Effects of Lake Level Fluctuations

Stretching more than 9,500 miles, the shores of the Great Lakes are constantly reshaped by the effects of wind, waves and moving water. Shoreline characteristics vary significantly, from flat, low-lying areas susceptible to flooding, to high bluff areas that are often prone to erosion. Erosion is a natural process that occurs during periods of low, average or high water levels. Erosion and flooding can be magnified during periods of high water or storms.

In some areas of high-density development, minor deviations from long-term average levels can produce pronounced economic losses. In less developed areas, these impacts can be modest or negligible.

Natural areas, such as wetlands, have evolved as a result of wide variations in water levels. Reducing these variations can have significant environmental consequences.

Empire Bluffs at Sleeping Bear Dunes National Lakeshore on Lake Michigan

Erosion processes

On the coast, natural forces causing erosion are embodied in waves, currents and wind. Most waves arrive at an angle to the shore. As successive wave fronts advance and retreat they set up a longshore current. As waves break, run up the shore, and return, they carry sedimentary material onshore and offshore. This sedimentary material is called **littoral drift**.

Although erosion is a natural process, its rate and severity can be intensified by human activity.

The energy in the moving water determines the size and amount of the material that will move and how far. The energy in a wave depends on the speed of the wind, its duration and the unobstructed water distance, or fetch, it blows over. Gentle waves move fine sand, whereas storm-generated waves move rocks and boulders. Materials picked up from shoreline areas are deposited wherever the water is slowed down and may be picked up again when the velocity of the water increases.

If erosion is not balanced by **accretion**, the depositing of sediment, the shore will be washed away. Erosion and accretion are two faces of the same process. These processes can occur at extremely slow rates or may occur dramatically in a short time.

Lake Michigan shoreline in Michigan

Natural shores are nourished by material that has been eroded from other areas, becoming part of the littoral drift system. Attempts to reduce erosion by building shore protection structures, or armoring the shoreline in one area, will result in reduced littoral drift available, starving an adjacent area downdrift.

Fluctuating water levels can expose new surfaces to erosion. As seasons change, wind strength and direction also change, altering the path of waves and currents. Where ice forms, it redirects wave energies offshore protecting beaches, but can increase erosion of the lakebed. Ice may also exert tremendous forces that can weaken shore structures.

Gently sloping shores, whether beaches or wetlands, are natural defenses against erosion. The slopes of the land along the edge of the water form a first line of defense called a **berm**, which dissipates the energy of breaking waves. During high water periods, a berm can prevent water from moving inland. Dunes and their vegetation offer protection against storm-driven high water and also provide a reservoir of sand for replenishing the littoral drift and rebuilding beaches.

Although erosion is caused by natural shoreline processes, its rate and severity can be intensified by human activity. Dredging marinas and bulldozing dunes remove natural protection against wind and waves. Pedestrian and vehicle traffic destroy vegetation, degrade dunes, and weaken bluffs and banks. Docks, jetties and other structures interrupt the natural shoreline movement of water and redirect erosive forces, possibly in undesirable directions. Inappropriate building practices in high bluff areas can seriously reduce bluff stability. In particular, drainage patterns from new building construction can cause infiltration of runoff directly into a bluff and can weaken its normal cohesive forces. Wise management of shoreline construction and land uses can significantly reduce economic losses due to erosion.

Habitat diversity

The region's glacial history and the tremendous influence of the lakes themselves create unique conditions that support a wealth of biological diversity, including more than 130 rare species and ecosystems. The Great Lakes are the only lakes of their size in a temperate climate. With the lakes' moderating effect on the climate, the ecosystem is able to provide habitat for a wide variety of species that otherwise might not survive. The Great Lakes - St. Lawrence River ecosystem features sand dunes, coastal marshes, rocky shorelines, lakeplain prairies, savannas, forests, fens, wetlands and other landscapes.

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The place where land and water meet is by far the most diverse and productive part of the Great Lakes - St. Lawrence River ecosystem. This interface includes small wetlands nestled in scattered bays to extensive wetlands such as those along Saginaw Bay on Lake Huron, river-mouth wetlands such as the Kakagon Sloughs of northern Wisconsin and the enormous delta marshes of the St. Clair River. Nearly all species of Great Lakes fish rely on nearshore waters for everything from permanent residence, to migratory pathways, to feeding, nursery grounds and spawning areas.

Most common types of wetlands along the shoreline are marshes, where the vegetation can tolerate the large short- and long-term fluctuations in lake levels. In fact, these wetlands are shaped by dynamic lake processes, including waves, currents and changes in water levels. They occur in areas where the erosive forces of ice and wave action are low, allowing the growth of wetland plants. Many wetlands have species successions that are dependent upon water level cycles. Seasonal and long-term water level fluctuations also limit the invasion of woody plants at higher elevations and extensive beds of submersed aquatic plants at lower elevations. Individual wetland species and vegetative communities prefer, and have adapted to, certain water depth ranges, allowing wetlands to be more extensive and more productive than they would be if water levels were stable.

In addition to providing habitat, coastal wetlands play other vital roles. These include protecting nearshore terrestrial ecosystems from erosion by dissipating wave energy, and improving water quality in adjacent aquatic systems through sediment control and absorption of nutrients.

A wealth of biological diversity (left to right): moose in Lake Superior watershed, wetlands along Saginaw Bay on Lake Huron and herons along Lake Ontario shoreline

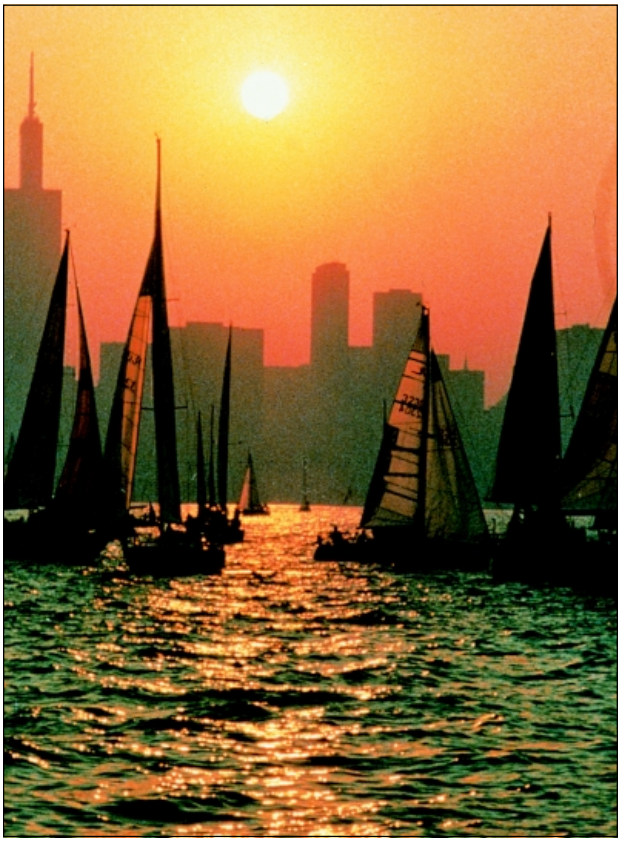
Commercial shipping and recreational boating

Lift Bridge in Duluth - Superior Harbor on Lake Superior

Water levels have a profound impact upon the economic viability of commercial shipping and recreational boating on the Great Lakes. In the U.S., for example, the federal government maintains 71 deep-draft harbors and 745 miles of dredged channelways to support commercial navigation. Along the nearly 5,800 miles of U.S. Great Lakes and St. Lawrence River shorelines, the government also maintains 65 shallow-draft recreational harbors. The depths to which the harbors and approach channels are dredged have been subject to U.S. congressional authorizations, many of which date back to the 19th century.

The authorized depth for dredging varies with the type of traffic involved, ranging from a low of 9 feet deep in most recreational boating harbors to 30 foot deep in channels used for ocean-going freighters. Since some harbors serve both commercial and recreational purposes, it is common to see a deeper entrance channel near the harbor mouth for commercial vessels, with progressively shallower depths for recreational interests as one moves upstream.

Boaters should be familiar with and make regular practice of using navigation charts for the waters they expect to navigate. These navigation charts are published in the U.S. by the National Oceanic and Atmospheric Administration (NOAA) and by the Department of Fisheries and Oceans in Canada. All depths or **soundings** on the navigation charts are referenced to **chart datum**, also known as Low Water Datum. Chart datum is different for each lake and is expressed relative to IGLD 1985. Current and forecasted water levels are reported relative to chart datum. With an up-to-date chart and current water level information, navigators can find the depth of water available for transit. For example, if the water level is currently 3 feet above chart datum and the soundings on the chart are 8 feet below chart datum, then there is an actual depth of 11 feet at that location.



Chicago lakefront on Lake Michigan

Boaters should always be aware that the Great Lakes, their connecting channels, and the St. Lawrence River are subject to fluctuating water levels on a short-term basis through storm events, through seasonal changes, and over longer periods due to climatic shifts. Boaters should always use caution and reduce vessel speeds when navigating unfamiliar waters.

Marina on Lake St. Clair

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