



ADAPTATION PLANNING USING NATURE'S BOUNDARIES

ICARP TAC Meeting: June 28, 2019

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Photo by: Press Democrat



In an urbanized estuary...

- The Bay and shoreline are **heterogeneous and dynamic**
- There is **no one-size-fits-all approach** for SLR adaptation
- **Natural infrastructure** (such as beaches and wetlands), in conjunction with levees, can lessen flood risk
- Natural infrastructure provides **other benefits**, such as **habitat, recreation, carbon sequestration, aesthetics**

Eleven years to save San Francisco Bay

By Laura Tam and Julie Beagle | June 21, 2019



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.

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



Courtesy of Google Earth



STEP 1

**Plan using
nature's
boundaries**

*(instead of traditional
boundaries)*

STEP 2

**Identify
adaptation
measures that
could work well
in a given place**

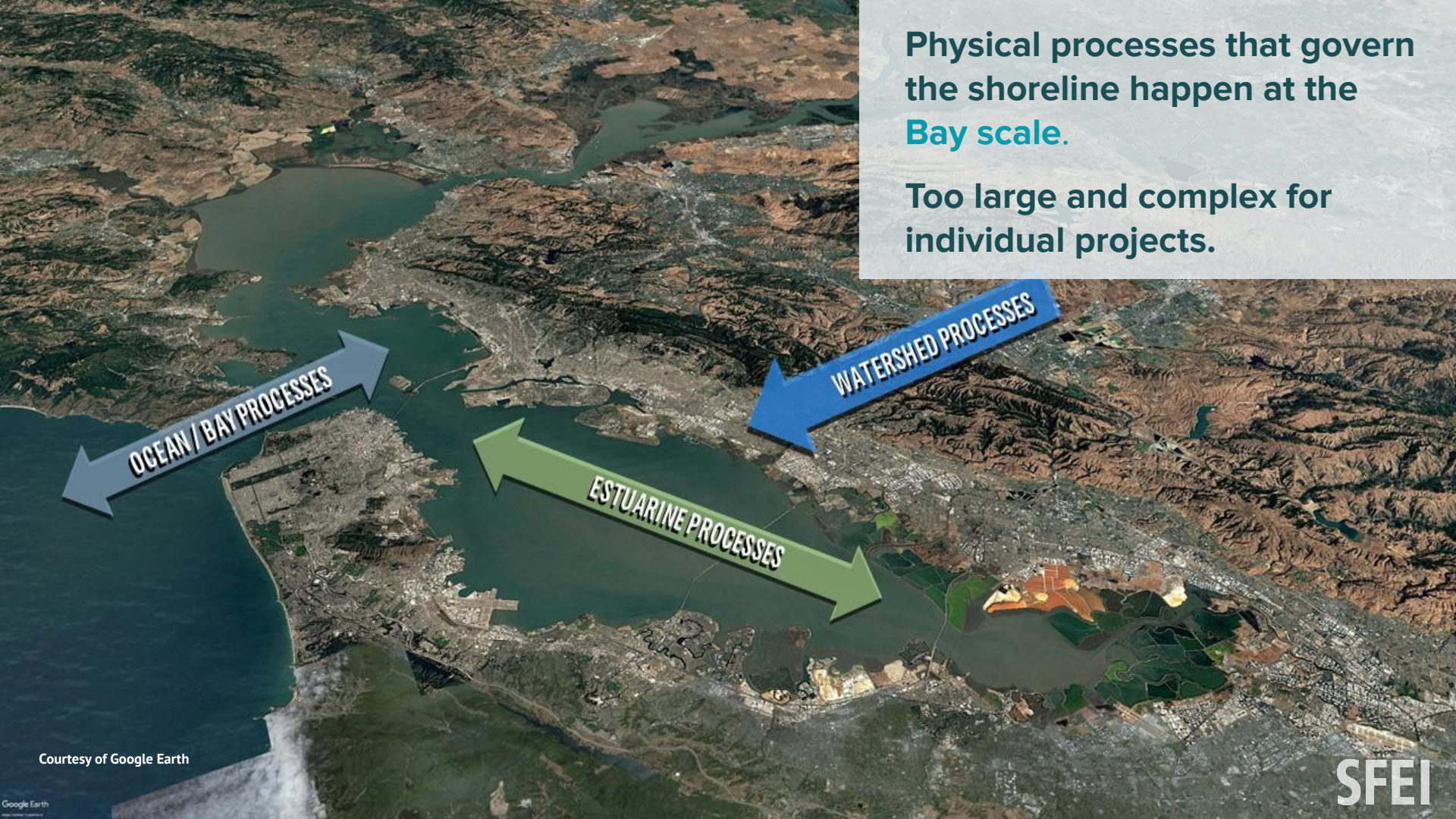
*(and use nature as much
as you can)*

STEP 3

**Use when
bringing
stakeholders
together to
envision a
resilient future**

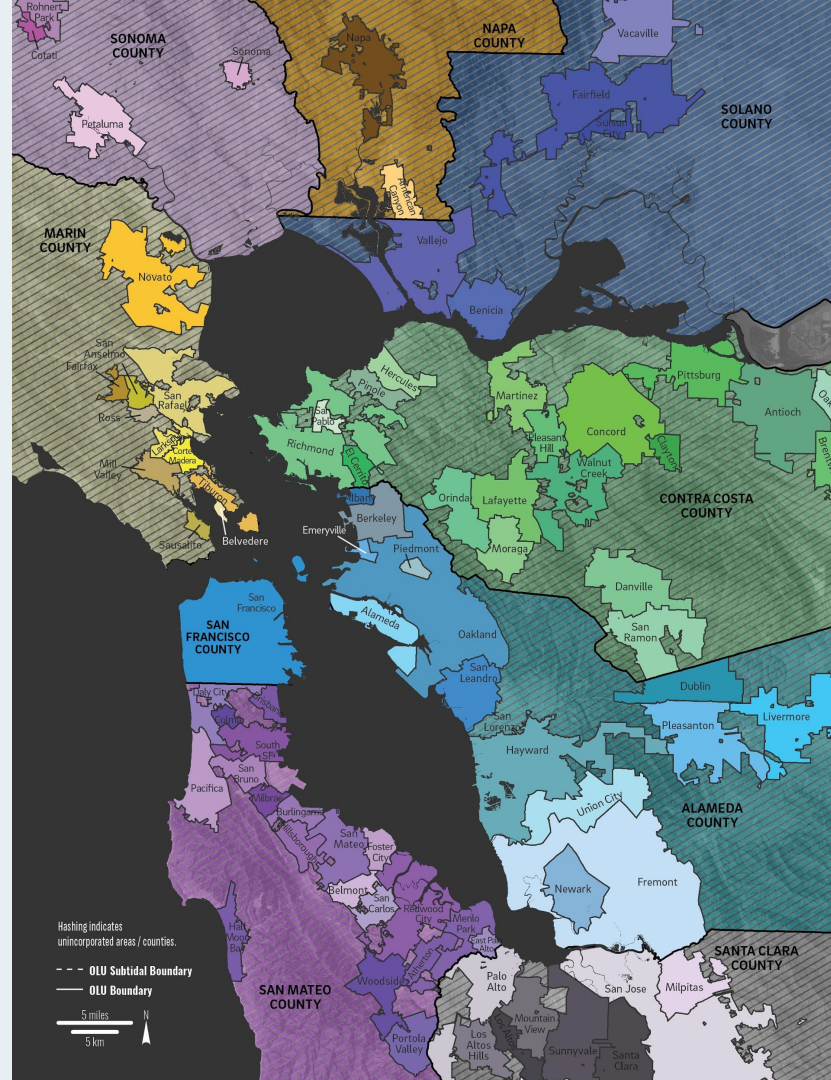
Physical processes that govern the shoreline happen at the **Bay scale**.

Too large and complex for individual projects.



Traditional jurisdictions

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



Sea level rise
will not stop at
city boundaries.

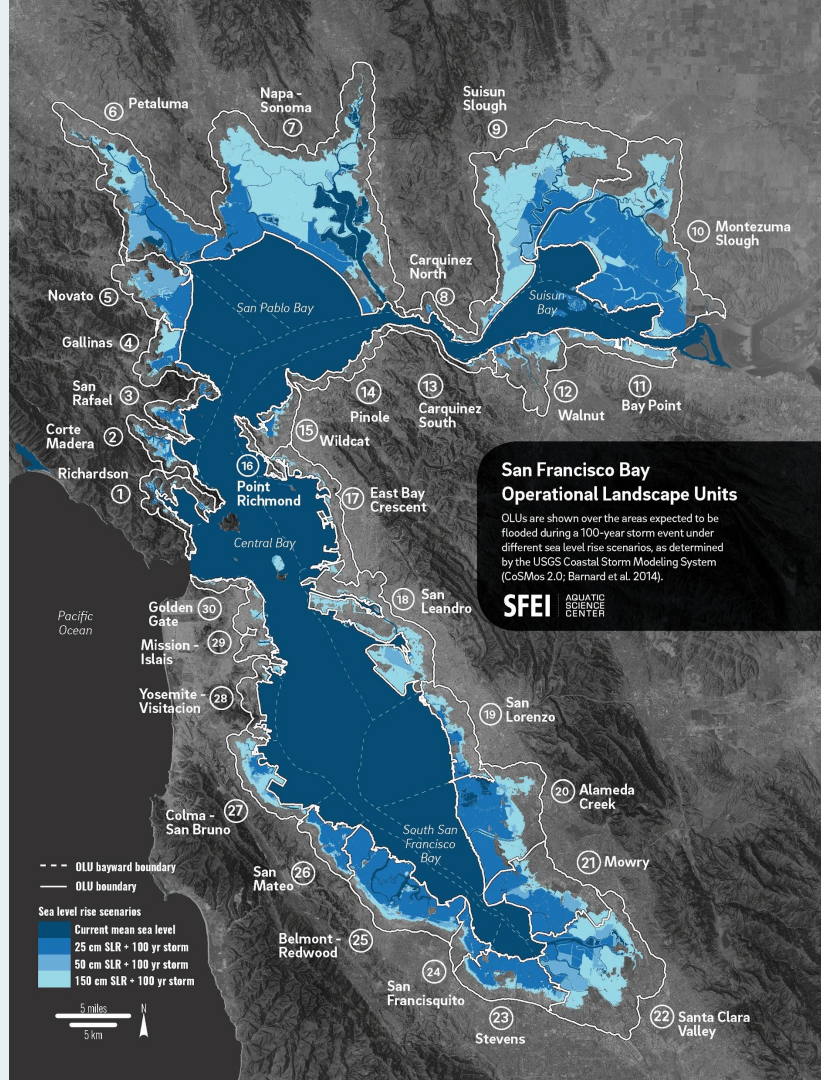


What is a useful scale?

Operational Landscape Units

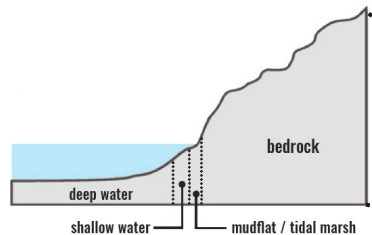
Areas with shared geophysical and land use characteristics *suited for a particular suite of nature-based measures*

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

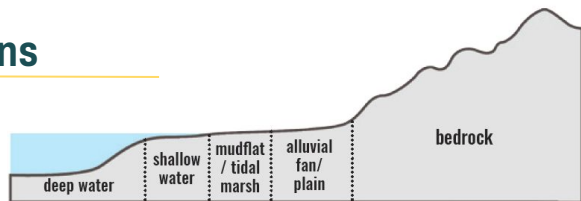


Geomorphic Unit Types

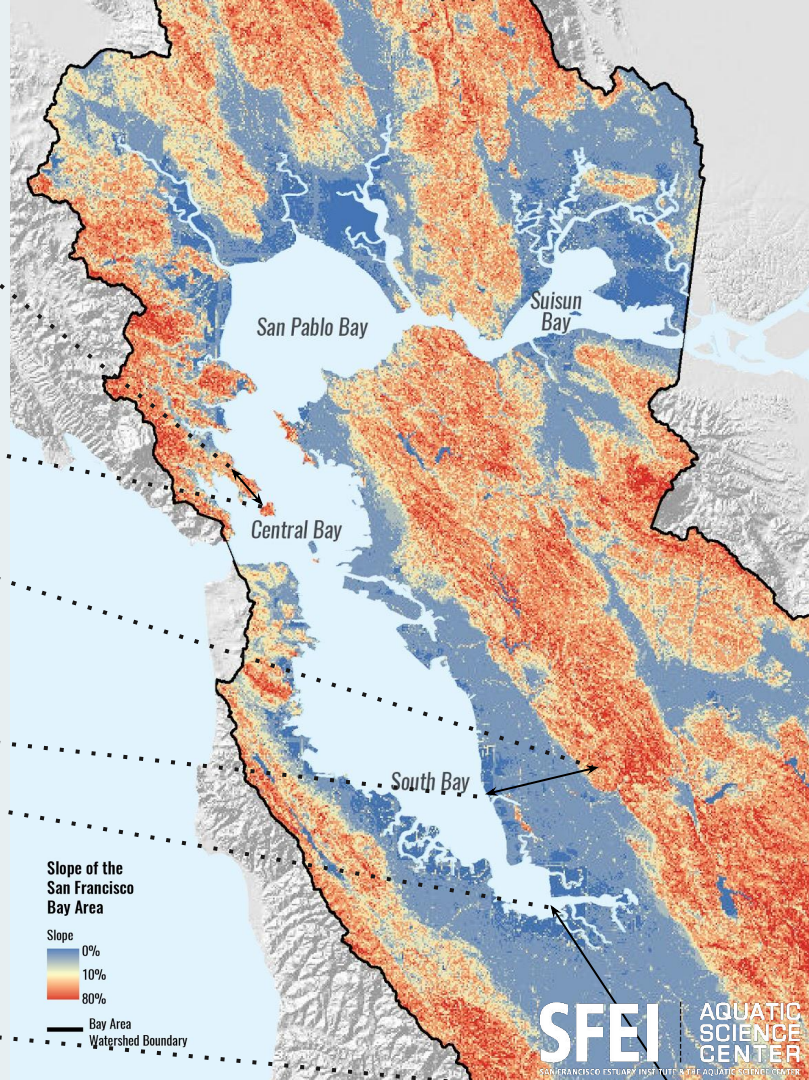
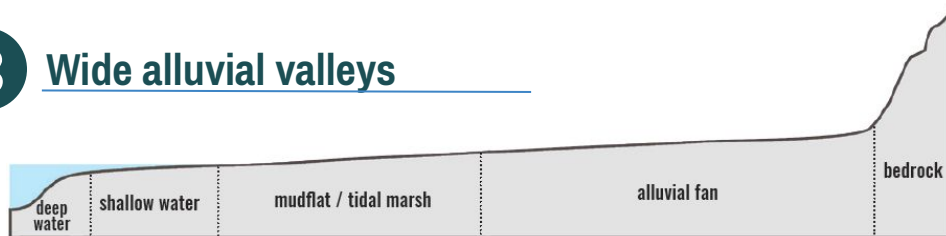
1 Headlands & small valleys



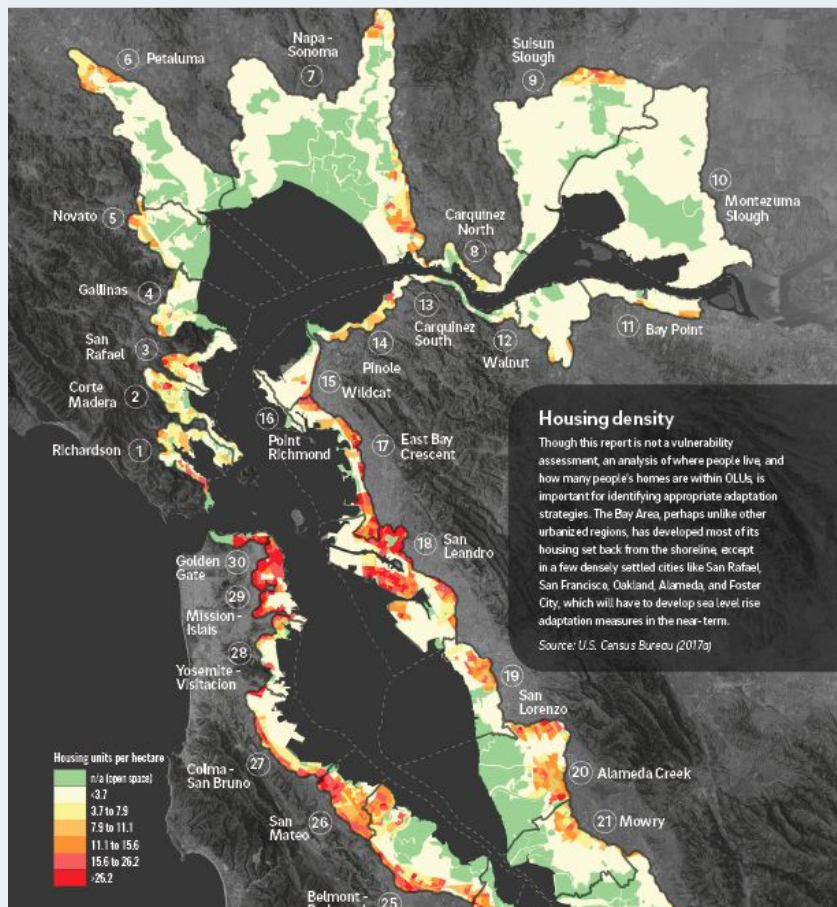
2 Alluvial fans & plains



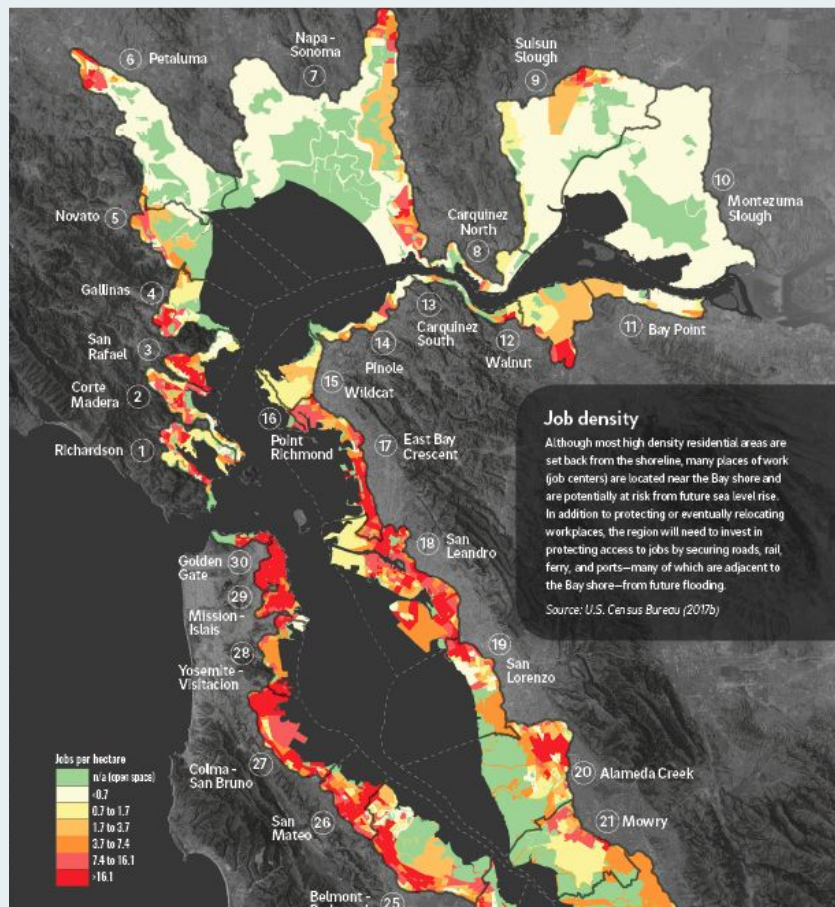
3 Wide alluvial valleys



Housing density



Job density





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Photo: Mark Taylor



SFEI

Photo: Mike Lowery



SFEI

7.12 ft NAVD - King Tide, 2019
Crab Cove Alameda

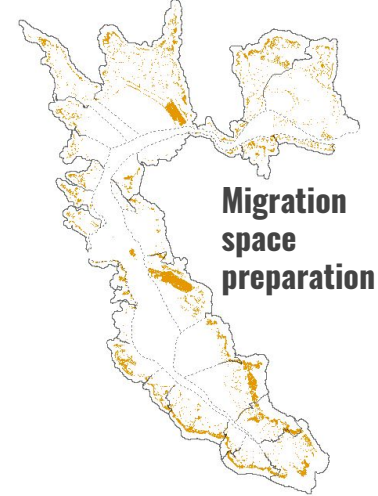
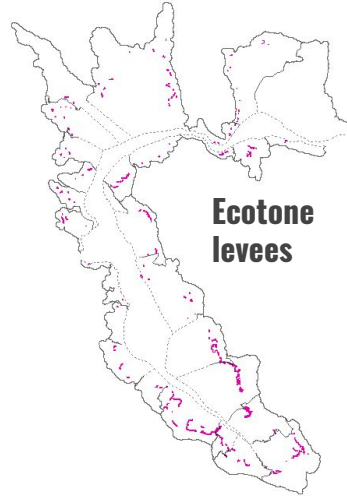
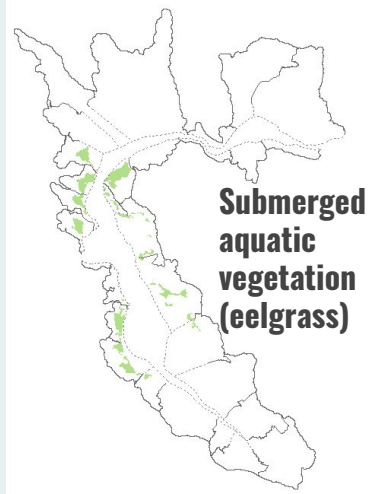
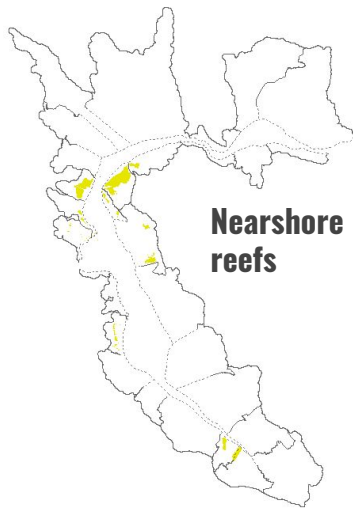
Adaptation measures

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



Suitability of nature-based measures

Suitability Rating



	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	○	○	●	○	○	○	○

Adaptation measures

Nature-based measures

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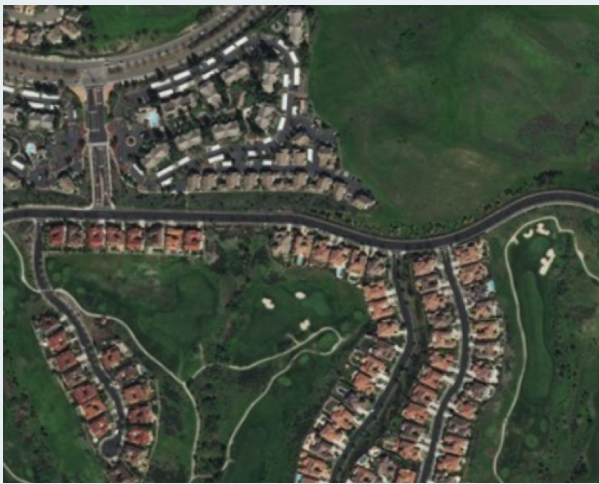
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Open space

Suburban edge



Urban neighborhoods

Office parks and commercial

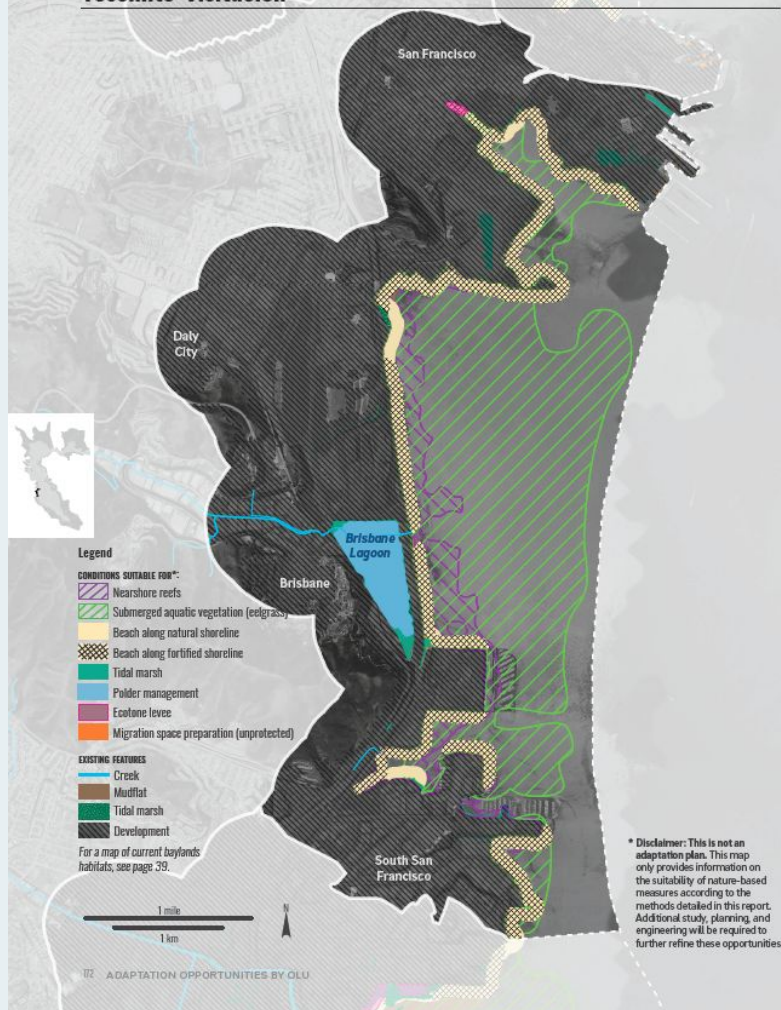


Secondary job centers

Dense mixed use



Yosemite-Visitation



Nature-based Adaptation Measures

The Yosemite-Visitation OLU is characterized by a hardened shoreline extended into the Bay by filling. As such there are few opportunities for nature-based adaptation. 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 natural eelgrass bed 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 is 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 stormwater infrastructure is implemented in the upper watershed to reduce fluvial flooding in the developed areas.

Beaches

Eel grass

Oysters

Polder management

Selected Measures	Suitability
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 Dec Searls, CC BY 2.0)

Other Adaptation Opportunities

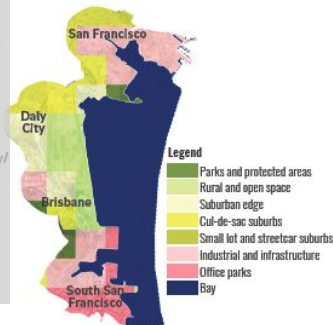
This OLU has a diverse mix of place types including office parks, industrial and infrastructure, developed open space, and low-to-moderate risk residential areas. The highest risk areas are the low-lying sea level rise risk is confined to small areas on the north (Hunters Point) and south (Brisbane) of the OLU, which are home to office parks and commercial redevelopment areas. Adaptation opportunities for Yosemite-Visitation include densifying and flood-proofing buildings, elevating roadways through building retrofits, perimeter protection with grey infrastructure or hybrid grey/green measures, and land and road elevation.

Flood-proofing buildings and retrofits

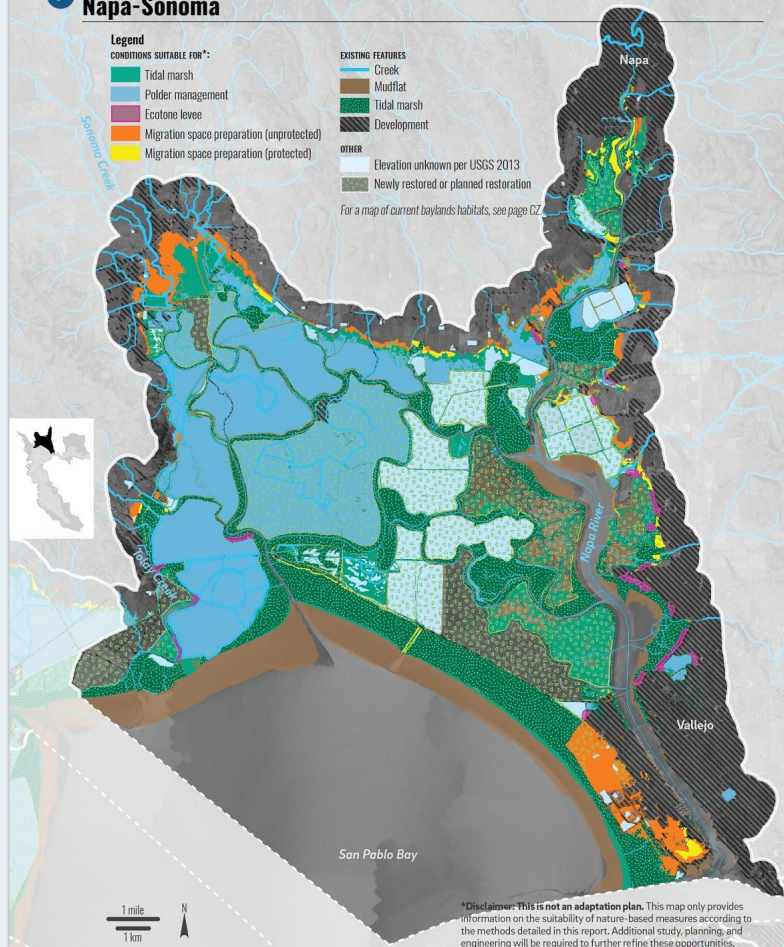
Elevating roadways

Perimeter Protection

Place Types Map



Napa-Sonoma



***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.

Nature-based Adaptation Measures

Polder management

Marsh Restoration

Migration Space

Creek connections

Other Adaptation Opportunities

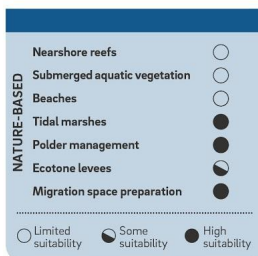
like Petaluma, the very large Napa-Sonoma OLU—by far the largest in the state—has a lot of open space issues, protected lands, and cultural and historic resources. It's a good candidate for restoration measures that allow flooding to occur and that facilitate recreation from recreational and agricultural uses to habitat or ecological uses over time, through restoration work, transition zone acquisition, and realigning public access. This OLU is at a good place to consider a variety of options, including easements, riparian shoreline acquisitions here can maximize nature-based solutions. A lot of the restoration is already being done, and the OLU is a good candidate for conservation easements or voluntary buyouts. For the suburban areas of the OLU that may experience sea level rise further in the future, buyouts and easements might be suitable alternatives to relocation or voluntary buyouts, depending 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

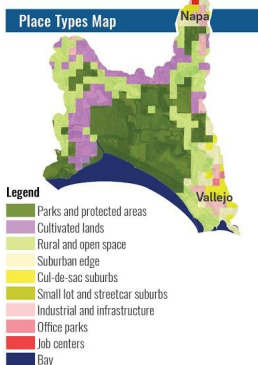
Marsh Restoration

Migration Space

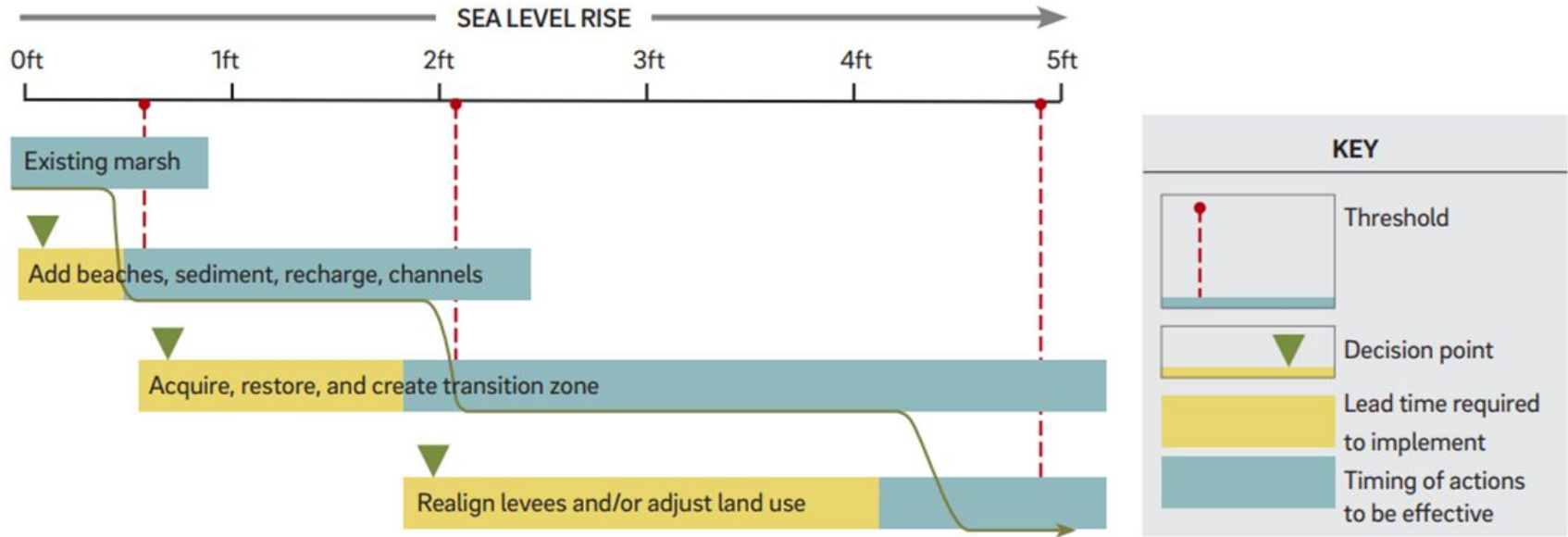
Creek connections



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



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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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**
- Guidance for **developers and project applicants**
- **Local, regional planners, and communities** creating adaptation plans and policies



THANK YOU

Contact: julieb@sfei.org

Thanks to our team: Jeremy Lowe, Sam Safran, Katie McKnight, Letitia Grenier, SFEI
Laura Tam and Sarah Jo Szambelan, SPUR

For more info: adaptationatlas.sfei.org