SLR ADAPTATION FRAMEWORK

PLANNING WITH NATURE:
A demonstration in Marin County

North Bay BAYCAN meeting

May 13, 2019

Point Blue
Conservation science for a healthy planet.

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Introduction

- Challenge of transitioning from vulnerability assessments to adaptation solutions
- Lots of interest in nature-based options, where are they appropriate?
- **Goal**: Develop a **framework process and set of tools** to support the transition from vulnerability assessment to adaptation strategies at a useful scale

Sea level rise

will not stop at city boundaries.

Traditional jurisdictions

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

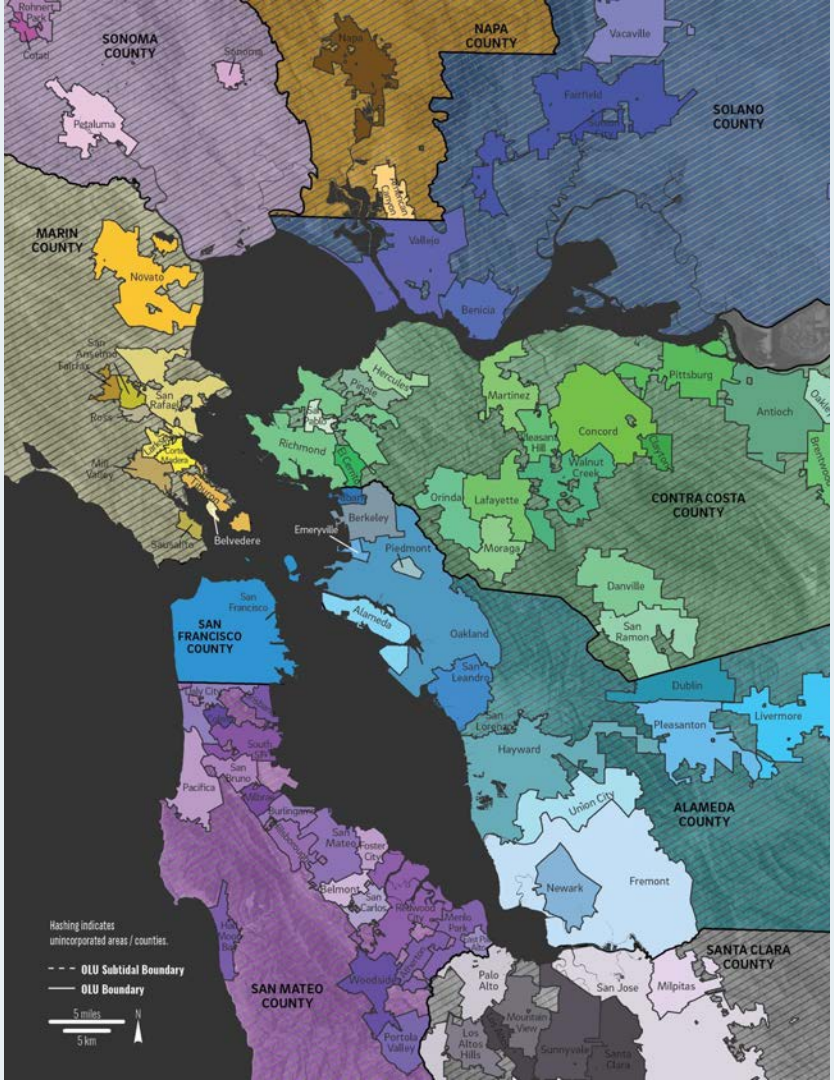

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Photo by: Press Democrat

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Addressing this challenge by:

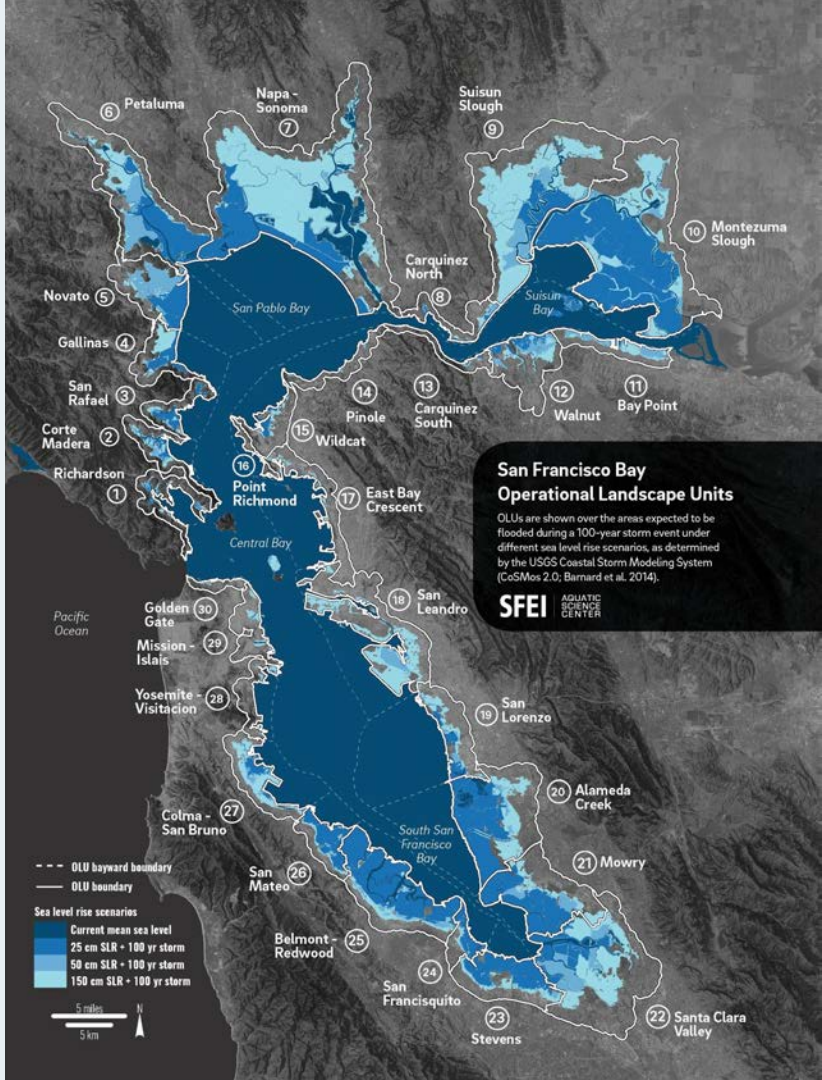
- Dividing up the Bay into manageable units that respond to the **physical and ecological processes**
- Mapping **suitability** for **nature-based adaptation measures**
- **Evaluate tradeoffs** between the choices we need to make

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***



What is a useful scale?

Operational Landscape Units

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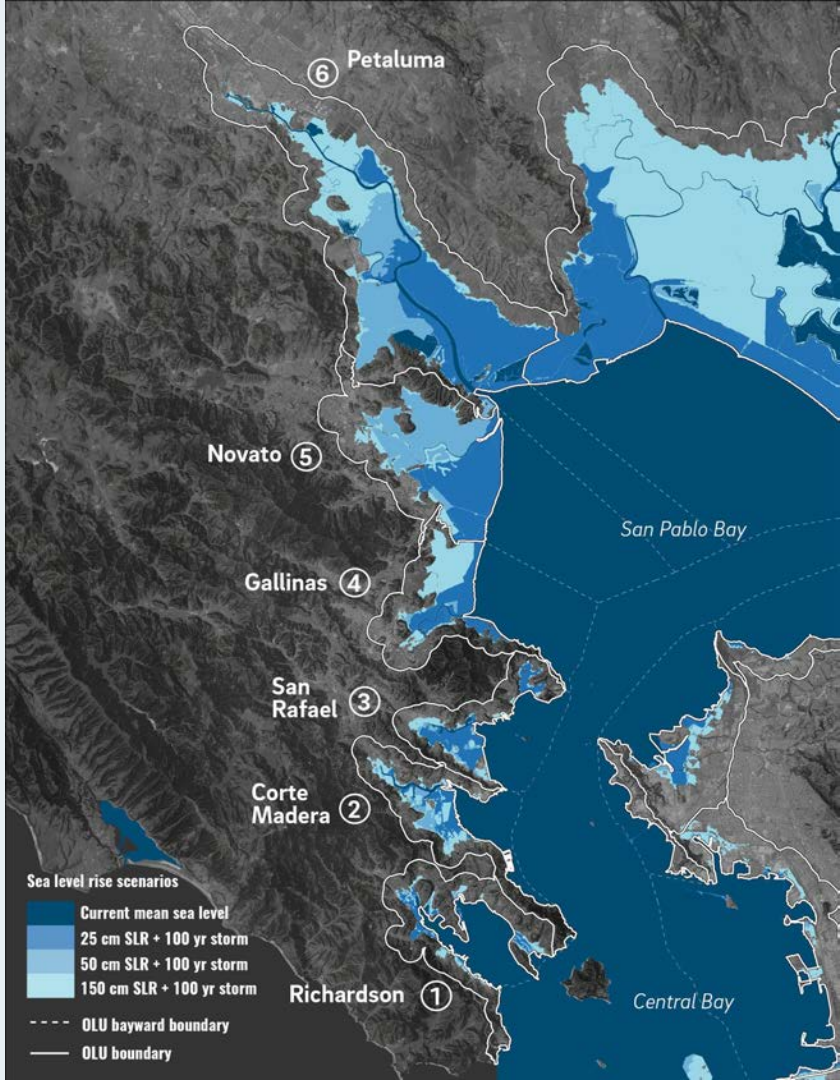
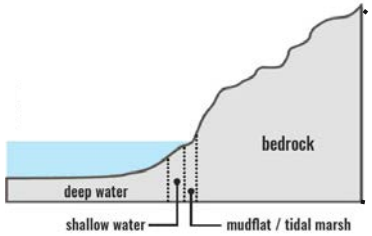
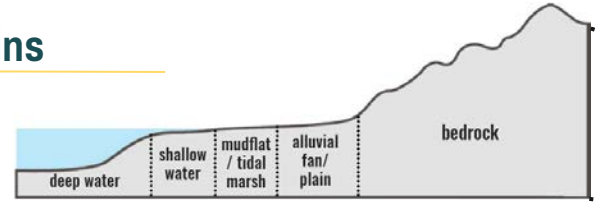


Geomorphic unit types

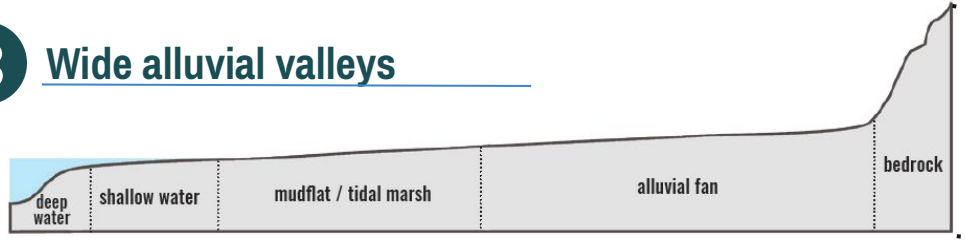
1 Headlands & small valleys

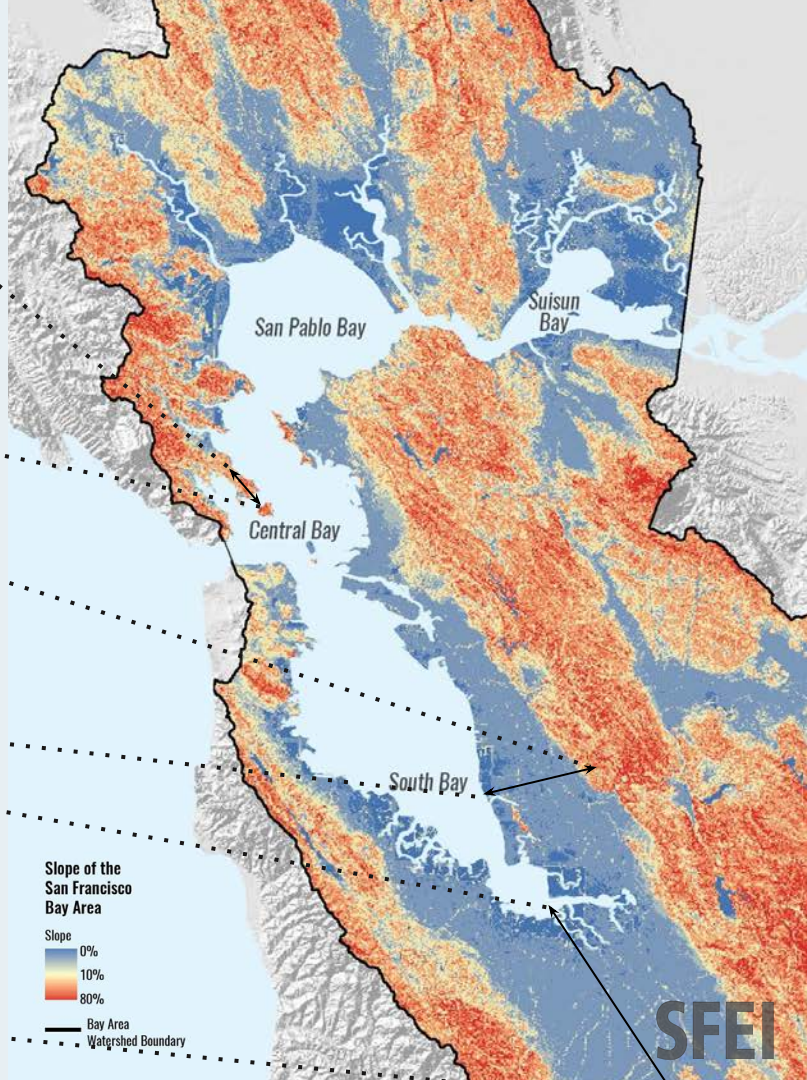


2 Alluvial fans & plains



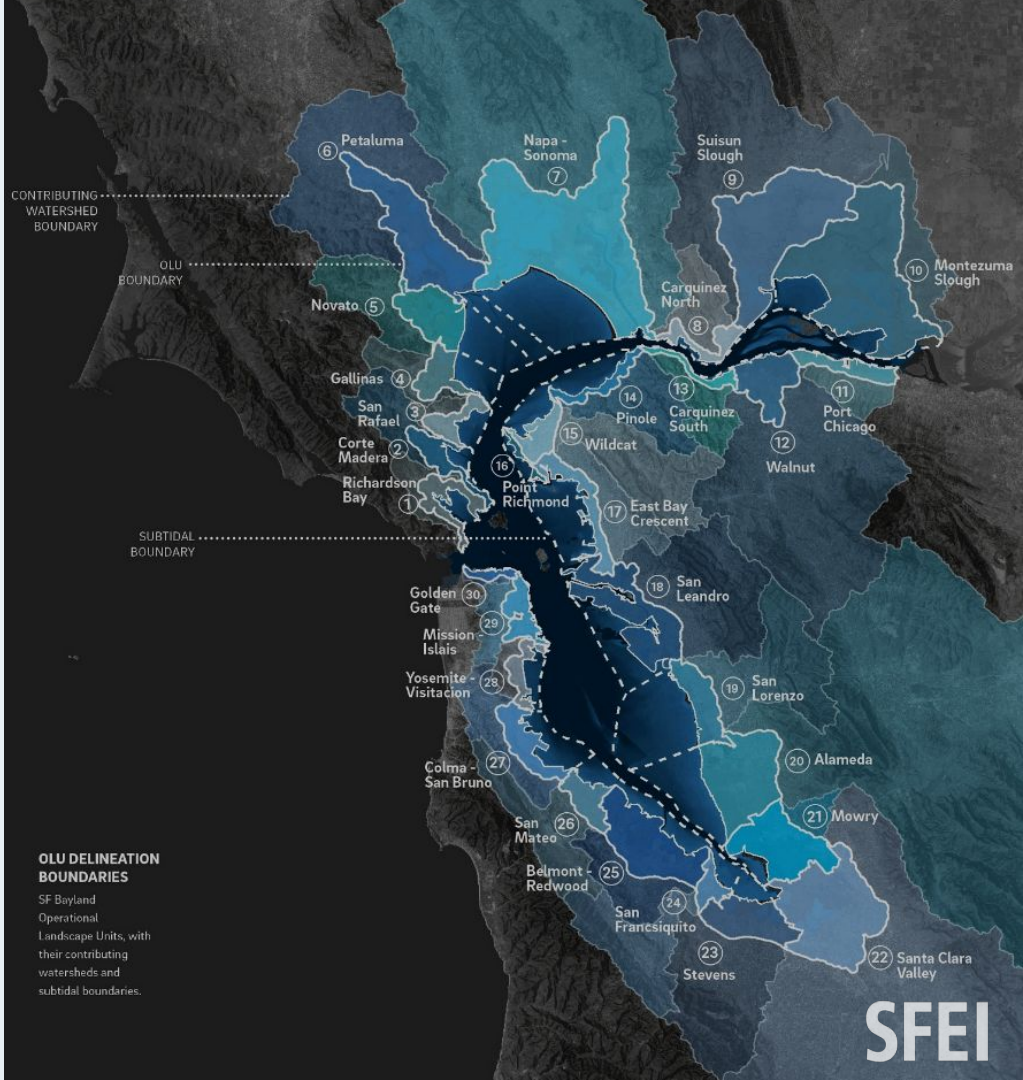
3 Wide alluvial valleys





Data inputs

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



How can this be used?

- As a toolkit to bring together stakeholders around a given shoreline unit (BCDC)
- A resource to assist environmental review and permitting (BCDC, RB2)
- Guidance for developers and project applicants
- Local, regional planners, and communities creating adaptation plans and policies
    - Cities, local visions

FRAMEWORK

Planning within nature's boundaries

STEP 1

Assess vulnerability

what assets are vulnerable & where; what is the source of vulnerability

STEP 2

Identify adaptation measures

that could work well in a given place *and use nature as much as you can*

STEP 3

Envision desired future(s)

what are desired outcomes? Develop visions/themes

STEP 4

Develop adaptation strategies

Strategy = a combination of "measures"; Develop for each desired future or theme

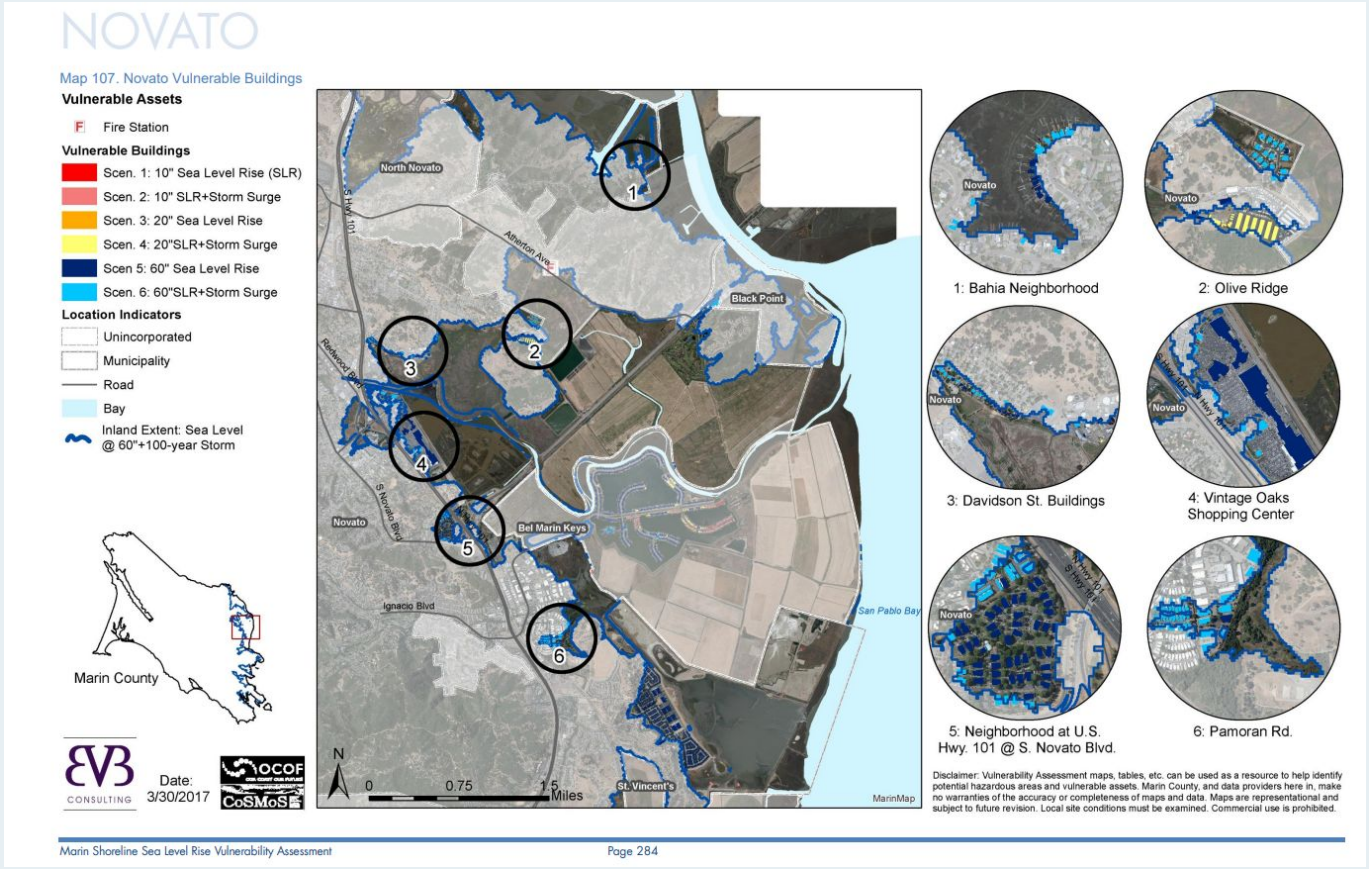
STEP 5

Evaluate and prioritize

assess benefits and tradeoffs among strategies

STEP 1

Assess vulnerability



BayWave

STEP 1 Assess vulnerability

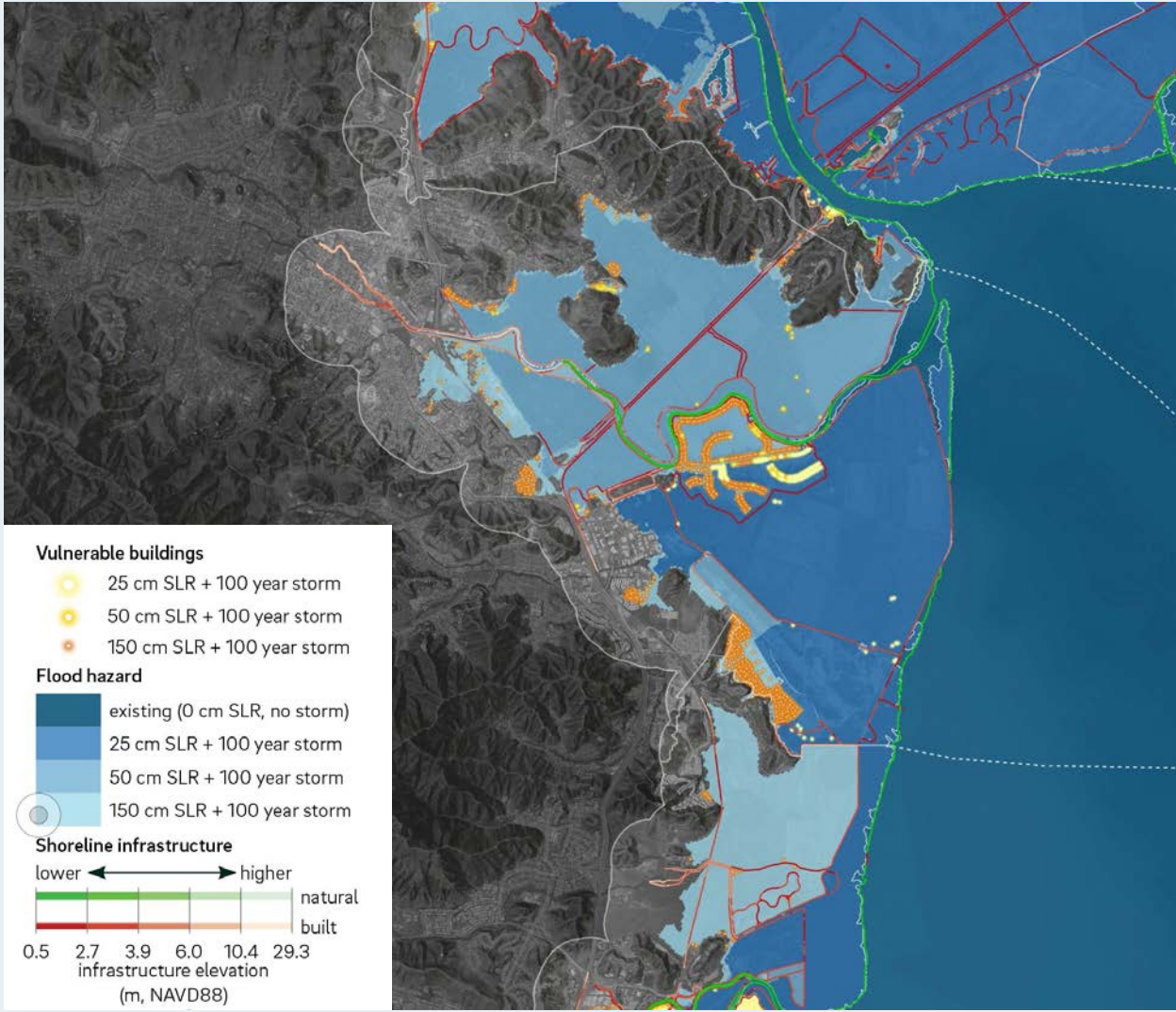
(what assets are vulnerable & where; what is the source of vulnerability)

Sources of vulnerability

- Combined flooding
- Subsided lands behind levees
- Eroding shorelines
- Infrastructure

Assets

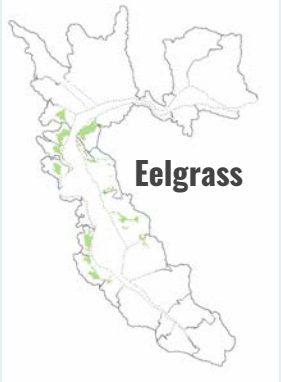
- Less developed, in public ownership
- Topography, sediment

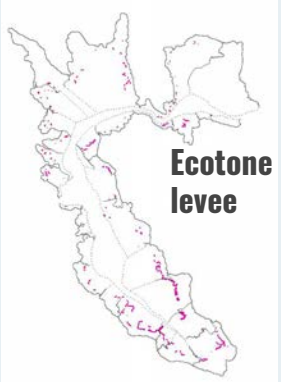


STEP 2 Identify adaptation measures

Nature-based measures

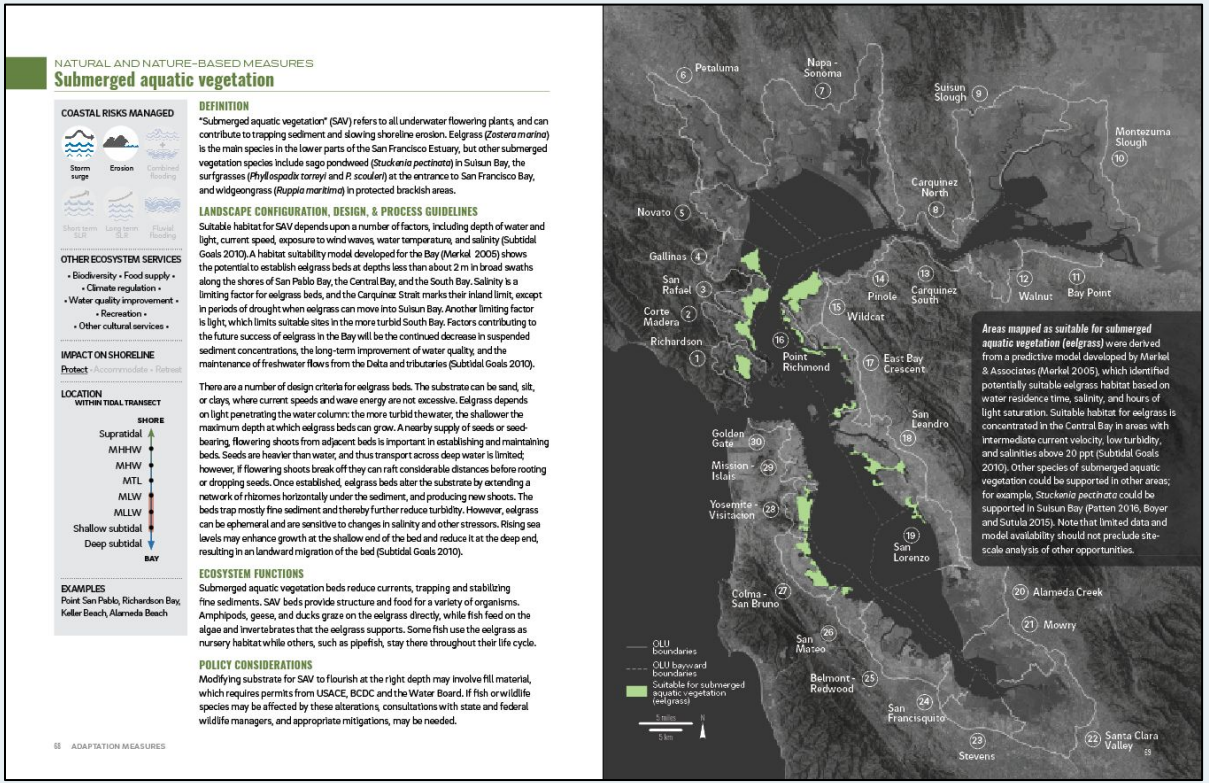
- Nearshore reefs
- SAV (eelgrass)
- Beaches
- Tidal marsh
- Polder management
- Ecotone levees
- Migration space preparation
- Creek-to-bayland reconnections
- Green stormwater infrastructure





	Nearshore reefs	Submerged aquatic vegetation (eelgrass)	Beaches	Tidal marshes	Polder management	Ecotone levees	Migration space preparation
1. Richardson	●	●	●	◔	○	◔	○
2. Corte Madera	●	●	●	◔	◔	◔	◔
3. San Rafael	●	●	●	◔	◔	◔	○
4. Gallinas	◔	●	○	●	●	◔	●
5. Novato	○	○	○	●	●	◔	●
6. Petaluma	○	○	○	●	●	○	●

For each adaptation measure



NATURAL AND NATURE-BASED MEASURES

Submerged aquatic vegetation

COASTAL RISKS MANAGED

Storm surge · Erosion · Combined flooding · Short term SLR · Long term SLR · Fluvial flooding

OTHER ECOSYSTEM SERVICES

• Biodiversity • Food supply • • Climate regulation • • Water quality improvement • • Recreation • • Other cultural services •

IMPACT ON SHORELINE

Protect · Accommodate · Retreat

LOCATION
WITHIN TIDAL TRANSECT

SHORE
Supratidal
MHHW
MHW
MTL
MLW
MLLW
Shallow subtidal
Deep subtidal
BAY

EXAMPLES
Point San Pablo, Richardson Bay, Keller Beach, Alameda Beach

DEFINITION

"Submerged aquatic vegetation" (SAV) refers to all underwater flowering plants, and can contribute to trapping sediment and slowing shoreline erosion. Eelgrass (*Zostera marina*) is the main species in the lower parts of the San Francisco Estuary, but other submerged vegetation species include sago pondweed (*Stuckenia pectinata*) in Suisun Bay, the surfgrasses (*Phyllospadix torreyi* and *P. scouleri*) at the entrance to San Francisco Bay, and widgeongrass (*Ruppia maritima*) in protected brackish areas.

LANDSCAPE CONFIGURATION, DESIGN, & PROCESS GUIDELINES

Suitable habitat for SAV depends upon a number of factors, including depth of water and light, current speed, exposure to wind waves, water temperature, and salinity (Subtidal Goals 2010). A habitat suitability model developed for the Bay (Merkel 2005) shows the potential to establish eelgrass beds at depths less than about 2 m in broad swaths along the shores of San Pablo Bay, the Central Bay, and the South Bay. Salinity is a limiting factor for eelgrass beds, and the Carquinez Strait marks their inland limit, except in periods of drought when eelgrass can move into Suisun Bay. Another limiting factor is light, which limits suitable sites in the more turbid South Bay. Factors contributing to the future success of eelgrass in the Bay will be the continued decrease in suspended sediment concentrations, the long-term improvement of water quality, and the maintenance of freshwater flows from the Delta and tributaries (Subtidal Goals 2010).

There are a number of design criteria for eelgrass beds. The substrate can be sand, silt, or clays, where current speeds and wave energy are not excessive. Eelgrass depends on light penetrating the water column: the more turbid the water, the shallower the maximum depth at which eelgrass beds can grow. A nearby supply of seeds or seed-bearing, flowering shoots from adjacent beds is important in establishing and maintaining beds. Seeds are heavier than water, and thus transport across deep water is limited; however, if flowering shoots break off they can raft considerable distances before rooting or dropping seeds. Once established, eelgrass beds alter the substrate by extending a network of rhizomes horizontally under the sediment, and producing new shoots. The beds trap mostly fine sediment and thereby further reduce turbidity. However, eelgrass can be ephemeral and are sensitive to changes in salinity and other stressors. Rising sea levels may enhance growth at the shallow end of the bed and reduce it at the deep end, resulting in an landward migration of the bed (Subtidal Goals 2010).

ECOSYSTEM FUNCTIONS

Submerged aquatic vegetation beds reduce currents, trapping and stabilizing fine sediments. SAV beds provide structure and food for a variety of organisms. Amphipods, geese, and ducks graze on the eelgrass directly, while fish feed on the algae and invertebrates that the eelgrass supports. Some fish use the eelgrass as nursery habitat while others, such as pipefish, stay there throughout their life cycle.

POLICY CONSIDERATIONS

Modifying substrate for SAV to flourish at the right depth may involve fill material, which requires permits from USACE, BCDC and the Water Board. If fish or wildlife species may be affected by these alterations, consultations with state and federal wildlife managers, and appropriate mitigations, may be needed.

68 ADAPTATION MEASURES

For each measure:

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

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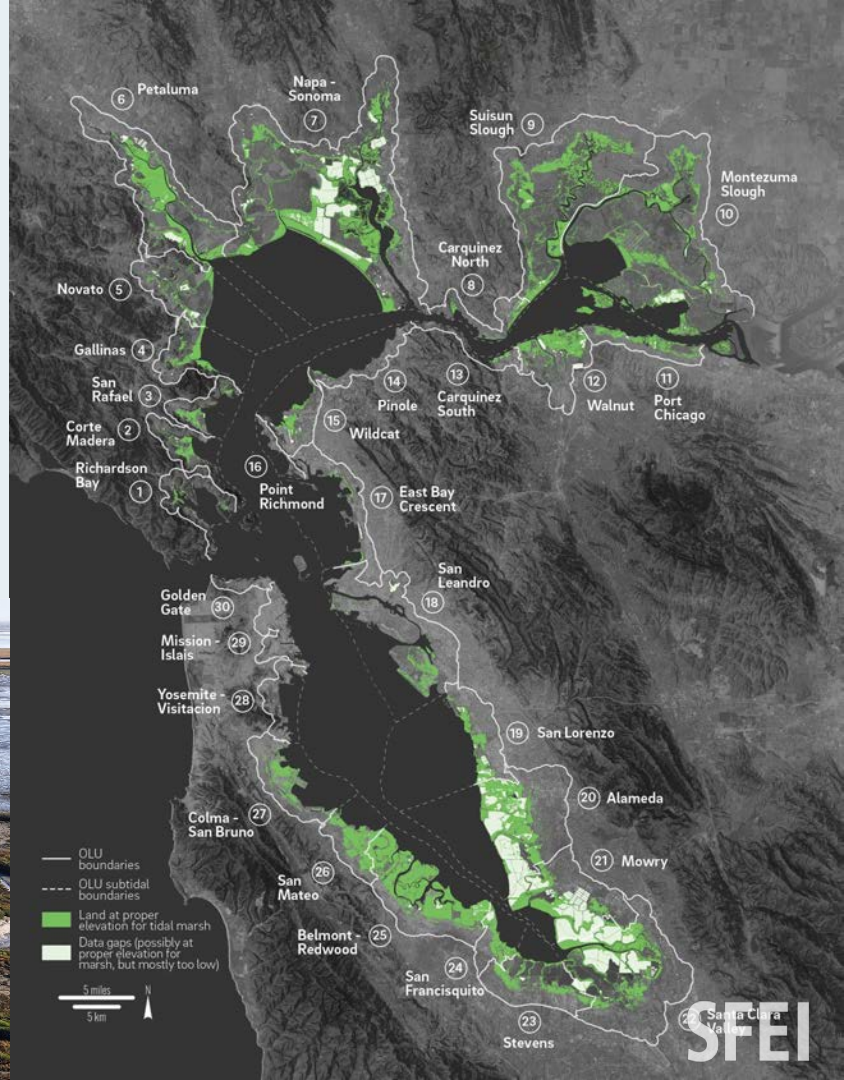
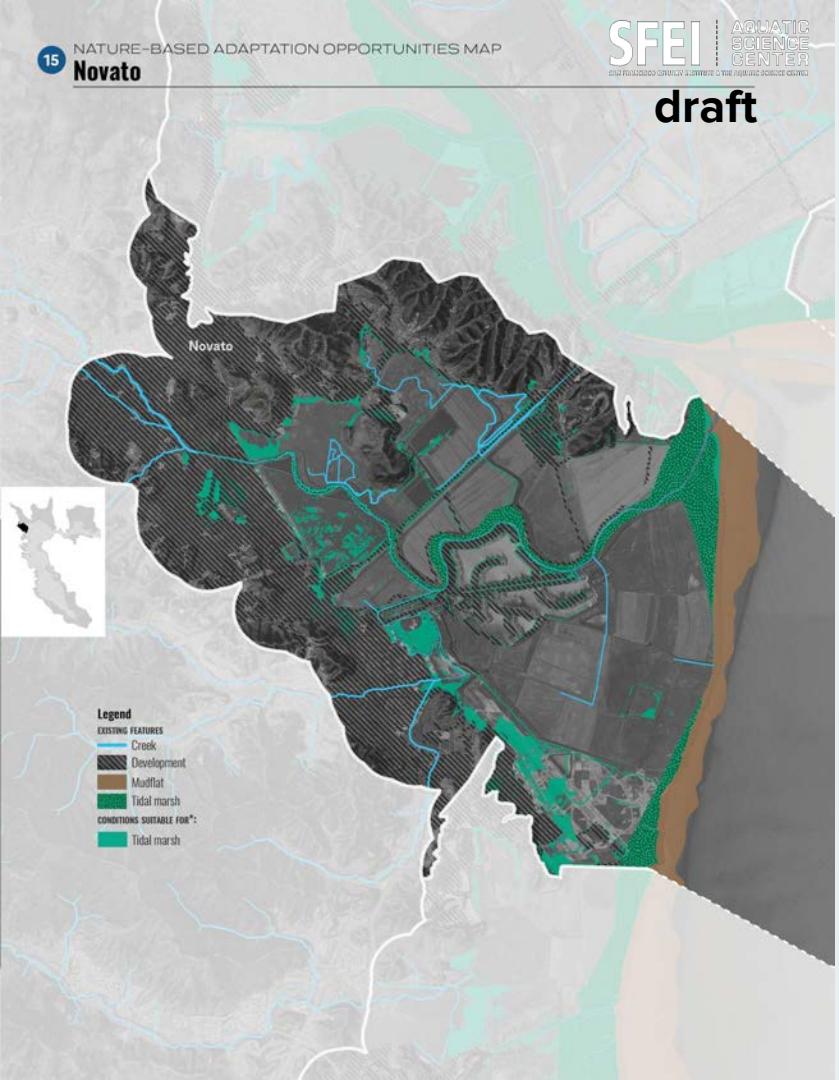
Marsh restoration

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



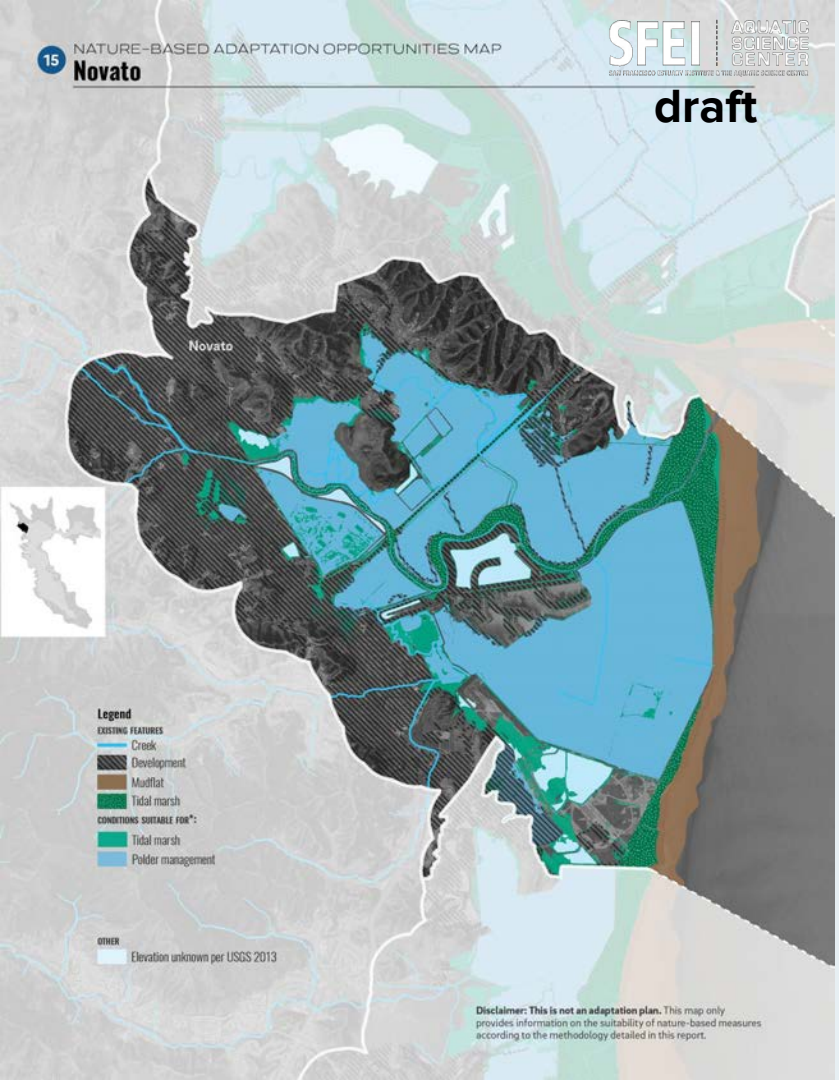


Novato OLU:

Suitable nature-based measures

- Tidal marsh

Breaching berms on land purchased by Marin Audubon in Novato to make way for tidal marsh (Photo by Chris Stewart)

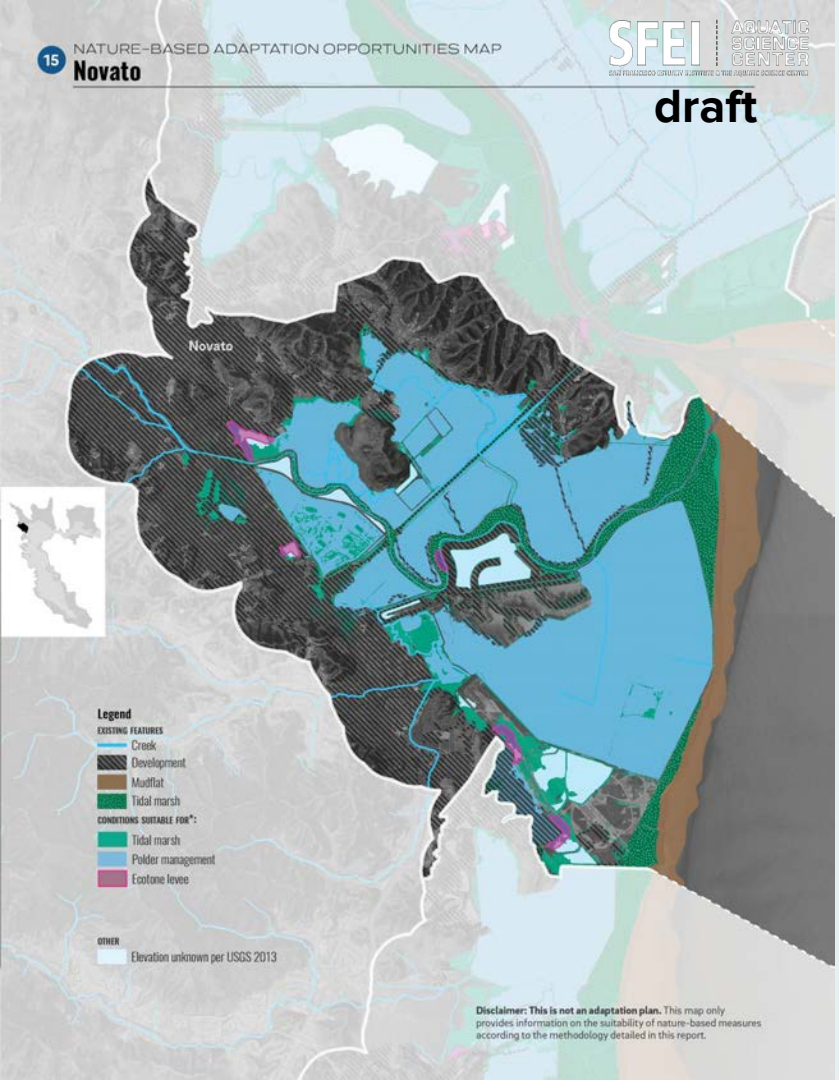


Novato OLU:

Suitable nature-based measures

- Tidal marsh
- Polder management

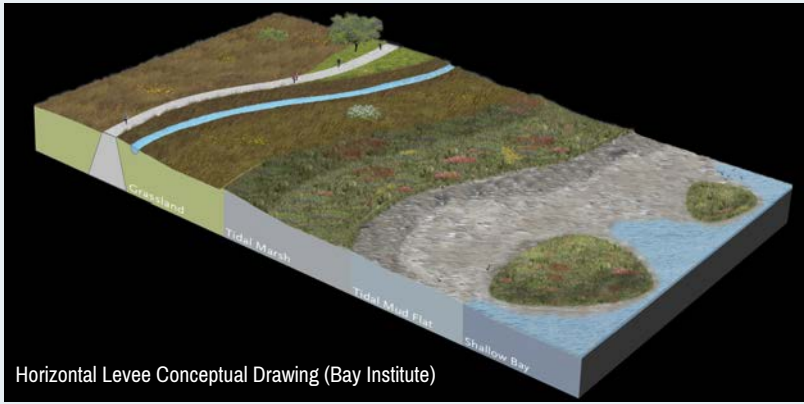
A polder (the site of Hamilton Airfield) before and after being opened to tidal action. (Photo courtesy Google Earth)



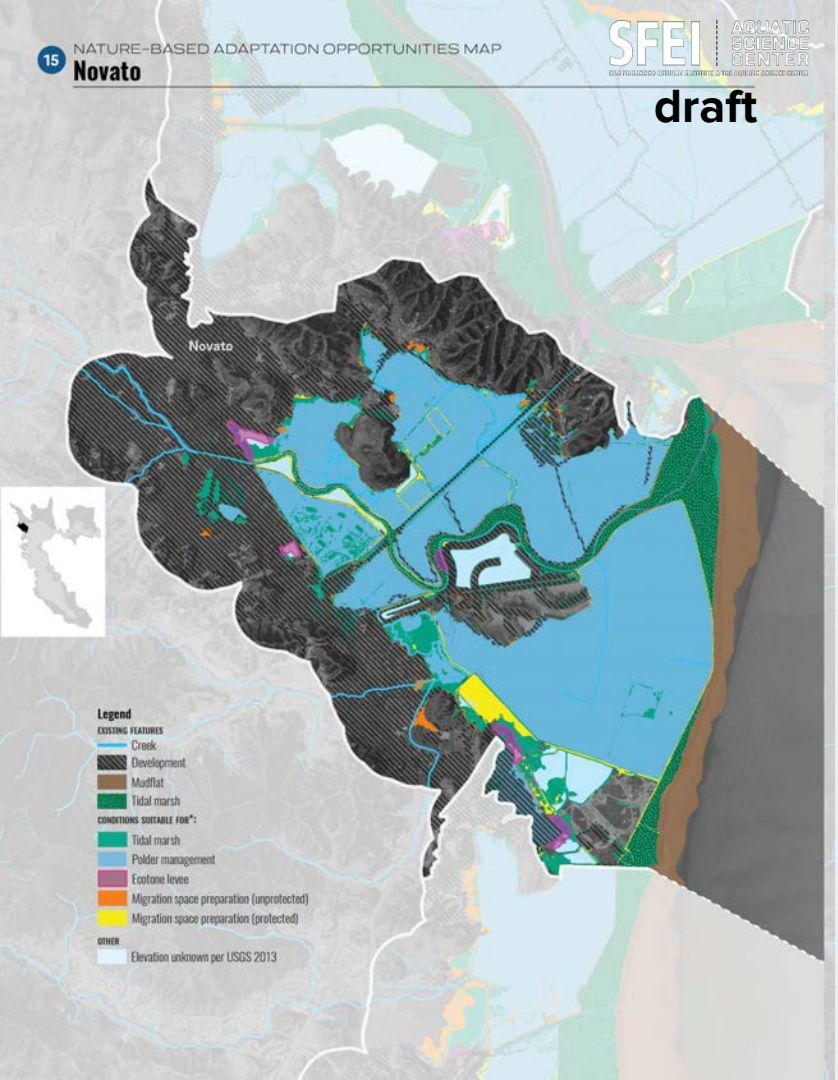
Novato OLU:

Suitable nature-based measures

- Tidal marsh
- Polder management
- Ecotone levee



Horizontal Levee Conceptual Drawing (Bay Institute)



Novato OLU:

Suitable nature-based measures

- Tidal marsh
- Polder management
- Ecotone levee
- Migration space preparation (unprotected and protected)

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

○ Limited suitability ◔ Some suitability ● High suitability

STEP 3

Envision desired futures

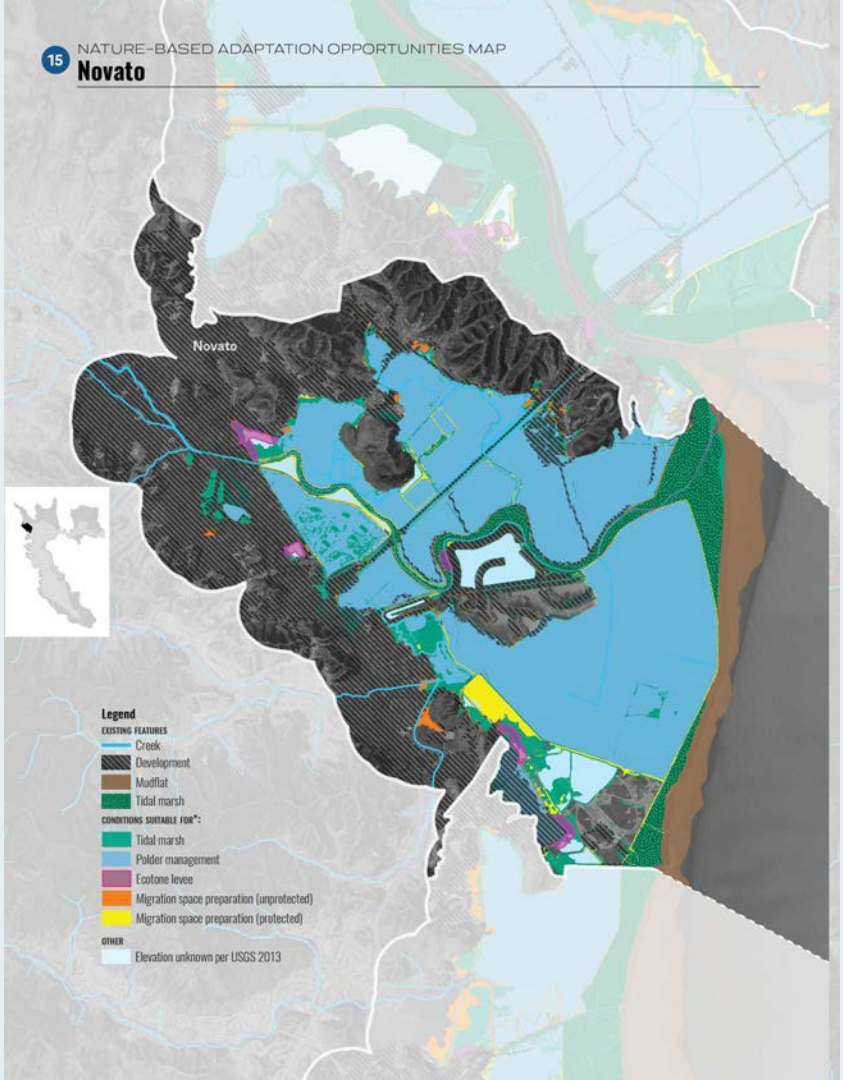
(What are desired outcomes? Articulate visions/themes for the future)

- A “strategy” combines adaptation measures within an OLU
- A distinguishing goal/theme and criteria are needed to develop strategies
- Strategy themes should be developed with stakeholders

STEP 3

Example
Theme #1
“Hold the line”

- Build up existing defenses
- Employ nature-based adaptation options bayward of existing first line of defense



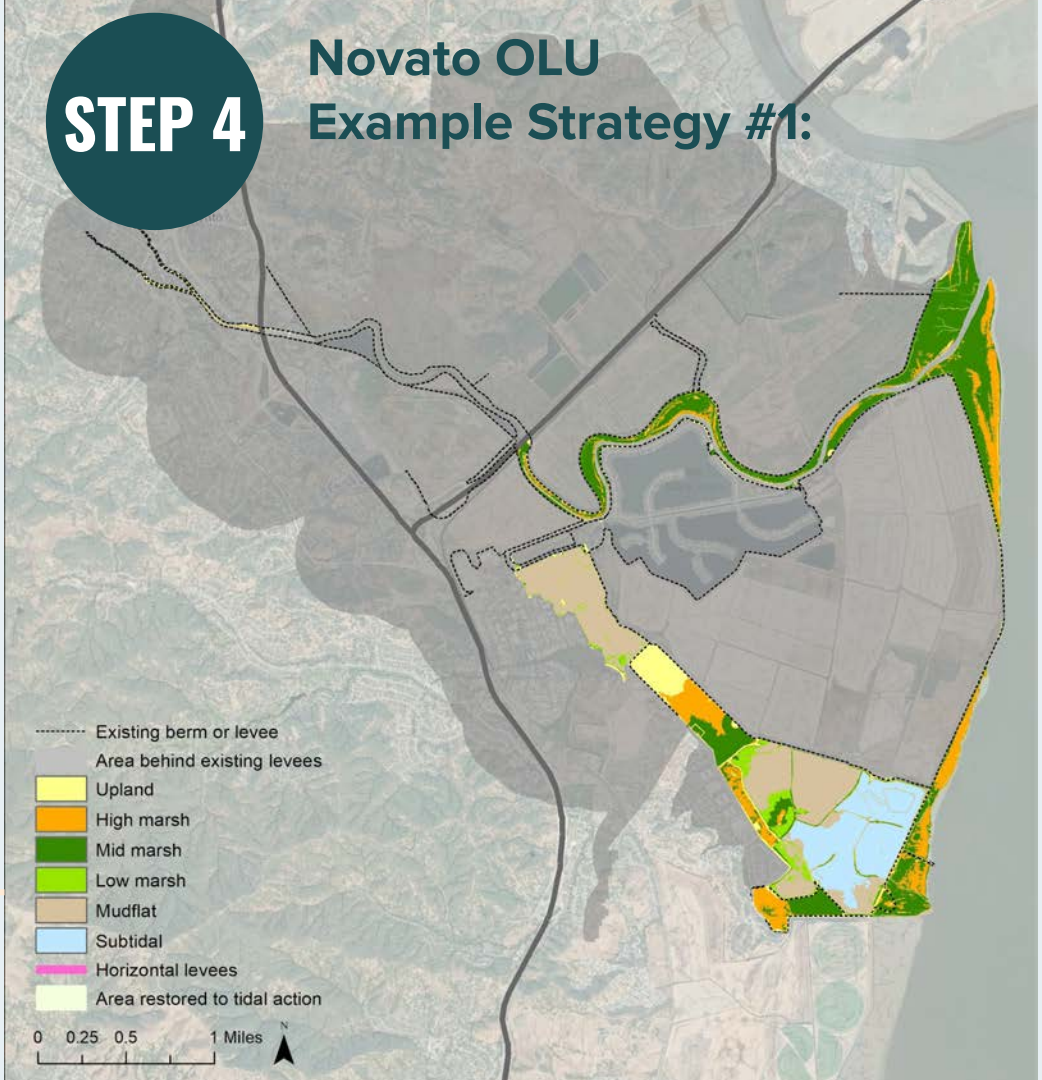
STEP 3

Example Theme #1 “Hold the line”

- Build up existing defenses
- Employ nature-based adaptation options bayward of existing first line of defense

STEP 4

Novato OLU Example Strategy #1:



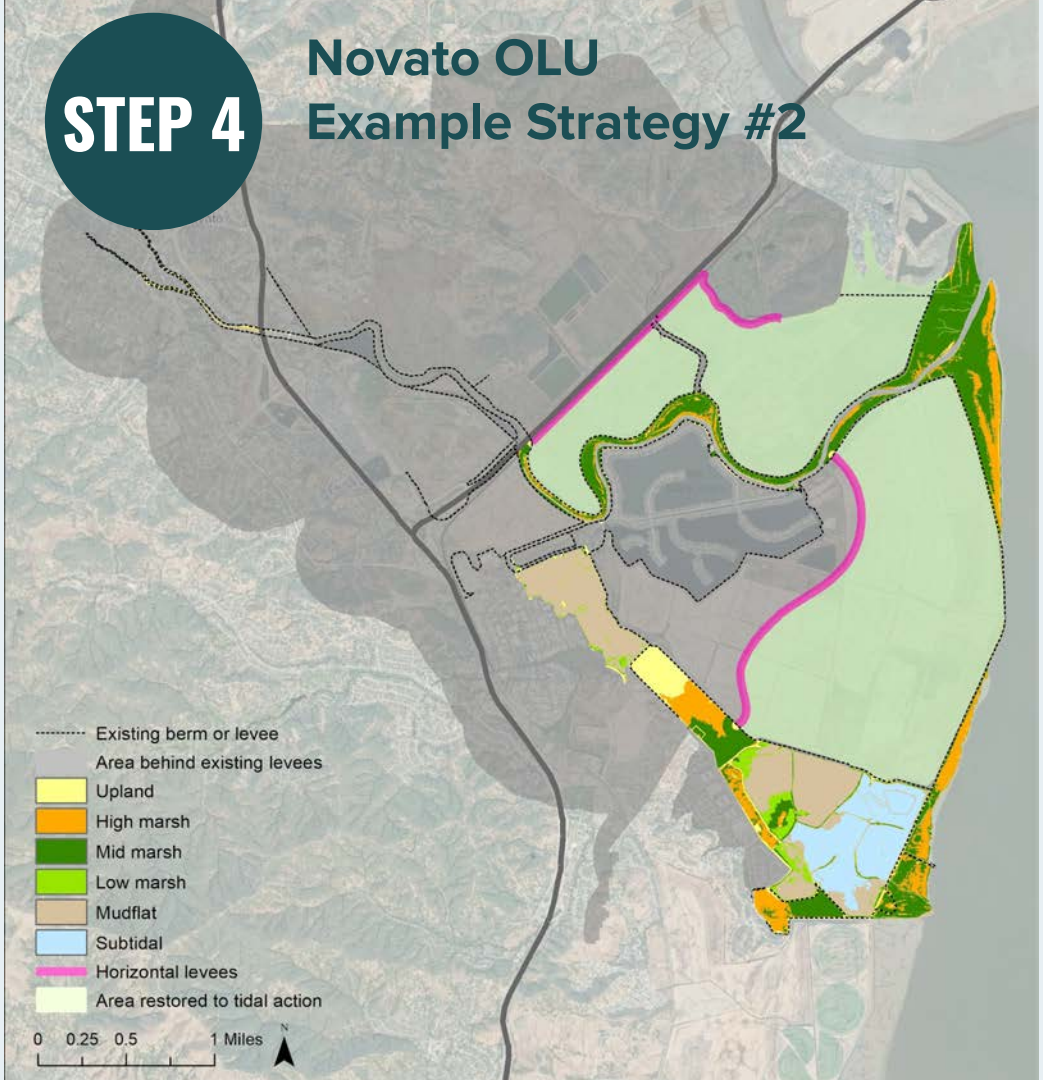
STEP 3

Example Theme #2: "Buffer w/ public open space"

- Existing people and infrastructure remain protected in place
- Retreat first line of defense only on public open space
- Retreat allows more space for additional nature-based options

STEP 4

Novato OLU Example Strategy #2



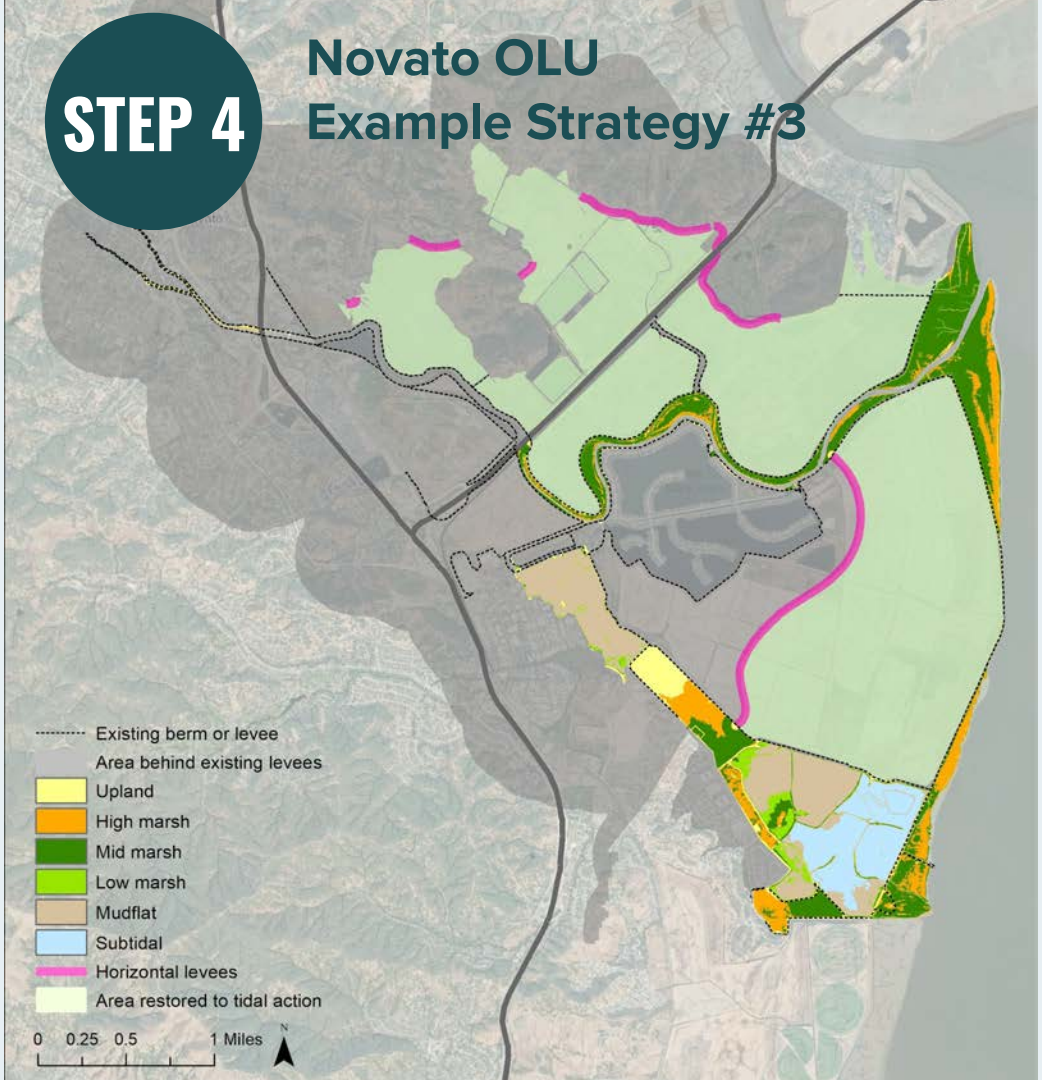
STEP 3

Example Theme #3: "Maximize habitat"

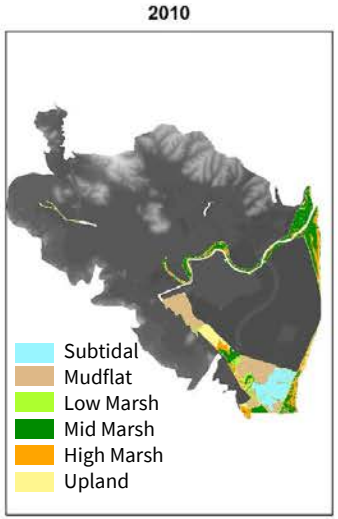
- Maximize opportunities for habitat enhancement
- Existing people/homes remain in place
- Key infrastructure may need to be re-aligned/ re-designed

STEP 4

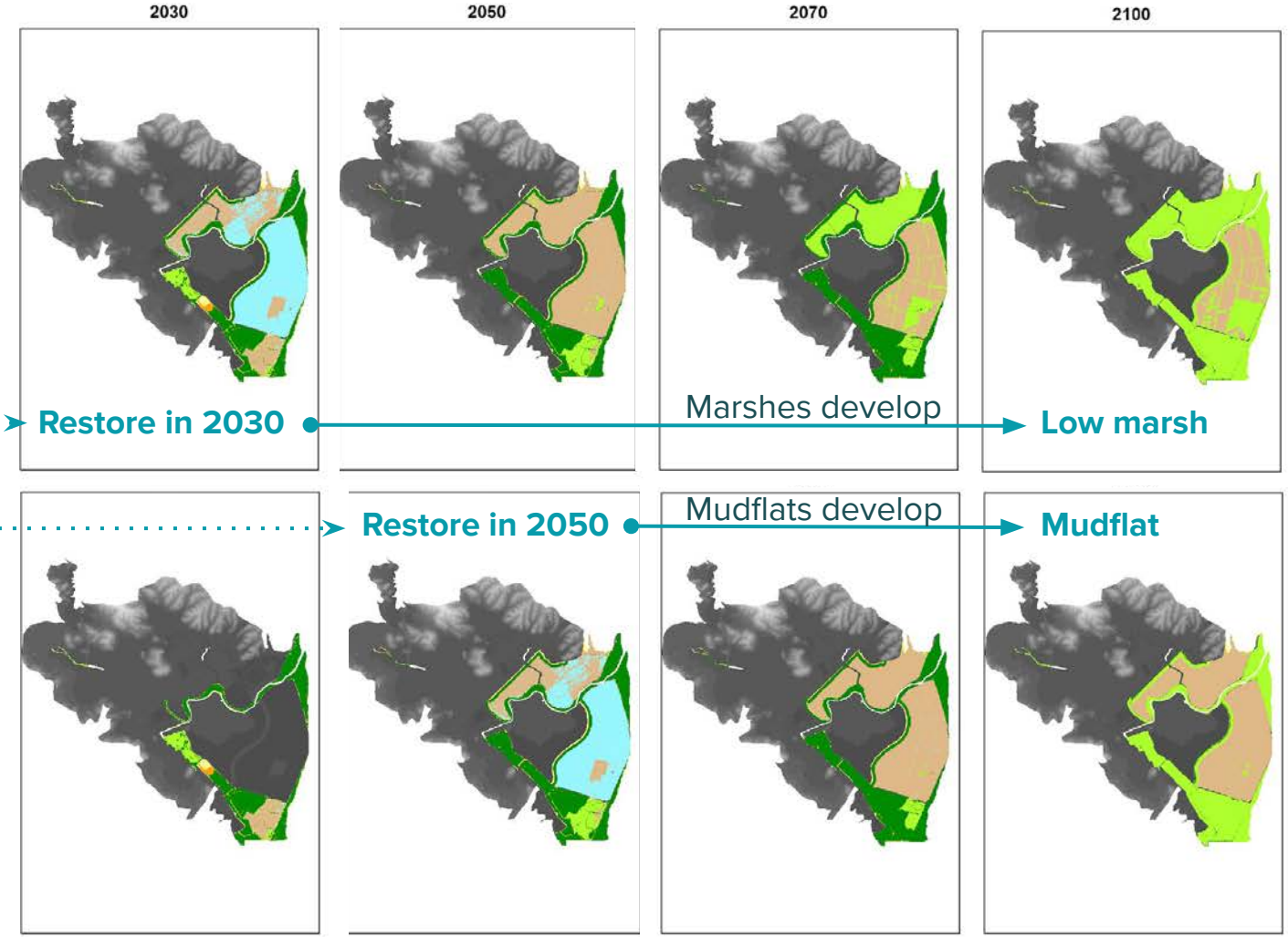
Novato OLU Example Strategy #3



Timing Matters



How might objectives change with SLR?



STEP 5

Evaluate and Prioritize Strategies

- **Identify benefits / services important to stakeholders**
- **Identify "benefit-relevant indicators" that can be measured (quantitative or qualitative)**
- **Assess trade-offs among strategies**

Cost Considerations
Low cost construction/maintenance
Ease of permitting
Political/community acceptability
Regulating Services
Coastal hazard reduction
Carbon sequestration and storage
Water filtration (improved water quality)
Supporting Services
Biodiversity support (habitat, species)
Nutrient cycling

Cultural/Social Services
Recreation
Education
Aesthetic
Spiritual/Sense of place
Services to disadvantaged communities/ vulnerable populations
Provisioning Services
Food (e.g., sportfish)
Raw materials

Examples of indicators

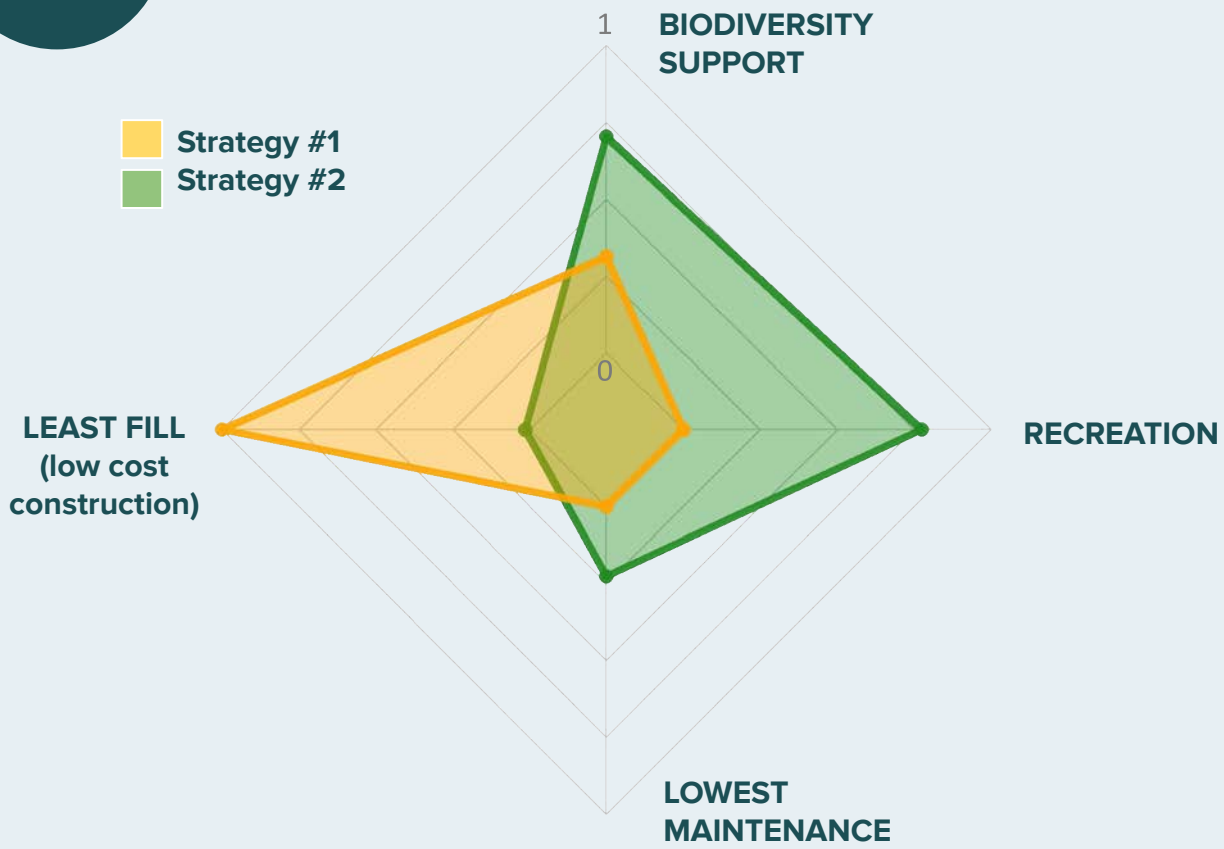
- Amount of fill needed
- Distance of existing shoreline protection to be raised/maintained
- Area of vegetated marsh habitat projected in Year 2050
- Total miles of trails

- Indicators defined by the community

NOTE: only need to quantify benefits that differ among strategies. For example, if coastal hazard reduction is equivalent across strategies (inherent in the designs)

STEP 5

Evaluate and Prioritize Strategies



- Higher values mean “more benefit”
- **Compare total benefits** of strategies, while still **seeing the tradeoffs**
- Can **weight** certain benefits more than others
- Supports an **informed choice**
- May lead to developing **alternative strategies**

Lessons Learned

- There is **no one-size-fits-all approach** for SLR adaptation
  - Some places there are a lot of options for nature-based measures and some places there aren't.
- **Options change with SLR**. Developing pathways is important. **Timing matters**.
- Needs to be done with and led by **stakeholders and communities**

Next Steps

- Developing **“User’s Guide”** of the framework with case study examples
- **Initial feedback** via existing planning process
- **Piloting approach in partnership** with the County

THANK YOU

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Coastal Conservancy

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Baywide OLU project:
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