COASTAL ZONE MANAGEMENT

LIVING SHORELINES

CZM1

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Aerial photographs of a living shoreline project area: (a) before implementation (2017) and (b) three years post-implementation. The project included a sill structure and shore-perpendicular reefs to create oyster habitat and support native vegetation planting.
Image Credit: [Barry et al.], [2025] Used under CC BY (Barry et al., 2025).

▶▶ What is it?

Living shorelines use natural elements like vegetation, sand, reefs and rock to stabilise coastlines, reduce erosion, and protect against storm surges. Unlike hardened structures, they preserve coastal ecosystems, support biodiversity, and improve water quality while adapting to changing environmental conditions, offering a sustainable alternative for shoreline protection and resilience (Arkema et al., 2013; Gedan et al., 2011).

Challenges this NbS addresses

- **Floods –** reduction/recovery;
- **Erosion –** prevention/reduction;
- **Drought –** prevention (coastal wetlands);
- **Climate change –** mitigation;
- **Storm surge –** protection;
- **Water pollution –** reduction/recovery

▼▼ Primary functions and key services

- **Wave Energy Dissipation:** natural elements like vegetation, oyster reefs, or logs can reduce wave energy, protecting coastal infrastructure from erosion and storm damage (Gedan et al., 2011).
- **Erosion Prevention:** root systems of marsh grasses and other vegetation stabilise soils, preventing shoreline loss that threatens nearby infrastructure.
- **Flood Mitigation:** by absorbing and slowing down water (Barbier et al., 2011), living shorelines help reduce flooding risks to adjacent infrastructure.
- **Sediment Retention:** by maintaining coastal integrity and reducing clogging of ports or drainage systems.
- **Durability Against Sea Level Rise:** living shorelines adapt to changing water levels (Bilkovic et al., 2016), offering sustainable protection compared to fixed structures like seawalls.

Ecosystem services

(Barbier et al., 2011; Judge et al., 2017)

- **Biodiversity Support:** provide habitats for fish, shellfish, birds, and other wildlife.
- **Carbon Sequestration:** capture CO_2 through vegetation, with marsh grasses, reeds, shrubs, and trees enhancing long-term carbon storage in coastal soils and biomass.
- **Water Quality Improvement:** filter sediments, nutrients, and pollutants, improving coastal water conditions.
- **Recreation and Aesthetics:** enhance opportunities for tourism, fishing, and nature appreciation.
- **Sediment Accretion:** promote sediment deposition, building up and maintaining land elevation.
- **Nutrient Cycling:** support the cycling and storage of key nutrients.

▼▼ Site suitability, scale and coverage

There are a number of factors to consider for site suitability of living shorelines including the geographic area, environmental hazards and the surrounding infrastructure. Living shorelines are best suited in coastal areas with moderate wave energy, sandy shores or wetlands. Urban settings may benefit from living shorelines as they protect against erosion and storm surges. In mountainous settings, living shorelines can be implemented in riparian buffer zones, along river beds to prevent soil loss (Arkema et al., 2013). Flooding and erosion risks need to be considered by first assessing infrastructure elements, such as watershed contour lines, sediment flow pattens and riverbed characteristics. Vegetation and natural sediment processes can reinforce coastal wetlands and salt marshes (Gedan et al., 2011).

Environmental impacts
(EU taxonomy)

- ☑ **Climate change mitigation**
- ☑ **Climate change adaptation**
- ☑ **Sustainable use and protection of water and marine resources**
- ☐ **Transition to a circular economy**
- ☑ **Pollution prevention and control**
- ☑ **Protection and restoration of biodiversity and ecosystems.**

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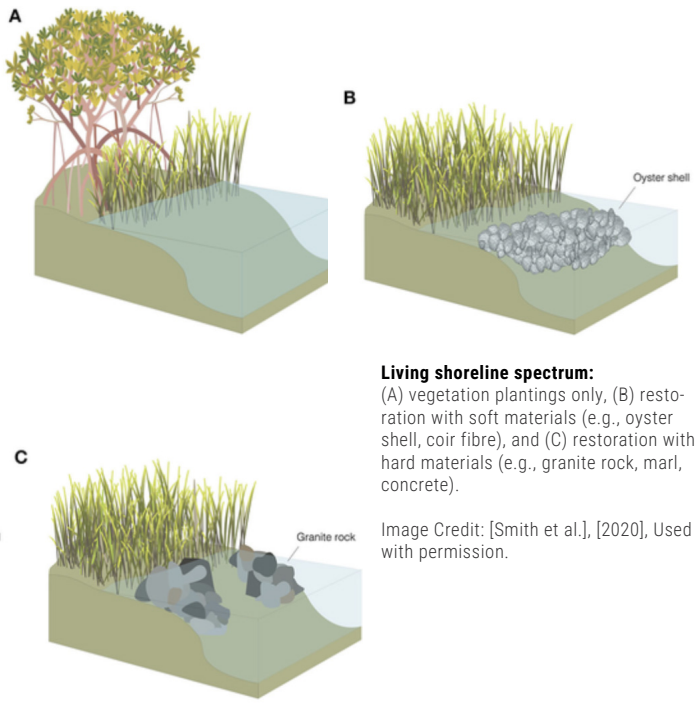
Main components

- **Native Vegetation:** plants like grasses and shrubs stabilise soil, reduce erosion, and buffer wave energy.
- **Natural Sediments:** sand or sediment placement supports habitat creation and shoreline stability.
- **Organic Materials:** coir logs, biodegradable mats, or natural fibre rolls enhance soil retention and promote plant growth.
- **Structural Features:** oyster reefs, mussel beds, or rock sills provide wave attenuation and habitat for marine species.
- **Tidal Pools and Channels:** maintain water flow, nutrient cycling, and support aquatic biodiversity.

Cost-benefit profile

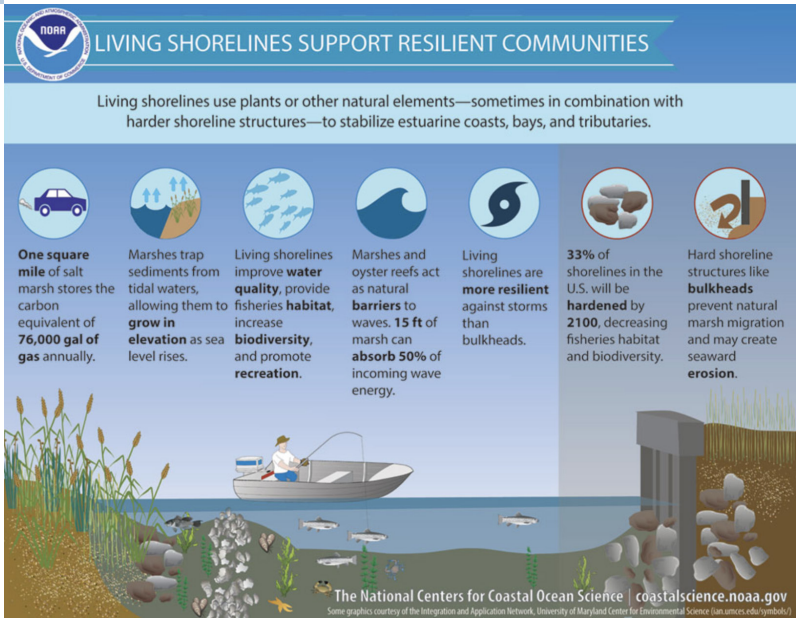
The cost analysis of living shoreline projects reveals significant differences when compared to conventional shoreline stabilisation approaches (Conservation Gateway, n.d). While living shoreline projects tend to have more evenly distributed costs over time, conventional methods typically incur higher upfront costs and costs associated with replacement phases throughout the structure's lifecycle.

Project costs are closely linked to the size and complexity of the project, with simpler, smaller projects being more affordable, while larger, more intricate projects tend to be costlier. Although living shoreline projects generally have **lower construction costs** than traditional shoreline stabilisation, they often incur **higher expenses** in areas such as **design, permitting, and monitoring**. In the project (Conservation Gateway, n.d.), some living shoreline projects benefited from reduced costs through the use of volunteer labour. Even when accounting for **long-term costs** like maintenance and monitoring, living shoreline projects **cost less per linear foot** compared to conventional projects. When only construction costs are considered, the cost per linear foot of living shoreline projects ranges from $45 to $1,661, whereas conventional grey alternatives range from $437 to $3,507 per linear foot (Conservation Gateway, n.d.).



Living shoreline spectrum:
(A) vegetation plantings only, (B) restoration with soft materials (e.g., oyster shell, coir fibre), and (C) restoration with hard materials (e.g., granite rock, marl, concrete).

Image Credit: [Smith et al.], [2020], Used with permission.



Living shorelines use plants or other natural elements to stabilise estuarine coasts, bays, or tributaries
Image Credit: [NOAA], [2024], Public domain.

LIVING SHORELINES

Example of installation

- **Brevard County Living Shoreline Demonstration Site** (Florida living shorelines, n.d.)
- **Location:** 505 5th Ave., Indialantic, Florida, USA
- **Implemented by:** involvement of the local community, NGOs and schools, supported by the Municipality's Environmental Education and Awareness Division. Financed by the EU Structural and Investment Funds & the EU Cohesion Fund.
- **Description and results:** this demonstration project (July 2016–June 2017) installed living shorelines across three adjacent properties using sills, breakwaters, and revetments made of oyster bags, native plants (e.g., mangroves, Spartina), and rip-rap. Designed for public visibility and education, it showcases four different shoreline treatments: at Riverside Park: narrow oyster breakwater in front of riprap; at Eastminster Presbyterian Church: living shoreline with large oyster breakwater, at Douglas Park: oyster revetment/oyster revetment and oyster breakwater both in front of a seawall. The site improved shoreline stability, provided habitat, and served as a learning hub for coastal resilience, supported by wave modeling and ecological research.
- **Costs**: $2,542 per linear meter, however the grant covered more than just the design, permitting, and construction—it also funded additional components like a shell bagging machine, the regional Shuck and Share program, an educational exhibit at the Zoo, wave energy modeling by Florida Tech, and other elements. As a result, the cost estimate is not directly applicable for planning similar projects.

Right: Oyster bag revetment at Douglas Park seawall
Image Credits: [Jake Zehnder, Brevard Zoo], [2017], Used with permission.

Left: Eastminster living shoreline
Image Credits: [Jake Zehnder, Brevard Zoo], [2017], Used with permission.

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