Leading Edge Approaches in Collaborative Living Shorelines Design and Implementation

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State of the Estuary Conference
Oakland, CA
May 29, 2024

State of California
Coastal Conservancy

Legacy of Shoreline Hardening
How can we adapt in a better way?

14% of U.S. shoreline is hardened

National support for nature-based solutions

Gittman et al. 2015 *Frontiers in Ecology and the Environment*

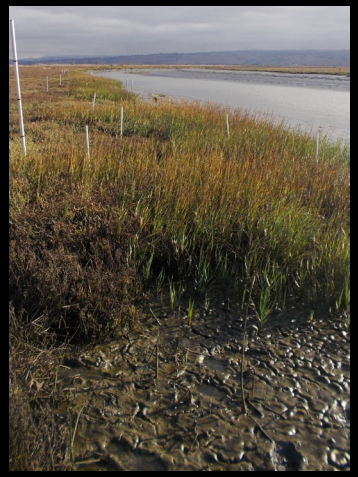
Living Shorelines

Dynamic Designs
Physical and Biological Goals
Using Nature's Architects to Adapt

Many Definitions and Interpretations

- Shoreline protection via strategic restoration design
- Diverse suite of habitat approaches and methods
- Minimize coastal erosion
- Maintain coastal processes
- Sea level rise adaptation
- Natural habitat for plants, wildlife, and people










Green-Grey Spectrum for Living Shorelines

RESILIENT SHORELINES SAGE THRIVING COMMUNITIES

GREEN - SOFTER TECHNIQUES
Small Waves | Small Fetch | Gentle Slope | Sheltered 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

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

Suitable 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
- Maintains aquatic/terrestrial interface and connectivity
- Flood water storage

Disadvantages

EDGING

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

Suitable For

Most areas except high wave energy environments.

Vegetation* Base with Material Options

(low wave only, temporary)

- "Snow" fencing
- Erosion control blankets
- Geotextile tubes
- Living reef (oyster/mussel)
- Rock gabion baskets

Benefits

- Dissipates wave energy
- Slows inland water transfer
- Provides habitat and ecosystem services
- Increases natural storm water infiltration
- Toe protection helps prevent

SILLS

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

Suitable For

Most areas except high wave energy environments.

Vegetation* Base with Material Options

- Stone
- Sand breakwaters
- Living reef (oyster/mussel)
- Rock gabion baskets

Benefits

- Provides habitat and ecosystem services
- Slows inland water transfer
- Dissipates wave energy
- Provides habitat and ecosystem services

BEACH NOURISHMENT ONLY

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

Suitable 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 strategy
- Redesigned with relative ease
- Provides habitat and ecosystem services

Disadvantages

- Requires continual sand resources for renourishment

BEACH NOURISHMENT & VEGETATION ON DUNE

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

Suitable For

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

Material Options

Sand with vegetation
Can also strengthen dunes with:

- Geotextile tubes
- Rocky core

Benefits

- Expands usable beach area
- Lower environmental impact
- Flexible strategy
- Redesigned with relative ease
- Vegetation strengthens dunes and increases their resilience to storm events
- Provides habitat and

COASTAL STRUCTURE

BREAKWATER

Offshore structures intended to break waves, reducing the force of wave action and encourages sediment accretion. Can be floating or fixed to the ocean floor, attached to shore or not, and continuous or segmented. A gapped approach would allow habitat connectivity, greater tidal exchange, and better waterfront access.

Suitable For

Most areas except high wave energy environments often in conjunction with marinas.

Material Options

- Grout-filled fabric bags
- Armorstone
- Pre-cast concrete blocks
- Living reef (oyster/mussel) if low wave environment
- Wood
- Rock*

Benefits

- Reduces wave force and height
- Stabilizes wetland

GROIN

Perpendicular, projecting from shoreline. Intercept water flow and sand moving parallel to the shoreline to prevent beach erosion and break waves. Retain sand placed on beach.

Suitable For

Coordination with beach nourishment.

Material Options

- Concrete/stone rubble*
- Timber
- Metal sheet piles

Benefits

- Protection from wave forces
- Methods and materials are adaptable
- Can be combined with beach nourishment projects to extend their life

Disadvantages

REVETMENT

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

Suitable For

Sites with pre-existing hardened shoreline structures.

Material Options

- Stone rubble*
- Concrete blocks
- Cast concrete slabs
- Sand/concrete filled bags
- Rock-filled gabion basket

Benefits

- Mitigates wave action
- Little maintenance
- Indefinite lifespan
- Minimizes adjacent site impact

Disadvantages

- No major flood protection
- Require more land area
- Loss of intertidal habitat

BULKHEAD

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

Suitable For

High energy settings and sites with pre-existing hardened shoreline structures. Accommodates working water fronts (eg: docking for ships and ferries).

Material Options

- Steel sheet piles
- Timber
- Concrete
- Composite carbon fibers
- Gabions

Benefits

- Moderates wave action
- Manages tide level fluctuation
- Long lifespan
- Simple repair

SEAWALL

Parallel to shoreline, vertical or sloped wall. Soil 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.

Suitable For

Areas highly vulnerable to storm surge and wave forces.

Material Options

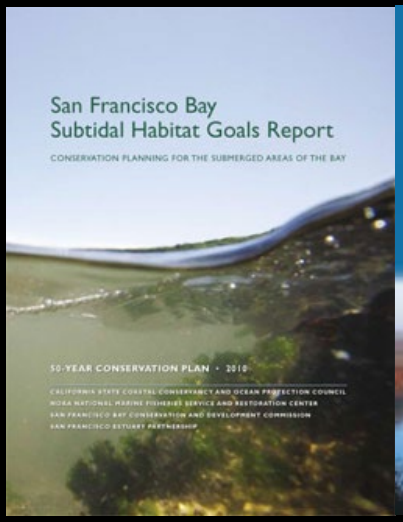
- Stone
- Rock
- Concrete
- Steel/vinyl sheets
- Steel sheet piles

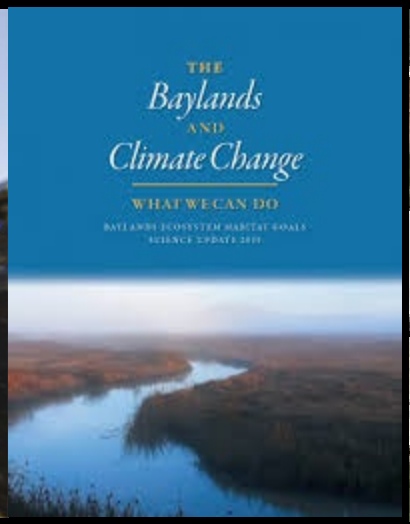
Benefits

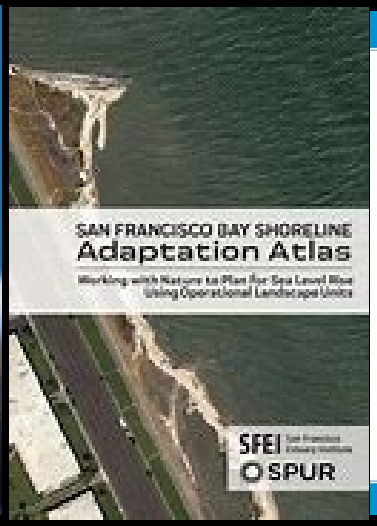
- Prevents storm surge flooding
- Resists strong wave forces
- Shoreline stabilization behind structure
- Low maintenance costs
- Less space intensive horizontally

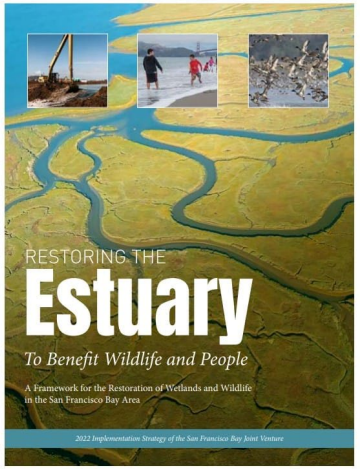
Regional Policy and Regulatory Support

Vetted Regional Goals with Input from Many Stakeholders and Agencies
Recent Programmatic Permit Tools – state and federal





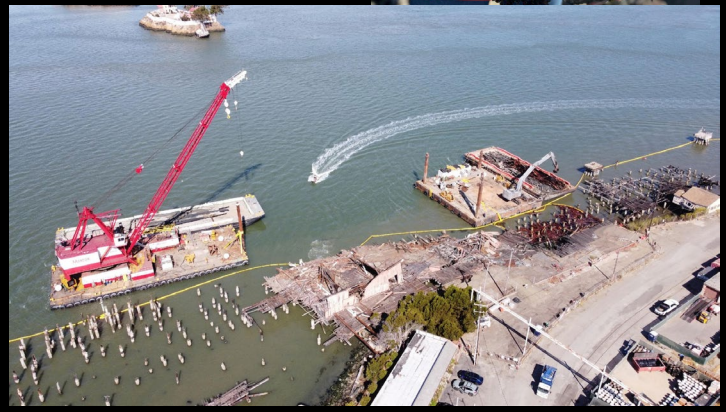




Demonstration Projects Are Generating Valuable Info

Site by Site 2010-2023

- Stages of Iterative Design
- Design Criteria
- Linking Biological/Physical Goals
- Hybrid Approaches
- Landowner Considerations
- Regulatory Consultations
- Bid Plans and Costs
- Marine Contractor Coordination
- Monitoring and Maintenance



Substantial Benefits Documented to Date

- Increased submerged and shoreline habitat types
- Increased biodiversity in the bay
- Benefits to fish, invertebrates, birds, wildlife
- Reproductive and spawning hot spots
- Food chain and foraging hot spots
- Increased wave attenuation
- Sediment accretion/ prevention of erosion
- Plant and animal propagules spread from treatments
- Co-locating treatments can maximize goals & benefits

State of California Coastal Conservancy

San Francisco State University

EOS center

Smithsonian Environmental Research Center

ESA

Ducks Unlimited

UC Davis

SFEI Aquatic Science Center
San Francisco Estuary Institute & the Aquatic Science Center

USGS
science for a changing world

East Bay Regional Park District

Informing Pilot Projects in CA

More Local Demonstration Projects Needed!

Humboldt Bay Living Shorelines *(City of Arcata, SCC, others)*

SF Bay Creosote Removal Project *(SCC, City of Richmond, Ducks Unlimited, AECOM, others)*

SF Bay Living Shorelines Projects- 5 pilot sites *(SCC, SF State, UC Davis, Smithsonian, ESA, USGS, OEI, others)*

Terminal Four Wharf Removal *(Port of Richmond, others)*

Heron's Head Project *(Port of SF, ESA, SFSU, LEJ, others)*

Cardiff Dunes Living Shorelines *(SCC, City of Cardiff, OPC, others)*

Newport Bay Living Shorelines Project *(SCC, CSU Fullerton, Heal the Bay, others)*

San Diego Bay Living Shorelines *(SCC, Port of SD, CSU Fullerton, ESA, others)*

Regionally Advancing Living Shorelines

Goals:

COLLABORATE

DESIGN ACROSS REGIONS

SCALE UP & BUILD ADAPTATION FASTER

TRANSFER AND SHARE KNOWLEDGE

Tasks:

Pilot Site and Baseline Data Collection

Regional Design/Constructability Guidance

Develop 30-60% Designs at 10 sites

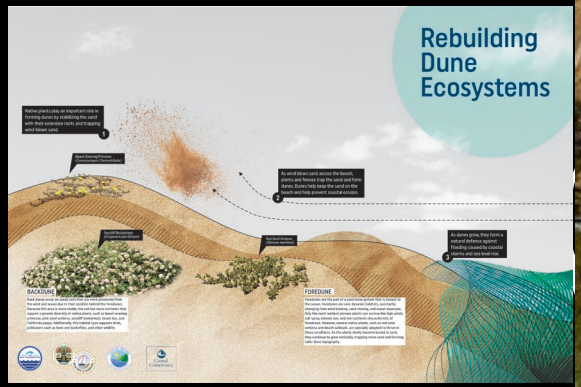
Programmatic Permit Approach

Living Shorelines Collaborative

Local Engagement/ Workforce Trainings

Scale Up and Normalize Approaches

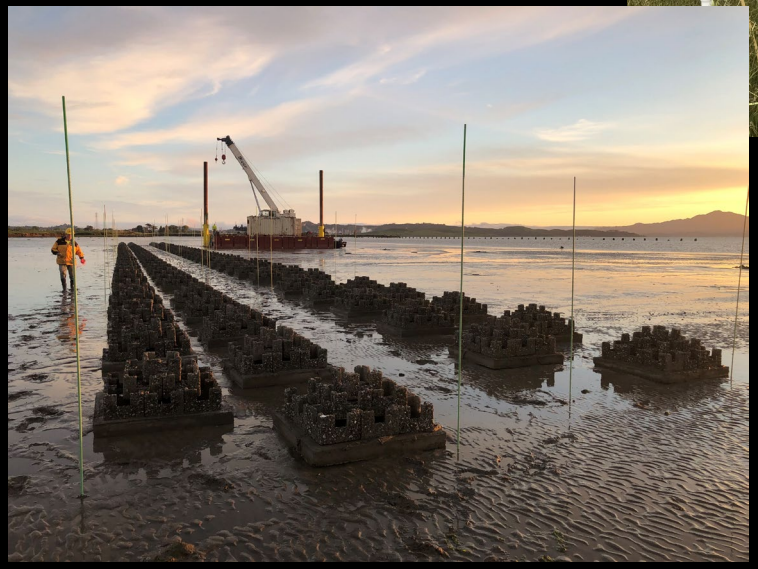
- Build Regional Capacity through Knowledge Transfer
- Build on pilot project data 2012-2023
- Advance Nature-based Adaptation Body of Practice
- Pilot Multi-Objective Designs in Different Settings
- Encourage Local Labor and Involvement



Regional Design & Constructability Guidance









Multi-Benefit Habitat Approaches

solo and in various combinations

1. Nearshore reef restoration
2. Submerged Aquatic Vegetation plantings
3. Shoreline Vegetation plantings
4. Sand, gravel, cobble beach restoration
5. Addition of woody debris
6. Invasive species prevention and removal
7. High tide islands and sediment addition
8. Biologically enhanced rock slopes
9. Vertical green-grey living seawalls
10. Derelict piling and debris removal








Living Seawalls- vertical methods

Port of San Francisco pilot project
Global Harbour Project
City of Seattle Seawall
City of Miami Seawall
City of San Diego Breakwaters

Need: Expand regional capacity to design and implement living shoreline projects.

Audience: Practitioners, cities, counties, natural resource agencies, landowners, community groups

Purpose: Design and constructability guidance for 10 habitat approaches.

Transfer previous lessons-learned and project outcomes.

Consistent best design methods and construction practices.

Authors: SCC, SFEI, Core Design Team, and coalition landowners

Schedule: Fall 2023 - Winter 2024

Design Guidance Content

Build on: California's 4th Climate Assessment Guidance for Natural Shore Infrastructure/5th in progress, SFEI Shoreline Adaptation Atlas, SF Bay Subtidal and Baylands Habitat Goals, others

Subjects: Hydraulics, geomorphology, biology, engineering, construction

Information:

Focus on multi-objective projects

Standardized NAVD88 datums and open data sources

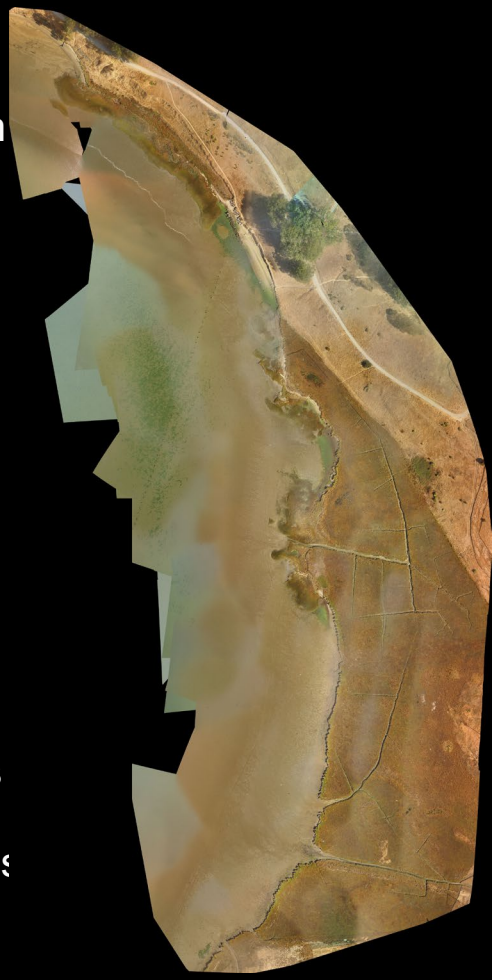
Best design and constructability practices, methods, materials, approach

Shoreline type, depth, physical and biological information

Sensitive and endangered species considerations

Logistical access, seasonal and tide timing, and equipment considerations

Site specific community, landowner, and permitting pathway considerations



Constructability in Different Settings

Importance of Assessing Feasibility

- Basic Site Suitability and Access
- Supportive Environmental Factors
- Stressors and Adjacent Land Uses
- Land Ownership and Permissions
- Sensitive Habitats and Permit Requirements

Opportunities to Field Test Methods

- Refine Methods Across Elevations
- Terrestrial and Marine Equipment
- Small and Large scale treatments
- Seasonal Phasing of Activities
- Document & Share Challenges/Solutions

Programmatic Permitting Multi-Habitat Projects

US Army Corps of Engineers®

NOAA FISHERIES

Green Jobs and Job Training













Thank You to All Partners and Collaborators

Local State Federal Support

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