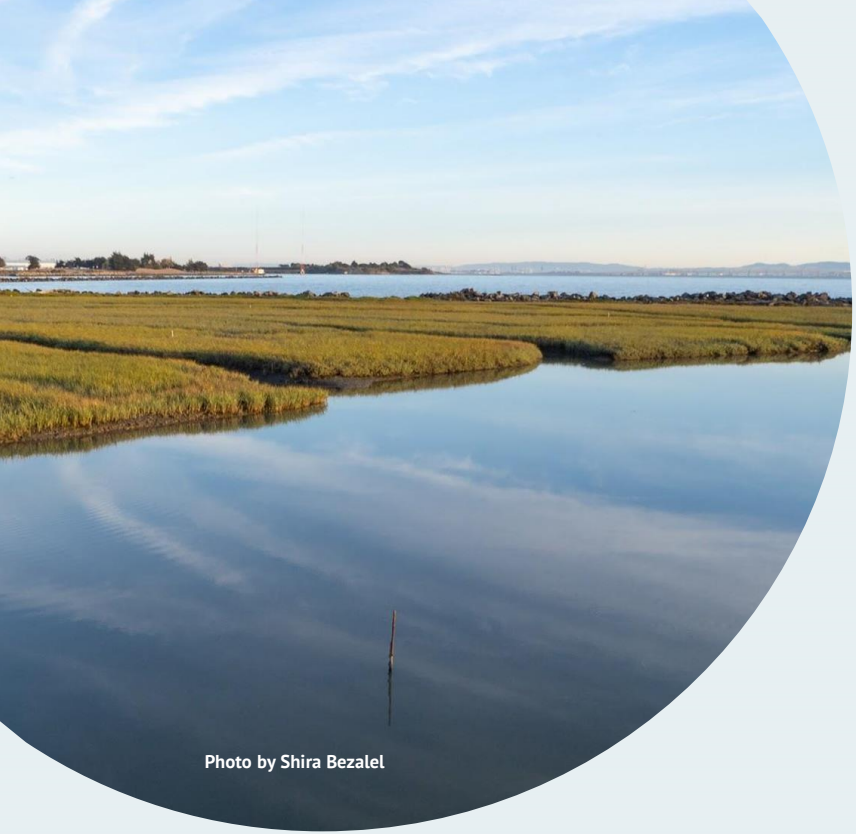


Photo by Shira Bezalel

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
- Beaches
- Tidal marshes
- Ecotone levees
- Migration space preparation
- Creek-to-bayland reconnections
- Green stormwater infrastructure

Regulatory & policy tools

- Zoning
- Setbacks, buffers,
- Building codes
- Rebuilding restrictions
- Conservation easements
- Tax incentives
- Geologic Hazard Districts
- Buyouts

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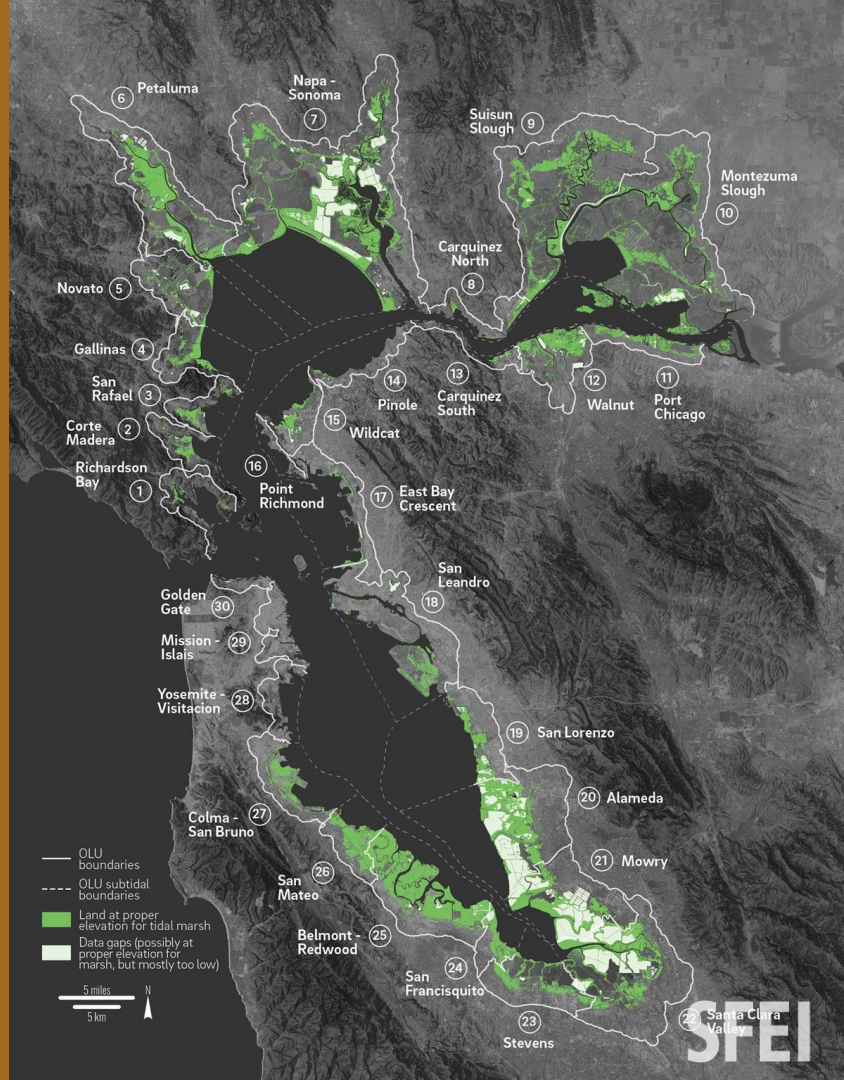
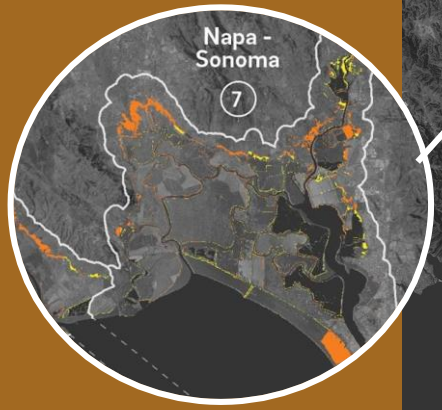
Marsh Restoration

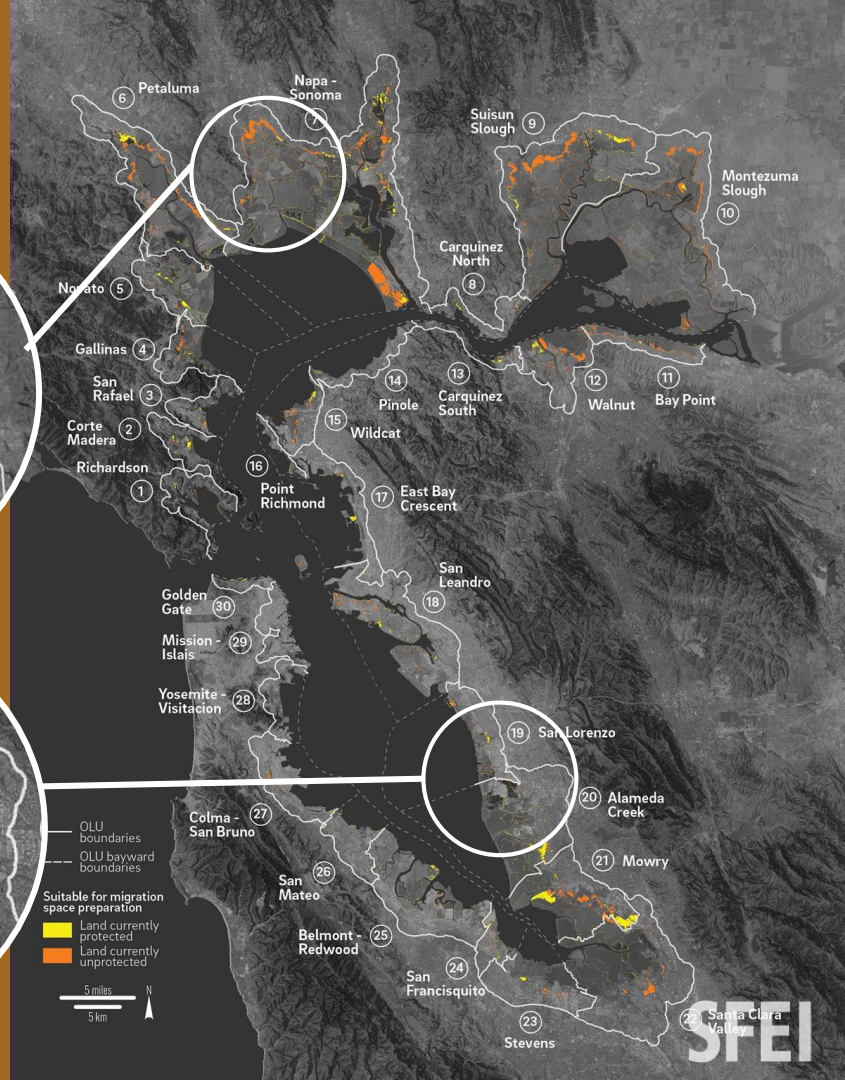


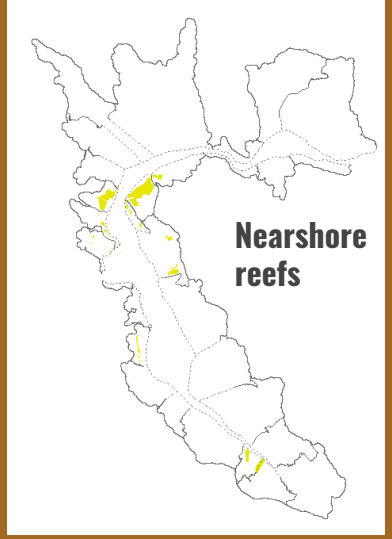
Migration space

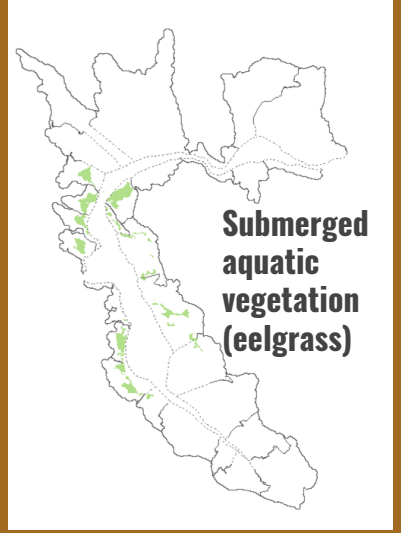
Protected

Unprotected



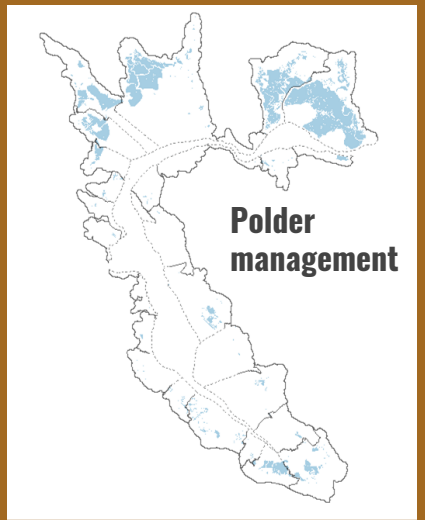


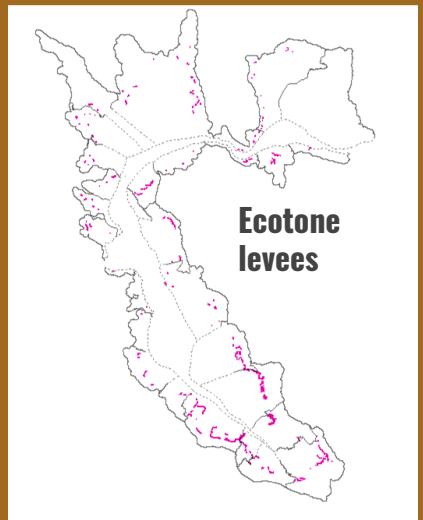

Nearshore reefs

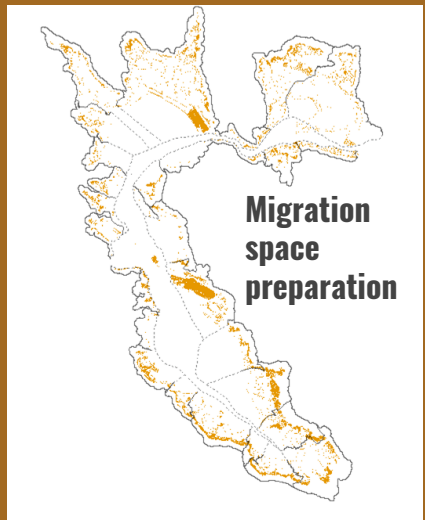

Submerged aquatic vegetation (eelgrass)


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. 66)	Submerged aquatic vegetation (eelgrass) (p. 68)	Beaches (p. 72)	Tidal marshes (p. 76)	Polder management (p. 80)	Ecotone levees (p. 84)	Migration space preparation (p. 88)
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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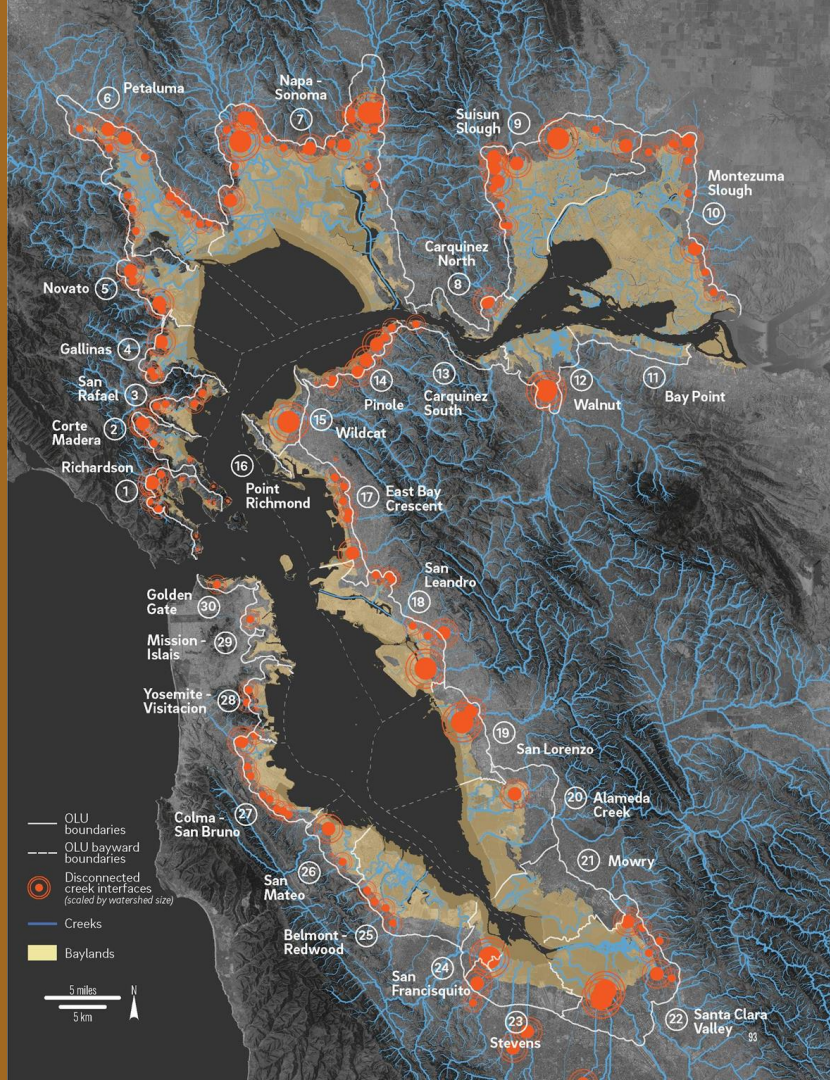
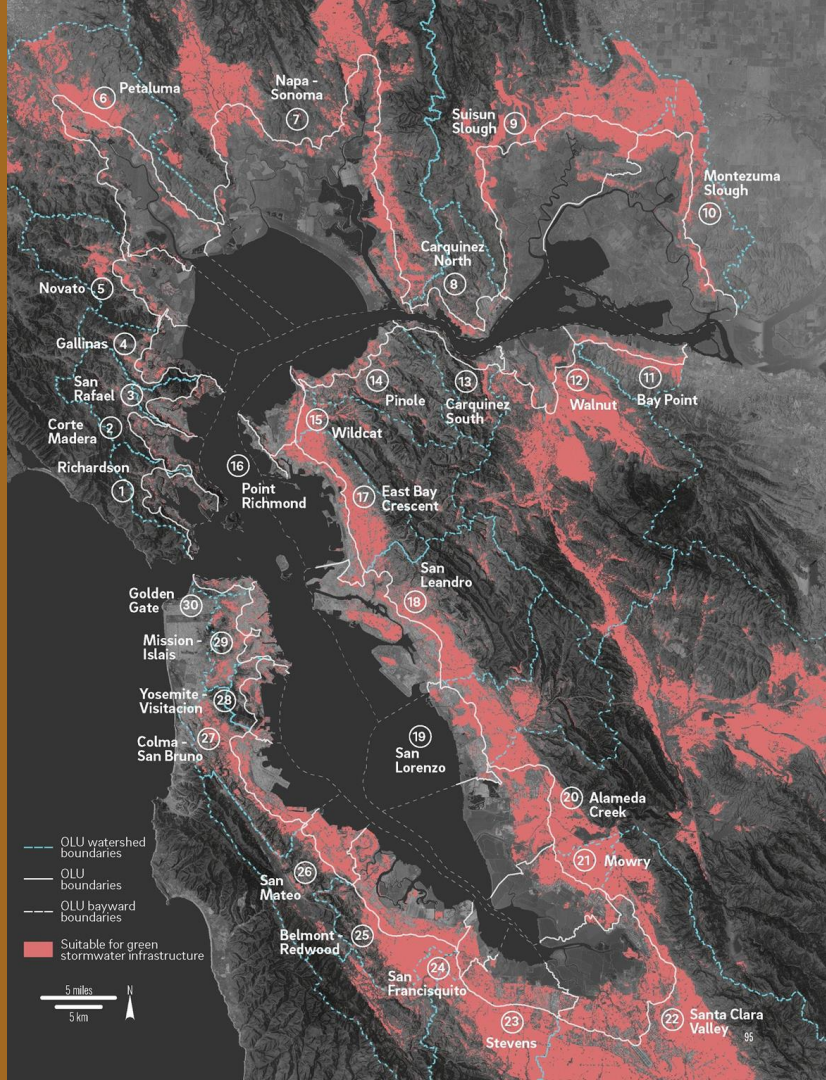
Potential for creek-to-baylands reconnections



Potential for green stormwater infrastructure



28 NATURE-BASED ADAPTATION OPPORTUNITIES MAP

Yosemite-Visitacion

* **Disclaimer: This is not an adaptation plan.** This map only provides information on the suitability of nature-based measures according to the methods detailed in this report. Additional study, planning, and engineering will be required to further refine these opportunities.

28 YOSEMITE – VISITACION

Nature-based Adaptation Measures

The Yosemite-Visitacion OLU is characterized by a hardened shoreline extended into the Bay by filling. As such there are few opportunities for [illegible] and most adaptation opportunities relate to the low-tide terrace (where it exists), and to shallow subtidal areas. Both eelgrass beds and nearshore reefs may be suitable in this OLU. A [illegible] along Highway 101 could be an alternative to riprap to provide a more natural shoreline, and would necessitate hybrid features such as groins or artificial headlands. Brisbane Lagoon itself [illegible] as a polder, and tidal action could be restored by improving the culverts under Highway 101, creating opportunities for mudflats, marshes, and ecotone levees within the lagoon. Green [illegible] implemented in the upper watershed to reduce fluvial flooding in the developed areas.

Beaches

Eel grass

Oysters

Polder management

Selected Measures	Suitability
NATURE-BASED	
Nearshore reefs	●
Submerged aquatic vegetation	●
Beaches	●
Tidal marshes	○
Polder management	◕
Ecotone levees	○
Migration space preparation	○

○ Limited suitability ◕ Some suitability ● High suitability

Office parks and industrial buildings located along South San Francisco and Brisbane's shoreline, looking northwest towards Brisbane Lagoon (Photo by Doc Searls, CC BY 2.0)

Other Adaptation Opportunities

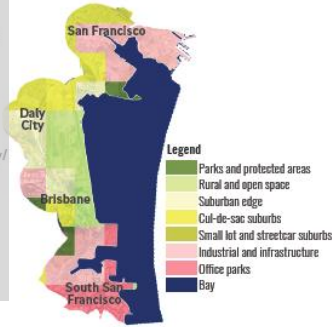
This OLU has a diverse mix of place types including office parks, [illegible] and infrastructure, [illegible] to moderate [illegible] sea level rise risk is confined to small areas on the north (Hunters Point [illegible] of the OLU, which are home to office parks and commercial redevelopment areas. Adaptation opportunities for Yosemite-Visitacion include densifying and flood-proofing through building retrofits, perimeter protection with grey infrastructure or hybrid grey/green measures, and land and road elevation.

Flood-proofing buildings and retrofits

Elevating roadways

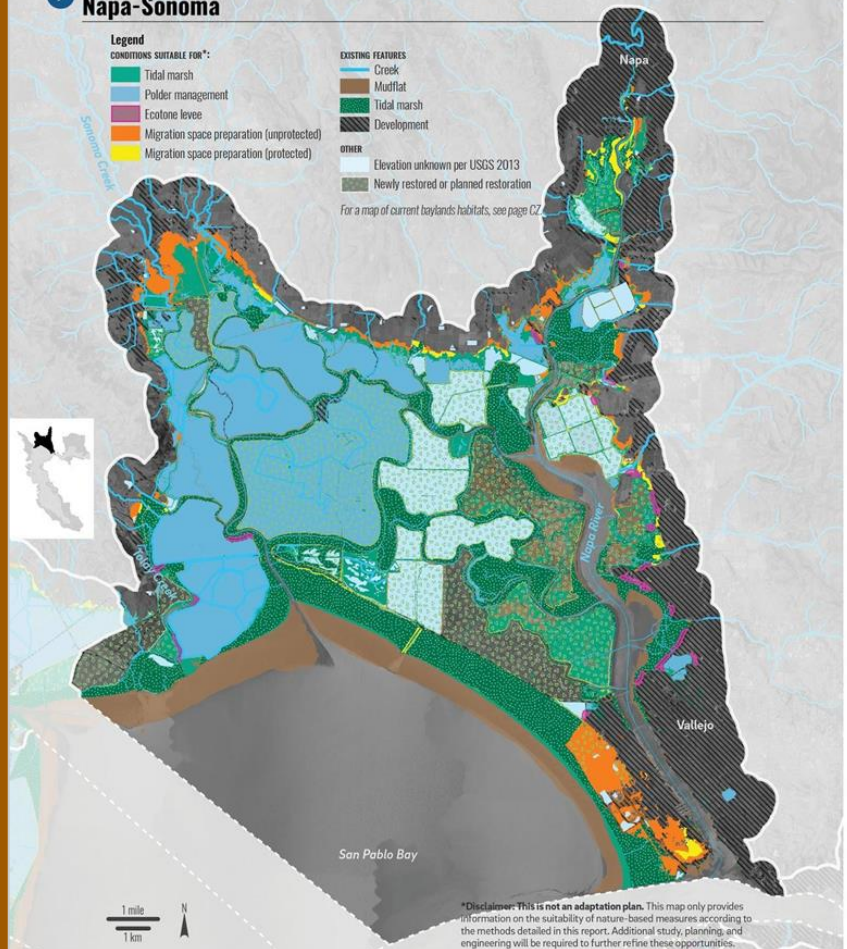
Perimeter Protection

Place Types Map



7 NATURE-BASED ADAPTATION OPPORTUNITIES MAP

Napa-Sonoma



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7 NAPA – SONOMA

Nature-based Adaptation Measures

In the Napa-Sonoma OLU there has been significant landscape-scale marsh restoration in areas such as the Napa-Sonoma Salt Ponds and [illegible] considerable opportunities to restore large connected patches of tidal marsh in the remaining diked baylands closer to Sonoma Creek. Road and rail corridors th[illegible] considerable constraints to the restoration of the marshes: they need existing levees to protect them from flooding, their creek crossings are narrow, and th[illegible] transition zone. All of the existing and potential tidal marsh will benefit from preparing migration space for the marsh to move upland as sea level rises. The majority of m[illegible] such of it being managed as drylands. Acquiring and protecting these areas will be key to creating marsh migration pathways. Much of the existing tidal marsh is adjacent to the creeks and is disconnected from undeveloped migration space by large and deep polders such as Skaggs Island. If raised to intertidal elevations, these polders could be converted to tidal marsh. However, the amount of sediment needed is considerable and realigning the shoreline may be more feasible. Significant opportunities exist to improve the delivery of freshwater, nutrients, and sediment from Sonoma Creek and the Napa River to build better elevation capital closer to upland in these subsided baylands, and to reduce flooding issues. There are also opportunities for widening the bridge crossings at Sonoma Creek and Tolay Creek if Highway 37 is raised on some combination of embankment and pilings. Ecotone levee creation is less critical in this OLU due to limited presence of development in need of protection, but ecotone levees could be incorporated into the design of embankments to raise Highway 37 or the railroads.

Other Adaptation Opportunities

Like Petaluma, the very large Napa-Sonoma OLU—by far the large[illegible] space uses, protected lands, and cultivated lands—makes it a good candidate for adaptation measures that allow flooding to occur and that fa[illegible] from recreational and agricultural uses to habitat or ecological uses over time, through restoration work, transition zone acquisition, and realigning public access. This OLU is not a good pl[illegible] shoreline adaptations here can maximize nature-based solutions. A f[illegible] conservation easements or voluntary buyouts. For the suburban areas of the OLU that may experience sea level rise further in the future, bu[illegible] ght be suitable alt[illegible] ding on what the community prefers to invest in. Elevating Highway 37 to allow tidal action northwards toward formerly diked wetlands would significantly support the large areas of restoration possible in this OLU.

Polder management

Marsh Restoration

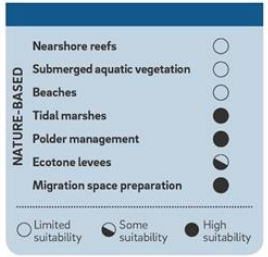
Migration Space

Creek connections

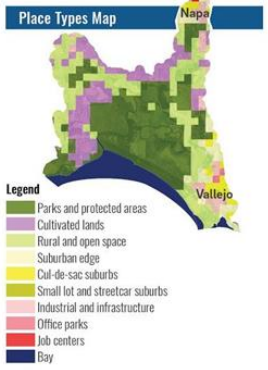
Acquiring migration space

Easements, buyouts in open/ protected areas

Elevating roadways



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



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Next steps

- Sediment availability tradeoffs
- Integrate water quality and infrastructure
- Develop adaptation pathways

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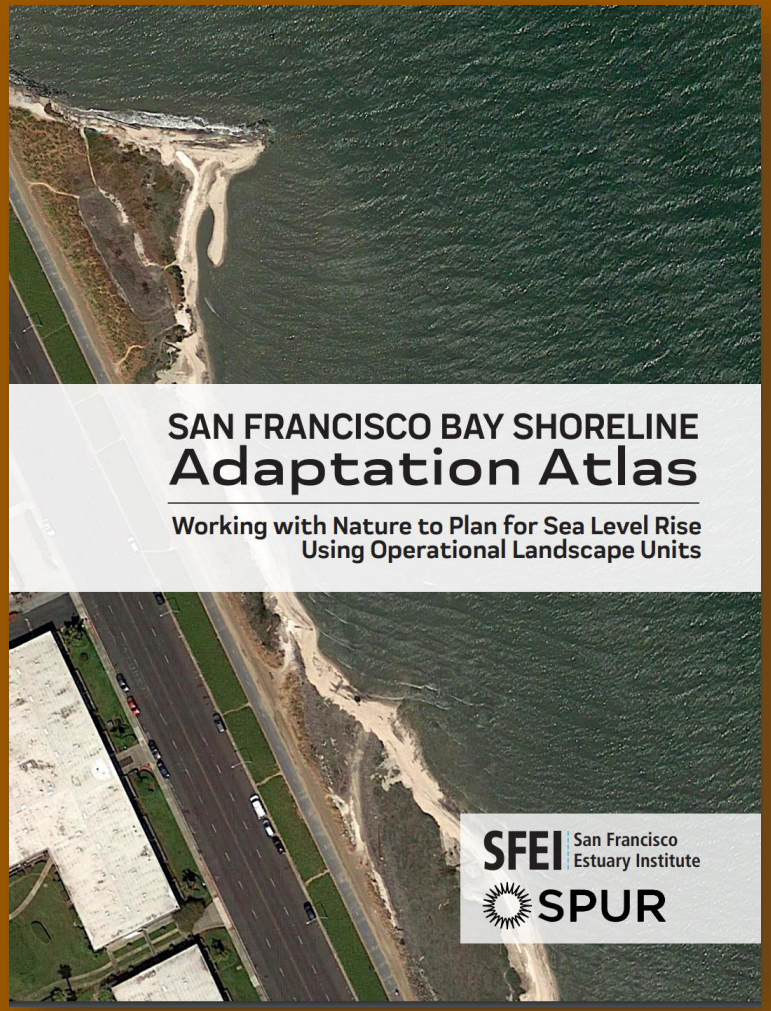
Download the report at:

adaptationatlas.sfei.org



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THANK YOU

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For more info: adaptationatlas.sfei.org

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