Mitigating Erosion Along Sheltered Coasts

A report of the National Academies

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Sponsors


Environmental Protection Agency
U.S. Army Corps of Engineers
Cooperative Institute for Coastal and Estuarine Environmental Technology
NOAA Coastal Services Center

Statement of Task

The study will examine the impacts of shoreline management on sheltered coastal environments (e.g. estuaries, bays, lagoons, mud flats, deltaic coasts) and identify conventional and alternative strategies to minimize potential negative impacts to adjacent or nearby coastal resources. The study will provide a framework for collaboration between different levels of government, conservancies, and property owners to aid in making decisions regarding the most appropriate alternatives for shoreline protection.

Statement of Task (condensed)

- What engineering approaches and land management/ planning measures are available to protect sheltered coastlines from erosion or inundation?
- What information (and time frame for monitoring) is needed to determine where and when these measures are reliable and effective both from an engineering and a habitat perspective?
- What are the likely individual and cumulative impacts of shoreline protection practices?
- Given current trends in erosion and acceleration of relative sea-level rise, how can design criteria, the mix of technologies employed, and land use plans be implemented for protecting the environment and property over the long term?

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Report Organization

- Understanding Erosion On Sheltered Coasts
- Methods For Addressing Erosion
- Mitigating Eroding Sheltered Shorelines: A Trade-off In Ecosystem Services
- The Existing Decision-making Process For Shoreline Protection On Sheltered Coasts
- A New Management Approach For Sheltered Shorelines

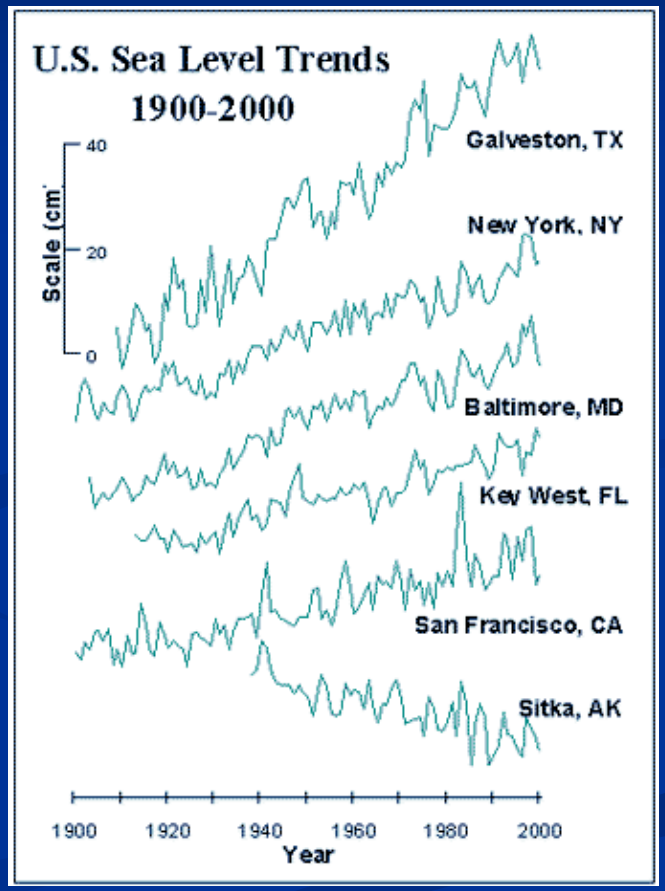
What *Is* A Sheltered Coast?

- Typically bays, harbors, and estuaries
- Generally smaller bodies of water with limited fetch and water depth
- Protected from the full force of ocean energy by an island, peninsula, or reef
- Irregular “compartmentalized” shoreline compared to linear open coasts
- High diversity of resources and conditions, unique habitats, ecologically productive
- Same processes as on open coasts, but the scale is greatly reduced

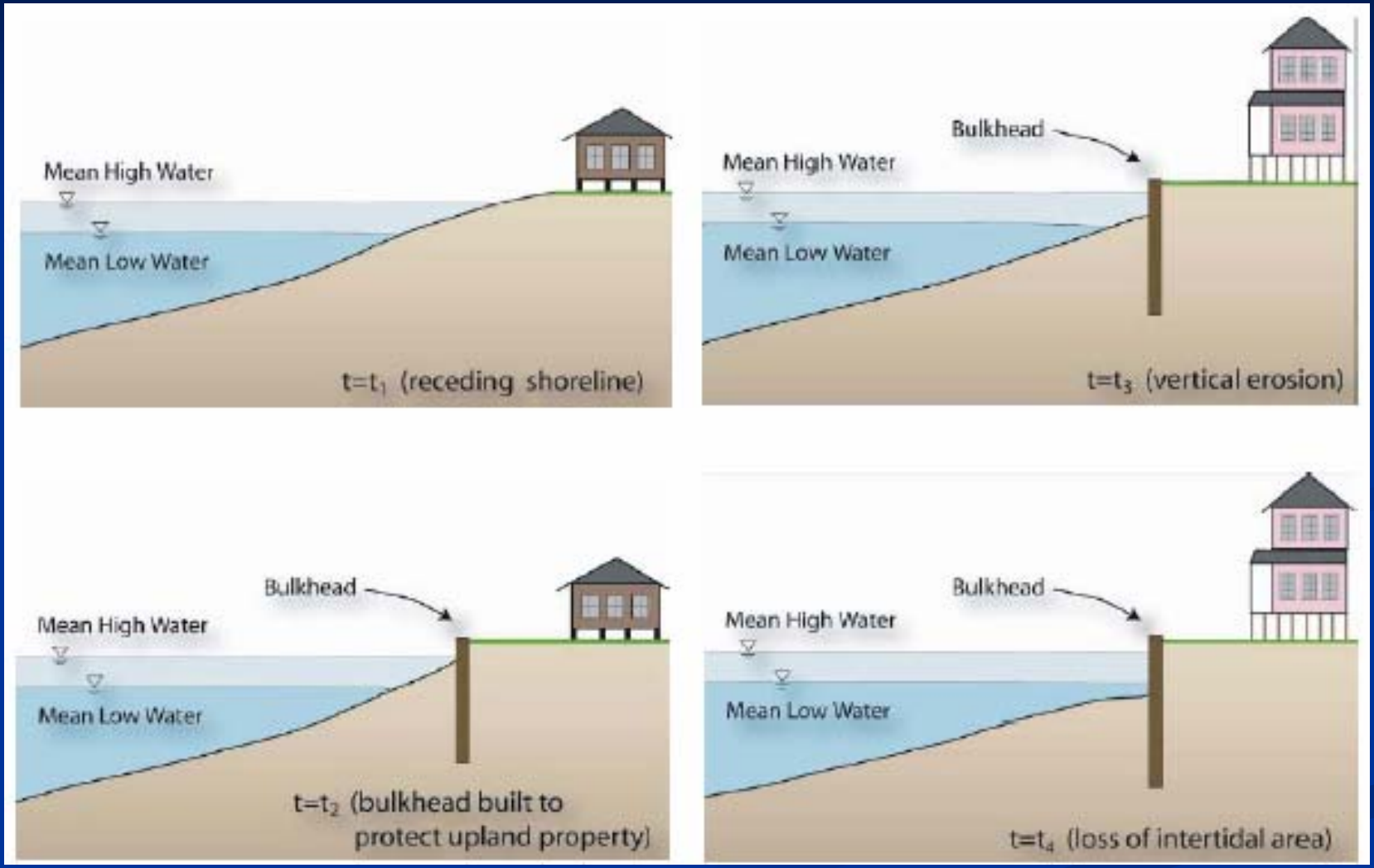

Sheltered Coasts
1
0.5
0
Miles
1,000
500
0
Meters
Aerial imagery © 2002 Commonwealth of Virginia
Lower Machodoc Creek
1
2
3
4
5
6
Beach
100 Yr.
MHW
MLW
Erosion Surface
Recent Sedimentation
Marsh
Beach/Dune

The Problem

- Sheltered coasts are sites of increasing development, with many people moving to the coast
- Sheltered coasts are vulnerable to chronic land loss from erosion and sea level rise
- Landowners typically select hardening technologies such as bulkheads, revetments, and groins to prevent land loss although “softer” alternatives are available.



Beach Loss after Installation of Bulkhead



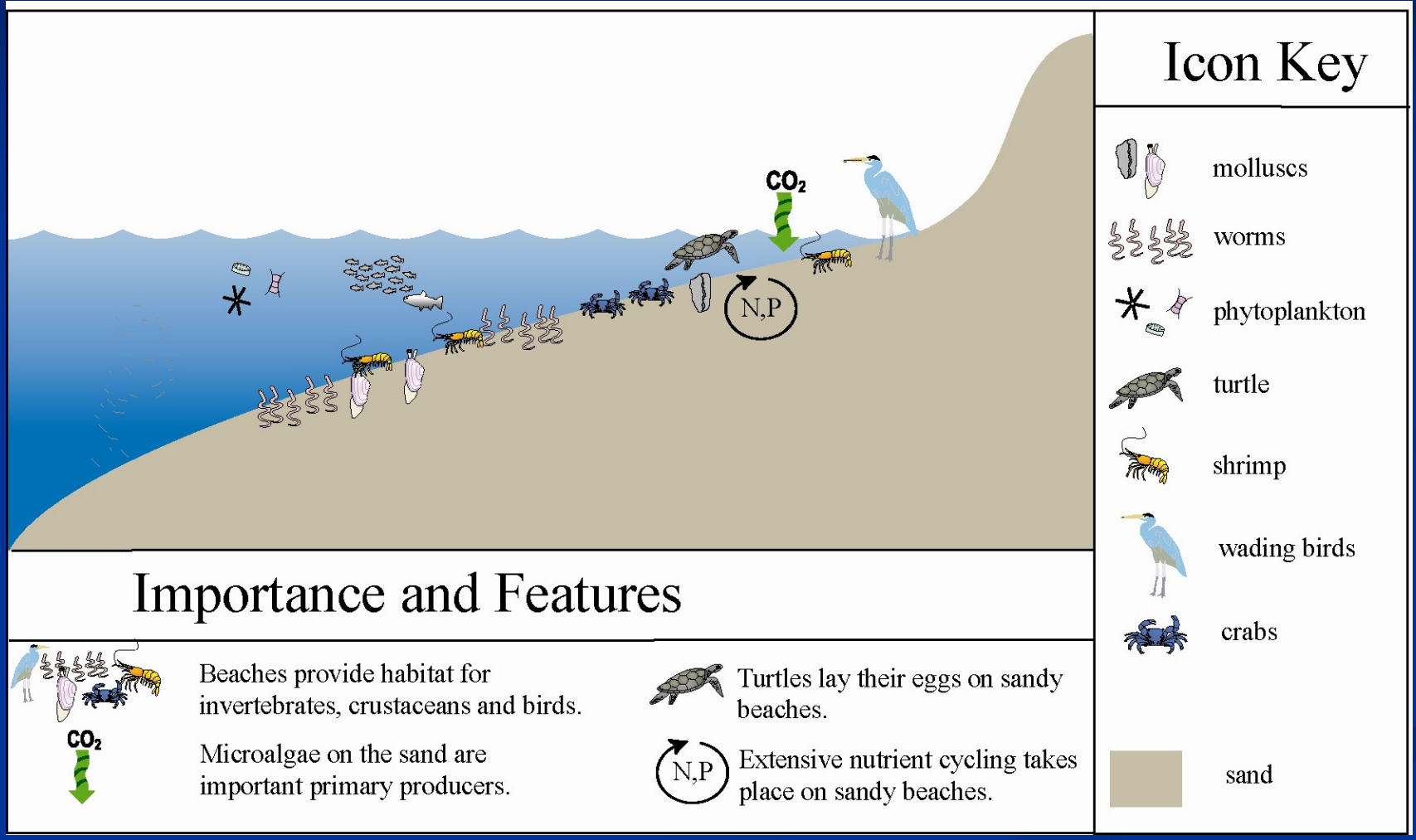
Source: After Tait and Griggs (1990) and Douglass (2005)

Geomorphic Settings

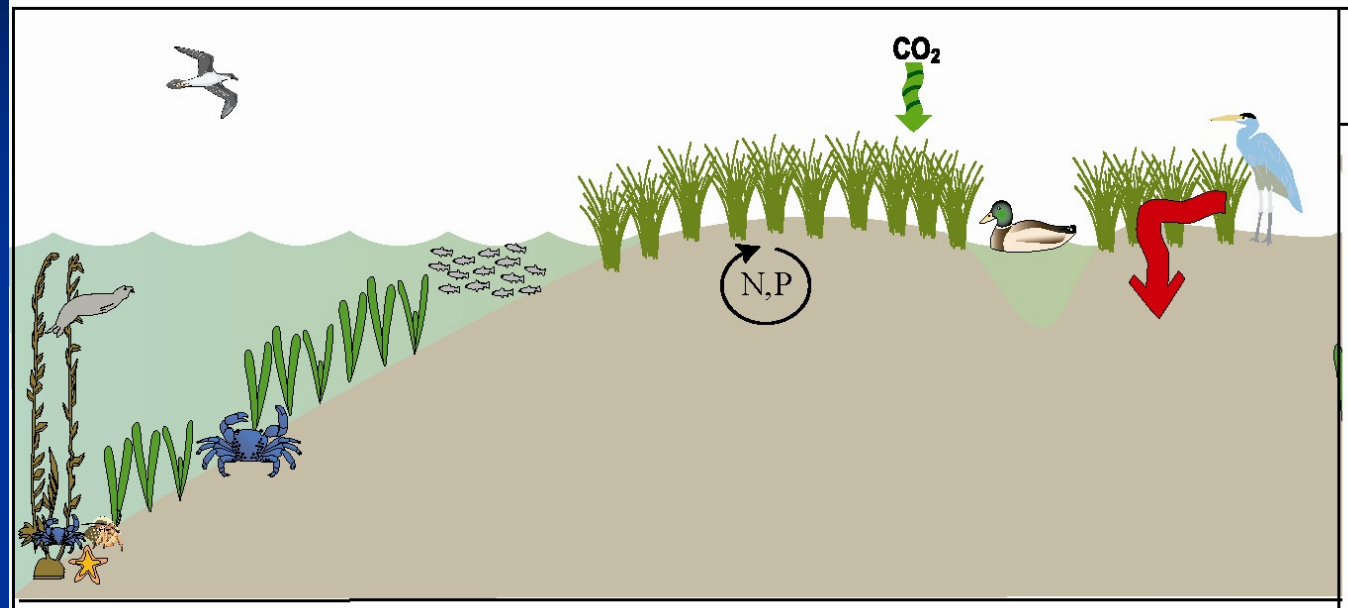
Three major categories:

- Beaches and dunes
- Mudflats and vegetated communities (marsh, macroalgae, seagrasses, etc.)
- Unconsolidated bluffs

Ecosystem Services - Beaches



Ecosystem Services - Marshes



Importance and Features

Salt marshes provide important nursery habitat for crabs and fishes.

Salt marshes act as a nutrient filter and is the site of nutrient cycle.

Salt marshes support high primary production.

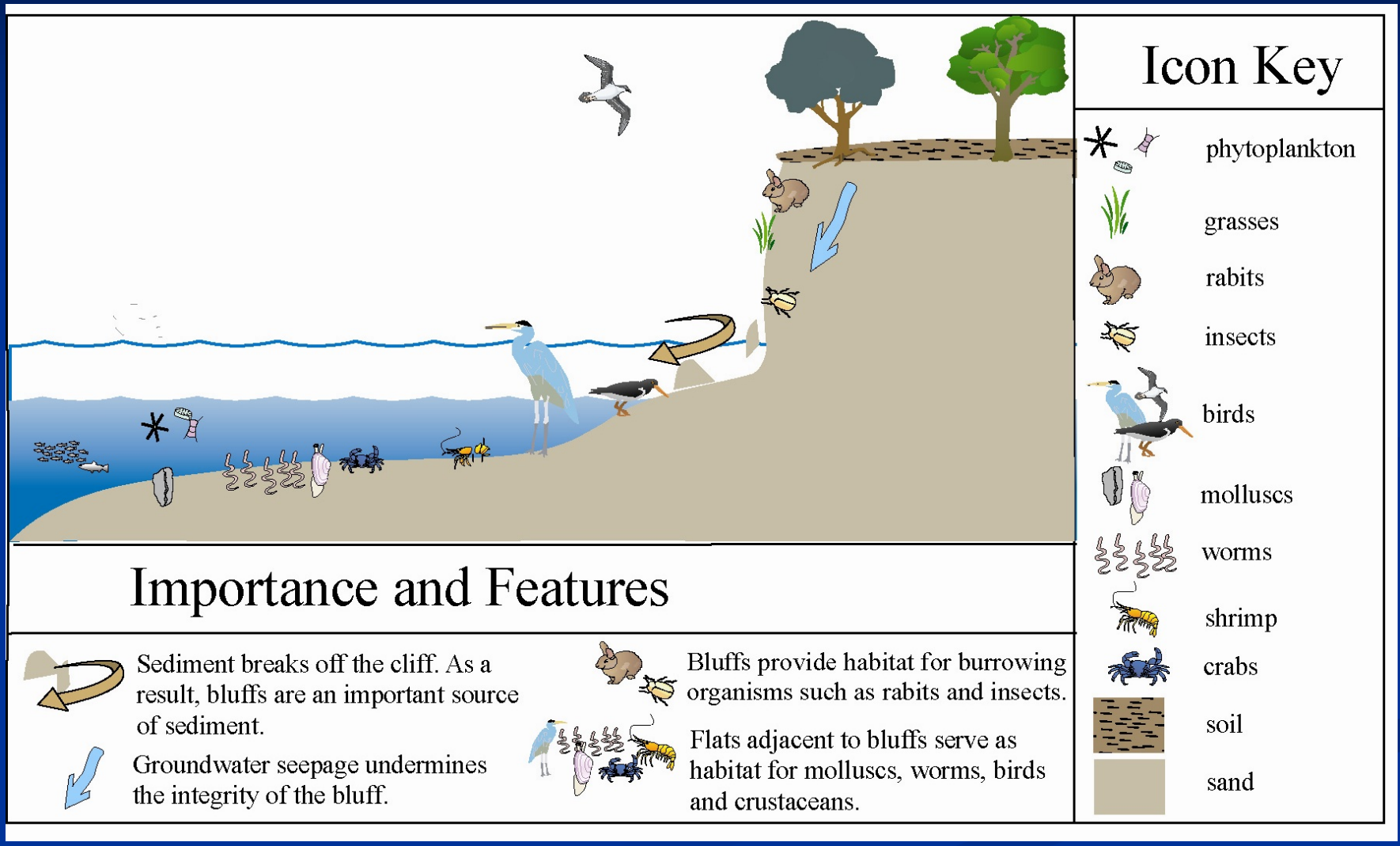
Seagrasses may or may not occur adjacent to marshes.

Kelp and their associated organisms may occur offshore of salt marshes.

Icon Key

- native marsh grass
- birds and waterfowl
- kelp
- sea otter
- kelp associated fauna

Ecosystem Services - Bluffs



Strategies for Addressing Erosion

- Harden
- Vegetate
- Trap and/or add sand
- Manage Land Uses
- Combination of one or more

Design Criteria

Top: Stone revetment built with only one layer of undersized armor stone on too steep a slope.

Bottom: failure after a modest storm event.

Source: Hardaway and Byrne, 1999

Combination Approaches

Shore protection system utilizing primarily headland breakwaters and beach fill with wetland vegetation, bank grading with upland vegetation, and an interfacing low-crested breakwater and revetment.

Source: Hardaway and Byrne, 1999

Findings and Recommendations

- Information Needs
- Erosion Mitigation and Permitting
- Cumulative Effects
- Shoreline Management Planning

INFORMATION NEEDS

FINDING:
Scope and accessibility of information on causes of erosion and overall patterns of erosion, accretion, and inundation in the broader region (estuary, lagoon, littoral cell) is insufficient in most areas to support the development of an integrated plan for managing shore erosion.

RECOMMENDATION:
Federal agencies (e.g., USACE, EPA, USGS, and NOAA), state agencies, and coastal counties and communities should support targeted studies to facilitate decision making based on the coastal system rather than individual sites.

INFORMATION NEEDS

These studies should:

- Identify trade offs in ecosystem services associated with various mitigation measures,
- Quantify the costs and benefits of non-structural erosion control techniques,
- Document system-wide process and hazard information, including mapping of erosion zones and rates. This information needs to be presented in non-technical formats such as summary maps that can be readily understood by decision-makers.
- Develop models to predict the evolution of coastal features under various scenarios.

EROSION MITIGATION AND PERMITTING

FINDINGS:

- Compared to open coasts, a greater variety of techniques are available to address erosion in sheltered areas

- New techniques (or structural materials) require a rigorous process of testing and evaluation to determine their effectiveness and evaluate their environmental impacts

- The current permitting system discourages the use of alternatives to shoreline hardening

EROSION MITIGATION AND PERMITTING

RECOMMENDATIONS:

- The major federal permitting agencies (EPA, USACE, and NOAA) should initiate a national policy dialogue on sheltered coasts to bring decision-makers together to share information on the potential use of different erosion mitigation approaches.

- The national dialogue should be used to develop guidelines for mitigating erosion on sheltered coasts that give deference to ecologically beneficial measures and ensure consistency of decision-making across regions.

- The regulatory preference for permitting bulkheads and similar structures should be changed to favor more ecologically beneficial solutions that provide shore protection.

- State and federal regulatory programs should establish a technical assistance function to provide advice on permitting issues and information on types of erosion mitigation approaches and their effectiveness under various site conditions.

CUMULATIVE EFFECTS

FINDING:

- The cumulative impact of the loss of many small parcels will at some point alter the properties, composition, and functioning of the ecosystem. In addition, the economic, recreational, and esthetic properties of the shoreline will change with potential loss of public use, access, and scenic values. Cumulative effects of shoreline hardening projects are rarely assessed and hence are generally undocumented.

RECOMMENDATION:

- Shoreline management plans should be developed to account for potential cumulative effects of shoreline hardening. Anticipation of the problem allows prioritization of projects to areas unsuited to non-structural alternatives or sites where structures are predicted to have less impact. In the absence of information, a precautionary approach should be taken.

SHORELINE MANAGEMENT PLANNING

FINDINGS:

- Many factors in addition to sediment budgets must be considered in the development of regional shoreline management plans including socio-economic factors (e.g., ownership of the shoreline, waterfront property values, beach access for recreational boating and fishing) and a broad range of ecological issues.

- Regional shoreline management plans could be implemented under the auspices of the federal Coastal Zone Management Act (CZMA), Section 309 - Special Area Management Plans, to ensure that federal permitting actions are consistent with the plan.

- The USACE Regional Sediment Management program provides a model for regional planning that matches the scale of planning effort to the scale of the processes and impacts.

SHORELINE MANAGEMENT PLANNING

RECOMMENDATIONS:

- Regional shoreline management plans (based on estuary, bay, or littoral cell) should be developed by local, state, and federal partners to address erosion on sheltered shorelines in a comprehensive, proactive manner and to avoid the unintended loss of recreational, aesthetic, economic, and ecological values of sheltered coastal areas.
- The essential elements of a regional shoreline management plan should include:
  - a shared vision for the future shoreline of the water body through stakeholder collaboration,
  - analysis of regional sediment budgets and the cumulative effects of existing shoreline management activities,
  - the mechanism for turning the vision into reality through consistent permitting provisions,
  - implementation, and
  - performance evaluation and monitoring requirements.

SHORELINE MANAGEMENT PLANNING

RECOMMENDATIONS:

- Information obtained from monitoring programs should be incorporated in subsequent planning activities. Adaptive management strategies should be used to consistently evaluate and refine regional plans.
- Each regional shoreline management plan should describe the physical and hydrodynamic settings, including the location and type of existing shoreline structures in a GIS format. The plan should describe the available mitigation options and discuss the applicability, relative cost and benefit, and effectiveness of each option.

In Summary

- Information on shoreline change is insufficient for sheltered coasts
- Decision makers (landowners, contractors, local and state authorities) are generally unaware of alternative erosion mitigation strategies and their effectiveness
- Individual decisions lead to cumulative impacts
- All mitigation measures affect ecosystem services
- Local, proactive shoreline management plans could prevent unintended consequences of site-by-site permitting
- Permitting systems should promote mitigation approaches that maintain more natural shorelines