

Living Shorelines in SF Bay

Restoring Habitat and Building Capacity to Adapt to Rising Seas



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Project Manager

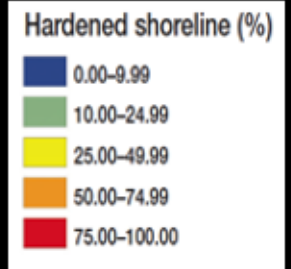


State of California
Coastal Conservancy

A Legacy of Shoreline Hardening



14% of U.S. shoreline is hardened



Affected flora and fauna

- Benthic invertebrates (e.g., Seitz et al. 2006)
- Shore birds (e.g., Dugan et al. 2006, 2008):
- Fish (Peterson et al. 2000, Gittman et al. 2016, Seitz et al. 2006)

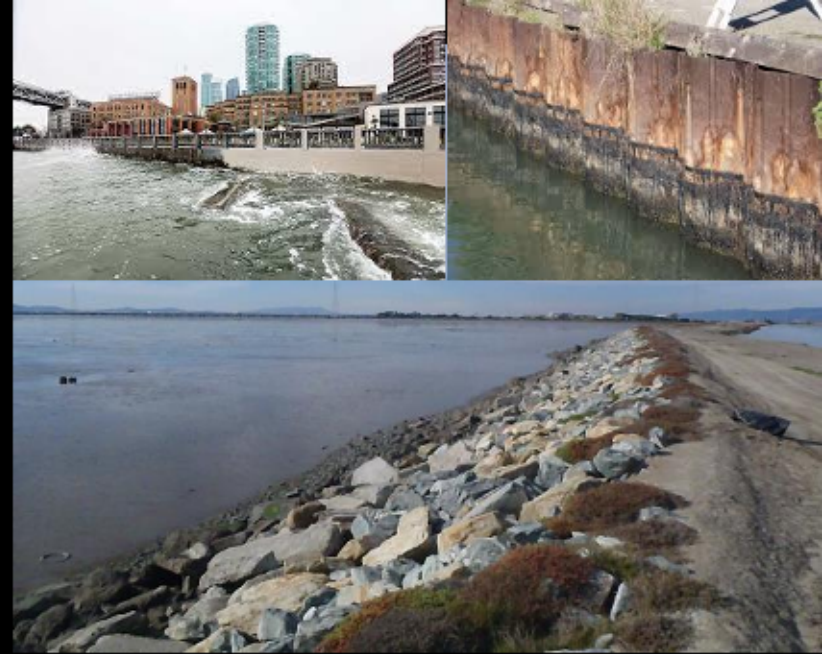


Shoreline access and uses



Hard Infrastructure

Necessary in certain locations
Impacts to shorelines, wetlands
and submerged habitats



Nature-Based Infrastructure
Biological and Physical Benefits
Habitat Connectivity
Climate Adaptation



Implementing New Approaches

- Advance Nature-based Adaptation and Design Guidance
- Build Regional Capacity through Knowledge Transfer
- Pilot Multi-Objective Designs in Different Settings
- Encourage Local Labor and Involvement

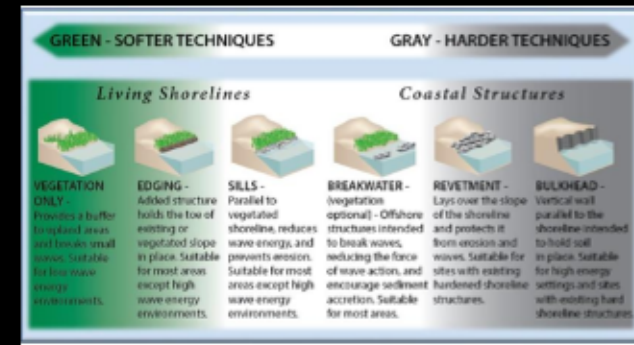


Living Shorelines

- Shoreline protection via restoration design
- Suite of techniques/habitat types
- Minimize coastal erosion
- Maintain coastal processes
- Natural habitat for plants, wildlife, and people



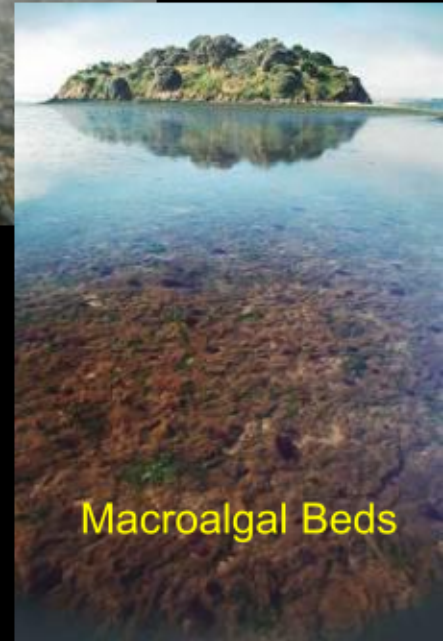
RESTORE
AMERICA'S
ESTUARIES



Submerged Aquatic Vegetation



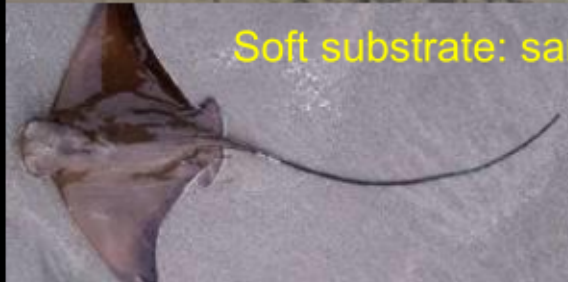
Rock Habitats



Artificial Structures



Soft substrate: sand

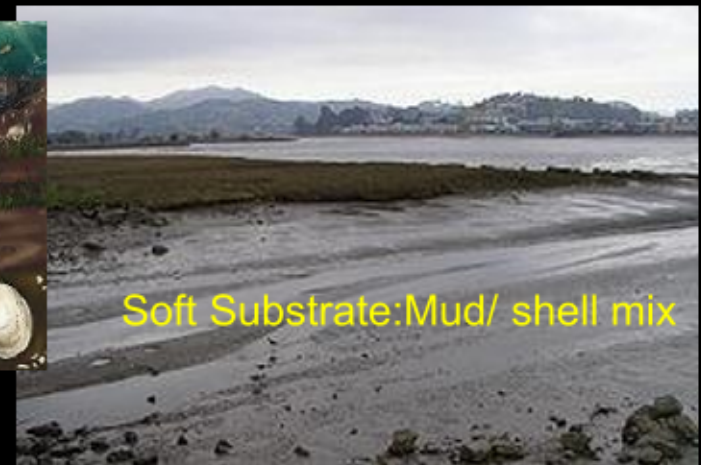


Macroalgal Beds

Shellfish Beds



Soft Substrate: Mud/ shell mix





Green-Grey Spectrum for Living Shorelines

GREEN - SOFTER TECHNIQUES

Small Waves | Small Fetch | Gentle Slope | Shaded Coast

HOW GREEN OR GRAY

SHOULD YOUR SHORELINE SOLUTION BE?

GRAY - HARDER TECHNIQUES

Large Waves | Large Fetch | Steep Slope | Open Coast

LIVING SHORELINE

VEGETATION ONLY

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

EDGING

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

SILLS

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

BEACH NOURISHMENT ONLY

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

BEACH NOURISHMENT & VEGETATION ON DUNE

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

Plants hold soil in place to reduce erosion. Provides a buffer to upland areas and creates small waves.

Sustainable For:

Low wave energy environments.

Material Options:

• Native plants

Benefits:

• Dissipates wave energy

• Slows inland water transfer

• Increases natural storm water infiltration

• Provides habitat and ecosystem services

• Minimal impact to natural community and ecosystem processes

• Maximizes aquaterrrestrial interface and connectivity

• Flood water storage

Disadvantages:

Structure to hold the toe of eroding or vegetated slope in place. Protects against shoreline erosion.

Sustainable For:

Most areas except high wave energy environments.

Material Options:

• Vegetation

Benefits:

• Slows inland water transfer

• Increases natural storm water infiltration

• Provides habitat and ecosystem services

• Minimal impact to natural community and ecosystem processes

• Maximizes aquaterrrestrial interface and connectivity

• Flood water storage

Disadvantages:

Parallel to existing or vegetated shoreline, reduces wave energy and prevents erosion. A rippled approach would allow habitat connectivity, greater tidal exchange, and better vegetation access.

Sustainable For:

Most areas except high wave energy environments.

Material Options:

• Vegetation

Benefits:

• Slows inland water transfer

• Increases natural storm water infiltration

• Provides habitat and ecosystem services

• Minimal impact to natural community and ecosystem processes

• Maximizes aquaterrrestrial interface and connectivity

• Flood water storage

Disadvantages:

Large volume of sand added from outside source to an eroding beach. Widens the beach and moves the shoreline seaward.

Sustainable For:

Low-lying oceanfront areas with existing sources of sand and sediment.

Material Options:

• Sand

Benefits:

• Expands usable beach area

• Lower environmental impact than hard structures

• Flexible structure

• Ridesigned with relative ease

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

Helps anchor sand and provide a buffer to protect inland areas from waves, flooding and erosion.

Sustainable For:

Low-lying oceanfront areas with existing sources of sand and sediment.

Material Options:

• Sand

Benefits:

• Expands usable beach area

• Lower environmental impact than hard structures

• Flexible structure

• Ridesigned with relative ease

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

BREAKWATER

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

SPRINT

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

REVEGETMENT

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

BULKHEAD

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

SEAWALL

Photo credit: USACE, Corps of Engineers, San Francisco District, San Francisco, CA

Orthogonal structures intended to break waves, reducing the force of wave action and encouraging sediment accretion. Can be flexible or fixed to the ocean floor, attached to shore or not, and continuous or segmented. A piped approach would allow habitat access as well, greater tidal exchange, and better vegetation access.

Sustainable For:

Most areas except high wave energy environments with no rippled approach.

Material Options:

• Concrete

Benefits:

• Dissipates wave energy

• Reduces wave force and height

• Reduces erosion

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

Perpendicular, projecting from shoreline, interrupt water flow and would allow parallel to the shoreline to prevent beach erosion and break waves. Ridesigned with rippled approach.

Sustainable For:

Coastal areas with beach nourishment.

Material Options:

• Concrete

Benefits:

• Dissipates wave energy

• Reduces wave force and height

• Reduces erosion

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

Lays over the slope of a shoreline. Provides slope from erosion and waves.

Sustainable For:

Coastal areas with beach nourishment.

Material Options:

• Concrete

Benefits:

• Dissipates wave energy

• Reduces wave force and height

• Reduces erosion

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

Parallel to the shoreline, vertical retaining wall. Intended to hold soil in place and allow for a stable shoreline.

Sustainable For:

Coastal areas with beach nourishment.

Material Options:

• Concrete

Benefits:

• Dissipates wave energy

• Reduces wave force and height

• Reduces erosion

• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

Parallel to shoreline, vertical or sloped wall. Not on one side of wall is the same elevation as water on the other. Absorbs and limits impacts of large waves and directs flow away from land.

Sustainable For:

Coastal areas with beach nourishment.

Material Options:

• Concrete

Benefits:

• Dissipates wave energy

• Reduces wave force and height

• Reduces erosion

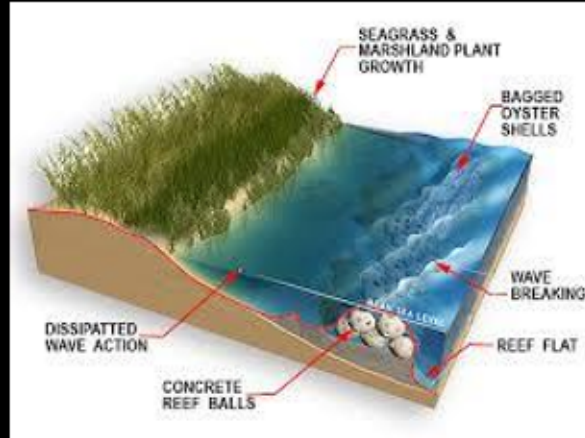
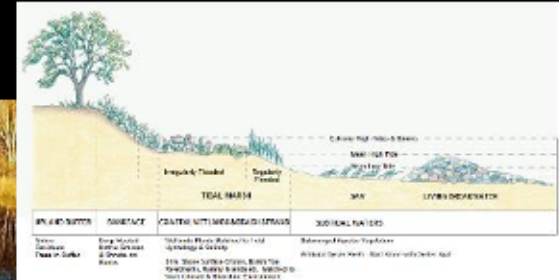
• Provides habitat and ecosystem services

Disadvantages:

• Requires continual sand resources for replacement

East, Gulf, Pacific NW Projects

- private shorelines
- short linear length
- stone sills, oyster breakwaters, dunes, plantings



Maryland Living Shorelines Protection Act of 2008

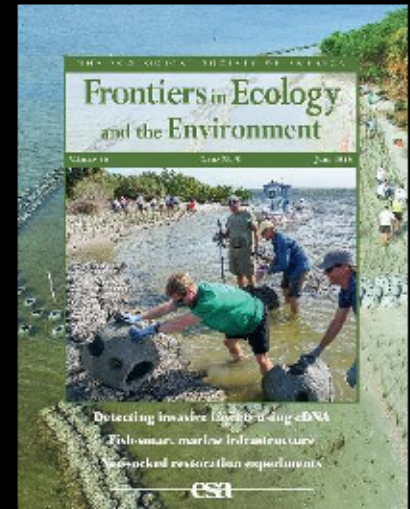
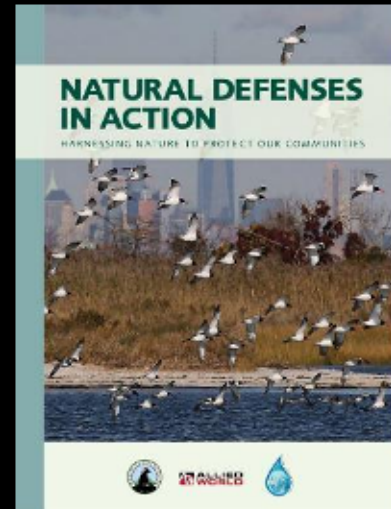
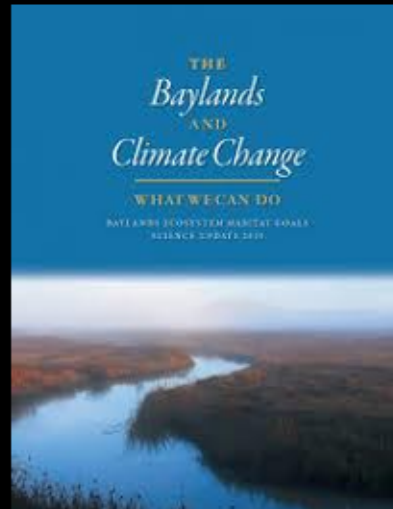
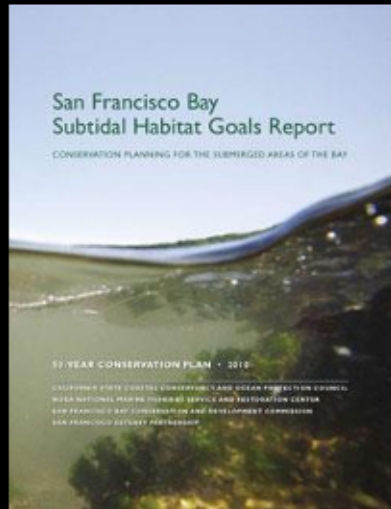
New York Waterfront Alliance Waterfront Edge Design Guidance

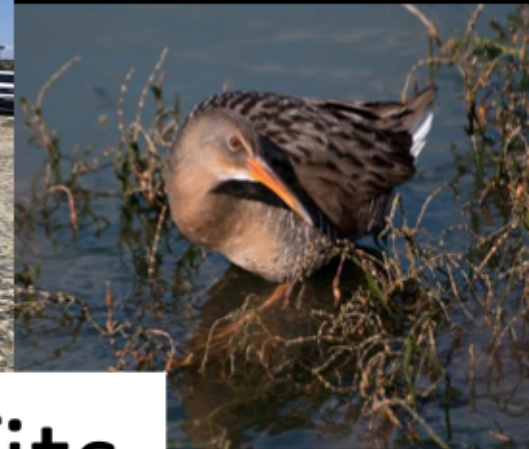
States - programmatic permits

- North Carolina
- Alabama
- Mississippi
- Maryland
- Delaware
- New Jersey



USACE Nationwide Permits 27, 54- Living Shorelines; Engineering with Nature
FWS Programmatic Biological Opinions, Section 6 Streamlined Permits
NMFS Programmatic Biological Opinions, Restoration Center NEPA
SWRCB General Order on Aquatic Restoration 401 cert- Riparian, Estuarine, Coastal
CDFW Cutting Green Tape Initiative and Permit Program & potential CEQA exemption
BCDC Beneficial BayFill for Habitat Amendment & Adapting to Rising Tides Joint Platform





Multiple Co-Benefits

- Create Fish and Wildlife Habitat
- Attenuate Wave Energy
- Accrete Sediment
- Reduce Erosion
- Can Provide Outdoor Recreation
- May Sequester Carbon
- May Buffer Ocean Acidification



Threading the Needle

Innovation and Feasibility

Barriers to Innovation:

- Science and data gaps
- Institutional Inertia
- Lack of broader context
- Lack of an advocate



Importance of Feasibility:

- Habitat and species
- Pilot projects – test
- Develop Best Management Practices
- Document success before scaling up
- Monitor long-term benefits and impacts



One Size Does Not Fit All



Design for specific conditions

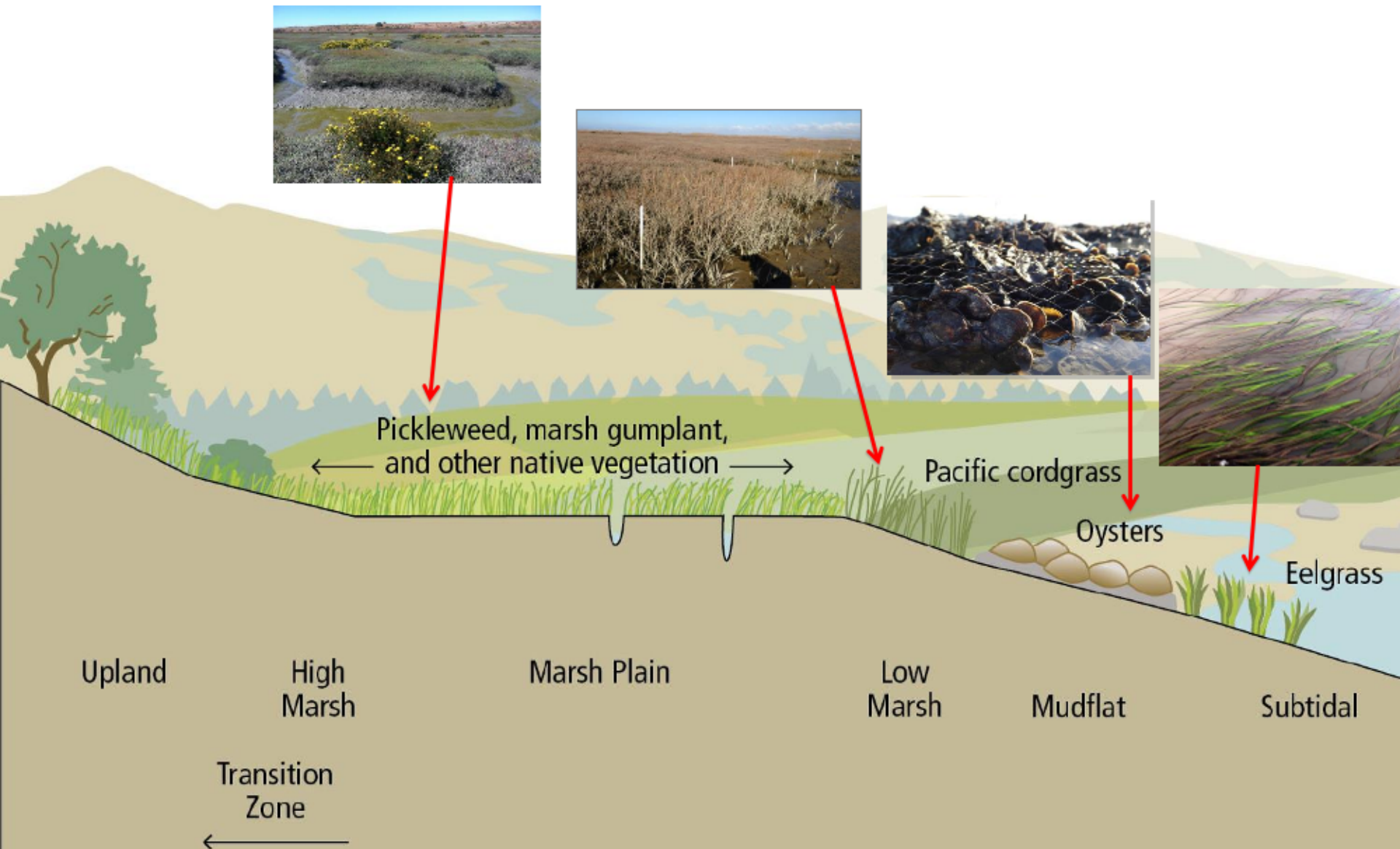
- Substrate/ soil
- Shoreline type/slope
- Wave exposure
- Adjacent infrastructure

Local support

- Government willingness
- Community engagement



Restore COMPLETE SYSTEMS



Pilot Projects in San Francisco Bay

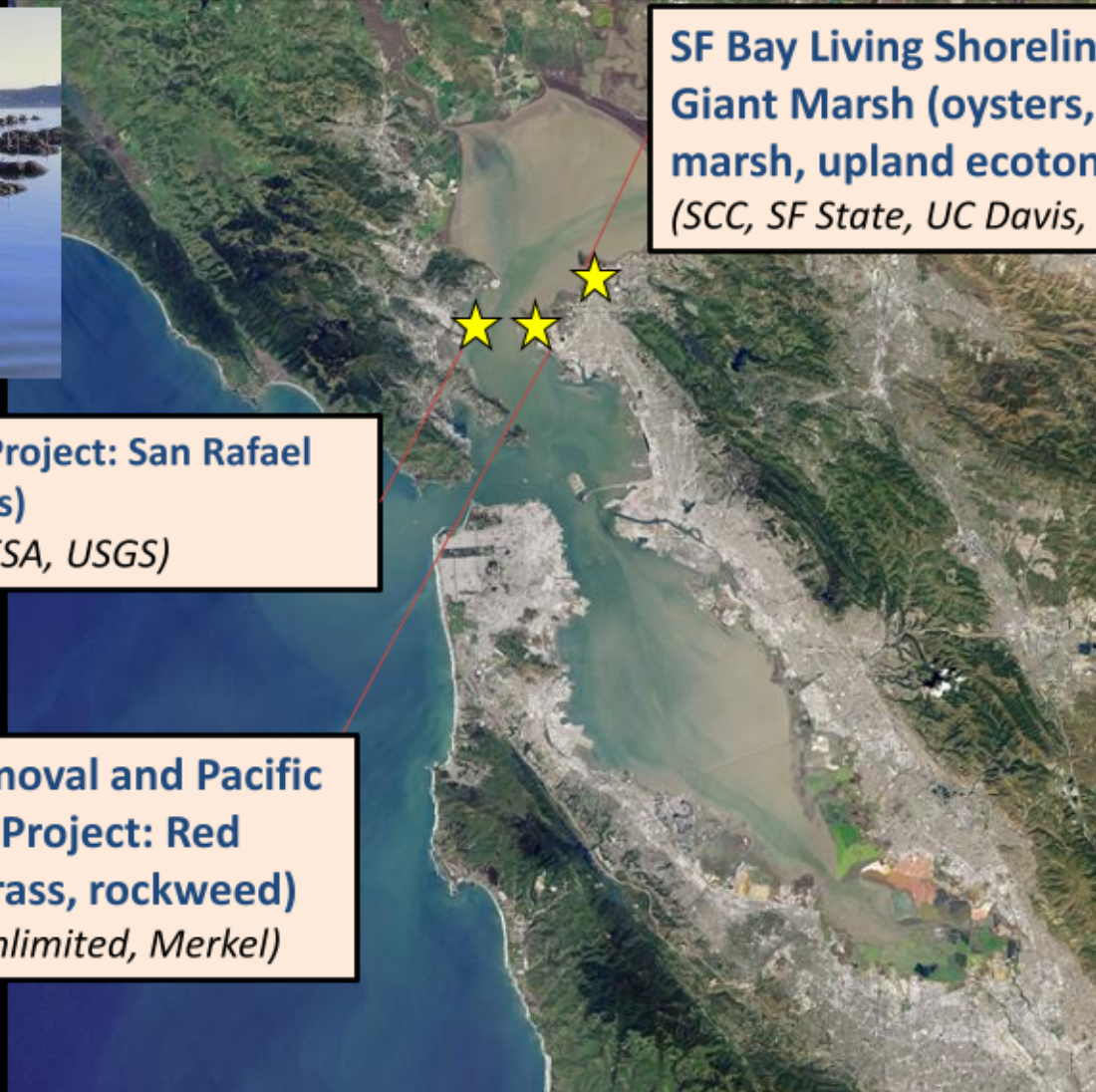
(Oyster Reefs, Eelgrass Beds, Tidal Marsh, Upland Ecotone)



SF Bay Living Shorelines Project: San Rafael
(Olympia oysters, eelgrass)
(SCC, SF State, UC Davis, ESA, USGS)

SF Bay Creosote Removal and Pacific Herring Restoration Project: Red Rocks
(oysters, eelgrass, rockweed)
(SCC, AECOM, Ducks Unlimited, Merkel)

SF Bay Living Shorelines Project:
Giant Marsh (oysters, eelgrass, tidal marsh, upland ecotone)
(SCC, SF State, UC Davis, ESA, USGS, OEI)



Nature's Architects

Native Olympia Oysters and Eelgrass

- Food source for other invertebrates, birds, fish
- Reproductive and physical structure



Creosote Pilings and Pacific herring

- More than 33,000 derelict pilings
- Toxic compounds and marine debris



Pacific cordgrass and Marsh gumplant

- Builds habitat, traps sediments
- Food chain- seed and detrital food resources



Living Seawalls- vertical methods

Global Harbour Project

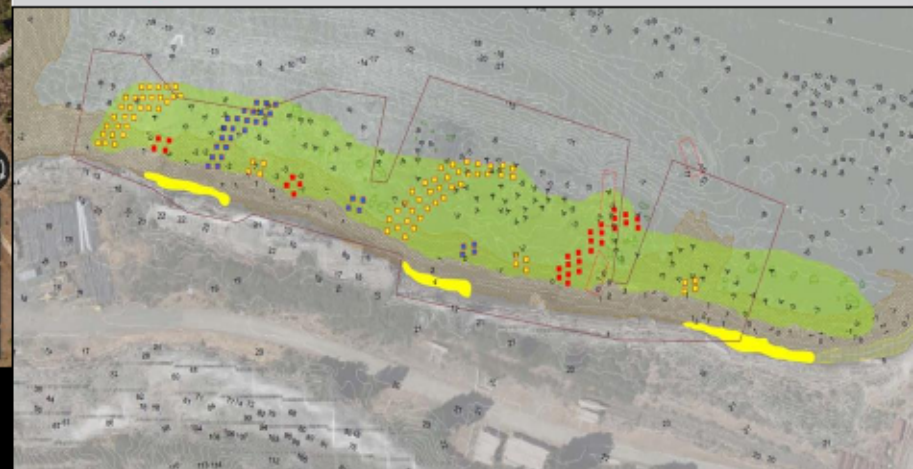
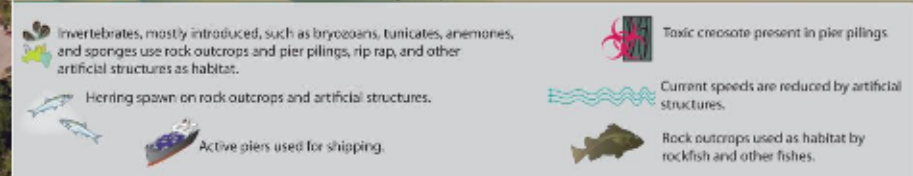
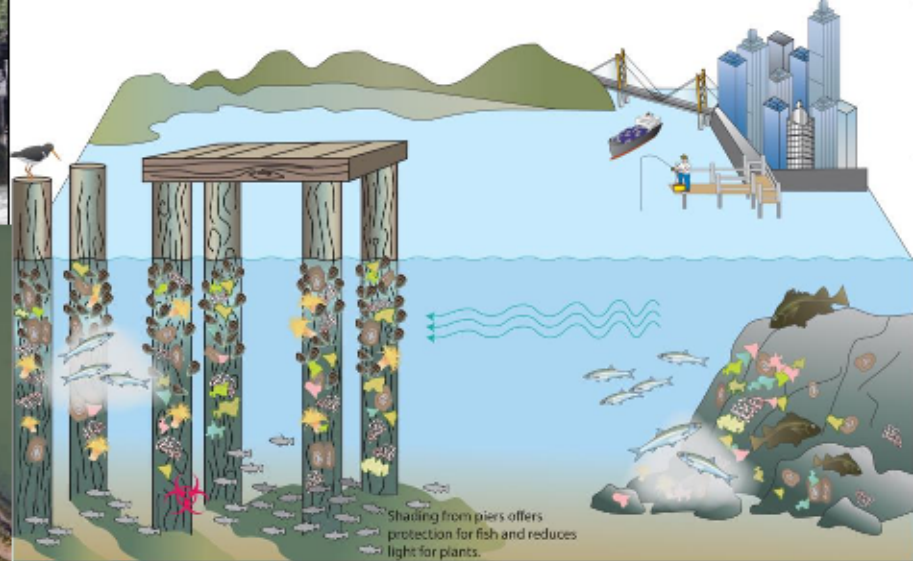
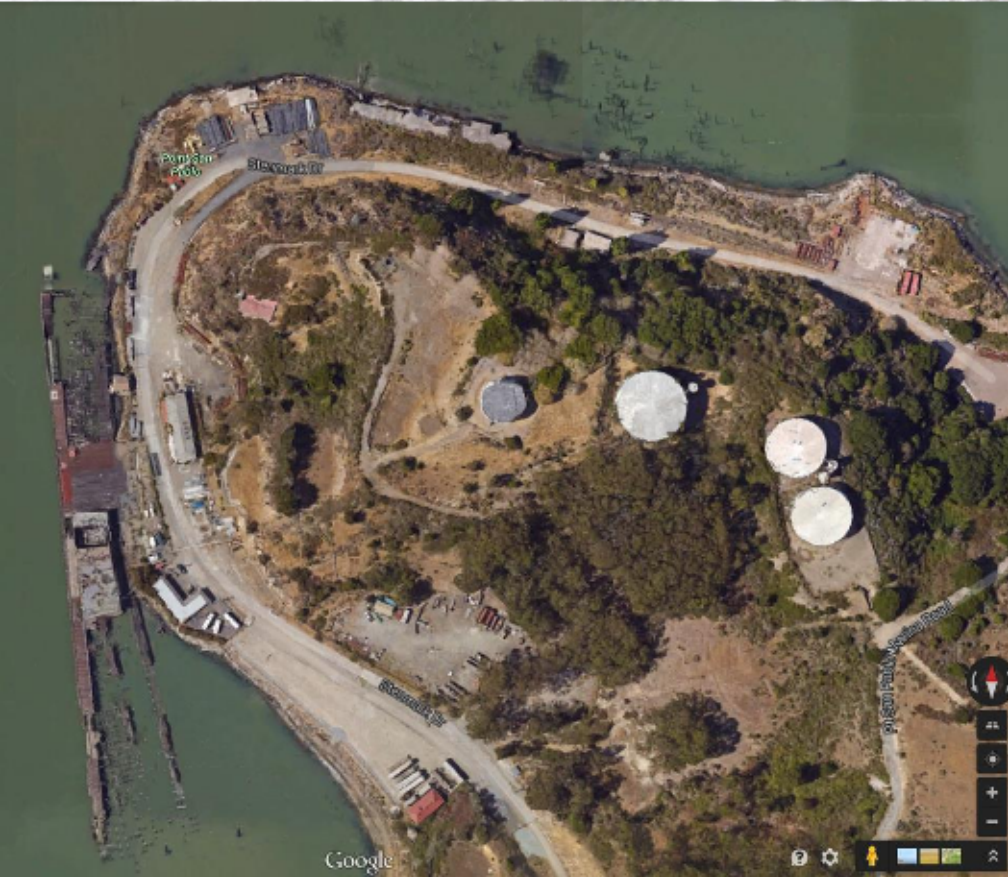
City of Seattle Seawall

City of Miami Seawall

City of San Diego Breakwaters







- Pacific herring substrate
- Eelgrass Beds- main focus
- Oyster Reefs- protection
- Rockweed- experimental



- Oyster treatments in multiple rows of 3
- Eelgrass plantings opportunistically throughout
- Focus on shoreline
- Oriented to dampen wave and wake energy from vessels

Site Specific Considerations

Existing Uses and Community Input

Parcel Ownership

Bathymetry

Depths for Habitat Restoration

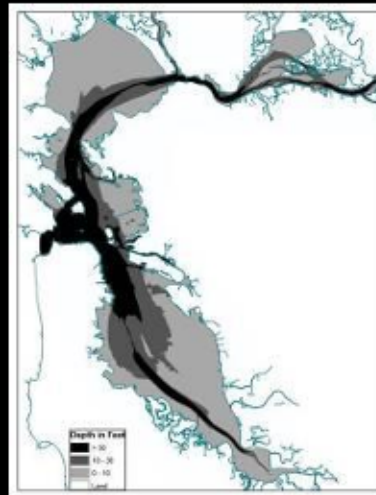
Depths for Access

Orientation to Wind/Waves

Existing Species and Habitats

Sea Level Rise Modeling

Physical Space Required



Issues to Consider Thoughtfully

Beneficial Fill Justification

Materials

Construction Methods and Timing

Avoidance of Species Impacts



Native Pacific Cordgrass

Spartina foliosa



Why is Invasive Spartina a Problem?

Degrades Habitat and Reduces Biodiversity
Dominates mudflats and impacts shorebirds
Endangers native Pacific cordgrass
Reduces flood control capacity
Creates mosquito breeding areas
Causes failed tidal marsh restoration



2011-2021 Native *Spartina*/Ecotone Revegetation

Planted 500,000+ seedlings at 40+ sites

Constructed 82 high tide refuge islands at 18 sites –

MLK Shoreline, Hayward Shoreline, others

Winter 2021-22:

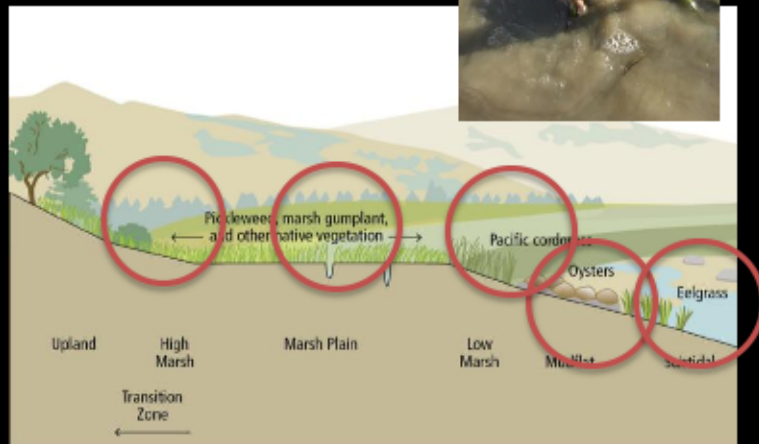
- 10 islands constructed Dumbarton Marsh and Bair Island
- 25,000 seedlings were installed at 10 sites
- Linked revegetation with Living Shorelines approach



Giant Marsh Living Shorelines Project – Point Pinole

Oysters, Eelgrass, Rockweed, Pacific Cordgrass, CA Seablite, Upland Ecotone

- Tidal marsh habitat
- Endangered Species
- High Marsh/ Ecotone
- High Tide Refugia

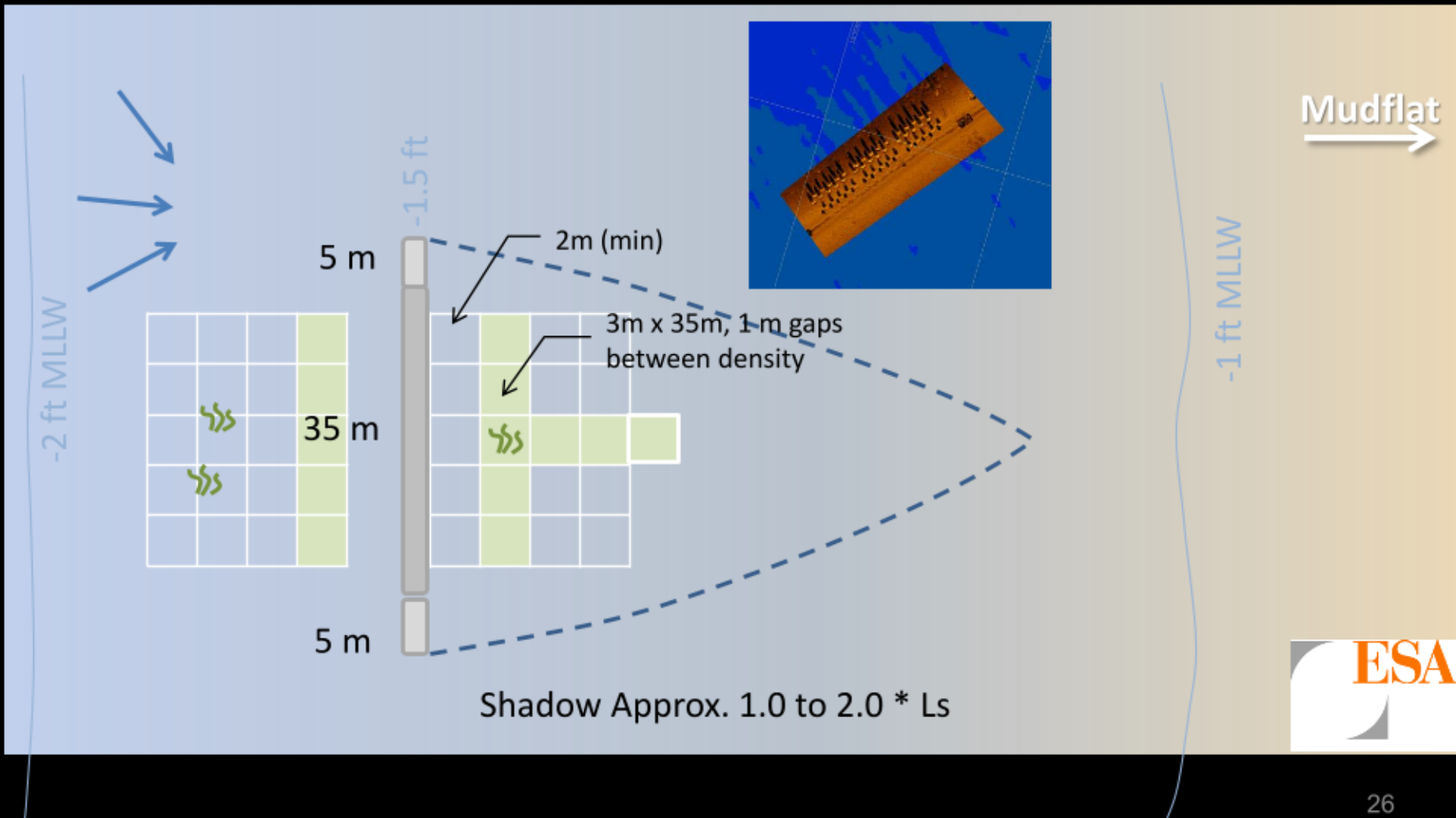


Wave modeling to inform design

Quantify wave shadow/area of oyster reef effect

Eelgrass offshore and inshore of oyster reefs

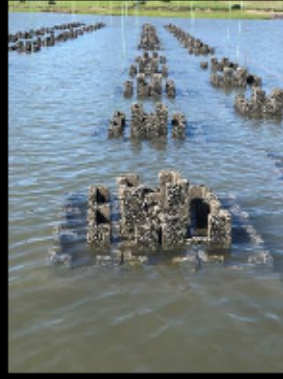
Cordgrass plantings with and without oyster reef protection



Green Jobs and Job Training



Local Contractors and Equipment



Permitting Multi-Habitat Projects



Monitoring is Critical to Building Proof of Concept

- Eelgrass, Oyster, Revegetation success
- Invertebrates- benthic and on reefs
- Fish- traps, seining, acoustic imaging
- Birds- shorebirds and waterfowl
- Physical-
 - bathymetry
 - sediment accretion and erosion
 - reef elements
 - water quality
 - wave attenuation



Habitat and Benefits to Birds, Fish, Wildlife



Physical Shoreline Benefits
Reduce Wave Energy ~30%
Sedimentation, reductions in erosion

Collaborative Partnerships

Communities, Technology, and Science



Regionally Advancing Living Shorelines

Goals:

COLLABORATE

DESIGN ACROSS OLU'S

SCALE UP AND BUILD ADAPTATION FASTER

TRANSFER AND SHARE KNOWLEDGE

Tasks:

Pilot Site and Baseline Data Collection

Regional Design/Constructability Guidance

Living Shorelines Collaborative

Develop 30-60% Designs at 10 sites

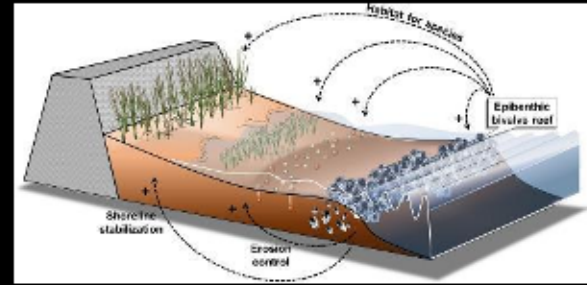
Programmatic Permit Approach

Local Engagement/ Workforce Trainings



Designing for the Future

Allow for habitat connectivity- above and below
Use nature-based and hybrid approaches
Experiment and Innovate
Encourage local labor and involvement
Coordinate with adjacent landowners



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