Lake Michigan Shoreline



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Need to establish some facts...

- Erosion is a dynamic process influenced by waves, lake levels and shoreline profile
 Shoreline hardening has been going on for over 100+ years
- People become passive during times of low lake levels and <u>PANICKED</u> at highs!
- This process has gone on as long as people have lived along the shoreline

Review 4 Key Factors:

Dynamic and fluctuating Lake Michigan water levels Effects of lakebed downcutting Sand movement/longshore transport challenges History and coastal structures



Fluctuating Water Levels

- Lake Michigan recently has fluctuated ~6.5' between low and high lake levels
- Evaporation is typically balanced by precipitation, making the level of the lakes fairly consistent
- Number of factors that impact lake levels make forecasting basically impossible
 Seasonally we anticipate a 1' fluctuation

14,000 years of Lake Michigan water levels



12,000 YBP Glacial Lake Chicago. Ridge Road in Wilmette is an old beach ridge - evidence for a lake elevation about 50 Outlet feet higher than today.





How does the lake level affect the size of the sandy beach? Beaches typically vary from a 1' vertical:12' horizontal slope to a 1':65' For example, with \sim 4' of lake level rise you can expect to submerge roughly 48' of beach 3'





Average lake water levels

2016



Does Lake Michigan's record low mark beginning of a new era for the Great Lakes – Chicago Tribune <u>Rising Lake Michigan waters</u> threaten shoreline homes-Chicago Tribune Lake Michigan below- average water <u>levels for 14 years</u> – Milwaukee Sentinel Lake Michigan levels, erosion is a "very big" concern - Milwaukee Sentinel



NOAA/NOS/CO-OPS Verified Monthly Means at 9087057, Milwaukee WI From 2013/01/01 00:00 LST to 2016/05/02 23:59 LST





Lake Michigan-Huron Monthly Mean Water Levels

Water levels will always fluctuate Lake Michigan came near the all-time high water level record of 582' in January, 2020 \sim 6.5' Higher than January, 2013 Seeing the affects of climate change: Record monthly rainfall – May 2020 September 2021 drought <u>almost</u> set a record Established a shorter duration metric between low and high water levels

Lakebed Downcutting

Lakebed downcutting is a geological process by hydraulic action (waves) that deepens a lake by removing cohesive material from the lakebed (lakebed clay)

The speed of downcutting depends on the lake's base water level, the lowest point to which the lake can erode

Low Lake Levels

Time 1

- Broad beach
- Lake-bottom sand cover

Eroding Lakebed Clay

Time 2

- Narrower and thinner beach
- Lake-bed downcutting

Erosion

Bigger waves at average conditions

Time 3

Erosion

- Deeper water closer to shore
- Undermining of shore protection

It is estimated that in areas where sand deposits are thin, the nearshore lakebed may erode at a rate up to 8 inches per year (Nairn, 1997)

Wilmette

Contraction of the

Google Earth



How does sand move?

- In many places there is a net movement of sand in one direction
- This is controlled by wave climate, bathymetry, shoreline orientation and natural or artificial headlands that deflect waves and currents
- Called littoral drift



Door County



South Lagoon O Simmons Island

Th

41

Indiana Dunes

Littoral Barriers

An obstacle to littoral drift or migration of material along the shore

 Littoral barriers may be natural, for example, rocky headlands or man made such as jetties, breakwaters or dredged channels. These hinder the normal drift of material along the shore

Waukegan Harbor-1939

Waterline is approximately 20' from Seahorse Drive

Courtesy Waukegan Historical Society – Jan. 19, 2012 Waukegan Harbor Citizens' Advisory Group – permission granted

Waterline is approximately 1,150' from Seahorse Drive today





Corps of Engineers estimate that $\sim 225,000 \text{ cy/yr of}$ sand cross the Illinois border and only ~14,000 cy/yd of sand are in the littoral system south of Waukegan

Coastal Structures







1907 Northwestern University

Edgewater Beach Hotel - 1916

Burnham Plan for Chicago: First large scale environmental management plan in USA

Lakefill

Maple Street Beach in Winnetka

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1985 Elder Beach



1985 Maple Street









Engineered Shorelines Today

Have new metrics as it relates to coastal design due to the recent high water levels Still balancing the cost benefit of constructing larger structures in response to the recent high lake levels Access to the beach and along the shoreline is not clearly defined by the Army Corps of Engineers and Illinois DNR

Army Corps of Engineers outlines in the Lake Michigan Regional General Permit (LMRGP) application the following:

- Structures must provide reasonable accommodations, as determined by this office, to maintain public access to the shoreline."
- The Illinois DNR in the 2008 permitting guidelines for coastal structures state:
 - Where possible, notably in areas where existing access along the lakeshore is available, the project should provide some type of reasonable access over or around it on the landward side."

Lloyd Boat Launch

17. 5





Spring 2020

- All

IT MARKEN

Acres 1

Winnetka Park District Lakefront Master Plan





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Presque Isle, Pennsylvania - Lake Erie



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Largest restored beach in the Great Lakes



Recognize times are changing!

- Acknowledge that we are dealing with a <u>dynamic</u> and <u>changing</u> environment
 - Climate change models are unpredictable
 - Extreme storm events are becoming common
 - Seeing changes in habitats, impacts of invasive species, varying water quality
 - Science and engineering are changing regularly as we continue to exceed historic conditions





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