Indicator: Lake Erie Shoreline Hardening in Lucas and Ottawa Counties, Ohio

Background

The Ohio shoreline of Lake Erie is one of the most developed and structurally protected in the Great Lakes. As described by Fuller and Gerke (2005), "structural protection began in the early 1800s with the development of harbors, which were designed as aids to waterborne navigation. Although the harbor protection structures allowed river mouths to stay open by reducing littoral sediment transport into the river mouths, the adjacent, downdrift shoreline was deprived of sand. Since sand beaches provide protection from shoreline erosion, the loss of littoral sediment has accelerated shoreline erosion in these areas."

As the Lake Erie Commission (2004a) explains, "to combat this erosion, lakeshore property owners began armoring (i.e., hardening with stone, concrete, or steel) the shoreline. Examples of hardening or armoring include: dikes, revetments, breakwalls, seawalls, jetties, piers, retaining walls, boat docks, groins, gabions, etc. (Figure 1). However, because each artificial structure can create erosion downdrift of the structure, the affected shoreline, in turn, requires armoring to mitigate the ravages of wave energy directly breaking on the shoreline and bluff as opposed to dissipating along the beach. This 'domino effect' of erosion and shoreline armoring continues to this day."

Figure 1. Lake Erie shoreline hardening with steel sheet piling (Photo credit: Greg Norwood).

In addition, many shore protection structures have limited natural habitat value and alter the coastal processes and hydrologic connections that support critical ecological processes and biological life cycles in nearshore areas. This is particularly significant in that Ohio's Lake Erie sport fishery alone is valued at $1 billion annually.

Status and Trends

Changes in the density of shoreline hardening or armoring along Ohio's western Lake Erie coast have been documented by the Ohio Department of Natural Resources since the 1870s (Fuller and Gerke 2005). In particular, there is a significant increase in the proportion of densely hardened or armored shoreline in both Ottawa and Lucas counties along Ohio's portion of western Lake Erie (Figure 2). For Lucas County, the western

Lake Erie shoreline is now 98% hardened and armored. Much of this shoreline is protected by armored flood control dikes to prevent flooding of adjacent upland areas during periods of elevated Lake Erie water levels and/or short-term storm events.

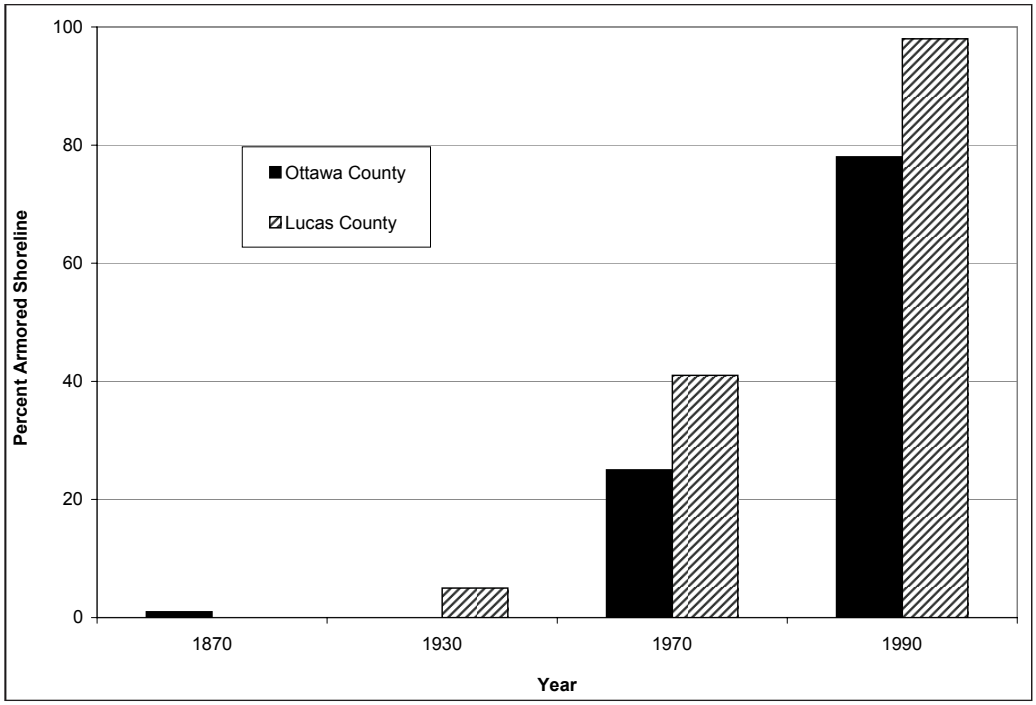
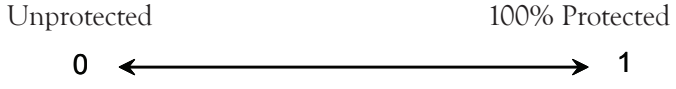


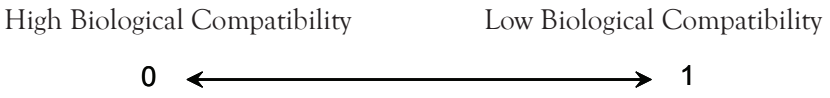
Figure 2. The percentage of armored shoreline along Ohio's Lake Erie western basin coastline has increased dramatically since the mid-1930s in response to development and higher Lake Erie water levels.

The shore structures were also analyzed for biological compatibility with critical nearshore environments. The trends for the mainland shore of western Lake Erie indicate that the majority of the shore protection structures were in the "poor" category, where the structure is nonfavorable to the nearshore biological community in both structure type and structure composition (Fuller and Gerke 2005).

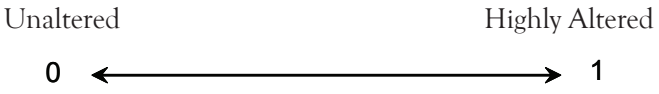
These data indicate that the present shoreline protection along Ohio's western Lake Erie shoreline is generally effective with respect to erosion and flood control, but is not biologically-friendly. The 2004 *State of the Lake Report* for Lake Erie suggested that a shoreline hardening indicator should be characterized not only by the number and extent of erosion control structures, but by the biological compatibility of those structures as well. We propose that the ratio of protected to unprotected shoreline be used as a measure of shoreline modification. In other words, a value of zero (0) would represent an unmodified natural shoreline and a value of one (1) would represent a highly modified or 100% engineered shoreline.



For a given reach of shoreline, these values would then be multiplied by the ratio of structures that have poor biological compatibility, where zero (0) would represent no biological or ecological impact (high compatibility) and one (1) would represent significant biological or ecological impact (low compatibility).



The resulting "Shoreline Alteration Indicator" (SAI) would range from zero (0) representing an unaltered shoreline to one (1) representing a highly altered shoreline. Within the context of this proposed indicator, alteration means impacted biological or ecological functions caused by modifications to the shoreline and/or associated coastal processes.



The advantage of this approach is that as structures are removed and/or modified to provide habitat enhancements, the indicator will shift toward a more unaltered or natural state. Conversely, if the number and extent of biologically incompatible shoreline structures increases, the indicator will shift toward a more altered state.

Management Next Steps

Clearly, the Ohio shoreline cannot be returned to the unprotected "natural" shore that existed before development began in the 1820s. Given this reality, it is recommended that any new shore protection structures along the coast of Lake Erie be designed to be biologically compatible with the many organisms that use the nearshore habitat during part of their life cycle. It is also recommended that management strategies be developed to encourage rehabilitation of existing structures with "habitat" enhancements to restore natural habitat functions and processes in nearshore zones. Moving toward a biologically enhanced nearshore habitat is an essential component to restoration of Lake Erie and the entire Great Lakes. Moreover, greater emphasis needs to be placed on exploring ways and means of modifying engineered structures to improve habitat (Caulk et al. 2000). Specific management recommendations include the following:

Use Effective Sand Resource Management

- Reduce suspended sediment loadings – In harbors and channels where clean, coarse-grained sediment is of sufficient quantity to be used for beach nourishment, efforts should be focused within the watershed to reduce the amount of fine-grained sediments entering the streams and rivers that empty into the harbor. This may result in the ability to place coarse-grained dredged materials from these ports along the shore (e.g., sand bypassing or backcasting) instead of in open-lake disposal sites or confined disposal facilities (LEC 2004b).

- Restore natural sediment transport processes – In circumstances where coarse-grained sediments have accumulated on the updrift side of harbor structures, the physical setting of the harbor should be evaluated to determine the feasibility of sand bypassing to the downdrift side of the harbor within the littoral zone. If appropriate, sand bypassing should be initiated to reestablish protective beaches in the downdrift areas.

- Implement a "no net loss of sand to the system" management policy – The overall cost of shoreline protection compared to the loss of beaches and nearshore bar systems should be identified through various permitting processes. It is suggested that an application for a shore protection structure identify the amount of coarse-grained sediment that will be lost to nearshore areas as a result of the installation of the structure, and that a comparable amount of coarse-grained sediment be placed in the nearshore to compensate for this loss.

Protect Remaining High-Quality Shoreline Properties

- Identify and protect critical shoreline areas – Focus should be placed on identifying and acquiring undeveloped shoreline properties that may provide a source of material for beaches and bar systems. Avoiding development of these properties will allow natural systems to operate, and reduce the need to harden the shoreline with erosion control measures.

Rehabilitate Existing Structures to Restore Natural Habitat Functions and Processes

- Rehabilitate and restore natural habitats – Encourage rehabilitation of existing structures with "habitat" enhancements to restore natural habitat functions and processes in nearshore zones.

- Restore natural coastal and hydrologic processes – Restore and reconnect coastal wetlands, estuaries, embayments, and riparian areas with the lake. Where feasible, restore hydrologic and biological connectivity with the lake.

Finally, it is critically important that the appropriate stakeholders are involved early on in the design and planning process. Redevelopment projects that include soft engineering principles should be encouraged into future waterfront designs where appropriate (Caulk et al. 2000). Soft engineering is achieved by using vegetation and other materials to soften the land-water interface, thereby improving ecological features without compromising the engineered integrity of the shoreline. The design process must identify opportunities and establish partnerships early in the process that integrate ecological, economic, and societal objectives.

Research/Monitoring Needs

In order to help protect the economic investment along Ohio's western Lake Erie shoreline and restore and maintain the Lake Erie ecosystem, emphasis should be placed on addressing the following research and monitoring needs:

- quantifying and predicting future coastal erosion rates, including associated economic and environmental impacts and benefits;
- quantifying the environmental, economic, and social benefits of incorporating habitat features into shore protection structures;
- forecasting future shoreline erosion processes and rates under predicted water level fluctuation scenarios; and
- developing new best management practices for simultaneously achieving erosion protection and habitat/biological integrity.

References

Caulk, A.D., J.E. Gannon, J.R. Shaw, and J.H. Hartig. 2000. Best management practices for soft engineering of shorelines. Greater Detroit American Heritage River Initiative. http://www.fws.gov/midwest/detroitriver/ahr/REPORT/treeview.pdf

Fuller, J.A., and B.E. Gerke. 2005. Distribution of shore protection structures and their erosion effectiveness and biological compatibility. Ohio Department of Natural Resources, Sandusky, Ohio.

[LEC] Lake Erie Commission. 2004a. *State of Ohio, State of the Lake Report*. Toledo, Ohio.

[LEC] Lake Erie Commission. 2004b. *Second Progress Report, Lake Erie Protection and Restoration Plan*. Toledo, Ohio.

Links for More Information

Ohio's Nonpoint Source Pollution Control Program: http://www.epa.state.oh.us/dsw/nps/NPSMP/docs/LEcoastobj.html

Ohio's Coastal Zone Management Program: http://www.ohiodnr.com/coastal/about/aboutocmp.htm

Shore structure permits in Ohio: http://www.ohiodnr.com/coastal/regs/factsheets/cmguide2.htm

Ohio's coastal erosion area permits: http://www.ohiodnr.com/coastal/regs/factsheets/cmguide5.htm

Best management practices for soft engineering of shorelines: http://www.fws.gov/midwest/detroitriver/ahr/REPORT/treeview.pdf

Contact Information

Constance Livchak
Ohio Department of Natural Resources
E-mail Address: Constance.Livchak@dnr.state.oh.us

Scudder D. Mackey
University of Windsor/Habitat Solutions
E-mail Address: scudder@sdmackey.com