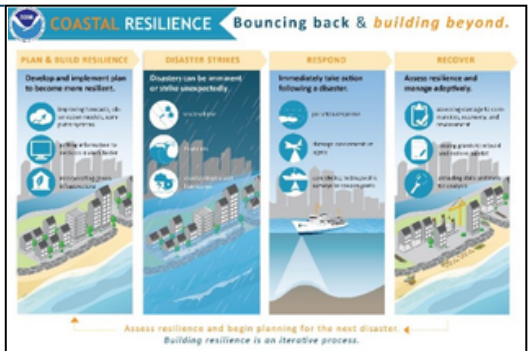


Adaptation Strategy Terms Glossary

This glossary provides definitions of hard and soft adaptation strategy terms, which represent potential adaptation options, including nature-based adaptation strategies (NBAS). These options are illustrative examples and may or may not have been implemented in California but are often used when discussing adaptation broadly. Strategies can be applied individually, in combination with other strategies, or as part of a phased approach to address short-, mid- and long-term sea level rise adaptation goals.

Term	Learn More
Adaptive Management Involves monitoring the results of a management decision, and updating actions as needed and as based on new information and results from the monitoring.	**Learn more at:** • California Ocean Protection Council • California Coastal Adaptation Planning Inventory
Bulkhead A vertical or near-vertical structure built along coastlines or waterfronts to stabilize land, retain soil, prevent erosion, or control water levels, which maintains shoreline integrity and manages water resources. Bulkheads are typically constructed from materials such as timber, concrete, or steel sheet piles. They may include rock or riprap placed at the toe to reduce scour but are distinct from rock revetments, which are sloped structures. *(See Hard Protection, Shoreline Protective Device, Gray Infrastructure)*	
Coastal Development Permit Development in the coastal zone generally requires a Coastal Development Permit (CDP). In areas of retained jurisdiction and areas without a certified Local Coastal Program (LCP), the Commission is generally responsible for reviewing the consistency of CDP applications with the policies of Chapter 3 of the Coastal Act (Public Resources Code Sections 30200-30270). In areas with a certified LCP, the local government is responsible for reviewing the compliance of CDP applications with the requirements of the certified LCP and, where applicable, the public access and recreation policies of the Coastal Act. Certain local government actions on CDP applications are appealable to the Commission. On appeal, the Commission also applies the policies of the certified LCP and applicable public access and recreation policies of the Coastal Act.	**Learn more at:** • California Ocean Protection Council • California Coastal Adaptation Planning Inventory

Coastal Resilience
The capacity of coastal communities, ecosystems, and infrastructure to adjust and respond to changing environmental conditions, hazards, while continuing to support essential functions over time. Resilience may involve restoration to return systems to past or historical conditions, and/or adaptation to prepare for and adjust to future conditions that may differ substantially from the past.



NOAA National Ocean Service

Cobble Berm
Sometimes referred to as dynamic revetments, cobble berms are constructed out of smaller, typically rounded, rocks called cobble (2.5-10 inches in diameter). The cobble can be moved by larger waves during storms to create berms that dissipate wave energy and stabilize the shoreline such as those that naturally occur around some river mouths.

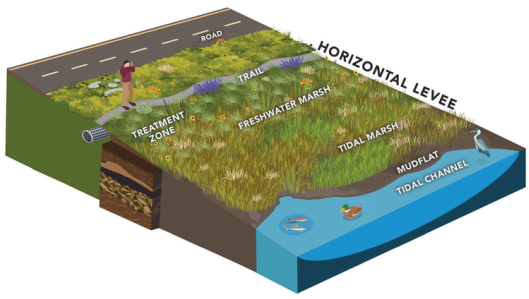

Surfer's Point, (Environmental Science Associates)

Co-benefit
An additional positive outcome of an adaptation action beyond its primary intended purpose. For example, a dune restoration project may be designed primarily to provide habitat, with reduced coastal erosion as a co-benefit. Conversely, a dune restoration project may be designed primarily to reduce erosion, with expanded habitat and recreational space emerging as co-benefits. These co-benefits can be limited in expanse, duration, or nature depending on future hazard events and ecosystem conditions.

Dune Enhancement/Restoration
Actions that rebuild, stabilize, or improve coastal dune systems by enhancing the conditions that allow natural dune-forming processes, like sand accumulation and vegetation establishment, to occur. Typical activities may include planting native dune vegetation, removing invasive plants, installing sand-trapping or protective fencing, or otherwise helping the dune system retain or accumulate sand more effectively. The goals of dune projects vary: some prioritize habitat restoration, others focus on shoreline protection, and some support both. The relative emphasis shapes design choices, since optimizing for one purpose can limit the extent to which the other is achieved. This differs from interventions such as creating dunes where they have not historically existed or hybrid approaches that include structural elements. *(See Nature-Based Adaptation Strategy, Green Infrastructure)*


Cardiff State Beach Living Shoreline (Cal Parks)

Ecotone Levee
Ecotone levees (also known as horizontal levees) are levees with a wide gently sloped footprint that extends from the subtidal zone to above mean higher high water (MHHW) to include the upland transition zone. They provide for extended zoning of ecological resources while simultaneously creating textured surfaces with vegetation and substrates that dissipate wave energy. Ecotone levees are particularly well-suited to create more opportunity for the range of habitats that occur on sheltered shorelines. With sufficient vegetation, the heights of ecotone levees can be reduced to account for the dissipation of waves by the vegetation. *(See Green Infrastructure)*



Palo Alto Horizontal Levee Pilot Project (City of Palo Alto)

Ecosystem Services
Benefits that nature provides to humans. For example, plants, animals, fungi and micro-organisms produce services or goods like food, wood and other raw materials, as well as provide essential regulating services such as pollination of crops, prevention of soil erosion and water purification, and a vast array of cultural services, like recreation and a sense of place.

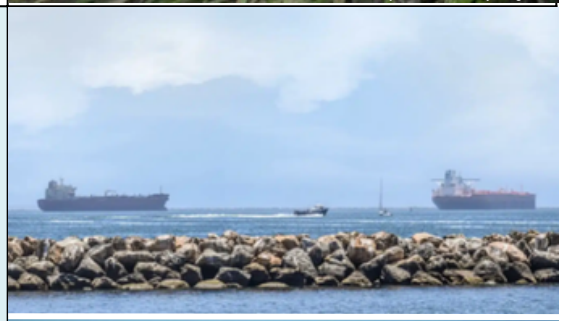


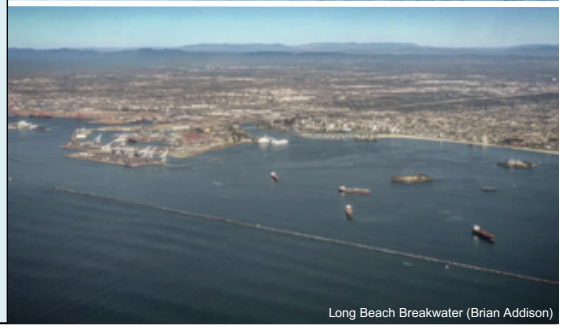
Peter Rowland Ukotije-Ikwut

Eelgrass Bed
Eelgrass beds are communities of eelgrass on soft bottom substrates at lower intertidal and subtidal areas that provide high levels of primary productivity, biodiversity, and species density. They are also important nursery habitat for many species, including those supporting fisheries. Eelgrass beds can provide protection by dissipating wave energy and slowing tidal currents at low tide. In addition, they can help attenuate other climate impacts through carbon sequestration and buffering against ocean acidification.


Morro Bay National Estuary Program

Emerged/Emergent Breakwater
An emerged breakwater is a shore-parallel offshore structure with its crest built above the surface water level to limit wave overtopping and reduce incoming wave energy. These structures, typically constructed from rubble-mound rock, create a physical barrier that alters wave patterns, nearshore currents, and sediment transport. Emerged breakwaters can offer substantial wave-attenuation benefits and have been used historically for harbor protection and erosion control. However, they can also alter natural shoreline processes in ways that can sometimes worsen erosion in other locations, and habitat disruption. *(See Submerged Breakwater, Shoreline Protective Device, Hard Protection/Armoring, Gray Infrastructure)*




Long Beach Breakwater (Brian Addison)

Environmentally Sensitive [Habitat] Area (ESHA)
Any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments (CCA §30240).

Learn more at:

- ESHA and the Coastal Act

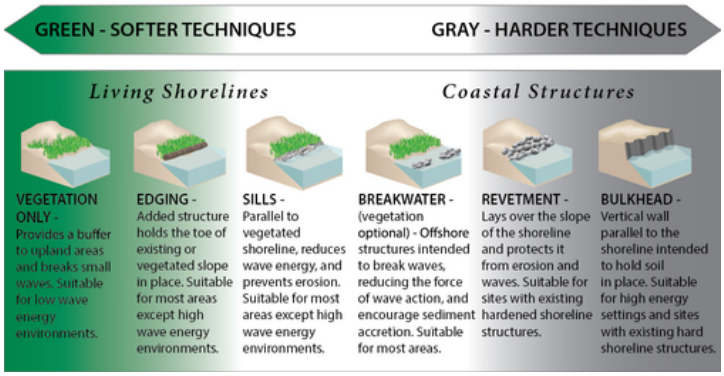
Floodplain Restoration/Reconnection
The process of re-establishing or improving the connection between a river and its floodplain by removing levees, breaching berms, or regrading land. Restored floodplains absorb floodwaters, slow runoff, recharge groundwater, and create valuable habitat for fish and wildlife.


Backfields Floodplain Restoration

Gabion
A structure composed of wire mesh baskets filled with stones or similar durable materials, used for erosion control, slope stabilization, and retaining walls. *(See Shoreline Protective Device, Hard Protection/Armoring, Gray Infrastructure)*

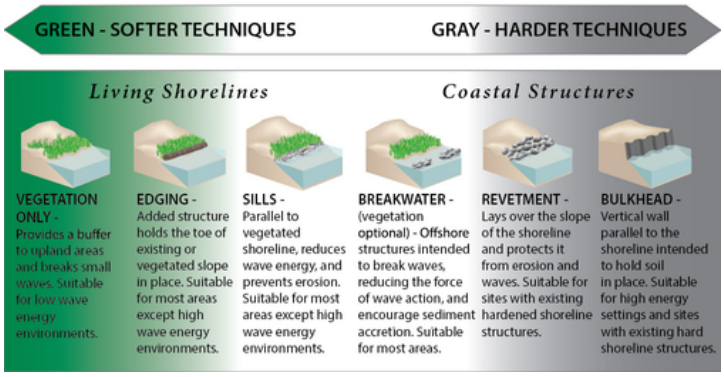

Slope Reinforcement Solutions

Green Infrastructure
Refers to the use of appropriate native vegetation, dune management, beach nourishment or other methods that mimic natural systems to capitalize on the ability of these systems to provide flood and erosion protection, stormwater management, and other ecosystem services while also contributing to the enhancement or creation of natural habitat areas. Green infrastructure exists along a spectrum and may include hybrid approaches that combine natural and engineered elements, rather than fitting into a strictly binary category.



North Carolina Department of Environmental Quality

Gray Infrastructure
Engineered hard structures built to protect shorelines from coastal hazards. These include seawalls, revetments, bulkheads, levees, and similar built defenses. Gray infrastructure exists along a spectrum and may be used in combination with natural or nature-based features as part of hybrid approaches to coastal protection. *(See Shoreline Protective Device, Hard Protection/Armoring)*



North Carolina Department of Environmental Quality

Groins
Groins are shore perpendicular structures typically made of rock and occasionally concrete armor units or sheet piles. They are designed to interrupt waves and limit the movement of sediment, primarily to combat beach erosion. By trapping sand moving along the shore due to longshore drift, groins can help build up and maintain beaches. *(See Shoreline Protective Device, Hard Protection/Armoring, Gray Infrastructure)*


Groin jetties north of Newport Beach Pier (Jeff Gritchen)

Hard Protection/Hard Armoring
A broad term for most engineered features such as seawalls, revetments, cave fills, and bulkheads that block the landward retreat of the shoreline. *(See Revetment, Bulkhead, Seawall, Groin, Emerged Breakwater, Submerged Breakwater, Gabion, Riprap, Shoreline Protective Devices, Gray Infrastructure)*

Hybrid Armoring
A nature-based adaptation strategy that combines fixing the shoreline, such as with a buried revetment or other shoreline protective device, with a nature-based feature. These projects are typically designed to reduce some of the adverse impacts associated with strictly hard armoring, with ecological or other benefits being secondary and less common. *(See Green Infrastructure, Gray Infrastructure)*

Large Woody Debris (LWD) Placement
The intentional placement of logs, root wads, or driftwood along rivers, floodplains, or beaches to add physical complexity that can influence water flow and sediment movement. On the coast, LWD placement can help facilitate dune development and increase dune persistence by trapping sand and attenuating some high energy forces, and creating microenvironments that benefit vegetation, while remaining a dynamic part of the coastal system.



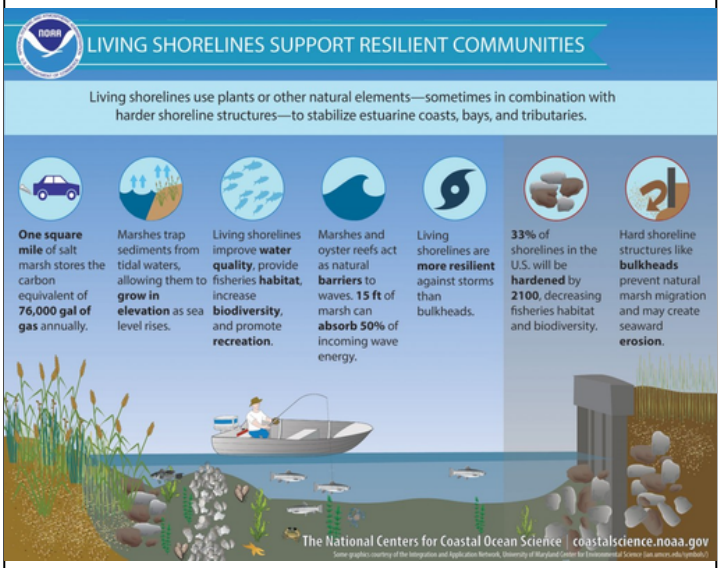
Rio del Mar Living Shoreline (Integral Consulting)

Living Seawall
While living seawalls do not restore natural processes and may have detrimental impacts to beaches similar to traditional seawalls, they incorporate design features that introduce more surface complexity than standard flat walls. This added complexity can help minimize some adverse ecological effects by providing additional microhabitat opportunities for certain intertidal and subtidal species where seawalls are necessary *(See Hard Protection/Armoring, Shoreline Protective Device, Gray Infrastructure)*.



Living Shoreline
A living shoreline is a nature-based adaptation strategy that stabilizes a shoreline and protects it from erosion. Living shorelines are sometimes referred to as green or soft shorelines. Unlike traditional "hard" shoreline stabilization techniques, such as concrete seawalls, living shorelines are made of natural materials such as plants, sand, rock, or oyster shells. These approaches may also be combined with structural elements to create a hybrid solution where appropriate.

Because they incorporate natural elements, living shorelines may reduce adverse effects and/or provide environmental benefits such as habitat for plants, animals, and algae, depending on the materials used. In some cases, these natural elements can also increase stability over time as they interact with and become integrated into the shoreline. *(See Hybrid Armoring, Nature-based Adaptation Strategy)*



NOAA Habitat Blueprint

Local Coastal Program (LCP)
The Coastal Act requires that local governments develop Local Coastal Programs (LCPs) that can carry out policies of the California Coastal Act at the local level. LCPs are land use planning documents that lay out a framework for development and coastal resource protection within a city or county's coastal zone area. They are prepared by the local jurisdiction and submitted to the Coastal Commission for certification. Each LCP includes a Land Use Plan (LUP) which contains policies, and an Implementation Plan (IP) which includes accompanying measures to implement the plan (such as zoning ordinances, zoning district maps, and other implementing actions). LCPs specify the appropriate kinds, location, and intensity of uses of land and water in the coastal zone portion of a local government's jurisdiction.

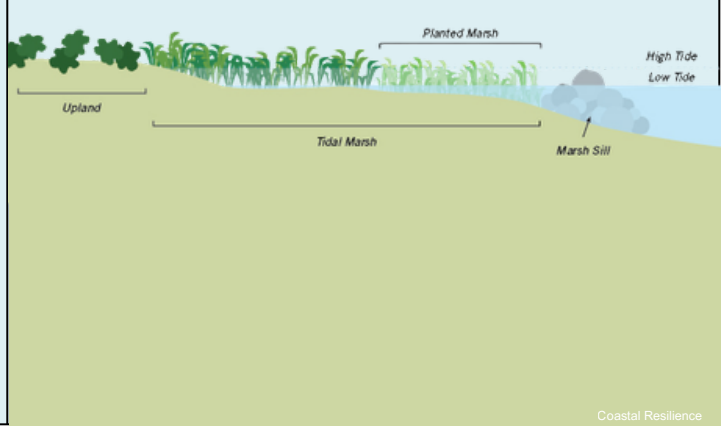
Learn more at:

- California Coastal Commission
- LCP Map

Managed Retreat
Managed retreat is an adaptation approach that intentionally realigns or removes existing development and infrastructure to reduce long-term risk from sea level rise. Managed retreat may create space for wetlands, tidal marshes, dunes, or other systems to migrate inland.



Marsh Sill
Marsh sills are shore parallel structures that combine a low-profile stone "sill" with wetland vegetation. The structural component provides protection to the marsh vegetation, allowing time for the plants to establish, as well as the upland environment by dissipating wave energy and reducing shoreline erosion. *(See Hybrid Armoring)*



Mudflat Augmentation
The intentional placement of fine silts and clays to elevate mudflats relative to rising tides and can include indirect placement of silts (through re/establishing hydrological connectivity) or direct placement (physical placement of dredged sediment). Mudflat augmentation helps reduce the risk of mudflat habitat loss from sea level rise and storm impacts and can support the recovery of declining coastal species that depend on these habitats. *(See Thin Layer Placement, Sediment Management)*


Santa Clara County Climate Collaborative

Native Vegetation Stabilization
Planting native vegetation that does not require irrigation in areas of the bluff where plants can establish can help stabilize the surface of slopes and reduce erosion. In contrast, invasive bluff vegetation, particularly iceplant (*Carpobrotus sp.* and *Mesembryanthemum sp.*), which is commonly found on bluffs throughout California, can increase erosion. Removing invasive species and replacing them with appropriate native vegetation can improve bluff stability and support ecological health.

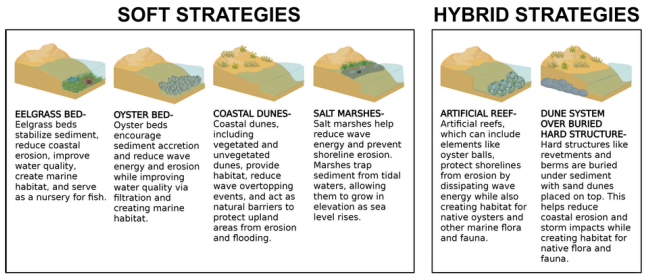

Bert Wilson

Nature-Based Adaptation Strategy (NBAS)
A coastal adaptation and/or erosion control method that is comprised of natural or mostly natural elements, which contributes to the persistence and enhancement of coastal processes and ecological benefits while also protecting inshore areas from accelerated erosion.

The Commission also recognizes that nature-based adaptation strategies can be further categorized along a spectrum between:

(1) Soft Strategies, which avoid fixing the shoreline with hard structures and instead use dynamic systems to attenuate coastal hazards, such as dune or wetland restoration, and,

(2) Hybrid Armoring, which combines fixing the shoreline, such as with a buried revetment or other shoreline protective device, with a nature-based feature to provide ecological and other benefits.



Learn more at:

- California Coastal Commission
- Nature-Based Adaptation Strategies in the Coastal Zone Story Map
- Nature-Based Adaptation Strategies Memo

Oyster Bed
Oyster beds are low-relief structures that consist of native oyster aggregates located in intertidal and subtidal zones. Oyster beds act as an important breeding and foraging habitat for many species. In some circumstances, they may provide protection by attenuating waves which can then, reduce shore erosion, and encourage sediment accretion.


Newport Bay Living Shoreline (Orange County Coastkeeper)

Public Trust Lands
All lands subject to the Common Law Public Trust for commerce, navigation, fisheries, recreation, and other public purposes. Public Trust Lands include tidelands, submerged lands, the beds of navigable lakes and rivers, and historic tidelands and submerged lands that are presently filled or reclaimed.

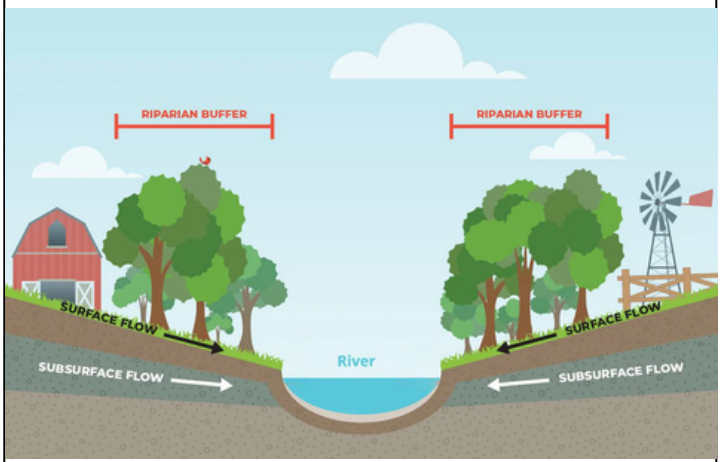
Learn more at:

- California Coastal Commission
- Who Owns the Beach? Understanding the Public Trust Doctrine Story Map
- Keeping California's Coast Accessible: Protecting Public Trust Lands and Uses as Sea Levels Rise Story Map
- Fact Sheet: Protection of Public Trust Resources in the Face of Sea Level Rise

Revetments
Sloped, engineered structures designed to act as a physical barrier to reduce erosion along shorelines, bluffs, and embankments, and in coastal settings, absorb and dissipate wave energy. Revetments can be built from materials such as large, loose stones (riprap), gabions, concrete, or other elements selected for site conditions. On California's outer coast, riprap revetments made of large stones are one of the most common armoring approaches (See Riprap, Hard Protection/Armoring, Gray Infrastructure, Shoreline Protective Device)


San Clemente Riprap Revetment (San Diego Union Tribune)

Riparian Areas
A vegetated strip of land associated with rivers, streams, or estuaries, often characterized by multiple plant layers such as trees, shrubs, and herbaceous vegetation. Riparian areas slow runoff, filter pollutants, stabilize banks, and can provide shade and habitat value. While they can occur adjacent to wetlands, riparian areas are typically distinguished by their layered vegetation structure, in contrast to marsh systems that are dominated primarily by emergent vegetation.



H2O Ohio

Riprap
A form of coastal defense made of loose stones or rubble that is used to protect shorelines and other structures from erosion by water and wave action. The stones, typically made of granite or other durable rock, are placed to absorb and deflect the energy of the water, thereby reducing erosion and stabilizing the immediate area. Riprap can vary in size and can be as big as large boulders, depending on the specific needs of the site. *(See also Hard Protection/Armoring, Seawall, Shoreline Protective Device, Revetment)*


Oceanside Harbor Breakwater (Mira Costa College)

Sand Berm
A temporary, elevated ridge of sand placed or formed along the upper beach or backshore to reduce wave overtopping and provide short-term flood protection. Sand berms are often constructed out of existing sand, but also may be built with imported material. These features can erode during large storms or be regraded back into the beach. Sand berms can also form naturally as waves and wind accumulate sediment along the upper beach.

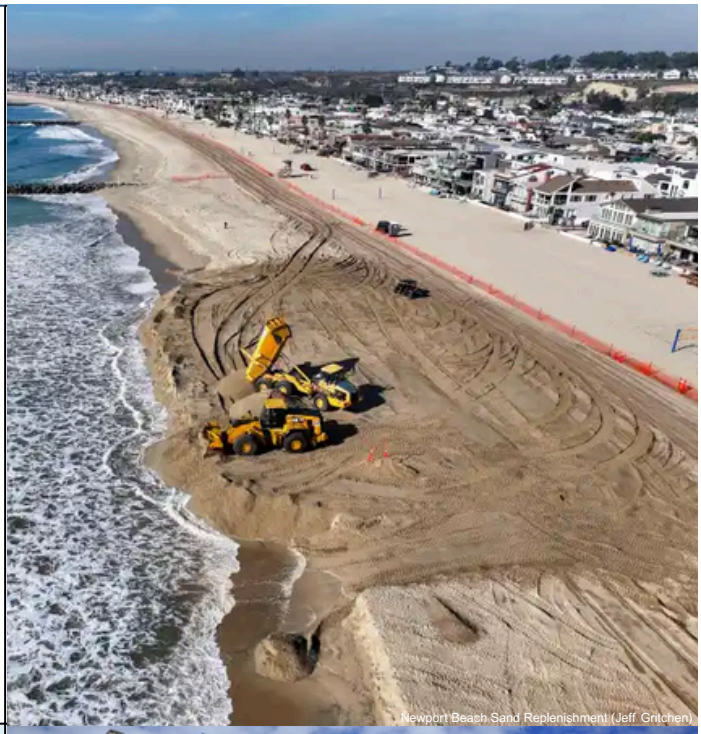

Ventura Sand Berm

Sand Dunes/Coastal Dunes
Coastal dunes are mounds or hills of sand and vegetation often situated landward of the wave runup zone of a beach. Their size and form can vary widely, from small, developing features to large, well-established dune fields. Dune vegetation helps trap wind-blown sediment, thereby building up or maintaining the general size of a coastal dune. Native dune vegetation provides important habitat for many rare and uniquely adapted species. Dunes can also act as a sand supply reservoir that helps re-nourish the beach when erosion from coastal storms and waves may deplete the sediment. Coastal dunes naturally provide protection by reducing wave overtopping events and inhibiting saltwater surface intrusion into the backshore environment.


Marina Dunes State Park

Sand Nourishment/Beach Nourishment/Sand Replenishment

Sand nourishment, beach nourishment, or sand replenishment, is the placement of sand onto a beach. The additional sediment gets redistributed either by waves and currents or through human manipulation until it reaches the general beach shape that naturally forms under prevailing wave conditions. Sand nourishment helps maintain the beach zone, expands recreational space, and acts as a buffer to reduce the impacts of coastal hazards. Its ecological effects vary by site, and any potential habitat benefits depend on local conditions. Its ecological effects vary by site, and any potential habitat benefits depend on local conditions. *(See Sediment Management)*



Newport Beach Sand Replenishment (Jeff Gritchen)

Seawall

A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action. It is usually a vertical wood, concrete, or steel wall as opposed to a sloped revetment. *(See also Hard Protection, Living Seawall, Revetment, Shoreline Protective Device)*



Solana Beach Seawall (LA Times)

Sediment Management

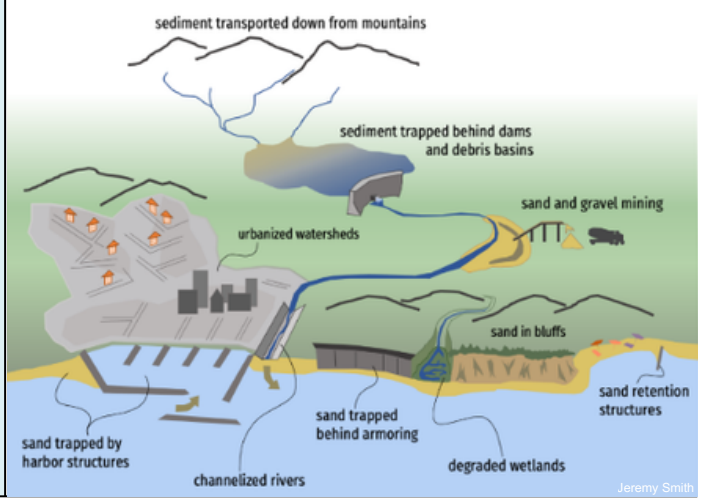
The system-based approach to managing coastal, nearshore, and estuarine sediments through activities that influence the transport, removal, or deposition of sediment. Examples include beach nourishment, beneficial reuse of dredged material, and sediment bypassing.

Learn more at:

- North-Central California Coast Sediment Coordination Committee
- California Coastal Sediment Master Plan
- Greater Farallones National Marine Sanctuary: Coastal Resilience Sediment Plan

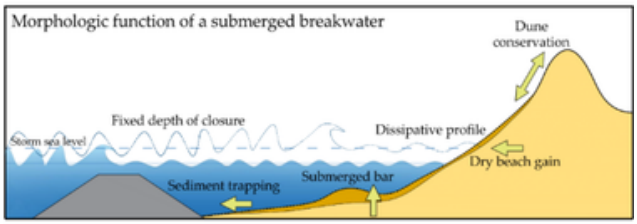
Sediment Supply

The total volume of sand, gravel, and other sediments available to a coastal system. Sediment is supplied by rivers, bluffs, dunes, and offshore sources. A sufficient sediment supply is critical to sustain beaches, dunes, and wetlands. Reductions in sediment supply due to armoring, development, or dams disrupt the natural processes that balance sediment gains and losses and can consequently lead to the loss of beaches and other coastal features.



Shoreline Protective Device
A broad term for constructed features such as seawalls, revetments, riprap, earthen berms, cave fills, and bulkheads that block the landward retreat of the shoreline and are used to protect structures or other features from erosion and other hazards.

Submerged Breakwater
A submerged breakwater is a low-crested, shore-parallel offshore structure placed in shallow water with its crest at or below the water surface. These structures—constructed in forms such as rubble-mound, articulated concrete, semi-circular, or geosynthetic units—are intended to dissipate wave energy offshore and influence sediment transport. In certain contexts, they may reduce shoreline erosion or help manage sedimentation in port and navigation areas. However, the science on their effectiveness, ecological impacts, and long-term performance is still developing. Their use is sometimes paired with beach nourishment or other coastal management techniques. *(See also Emergent Breakwater, Hard Protection/Armoring, Shoreline Protective Device)*

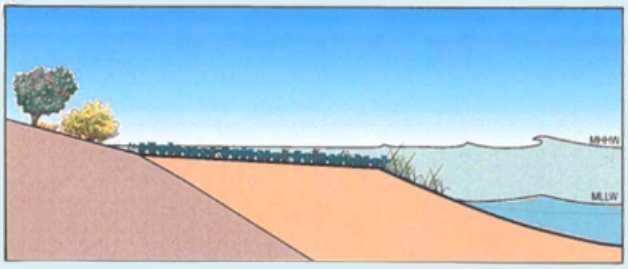


Rojas et al. 2021

Thin Layer Placement (TLP)
A marsh restoration method used to sustain tidal marshes by adding a shallow layer of sediment (typically 1-50 cm thick, most often 10-20 cm), to raise marsh elevation relative to sea level. Because marsh sustainability and ecological integrity depend strongly on vertical position relative to sea level, TLP is used to maintain plant and animal communities within their tolerances for flooding frequency and duration. *(See also Mudflat Augmentation, Sediment Management)*


Seal Beach Thin Layer Placement

Tidal Bench
Similar to ecotone levees, tidal benches are gently-sloping surfaces created by placing fill in tidal waters to raise the bathymetry while maintaining tidal influence. Unlike ecotone levees, which extend into the upland transition zone, tidal benches remain within the tidal range and slope toward the shoreline. They may be planted with tidal vegetation where appropriate or left unvegetated, such as mudflat-like surfaces. Tidal benches can dissipate wave energy and promote sediment accretion.



Newkirk et al. 2018

Tidal Marsh
Coastal wetlands that are flooded and drained by water moved by the tides, whether on the surface or through groundwater connections.

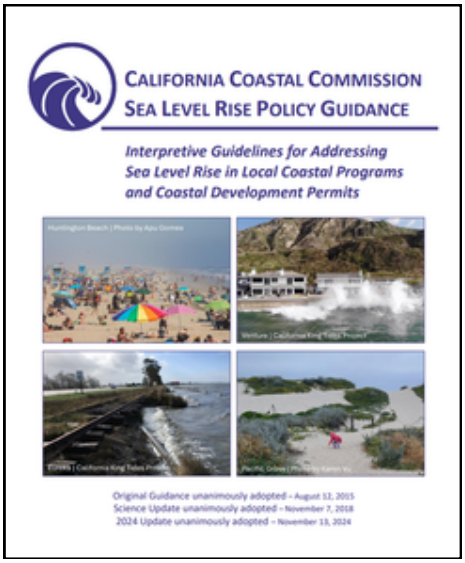

Carmel Valley Road Salt Marsh (Southern California Wetlands Recovery Project)

Wetland Restoration
Actions that improve the condition or function of former or degraded wetlands. Within the Coastal Zone, wetlands may be tidal, freshwater, seasonal, or otherwise defined under the Coastal Act. Techniques may include placing sediment, removing invasive vegetation or other foreign materials, or planting appropriate native wetland vegetation. These techniques can absorb wave energy, stabilize soils, increase sediment retention, and/or dampen incoming waves and coastal scour. Depending on site conditions and ecological objectives, efforts may constitute restoration, which is aimed at recovering a broad suit of self-sustaining functions, or enhancement, which focuses on improving more limited functions without fully restoring the system.


San Elijo Lagoon (Tim Buss)

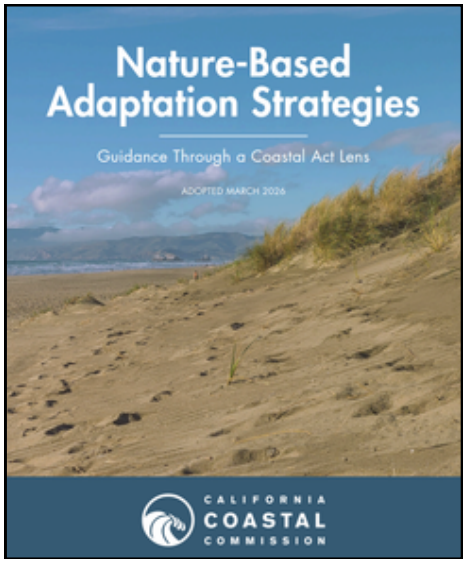
Planning for Sea Level Rise

Explore Coastal Commission guidance for planning, evaluating, and implementing sea level rise adaptation strategies.



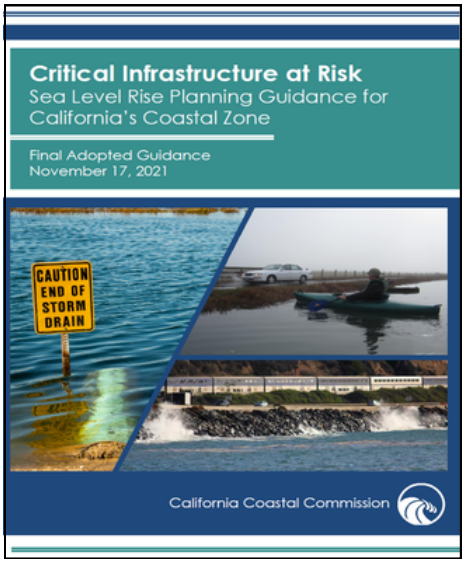
Sea Level Rise Policy Guidance

Learn how to address sea level rise in Local Coastal Programs and Coastal Development Permits.



Nature-Based Adaptation Strategies Policy Guidance

Explore how nature-based approaches reduce coastal hazards and build resilience.



Critical Infrastructure Policy Guidance

Learn how to assess and adapt critical infrastructure to sea level rise.

Keep exploring

Find additional resources for sea level rise adaptation planning.

Explore Coastal Commission Resources