NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

Sea Grant
New York

# Nature-Based Shoreline Workshop *Sustainable Beaches*

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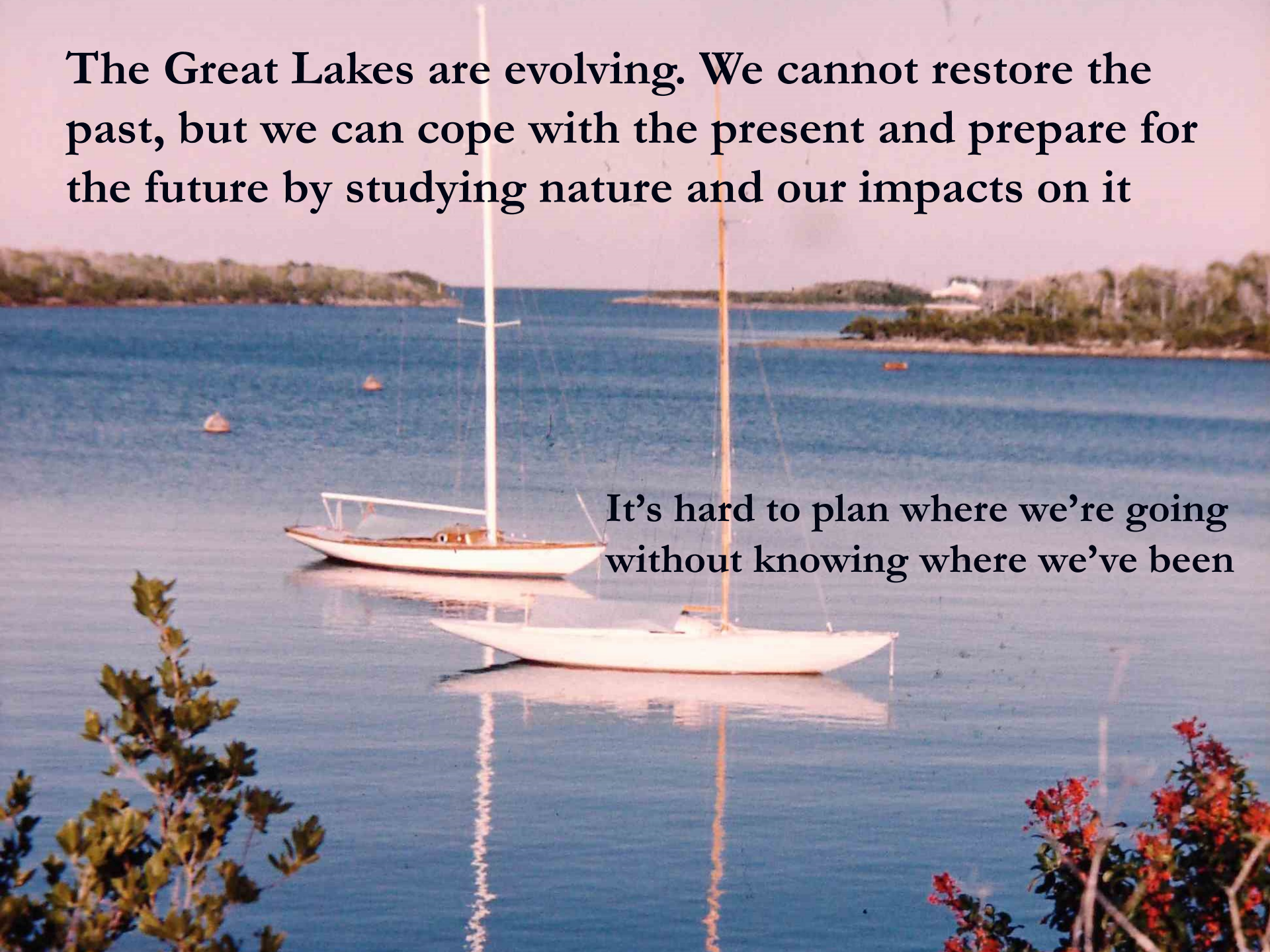
Sustainable Coastal Solutions

asbpa
American Shore & Beach Preservation Association
Advocating for healthy coastlines


The Great Lakes are evolving. We cannot restore the past, but we can cope with the present and prepare for the future by studying nature and our impacts on it
It's hard to plan where we're going without knowing where we've been

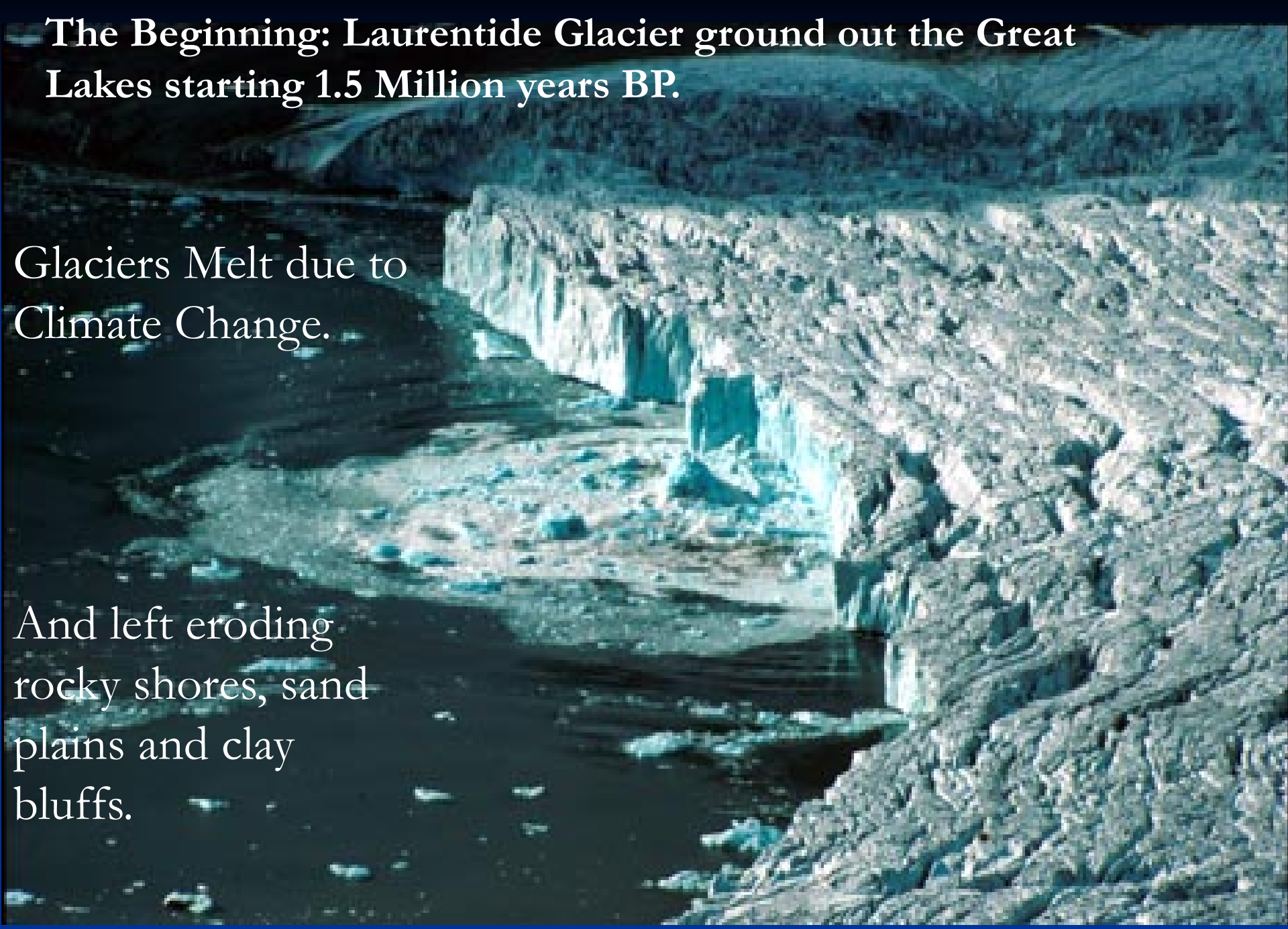



Photo courtesy W.K. Dallmann www.geonet.npolar.no

# Great Lakes Beach History

**Natural Beaches:**
Sand and cobbles are supplied by eroding lakeshores – rocky cliffs, clay bluffs, relict dunes, and rivers.

**Human Activities Accelerate Loss of Natural Sand Beaches**:
Armoring bluffs to protect real estate, building dams on rivers and building jetties to protect harbors, all have reduced the sand supply to the coastal system (*sand starvation*).

**Today, natural beaches are rare in the Great Lakes, especially in urban areas.**

# In the northern Great Lakes, the Glacier left: Natural Rocky Headlands - Nature's Pocket Beaches

**Apostle Islands National Lakeshore, WI**

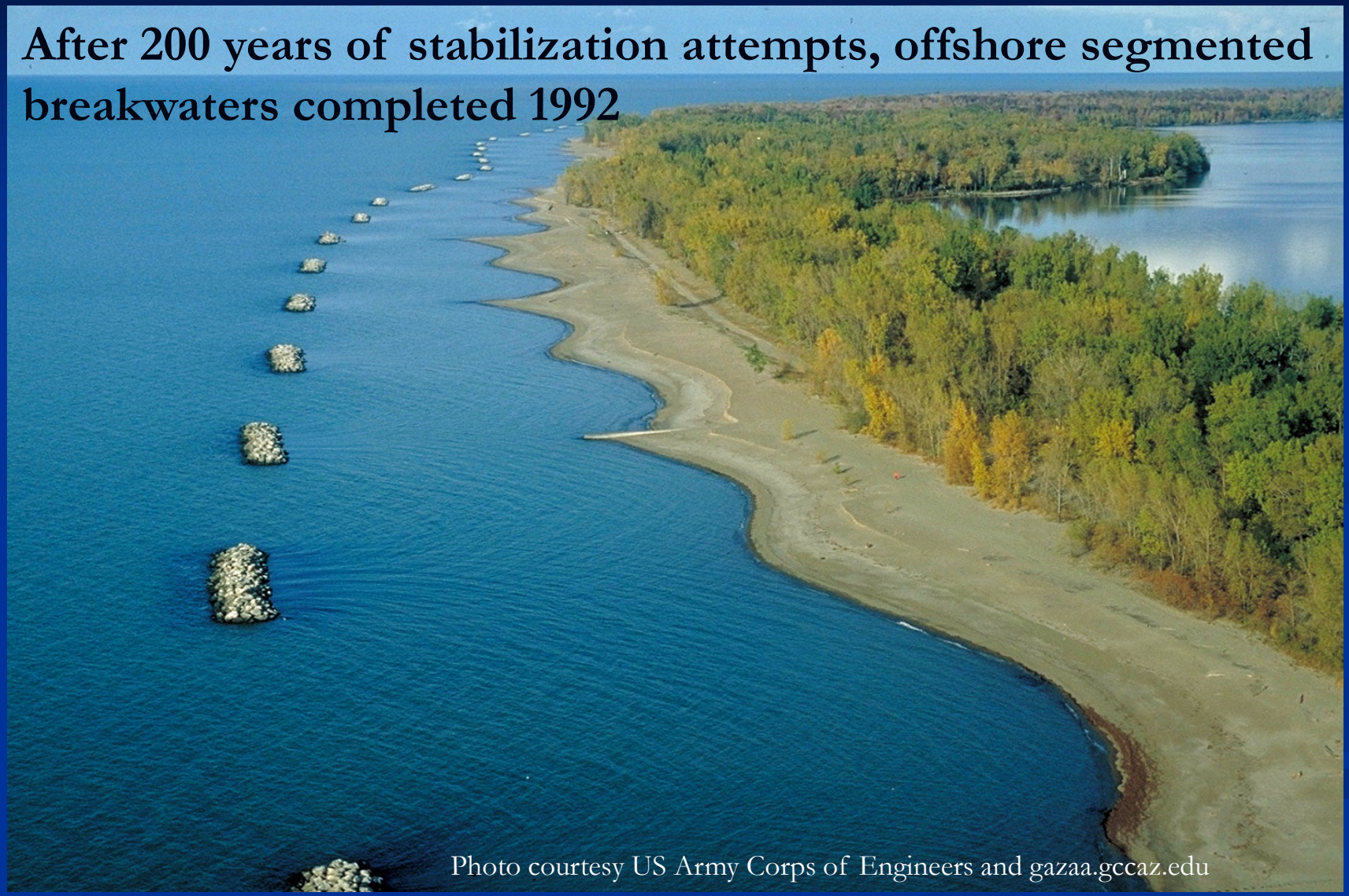
**Terrace Bay, Lake Superior**

In addition to natural rocky shores, the glacier left open sandy coasts and eroding clay bluffs with ephemeral beaches including:

- **Open Sandy Coasts**: relict sand plains, dunes, marshes, lagoons and beaches. Examples:
  - Presque Isle, PA
  - Illinois Beach State Park
  - Lakeview Wildlife Management Area, NY

- **Eroding Cohesive Clay Bluffs** and ephemeral beaches. Examples:
  - Lake Michigan Illinois North Shore
  - Lake Erie South Shore
  - Lake Ontario South Shore

**Sandy Coast**: Presque Isle National Lakeshore, Lake Erie.
Problem: diminished sediment supply causes breaches into harbor




Sustainable: Regular updrift beach nourishment

**Sandy Coast:** Illinois Beach Park, Lake Michigan. Problem: Diminished sand supply updrift, sand chokes Waukegan Harbor downdrift

Photo Courtesy: www.Curtistothethird.com

# Beach nourishment or sand backpassing has worked in the past for Illinois Beach State Park

**Sandy Coast**: Lakeview Wildlife Mgmt. Area, NY Lake Ontario: Naturally Eroding coastal sand plains and wetlands. Problems?

Photo courtesy Mathew Levine. www.nature.org

For over 50 years, the levels of Lake Ontario and the St. Lawrence River have been regulated by the Moses Saunders Dam. Plan 2014 uses modern simulations to adjust the dam's operating plan to work with nature.

# Open Sandy Coast Beach Issues

- **Ecosystem -** A refuge for rare and endangered species. Need to control invasives
- **Beach -** Requires regular beach nourishment or sand backpassing unless erosion is not an issue.
  - **Presque Isle ± 35,000 $y^3$/yr. Underfunded**
  - **Illinois Beach Park ± 80,000 $y^3$/yr. Underfunded**
  - **Lakeview Wildlife Management Area ?**
- **Public Trust** – If some of the riparian property is private, maintenance cost-sharing can be an issue.

# Natural Eroding Bluffs and Ephemeral Beaches. Southern shores of Lakes Michigan, Erie and Ontario

Photo courtesy Tom Bender www.losl.org

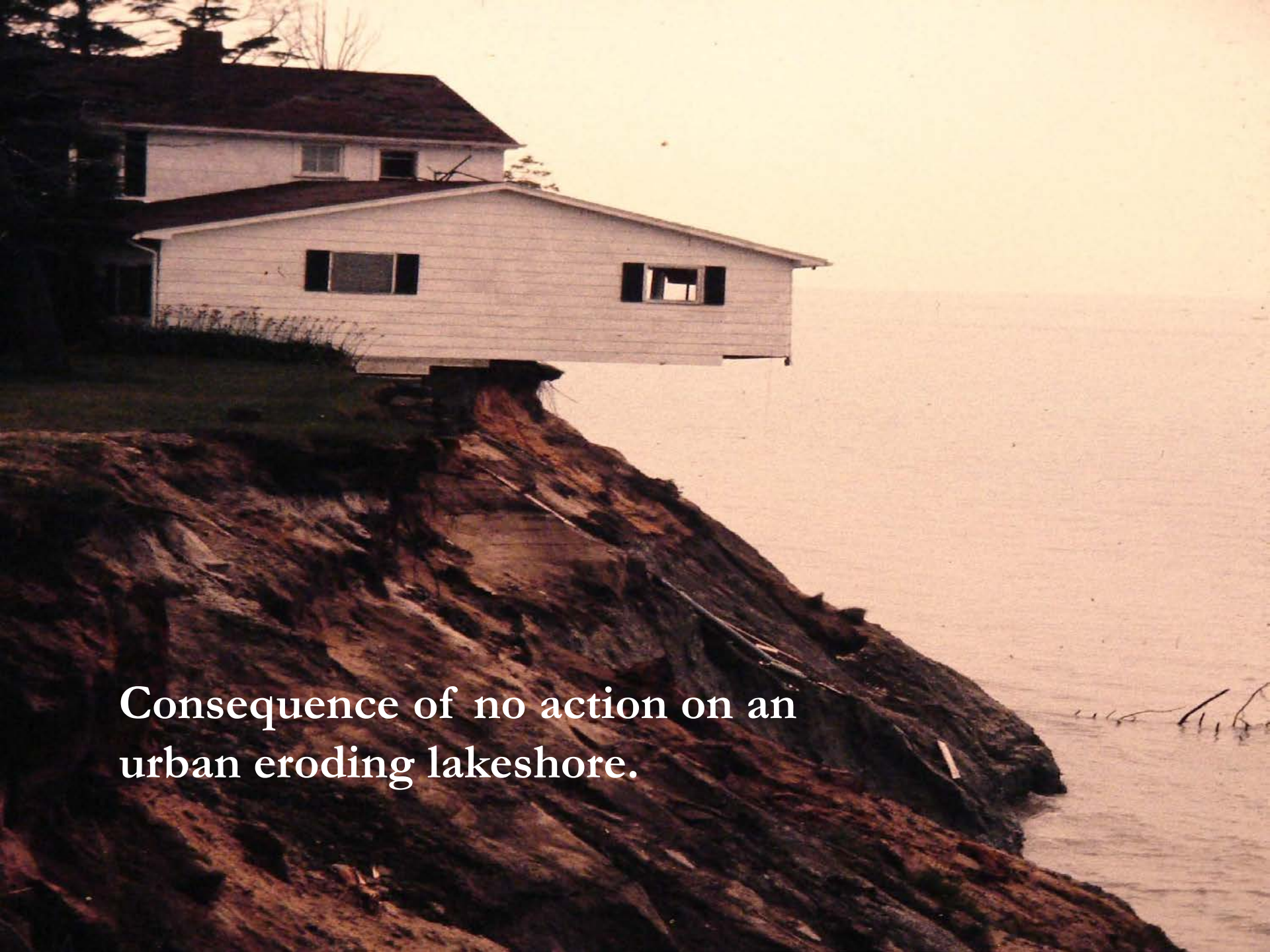
Narrow beaches at low lake levels

No beach at high lake levels

# Eroding Cohesive Clay Bluffs and Ephemeral Beaches.

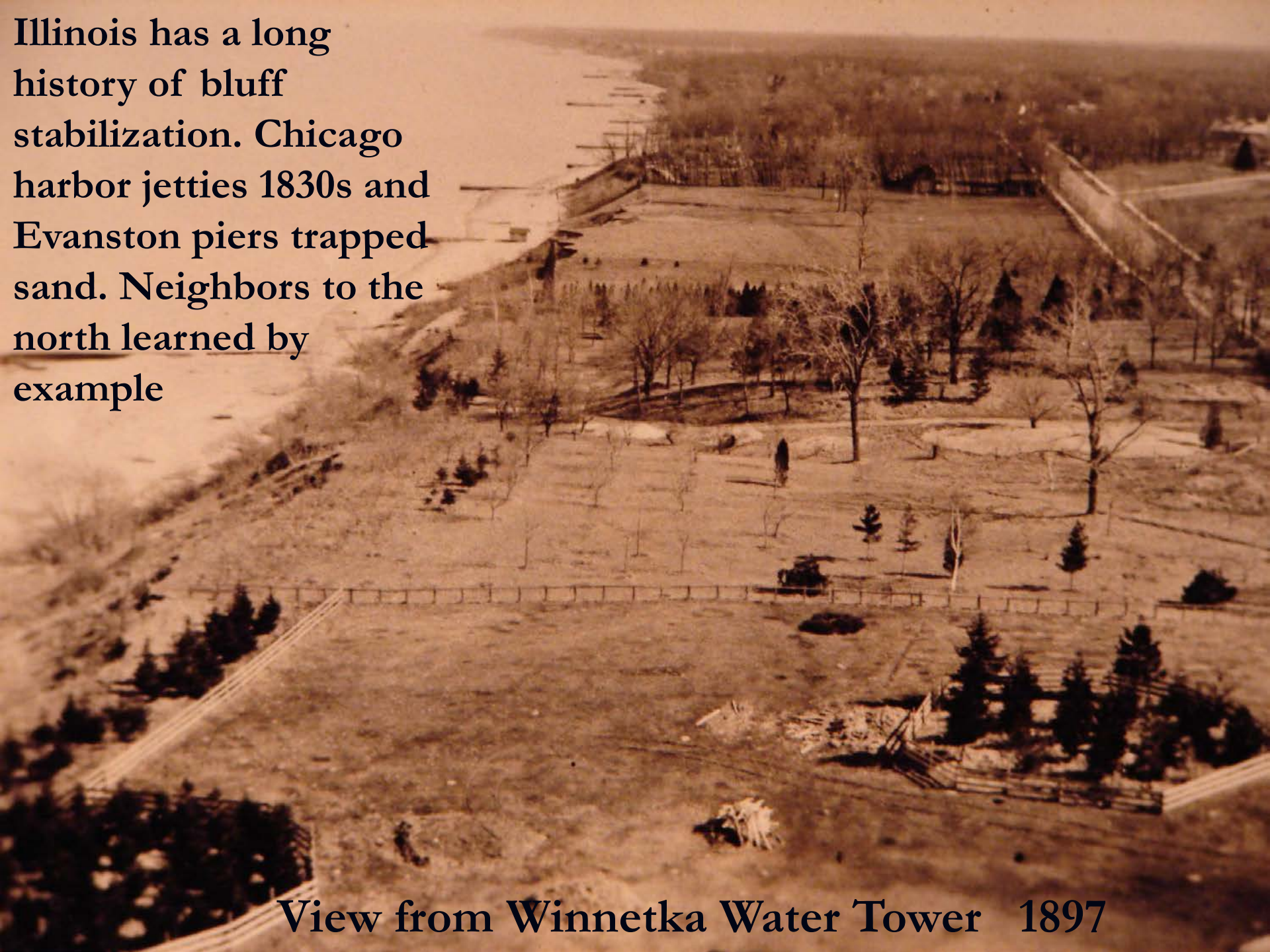
**Loss of Natural Sand Beaches**: Armoring bluffs to protect real estate, building dams on rivers and building jetties to protect harbors, all have reduced the sand supply to the system (*sand starvation*). Today, natural beaches are rare in Great Lakes urban areas.

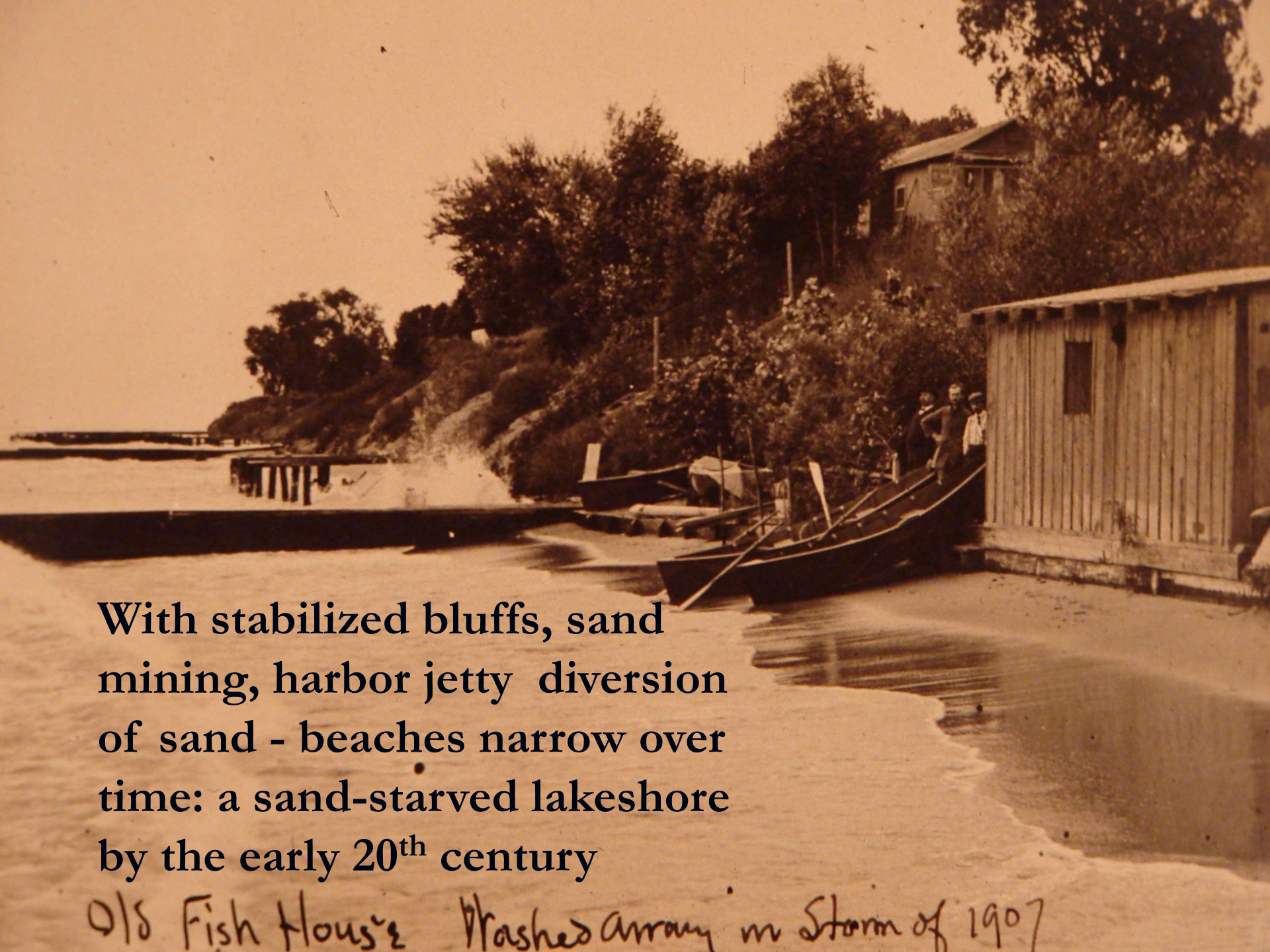
For eroding and *sand-starved* urban shores: structure-held beaches (groins or pocket beaches may be preferred to no action).



Consequence of no action on an urban eroding lakeshore.

Lessons from the past: The Illinois lakeshore, while only about 60 miles long, has been impacted by human activities for more than 170 years


Illinois has a long history of bluff stabilization. Chicago harbor jetties 1830s and Evanston piers trapped sand. Neighbors to the north learned by example
View from Winnetka Water Tower 1897

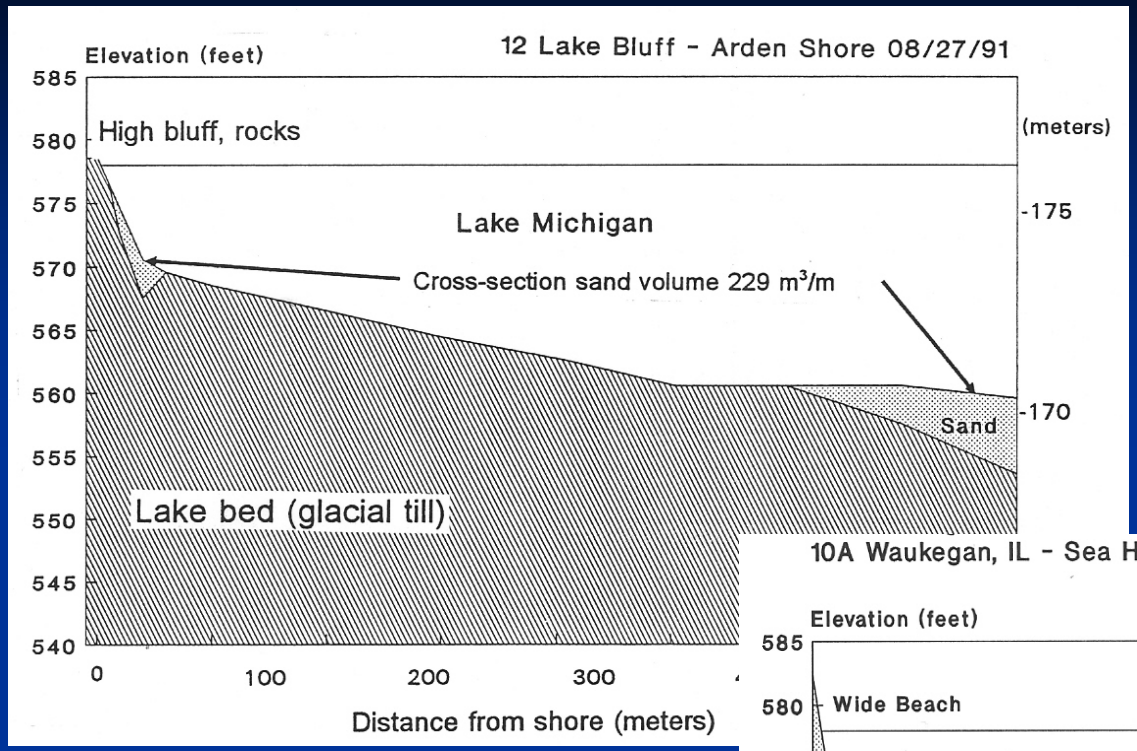


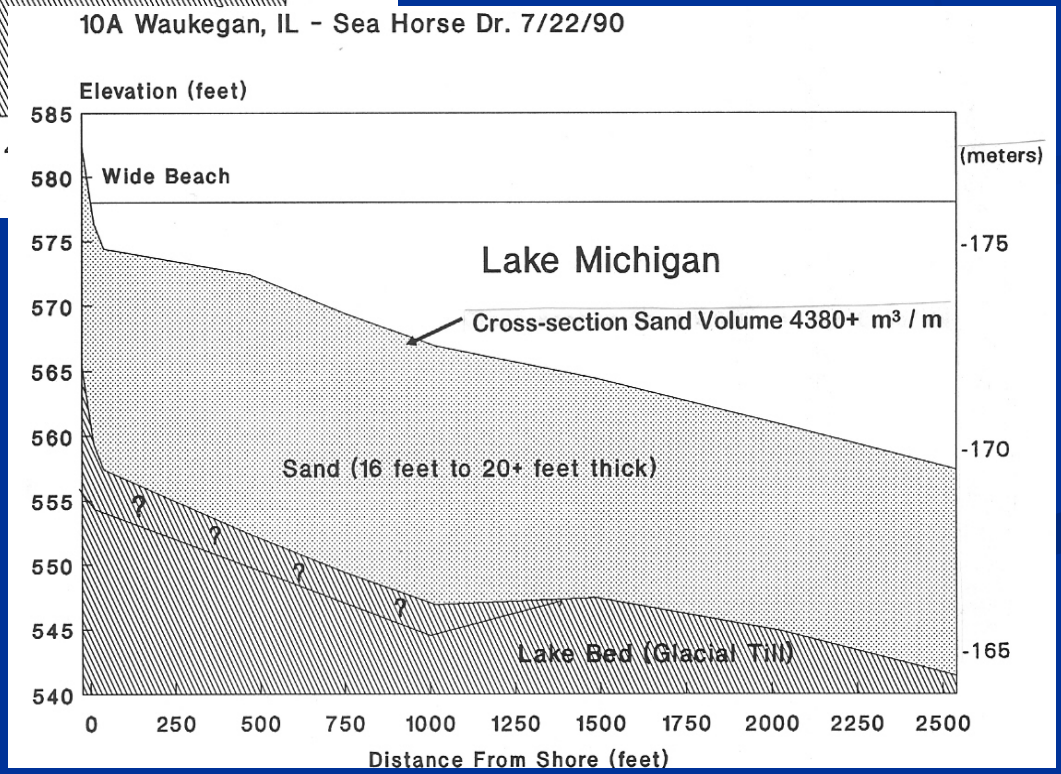
**With stabilized bluffs, sand mining, harbor jetty diversion of sand - beaches narrow over time: a sand-starved lakeshore by the early 20th century**

O/S Fish House Washed away in Storm of 1907

Evidence: 1989-1992 Sand Survey. Sponsors:
USGS, Sea Grant

# The nearshore lakebed is eroding clay. Thin sand deposits




For comparison: Broad sand plain at Illinois Beach Park

After 100 years, most groins are no longer effective at holding sand:  Lakebed downcutting

Learn from nature: Rocky headlands and pocket beaches. Lake Superior
Pocket Beach

Forest Park Beach, Lake Forest, Illinois Lake Michigan
Engineered pocket beaches built within surf zone,
pre-filled with sand.
89 5 16

Sunrise Park Beach, Lake Bluff, Illinois. Lake Michigan - 1989
Water treatment plant endangered, bluff eroding

New Pocket Beach 1992

# Sunrise Park Beach named ASBPA Top Restored Beach 2012

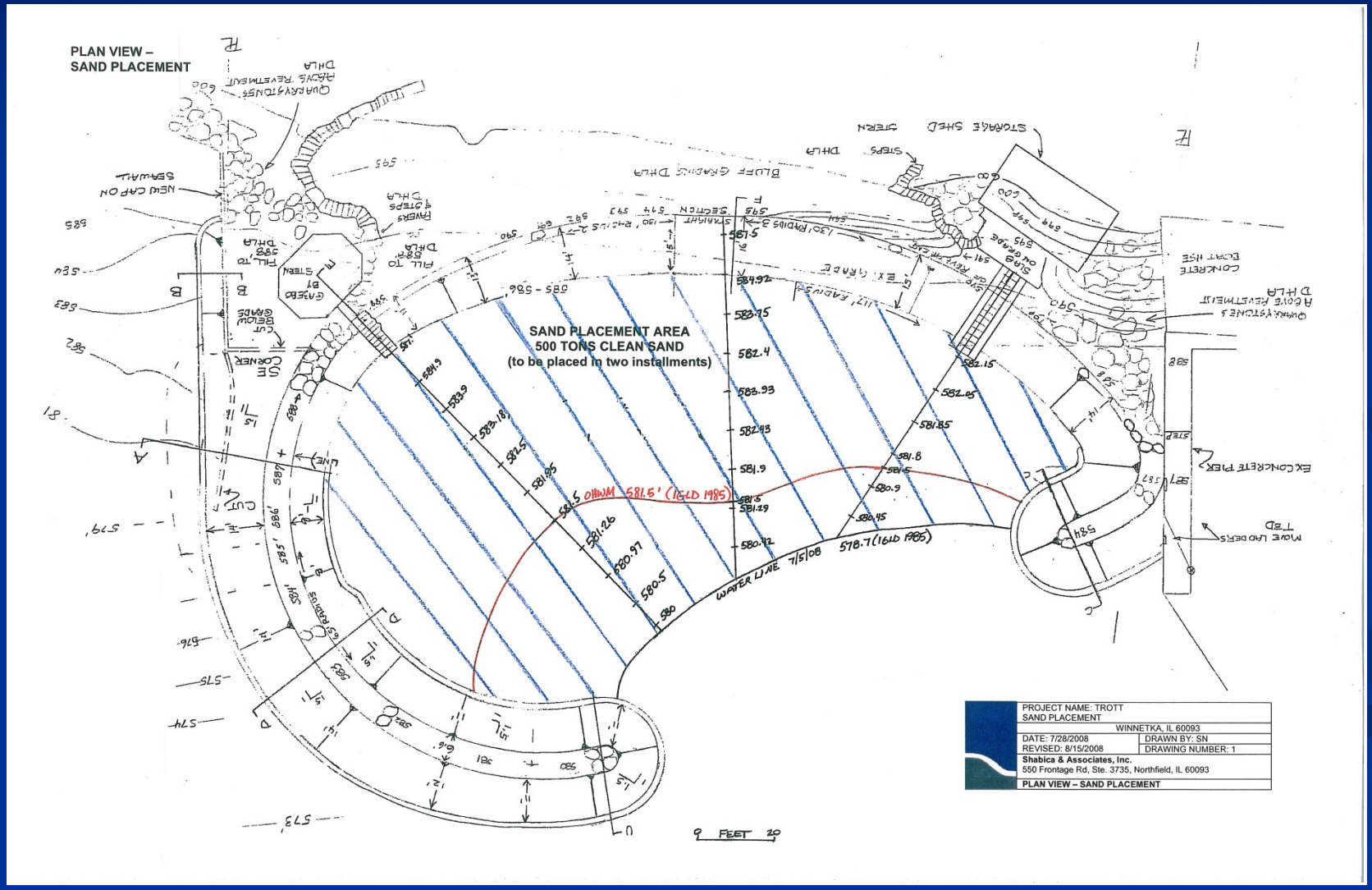
# *Worst Coastal Site* – Illinois State Geological Survey.

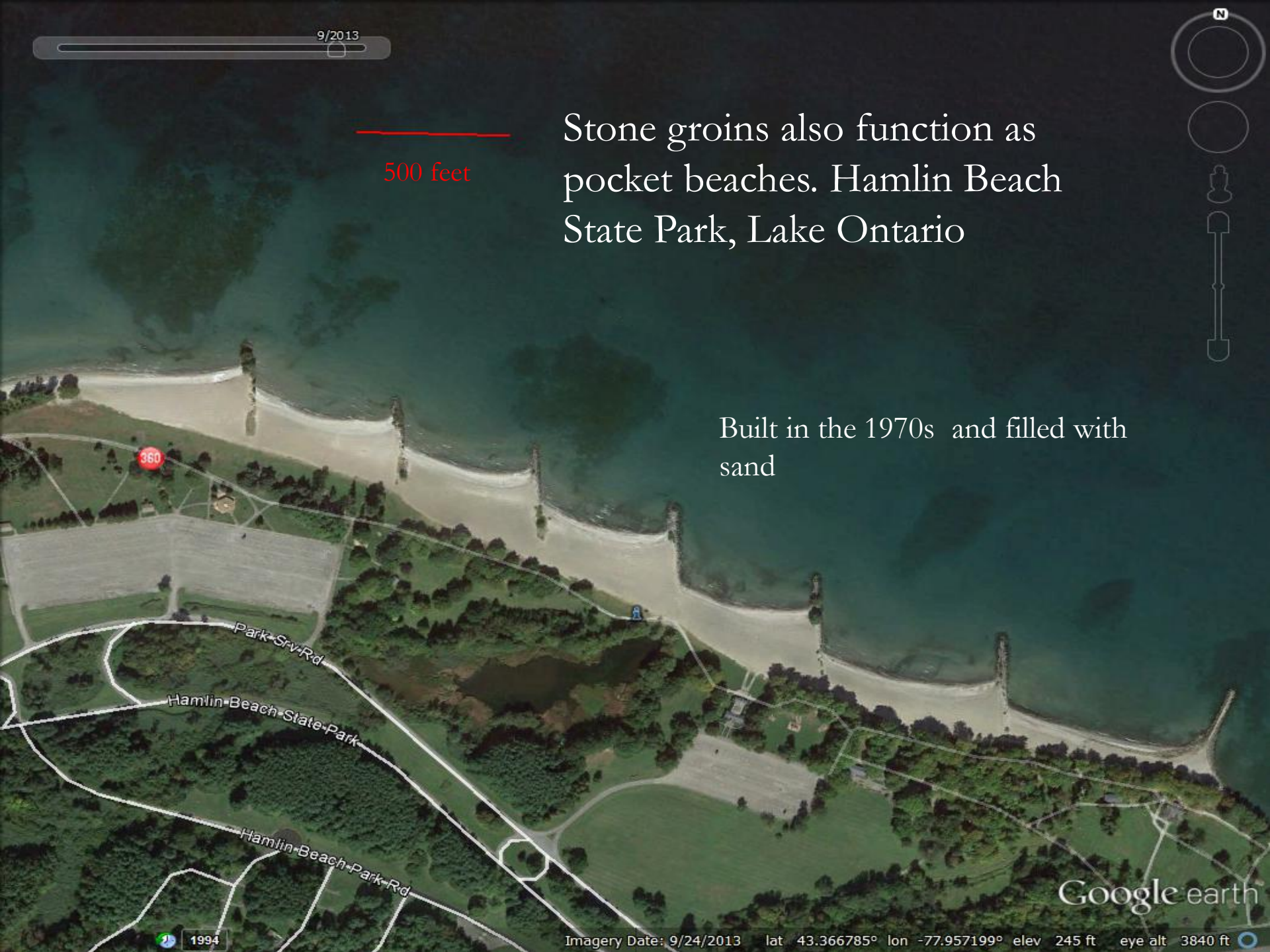
# New Pocket Beach and Bluff Restoration 2002

Breakwaters typically extend less than 125 feet into the lake

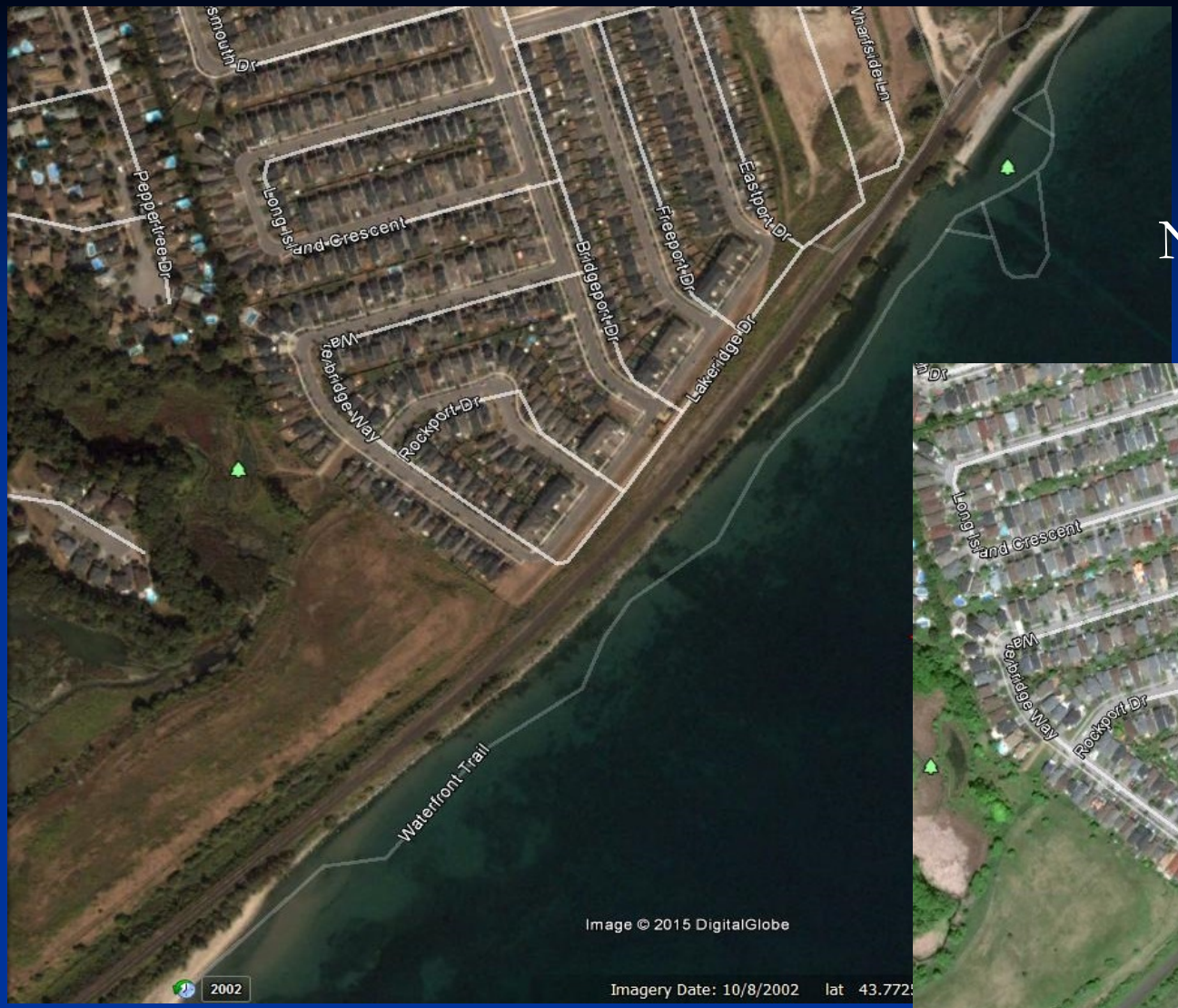
1993
300ft long revetment protects private property. Winnetka, Illinois
2005
Replaced with pocket beach.

New breakwaters are engineered to provide beach protection at a range of lake levels.




9/2013
500 feet
Stone groins also function as pocket beaches. Hamlin Beach State Park, Lake Ontario
Built in the 1970s and filled with sand
360
Park Srv Rd
Hamlin Beach State Park
Hamlin Beach Park Rd
1994
Google earth
Imagery Date: 9/24/2013 lat 43.366785° lon -77.957199° elev 245 ft eye alt 3840 ft

# Nearshore Breakwaters



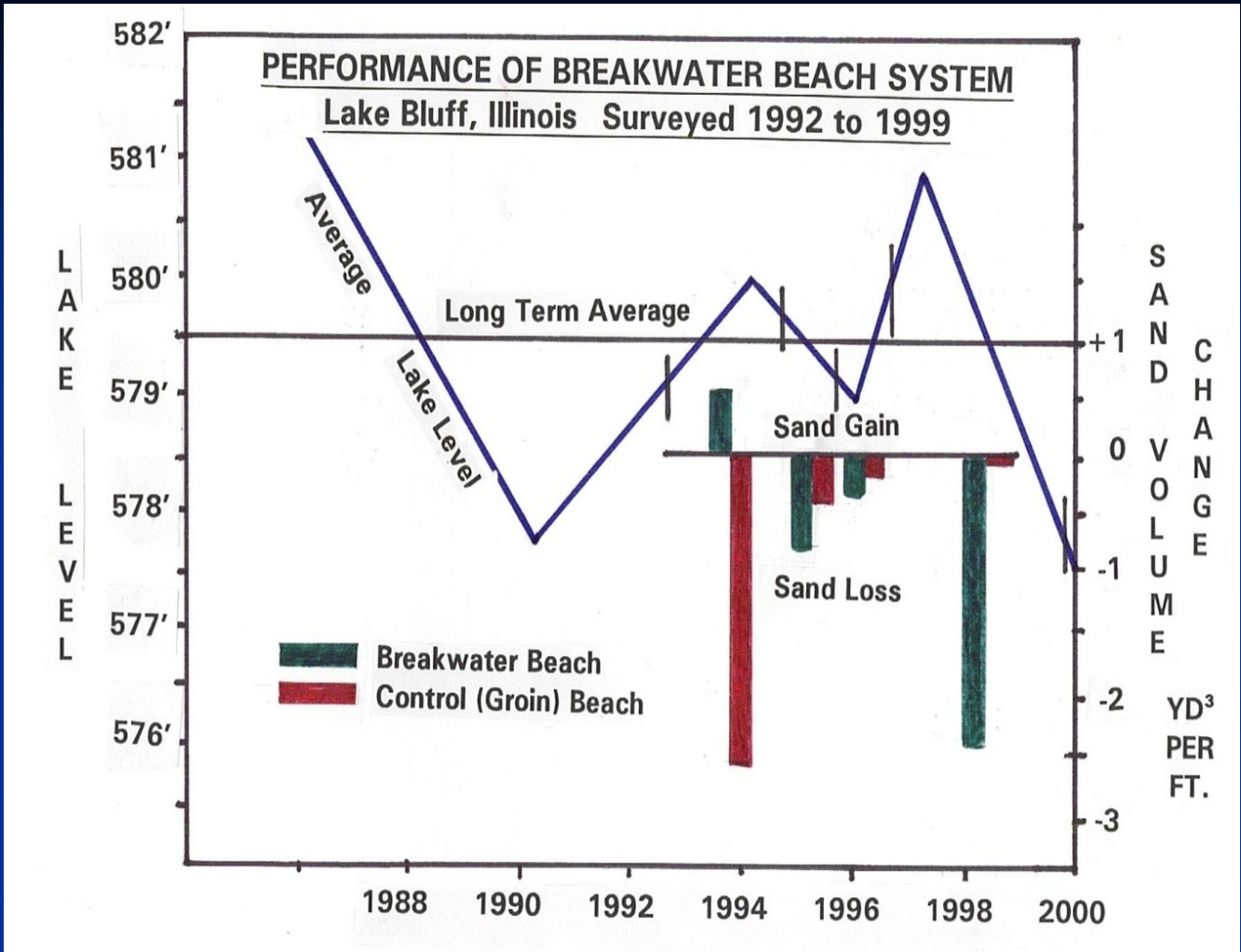

Port Union Ontario, 2002

# Pocket Beaches Issues

- **Design & Engineering**
  - Full understanding of regional and local processes & evolution
  - Solution based on prototype analysis (nearby structures), physical hydraulic model (large structures), numerical modelling
- **Environment –**
  - 20% sand overfill to assure no negative impact. If cohesive lakebed is eroding will require periodic renourishment
  - Maintain littoral drift bypassing - Build well within surf zone. 5 years of monitoring to assure sand bypassing
- **Regulatory and Public Trust –**
  - State: Privately funded beaches built on state-owned lakebed should be minimal in size and allow public access
  - USACE: Structures must be maintained or removed
  - EPA: Clean sand and armorstone

Bluffs and beaches can be restored with native species but without intervention will be lost
Foss Park, North Chicago – NOAA/IDNR Grant

Perched Wetland at eroding updrift end of beach

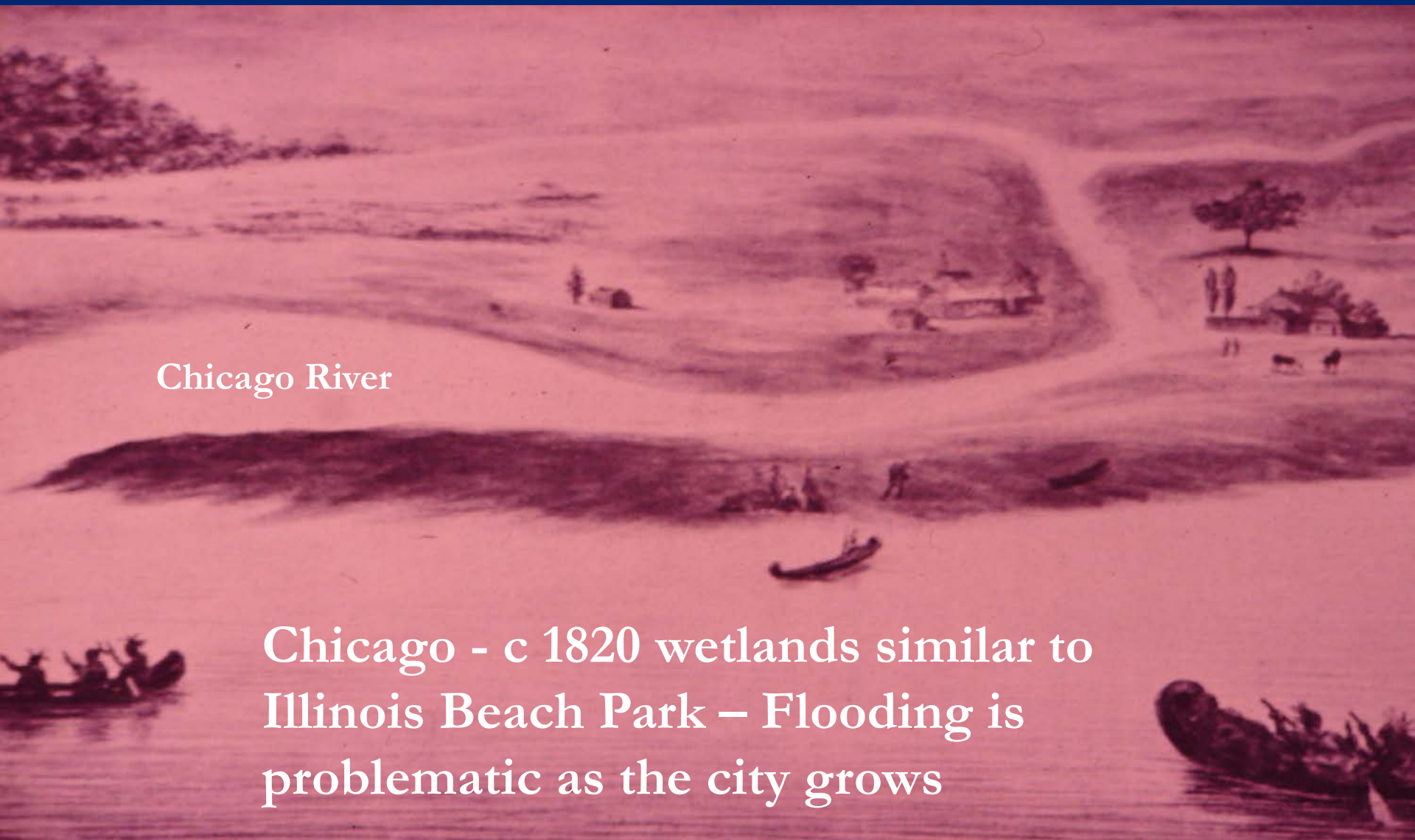



Monitoring 78 Great Lakes (24 in Illinois) pocket beaches – Stable ecosystems, no negative impact. Native species like Sea Rocket and Seaside Spurge re-established

# Sandy Pocket Beach a Living Shore: Improved Ecosystem

- Erosion – Controlled with natural materials
- Improved Water Quality – Beach sand: a natural filter supporting a robust native bacterial community
- Substrate – rocky headlands, beach dunes and swales – new habitat for plants, fish and shore birds.
- Littoral Drift Sand and Neighbors – Built well within the surf zone and over-filled with new sand. 20+ years monitoring – neighbors happy!

# Sometimes intense urbanization requires large-scale solutions: Fills




Chicago - c 1820 wetlands similar to Illinois Beach Park – Flooding is problematic as the city grows

Unmanaged growth left the Chicago lakefront a mess. Railyard revetments help protect the downtown area from storms and flooding

**A Grand Solution:** *Reclaim land in the lake.* **First large scale environmental management plan in USA**

**1909 Burnham Plan for Chicago**

Chicago Lakefill – 24 miles of higher elevation parkland: A buffer against intense storms, and rising lake levels

Chicago Lakefill: Beats a seawall next to the tracks. – A win-win solution!
100th Anniversary in 2009

Coping with gradually rising lake levels and more intense storms.
And Pocket Beaches!
Require minimal maintenance

Municipal Lakefills like Chicago or Toronto are sustainable solutions to intense urbanization and climate change (take note Manhattan Island…)

Toronto Lakefill

photo courtesy: Cargocollective.com

# If you build it, they will come!

# Lessons Learned for the Great Lakes

- Coastal erosion is here to stay
- It is possible to stabilize and preserve the shore with:
  - Engineered lakefills
  - Engineered pocket beaches
  - Sand nourishment and backpassing.
- Eroding lakebed is like rising sea level. Requires periodic sand re-nourishment

Wetlands and beaches support a powerful ecosystem. They also greatly improve our quality of life

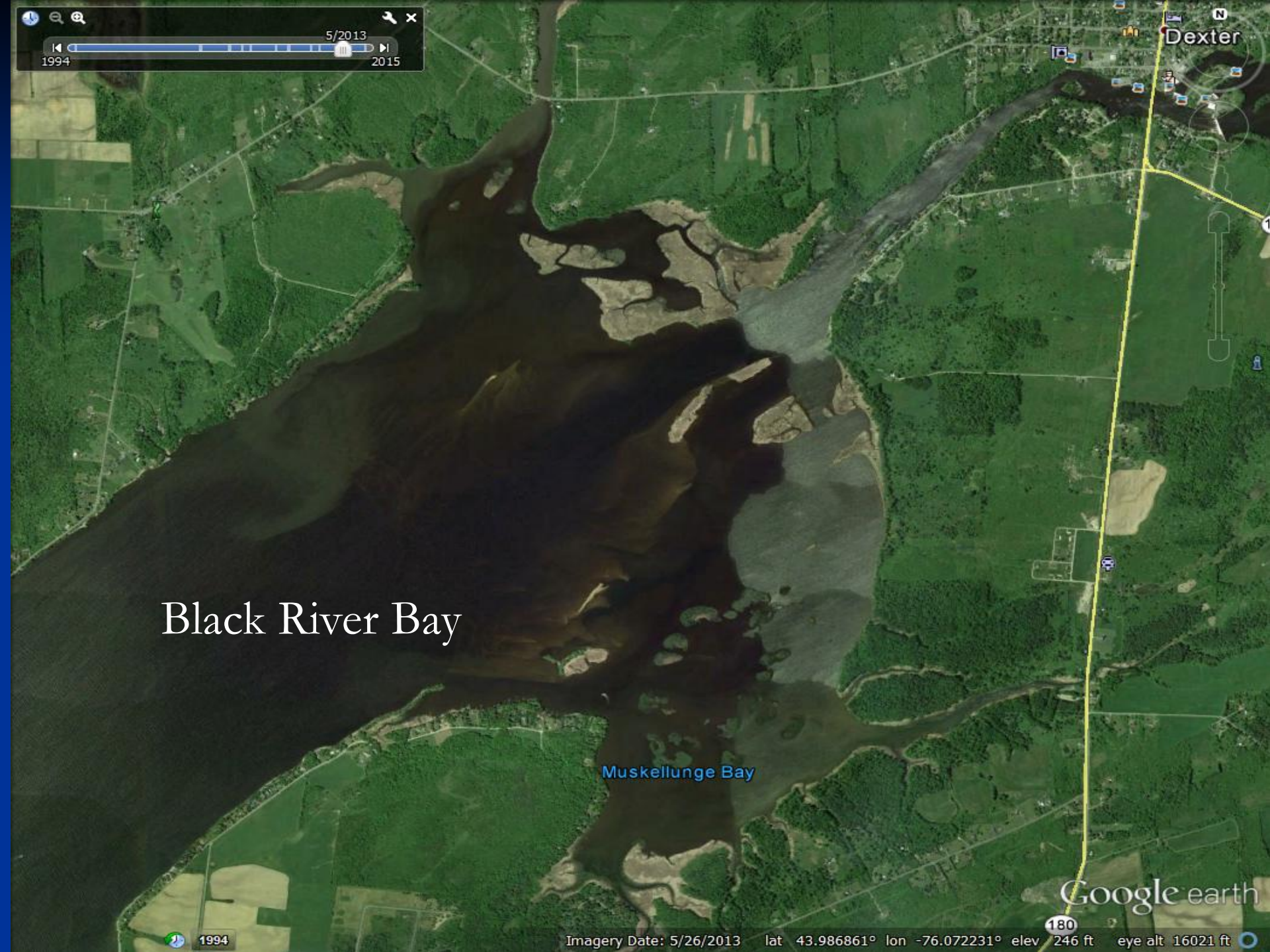
**We've come a long way -**
**But have a long way to go!**

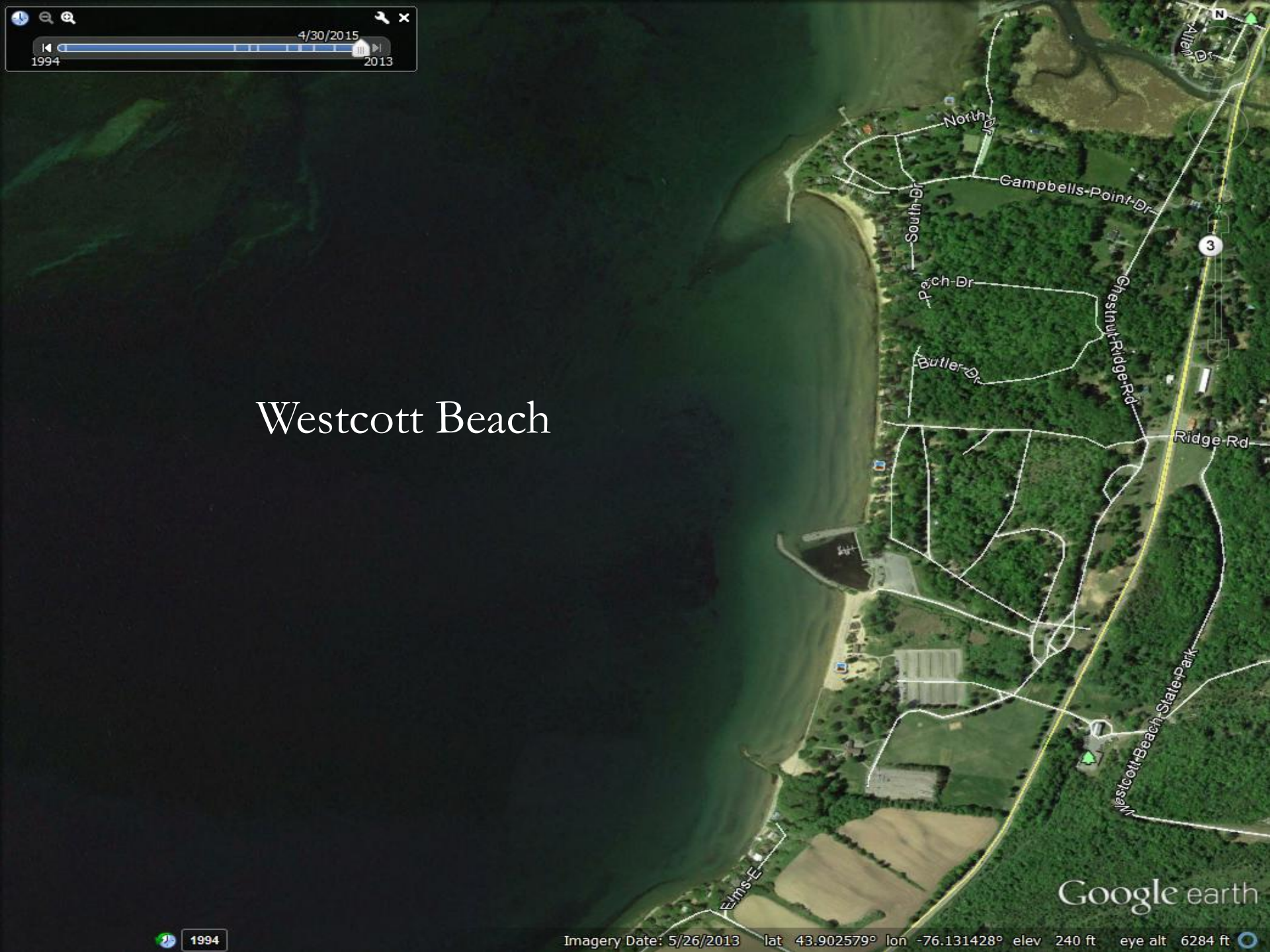
**In 2011 there were dozens of swim bans on Great Lakes beaches often related to deteriorated infrastructure: leaking sewers**

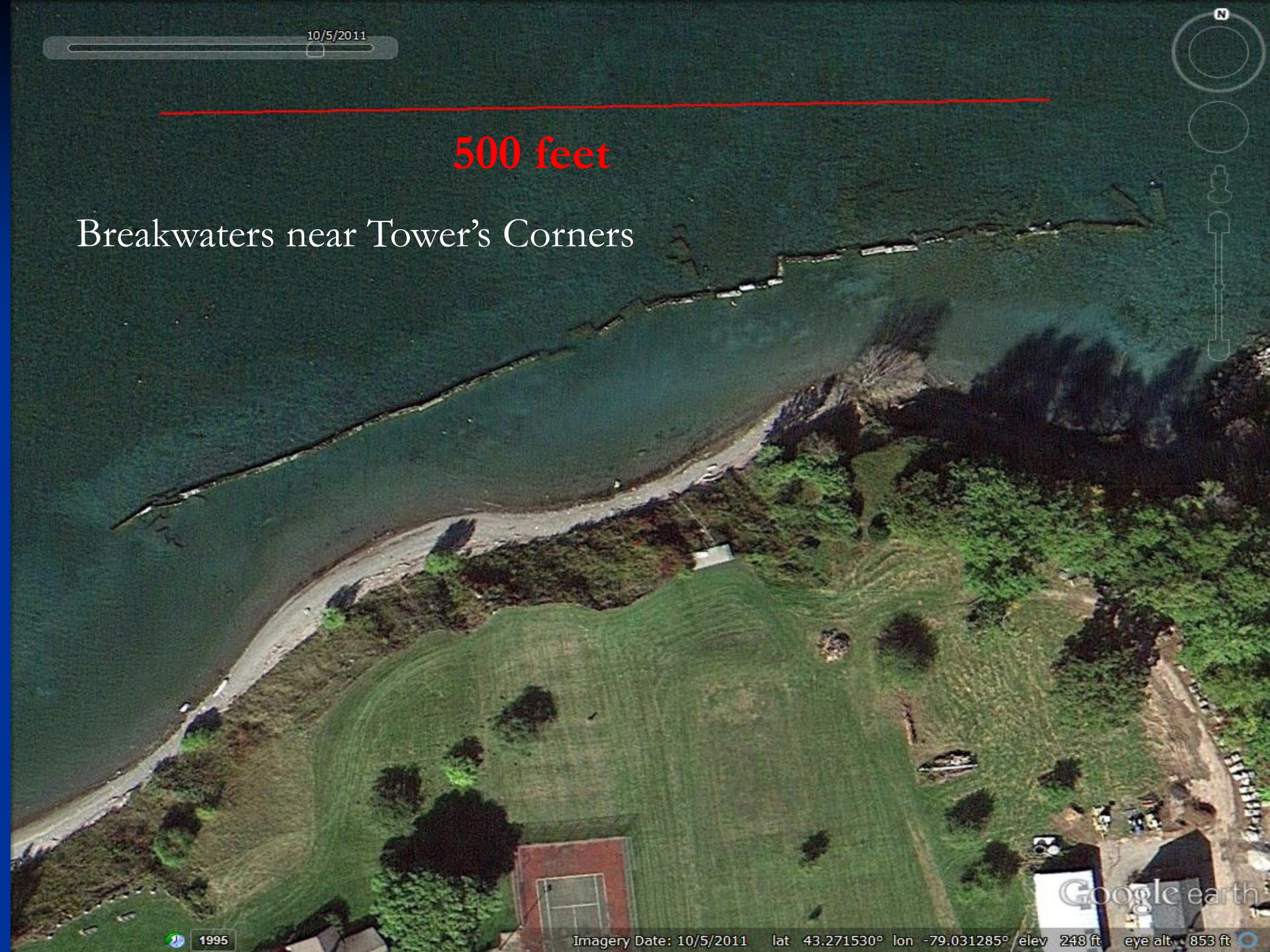
Thank You
Shabica & Associates
Sustainable Coastal Solutions

# Sandy Creek Inlet

# Irondequoit Bay Inlet


5/2013
1994
2015
Dexter
Black River Bay
Muskellunge Bay
Google earth
1994
Imagery Date: 5/26/2013 lat 43.986861° lon -76.072231° elev 246 ft eye alt 16021 ft

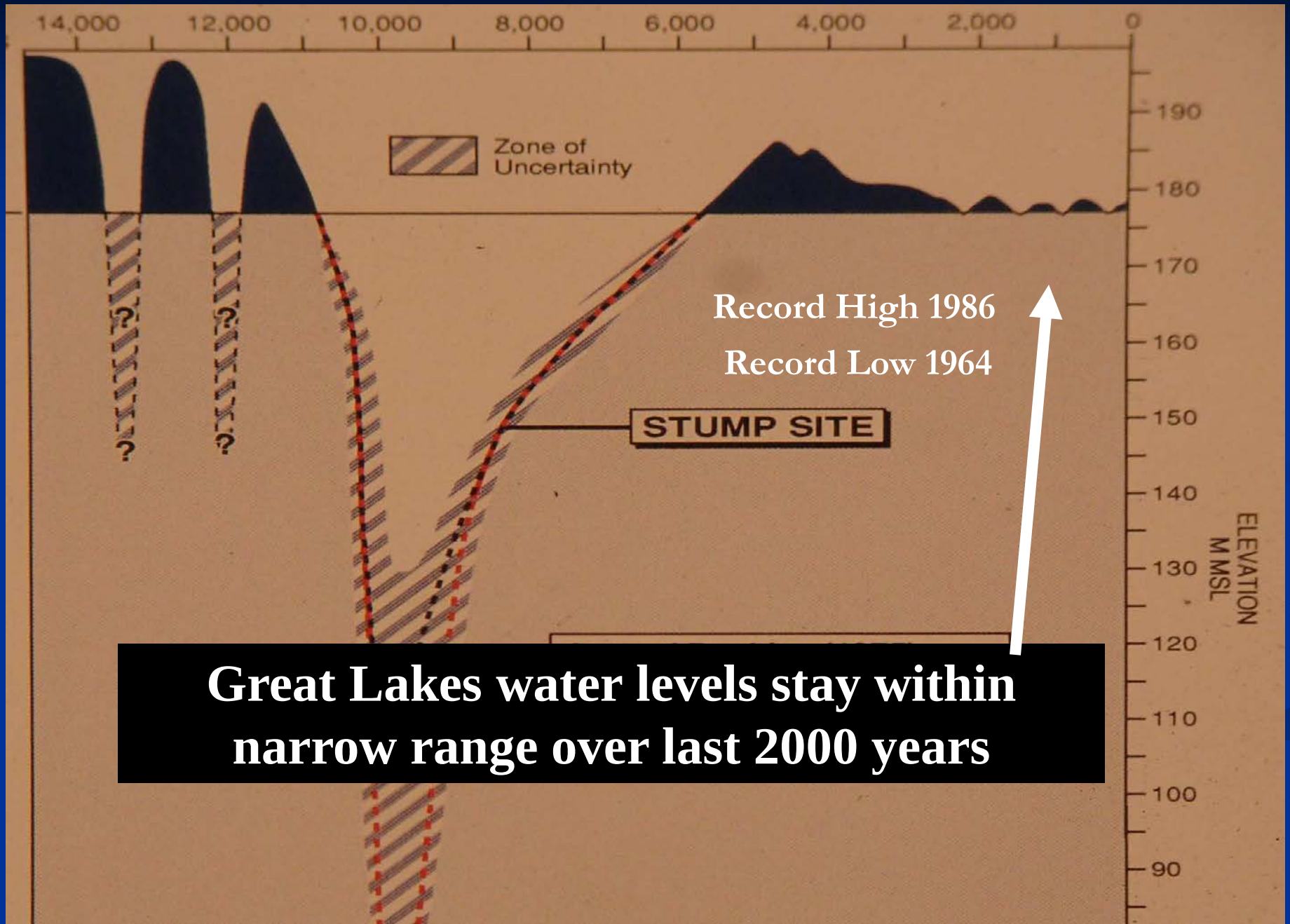

4/30/2015
1994
2013
Westcott Beach
North Dr
Campbells Point Dr
South Dr
Beach Dr
Chestnut Ridge Rd
Butler Dr
Ridge Rd
Allen Dr
Elms E
Westcott Beach State Park
3
N
Google earth
1994
Imagery Date: 5/26/2013 lat 43.902579° lon -76.131428° elev 240 ft eye alt 6284 ft

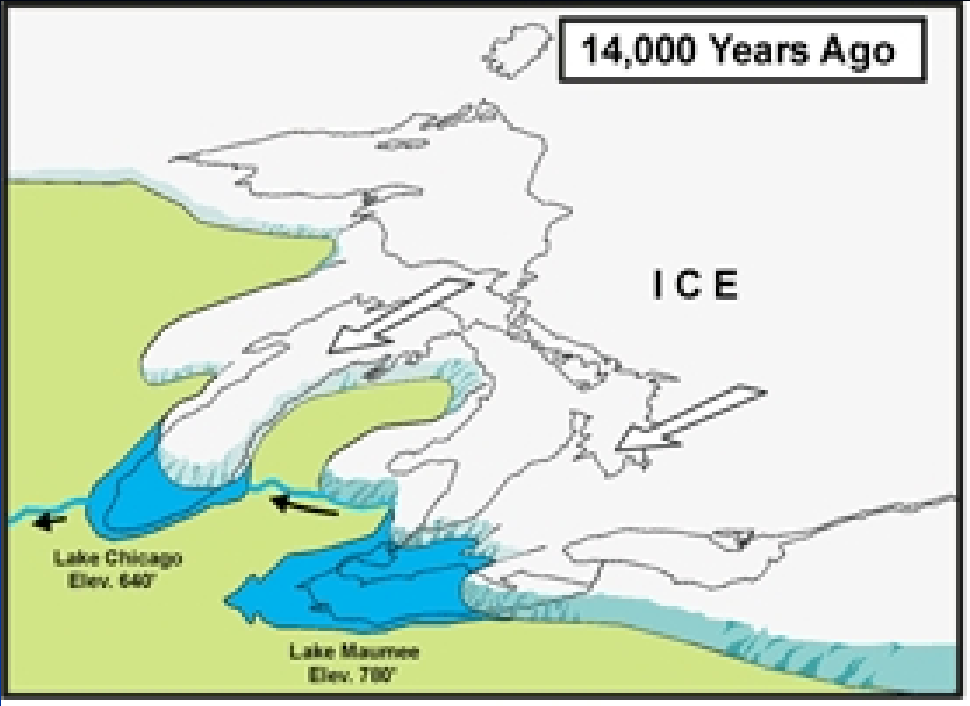

10/5/2011
500 feet
Breakwaters near Tower's Corners
1995
Imagery Date: 10/5/2011 lat 43.271530° lon -79.031285° elev 248 ft eye alt 853 ft
Google earth

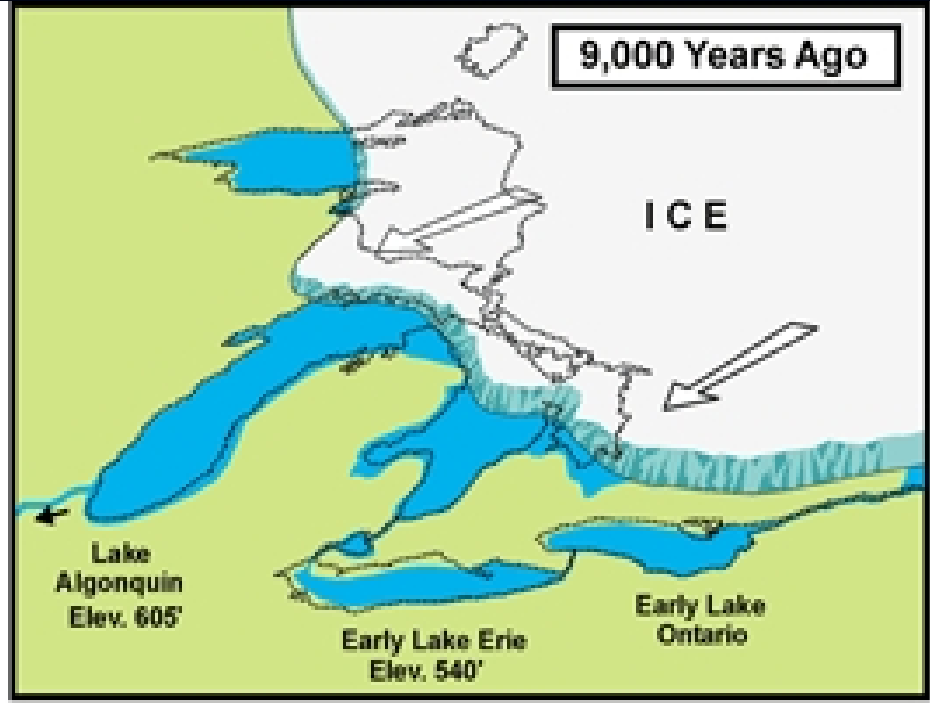
500 feet
Spur Breakwater East of Niagara, NY
Powell Dr

# Climate Change predictions for the Great Lakes:

- Average temperature up (more evaporation, less winter ice)
- Precipitation up 25%
- Lake levels will continue to vary 4 to 6 feet
- More frequent and intense storms (erosion)
- Beaches will need periodic sand nourishment


14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Zone of Uncertainty
Record High 1986
Record Low 1964
STUMP SITE
190
180
170
160
150
140
130
120
110
100
90
ELEVATION M MSL
Great Lakes water levels stay within narrow range over last 2000 years


14,000 Years Ago
ICE
Lake Chicago
Elev. 640'
Lake Maumee
Elev. 780'


9,000 Years Ago
ICE
Lake
Algonquin
Elev. 605'
Early Lake Erie
Elev. 540'
Early Lake
Ontario

7,000 Years Ago
ICE
Lake Stanley
Elev. 280'
Lake Chippewa
Elev. 230'
Early Lake Ontario
Early Lake Erie
Elev. 540'

4,000 Years Ago
Nipissing Stage
Elev. 605'
Ontario River
St. Lawrence River
Illinois
River
U.S. Army Corps of Engineers, Detroit District