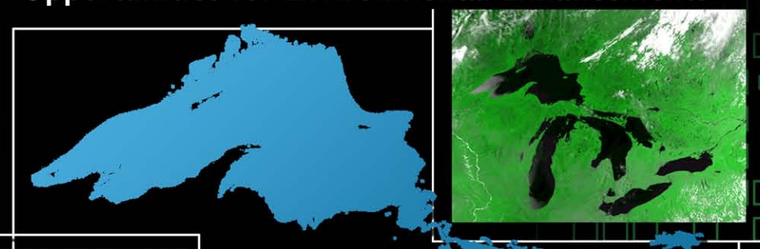
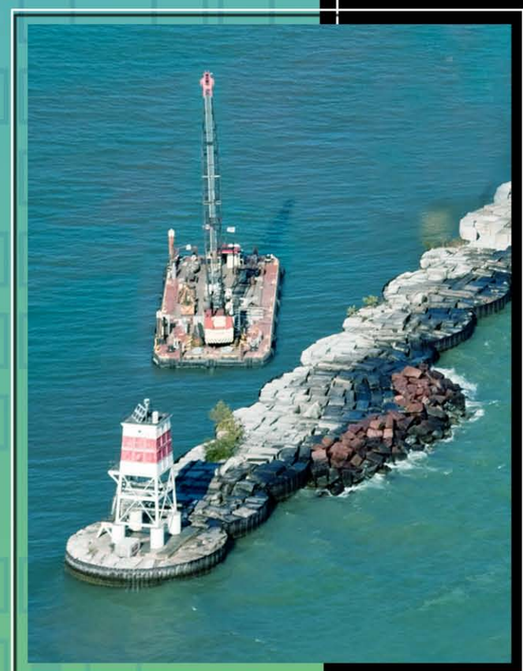
Opportunities for Environmental Enhancements





Making Great Lakes Coastal Structures Greener

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U.S. Army Corps of Engineers, Engineer Research and Development Center
Environmental Laboratory • Coastal and Hydraulics Laboratory
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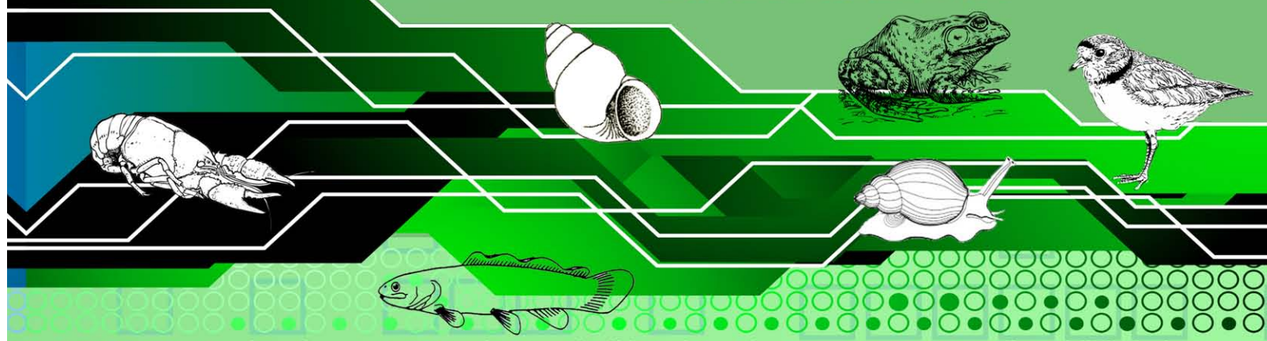

Designing breakwaters, piers/jetties, bulkheads and revetments to provide wildlife habitat

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Making Great Lakes Coastal Structures Greener

WHAT IS THIS?
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There are hundreds of miles of engineered coastal structures (breakwaters, piers/jetties, bulkheads and revetments) in the Great Lakes. These structures already provide valuable habitat for fisheries and waterfowl, but these habitat features are often "accidental" — as opposed to being deliberately planned into the structures' design. This effort, Making Great Lakes Coastal Structures Greener, explores opportunities for enhancing these structures' life-promoting features. Low-cost measures could be implemented as part of routine maintenance, scheduled repairs or new modifications, and would result in improved habitat for wildlife.

U.S. Army Corps of Engineers
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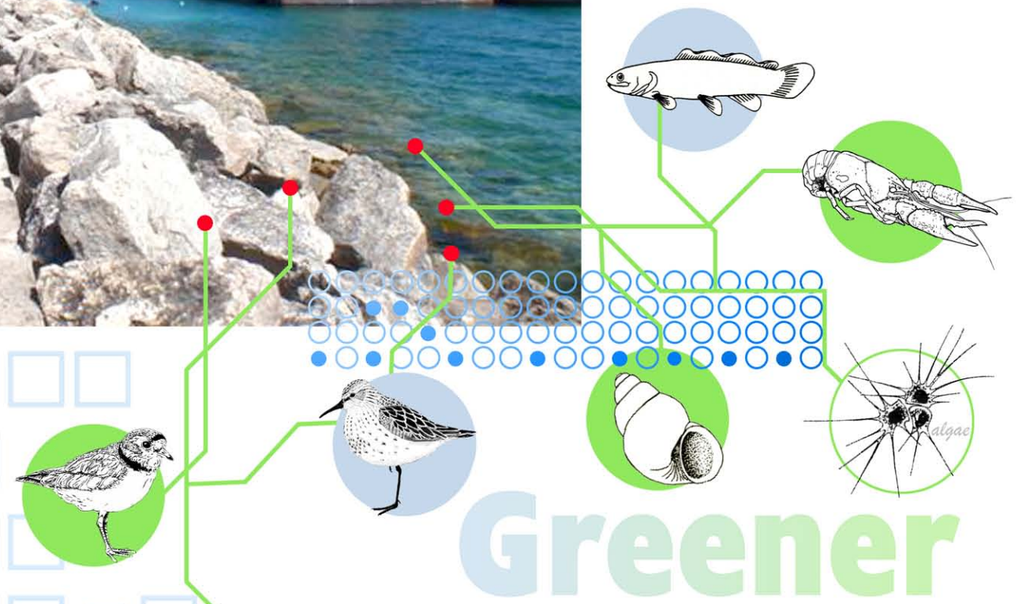
Visit the Great Lakes Restoration Initiative (GLRI) website
http://www.glri.us

How does the "green" concept apply to Great Lakes coastal structures?

Engineered coastal structures on the Great Lakes can be made "greener" if they are designed to provide life-promoting habitat for the region's native wildlife (fish and birds) and their food sources (insects and aquatic plants). Structures like breakwaters and jetties are usually designed to manage some aspect of the natural environment; for example, to improve navigation or to control erosion and floods. The first consideration for planners is usually to minimize any unintended negative impacts on the environment from a new structure. However, with planning and forethought, a project can also be designed to create environmental benefits. When they are identified early, it is easier to add these "green" design ideas into coastal projects. In addition, green features can be incorporated into the maintenance and rehabilitation of older or degraded structures.



Designing breakwaters, piers/jetties, bulkheads and revetments to provide wildlife habitat

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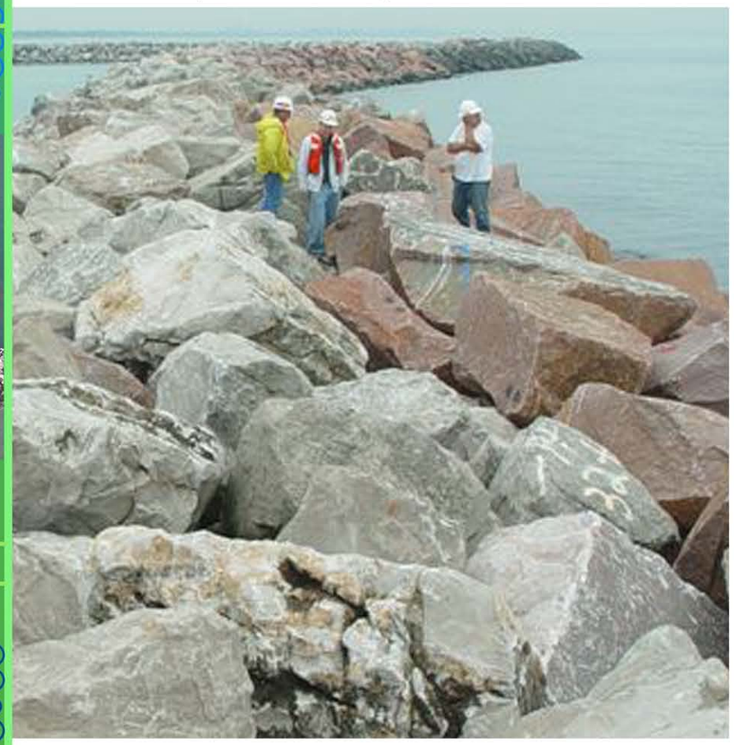
http://chl.erdc.usace.army.mil/

What are these coastal structures?

BREAKWATERS

Breakwaters are typically constructed in high wave energy environments along shorelines to prevent wave energy from reaching the protected area.

A breakwater is an engineered structure protecting a shoreline, navigation channel, or basin from waves; it is similar to a natural sandbar or nearshore island. A breakwater is usually constructed parallel to the shoreline. It reduces the amount of wave energy that reaches the protected area. Since the mid-1800s, breakwaters on the Great Lakes have typically been constructed using timber cribs, sheet piling, rubble mound stone, stacked stone, or concrete.



Jetties are built at the mouths of rivers or harbors to help deepen and stabilize a channel for ease of navigation.

JETTIES

A jetty or a "pier" is a structure built perpendicular to the shoreline. A jetty is commonly used for training water channels and stabilizing inlets. A jetty prevents the transport of sediment and helps control current flow; this helps keep the channel at a depth that's safe for navigation. Jetties are traditionally constructed of rubble mound stone, but on the Great Lakes jetties are frequently constructed from timber crib with concrete cap, sheet piling, or stacked stone.

A bulkhead is a vertical retaining wall that prevents soil from eroding into a lake or river. A bulkhead provides stability to a cliff or a bluff by protecting the bottoms of these steep banks from eroding. If the bottom — or toe — erodes, an overhang is created that may eventually collapse into the body of water. Bulkheads are constructed a number of ways depending on the need, but are typically cantilevered, anchored sheet pile, or structures that sit on strong foundation soils (these are also known as gravity structures). They can be built using rock-filled timber cribs, steel wire-mesh baskets holding stones, or rock or concrete blocks cut to a uniform size.

A revetment is a structure protecting a shoreline or an embankment from erosion by waves. A revetment is a hardened protective layer usually built along the shoreline or embankment; it also may provide flood inundaton protection. Revetments are typically constructed of materials that are able to endure years of wave action; these materials include fabric, quarry stone, concrete, or interlocking concrete block.

What are these coastal structures?

BULKHEADS

Bulkheads are structures built along waterfronts to reduce the sliding of land into the water. They can also protect dry land above the high water mark from damage due to wave action. Bulkheads are much more common in the Great Lakes than seawalls.

REVETMENTS

Revetments are usually constructed to be a protective barrier along the shore of lakes, rivers and oceans, and this layer prevents the shorelines of these water bodies from eroding too quickly.

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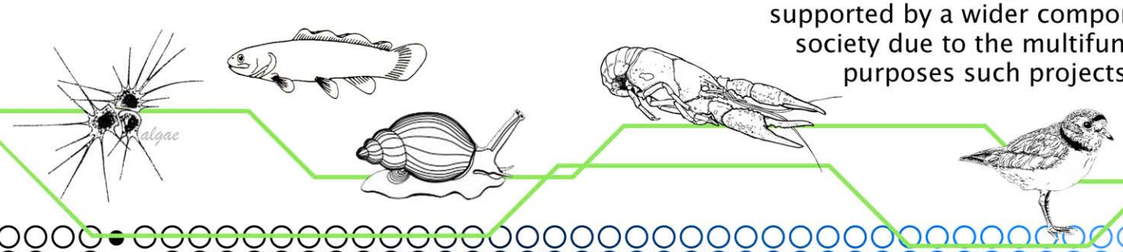
Do these structures currently provide any environmental benefits?

Existing breakwaters and jetties do provide some environmental benefits. For nearly 30 years, it has been known that rubble-mound breakwaters provide reef-like or rocky shore habitat for a variety of animals, fish, and birds. Such structures provide a place that many species of algae, aquatic plants such as sedges and rushes, and animals such as crayfish can call home. Since these species serve as a potential food resource for many fish, some of these structures serve as sheltering, foraging, spawning, or nursery habitat by fish and invertebrate populations. This is why shoreline rubble-mound structures are such popular recreational fishing spots.

Why do we think we can improve on present conditions?

Engineered coastal structures feature prominently throughout the nation's waterways. However, few of the hundreds of breakwaters, jetties, bulkheads, and revetments were designed specifically to provide environmental benefits. With advance planning, the opportunities for adding environmental enhancements could be considerable. Each year, new structures are constructed and existing ones undergo modification or maintenance. Many Great Lakes structures are aging and are in need of significant repair. As plans for the new structures or maintenance of the existing ones are developed, planners, engineers, designers, ecologists and stakeholders may be able to identify project design features that will better support wildlife species and that can be incorporated with little to no cost increase.

Adding design features that are better for the environment and that support wildlife may serve the needs of other interested parties willing to share the additional costs (this is also known as cost sharing). Involving wildlife-focused agencies and organizations can create an enhanced project and review dynamic. This, in turn, leads to projects that can be supported by a wider component of society due to the multifunctional purposes such projects serve.

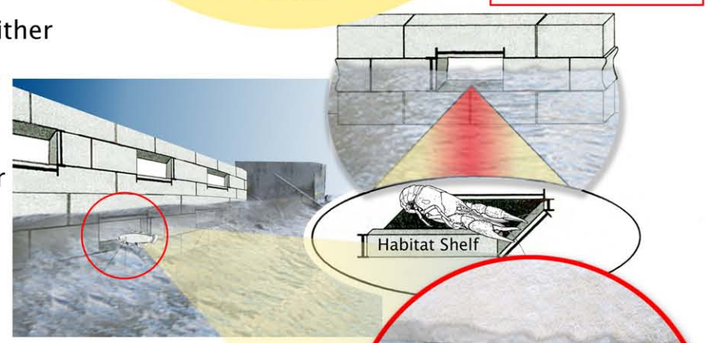


What kinds of green enhancements might be possible?

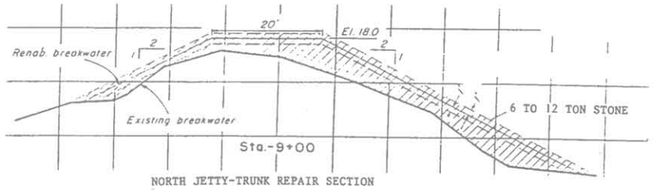
Some examples of green coastal structures are currently in place, and others have been suggested as part of the planning process; there are also opportunities to modify existing structures that can offer some environmental benefits to native species including:

- Adding pea gravel around a breakwater toe to enhance the available fish-spawning substrate
- "Scratching" hard structures in freshwater systems to enhance the settlement of aquatic insects
- Using different sizes of stone (i.e., to increase surface complexity) or placing cross-sectional modifications around other "green" coastal structures like revetments to enhance habitat
- Placing underwater reef segments/prefabricated reef modules either extending linearly from the ends of breakwaters and piers/jetties, or placed in concentric arcs
- Providing terrestrial nesting habitat for birds on offshore breakwaters
- Providing fish habitat shelves by adding recesses or hollow, perforated units to existing, featureless walls to provide shelter for fish and invertebrates where none currently exists

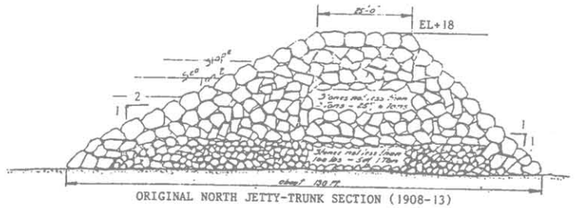
Underwater view showing varied slopes, sinuous toe, caverns, and varied stone size.



This concept adapted from: Chapman, M. G. and Underwood, A. J. 2011. "Evaluation of ecological engineering of 'armoured' shorelines to improve their value as habitat." *J. Exp. Mar. Biol. Ecol.* 400:302-313 DOI: 10.1016/j.jembe.2011.02.025.



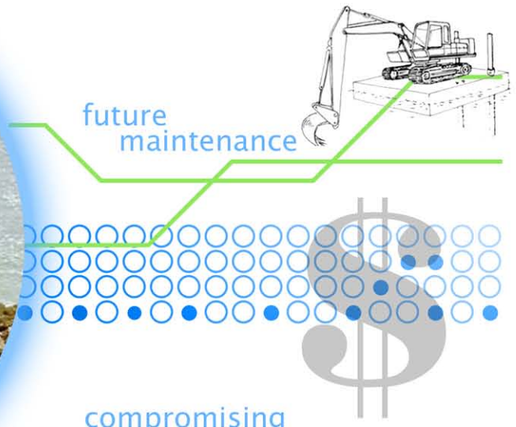
NORTH JETTY-TRUNK REPAIR SECTION

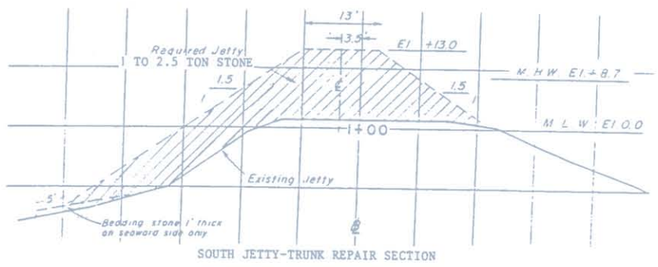


ORIGINAL NORTH JETTY-TRUNK SECTION (1908-13)

What are the main challenges to implementing green enhancements?

Future maintenance of infrastructure projects is a concern because maintenance would be subject to potential environmental restrictions, thus making the maintenance more complex and costly. At some projects, apprehension about future maintenance has led to the abandonment of any effort to green coastal structures. Ensuring the structural integrity and functional performance of these projects while adding life-promoting features is also a concern.





SOUTH JETTY-TRUNK REPAIR SECTION

Cost sharing Cost Sharing is a potential impediment to implementing some green coastal structures projects. For example, Sections 1135 and 204 of the Water Resources Development Act (WRDA) of 1986 and 1992, respectively, require that non-federal entities pay a share of the design and construction costs of USACE-led projects for improvement, protection, or restoration of habitats, and assume all Operation and Maintenance responsibility for the environmental project features after construction.

What potential solutions could be used to overcome the challenges?

The following are potential solutions to the challenges of implementing the green coastal structures concept.

• Maximize use of coordination mechanisms. Green engineering projects will require coordination among multiple stakeholders.

• Document existing projects. The green engineering concept will be more quickly adopted if there are documented projects that demonstrate success and benefits. Identifying and documenting good case studies will help sell the concept.

• Conduct pilot projects. Pilot studies provide an excellent opportunity to conduct field-scale proof-of-concept projects. Pilot projects are a good way to quickly develop and refine innovations. Developing a range of pilot projects, in coordination with construction or maintenance, will help to promote the concept of green coastal structures.

• Seek new funding mechanisms for green infrastructure projects. Cost sharing will be an ongoing challenge to implementing the concept. Solutions may include developing a special regional program to support these activities. Another possibility would be to promote corporate donations and utilize non-profit funding avenues to support the green engineering structures concept.

• Develop interagency agreements. Interagency agreements that describe long-term policy towards green engineering projects have great potential to decrease resistance to project implementation and future misunderstandings. Interagency agreements could be project specific or regional.

Opportunities & Solutions

Promoting Constructing Innovating Maximizing Cost Sharing Utilizing Coordinating Creating Opportunities Developing

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How can you become involved in this effort?

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Please also visit:
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