



PENNSTATE



# Water Resources in the Great Lakes

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# Outline

- I. Introduction to the Great Lakes
- II. Natural Factors of Water Change
- III. Controlling Water Levels
- IV. Effects of Lake Fluctuation
- V. What is the Problem?
- VI. Is There Really a Problem? / Conclusion



# Introduction to the Great Lakes

# What Makes Them So Great?

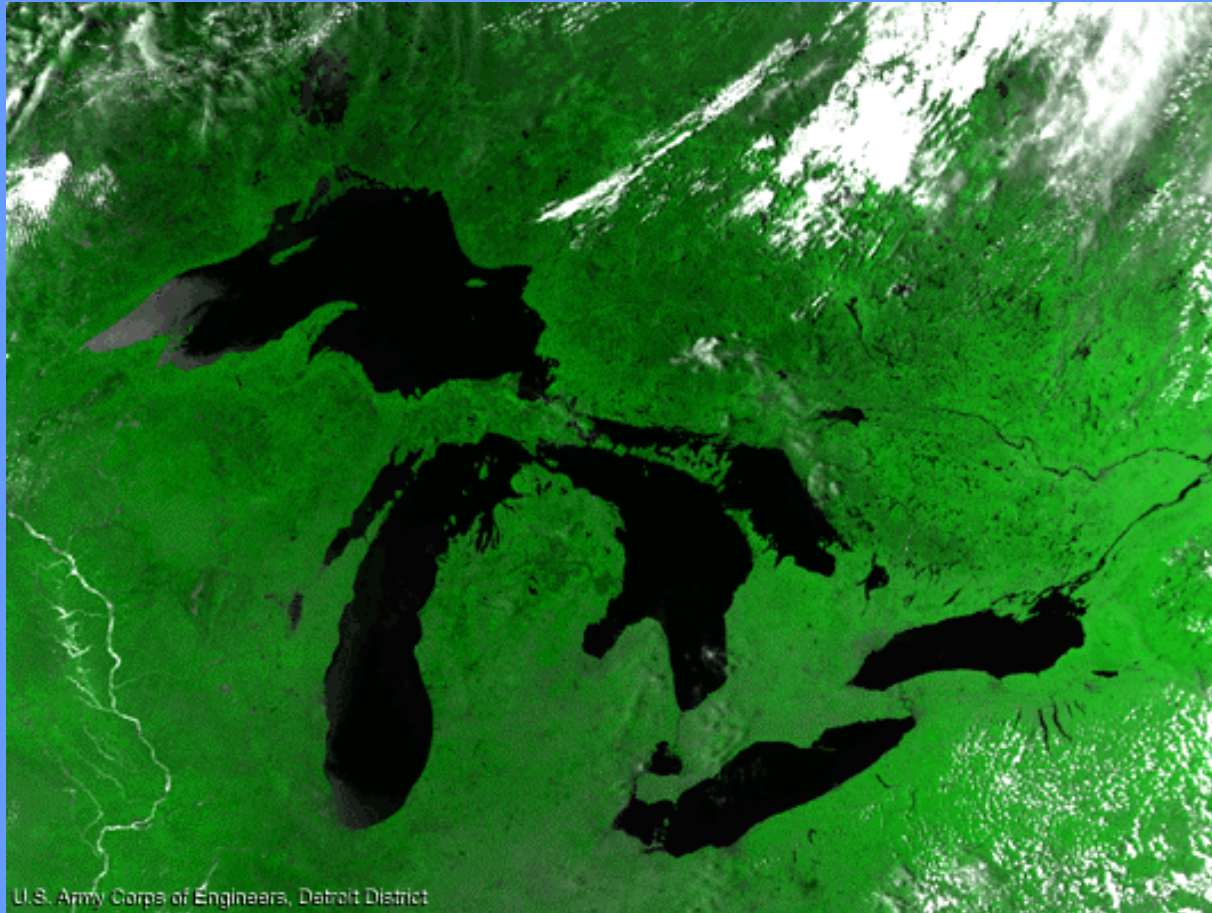


- 5 adjoining lakes
- Cover 94,000 square miles
- Holds 6 **quadrillion** gallons of water

# Location Is Everything



# Satellite Image



U.S. Army Corps of Engineers, Detroit District

April 25, 2001

Geography 10 Honors

# Ecosystem



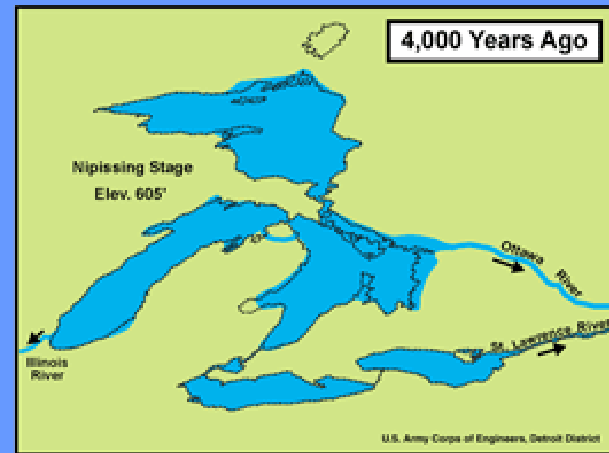
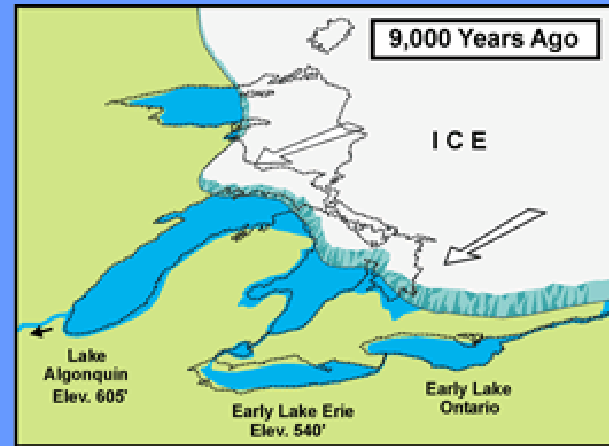
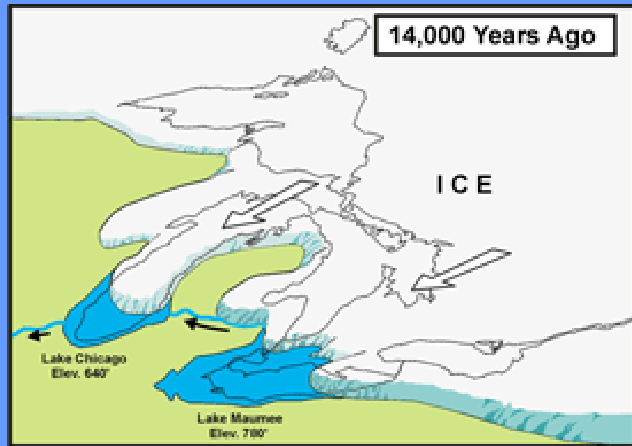
- Huge Forests and Wilderness Areas
- Rich Agricultural Land
- Hundreds of Tributaries
- Thousands of Smaller Lakes
- Extensive Mineral Deposits
- Abundant Wildlife
- World-Class Fishery



# How Did It Get Here?

- Volcanic Activity about a billion years ago
- Lava flows into fracture for 20 million years
- Glaciers arrive and retract for last 5 million years
  - Glacier ice sheets level mountains and carve out massive valleys
- Glaciers start to retreat 14,000 years ago, and completely leave region 7,000 to 9,00 years ago

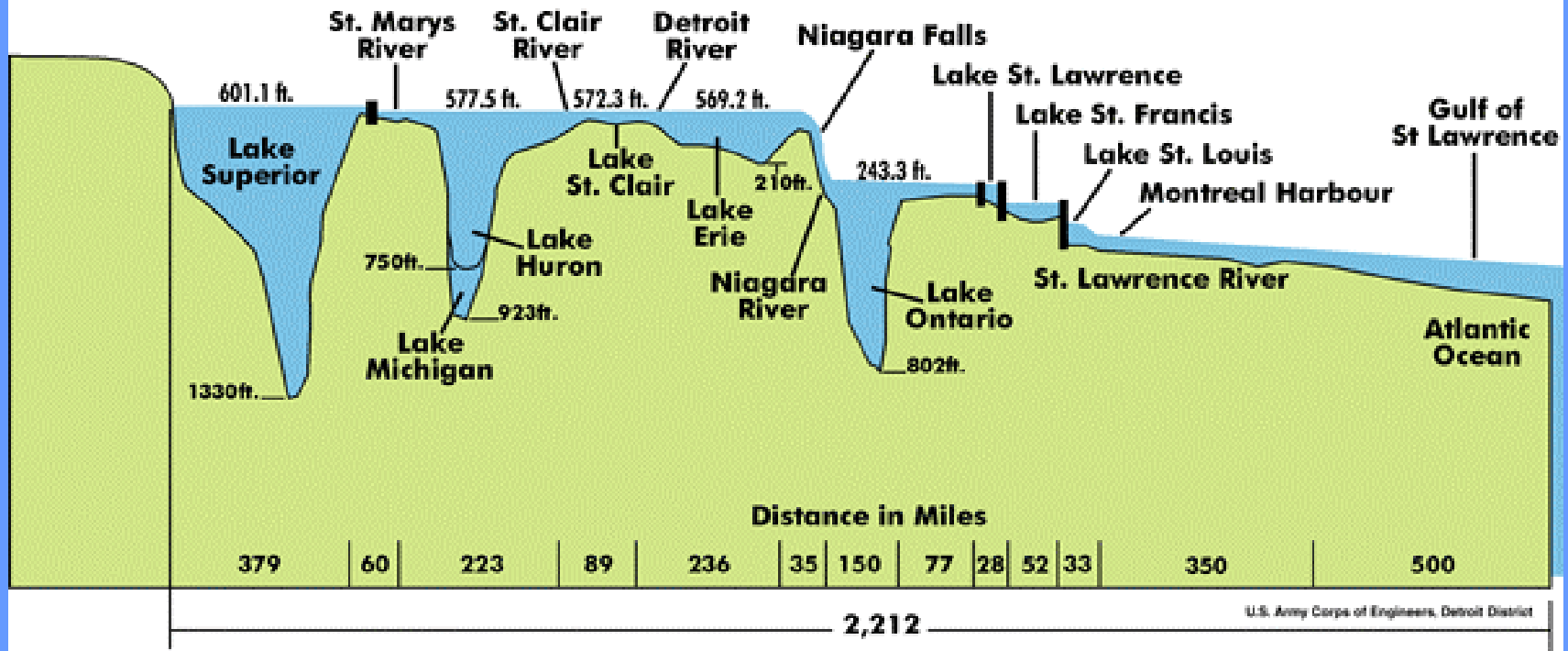
# How Did It Get Here?



# The Deep Network



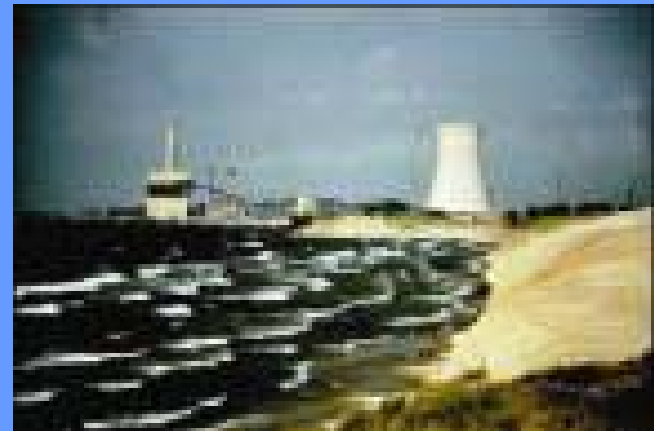
## Great Lakes System Profile



# People and the Great Lakes



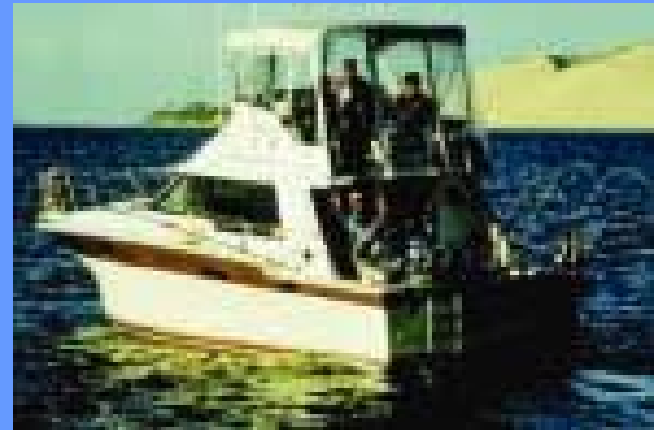
- Consumptive Uses
  - Drinking Water
  - Industry
  - Agriculture
  - Thermoelectric Power



# People and the Great Lakes



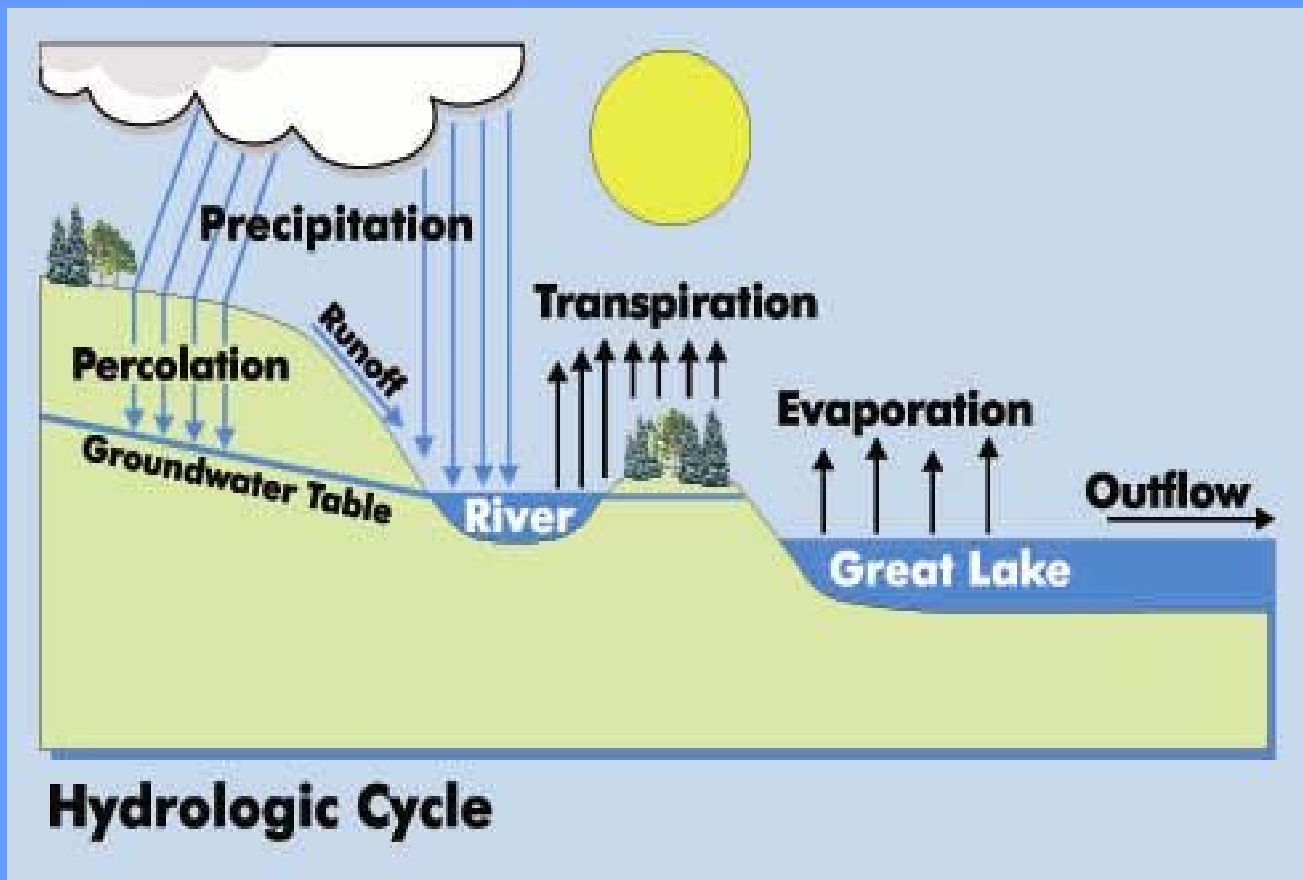
- Nonconsumptive Uses
  - Recreation
  - Hydroelectric power
  - Shipping





# Natural Factors of Water Change

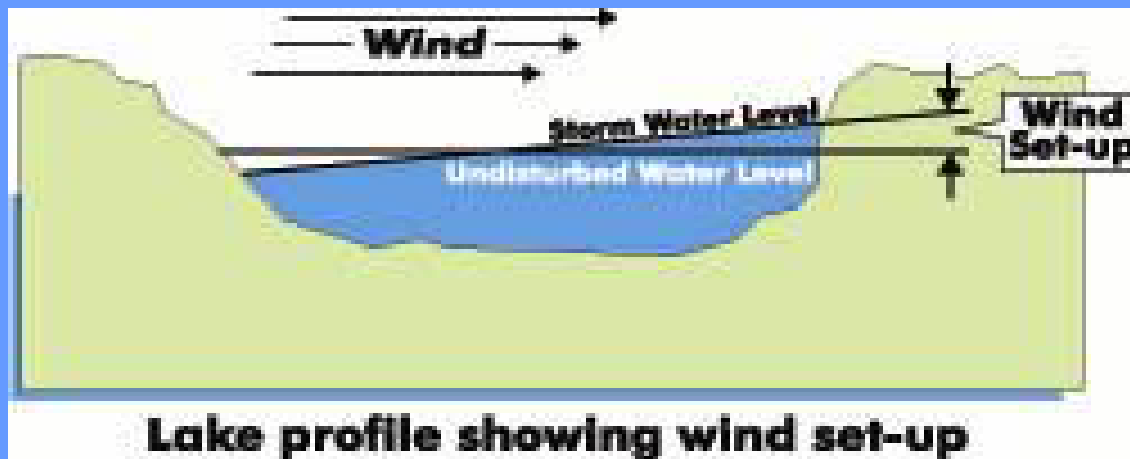
# The Hydrologic Cycle (A Review . . . I Hope)



# Short Term Changes



- Wind



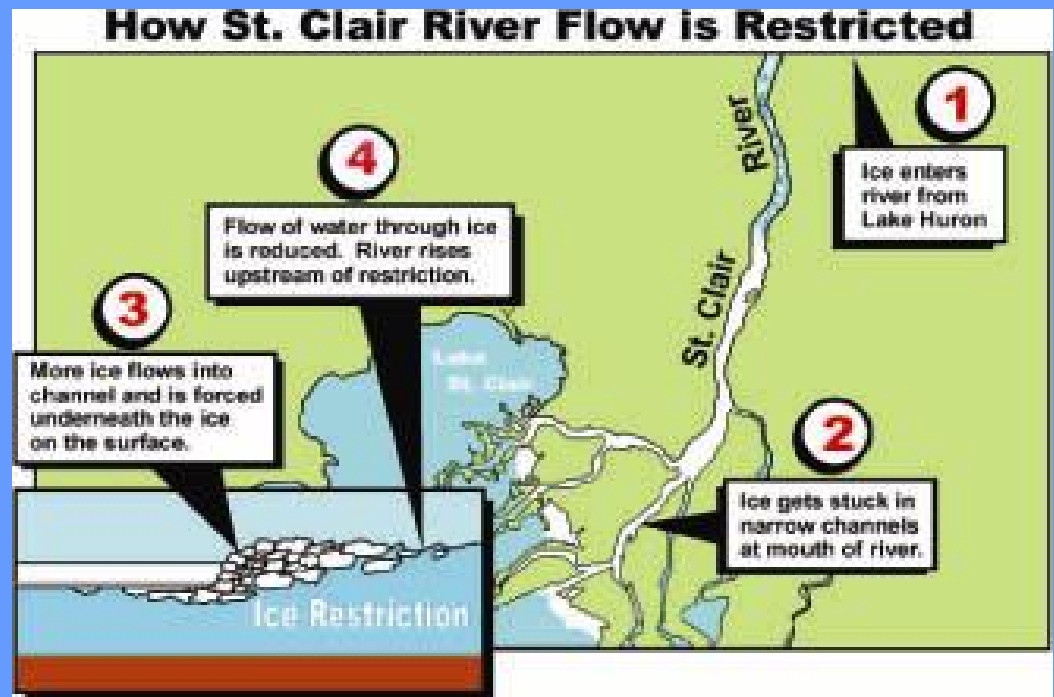
**Lake profile showing wind set-up**

- Storm Surge
- Seiche

# Short Term Changes



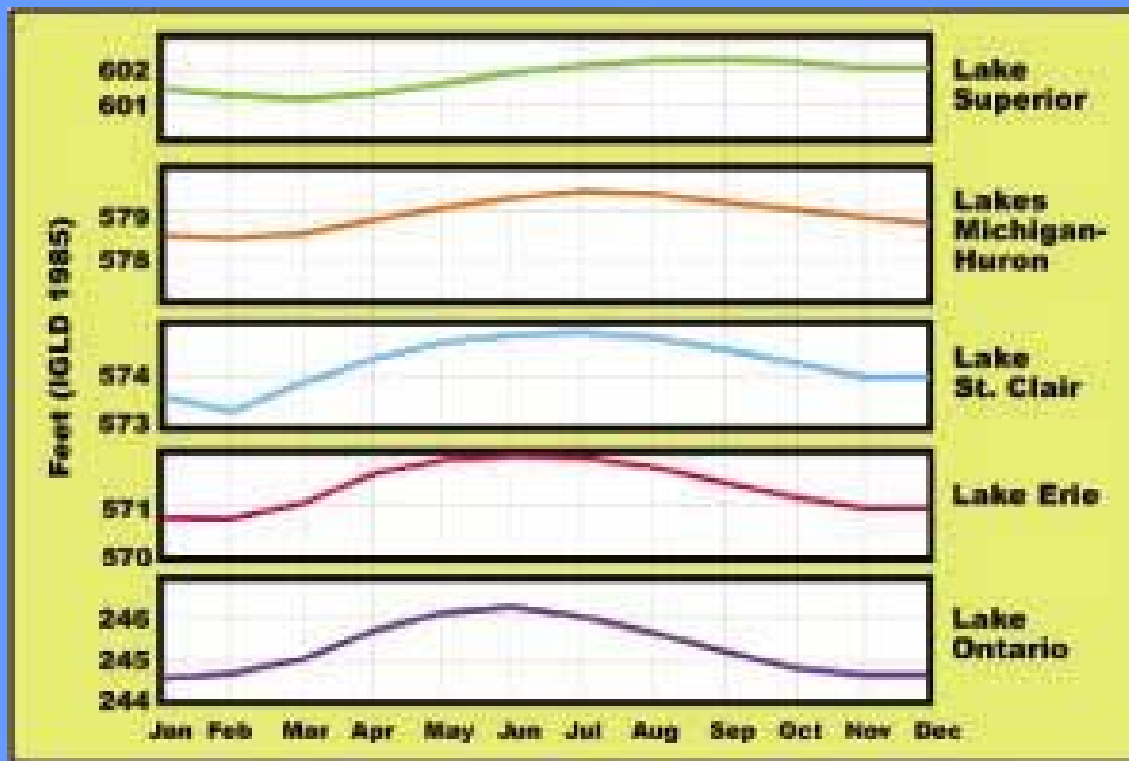
- Plant Growth
- Ice Restriction



# Short Term Changes



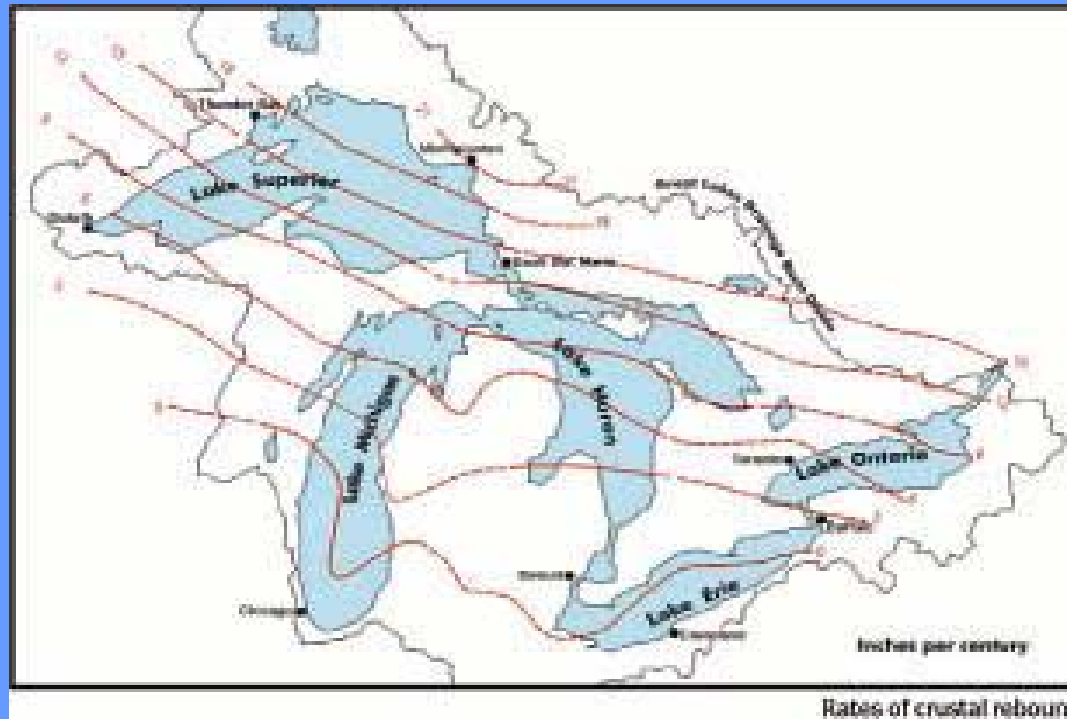
- Seasonal Fluctuation



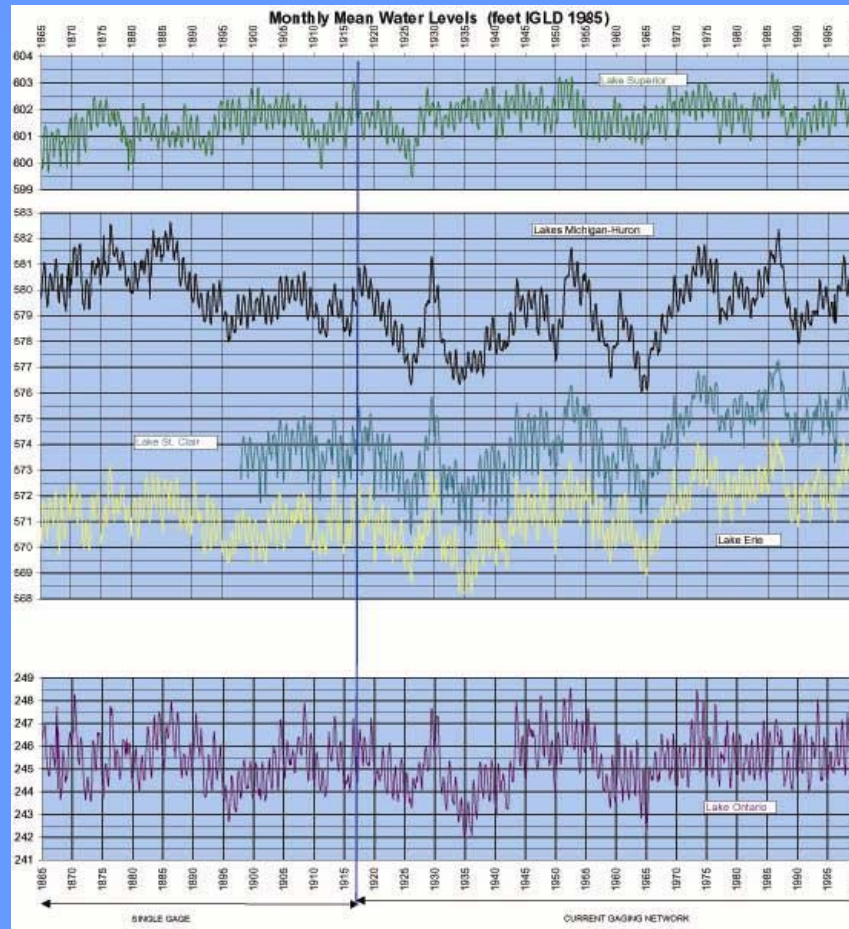
# Long Term Changes



- Crustal Movement



# Historic Water Levels





# Controlling Water Levels

# Human Influence



- Lake Superior and St. Mary's River
- St. Clair River, Lake St. Clair, and Detroit River
- Niagara River
- Lake Ontario and St. Lawrence Seaway Power Project
- Diversions



# Effects of Lake Fluctuations

# Shoreline



- 9,500 mile shoreline
- Shoreline varies significantly, from flat, low-lying areas susceptible to flooding, to high bluff areas often prone to erosion
- Erosion and flooding is magnified during periods of high water or storms
- In some areas of high-density development, minor deviations from long-term averages can produce economic losses

# Erosion



- Littoral Drift
  - Sedimentary material left from wave breaks
- Accretion
  - Deposition of sediment
  - If accretion does not balance erosion, shore will be washed away
- Berm
  - Gently sloping shores; defend against erosion



# What is the Problem?

# What is the Problem?



- “Between 1998 and 2000, the levels of Lakes Michigan and Huron dropped at the fastest pace ever recorded.”
- “Lake Superior and Michigan-Huron are at their lowest levels since 1926 and 1965, respectively.”
- “Lake Erie is the lowest since 1967.”

NOAA Report, March 2001



# Why are Water Levels Low Now?

- Since the fall of 1997:
  - Decreased precipitation over the Great Lakes basin, particularly in the upper lakes
  - Significantly above-average temperatures
  - Ice cover has been below normal
- **RESULT:** Lower-than-normal water supplies

NOAA Report, March 2001

# Why Has It Been So Warm?



- El Niño (1997)
  - Kept cold air masses away from the lakes
  - Milder winter and light precipitation
  - Less snowmelt and lake ice
- La Niña (1998-2000)
  - Supposed to bring cold temperatures, but winters were still warmer than usual

# Lake Level Drops



- Warmth factors attributed to high drops in water level over the last 3 years:
  - 101.6 cm (40”) in Lakes Michigan and Huron
  - 45.72 cm (18”) in Lake Superior
  - 78.74 cm (31”) in Lake Erie
  - 25.90 cm (10.2”) in Lake Ontario

(Figures as of May 2000)

NOAA Report, August 2000



# Is There Really A Problem?

## Conclusion

# Past Lows



- Despite these low water levels, they are not the lowest levels on record
- Lakes Michigan and Huron
  - Levels in early 20<sup>th</sup> Century were lower than current
  - Record low 1964 are still 7 inches lower than present levels

NOAA Report, March 2001

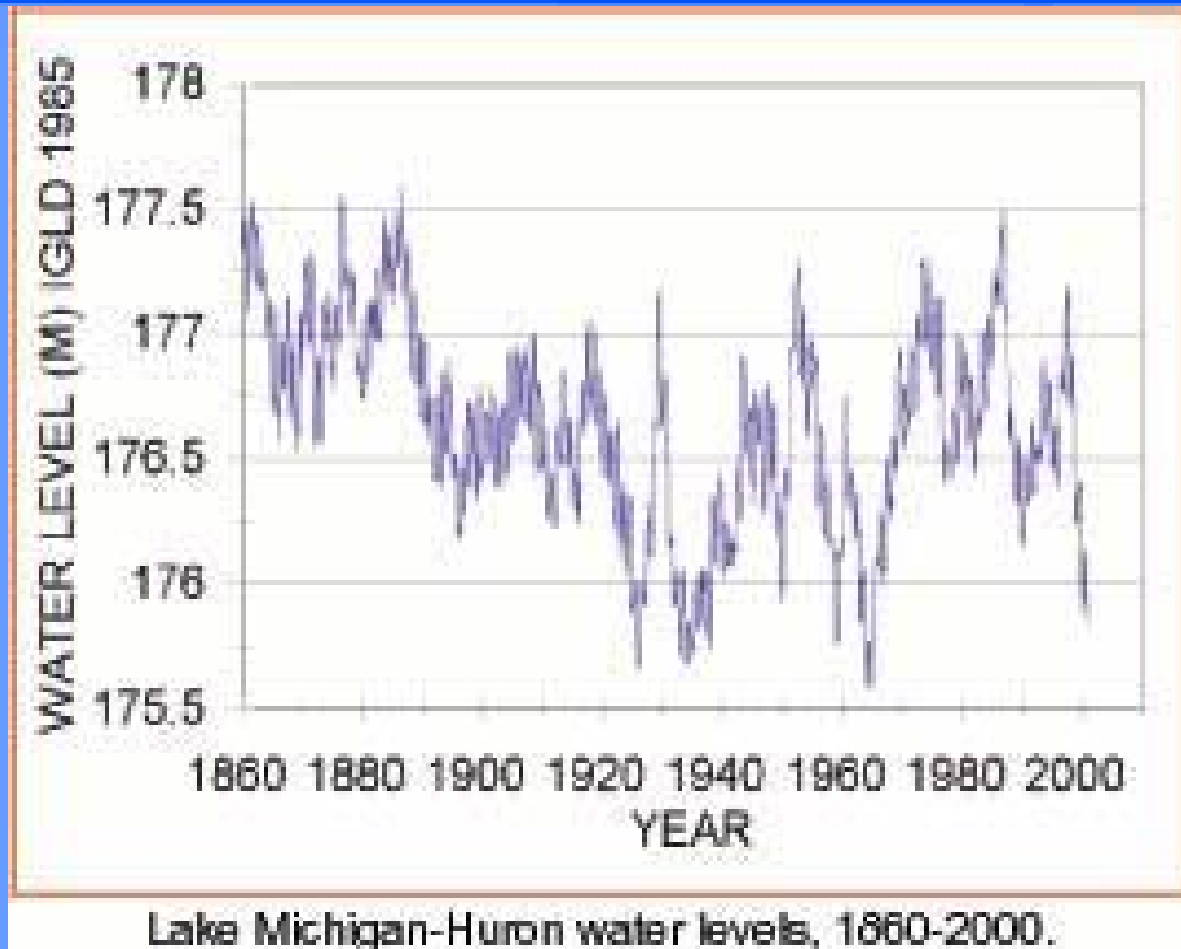
# Past Lows



- Lake Superior
  - 1926: Lake was 7 inches lower than present level
- Lake Erie
  - 1934: Lake was 29 inches lower than present level
- Lake Ontario
  - 1935: Lakes was 27 inches lower

NOAA Report, March 2001

# Past Lows



NOAA Report,  
March 2001

# Is History Repeating Itself?



- Droughts were a primary factor in the past
- Scientists are not sure of all the reasons for past water level lows; Factors that influence lake levels are poorly understood
- We know evaporation affected levels in the past, but data was not collected as thoroughly as now

NOAA Report, August 2000

# Future Outlook



- Lake levels expected to continue with peaks from 2 to 8 inches lower than last year

NOAA Report, March 2001



# Future Water Control

- Dams and diversions can control amount of water leaving, but not amount of water entering lakes
- Amount of water entering the lakes depends of the weather, and forecasting is not an exact science
- Levels can rise as quick as the fall (1926 to 1934 is a prime example)

NOAA Report, August 2000



# GLERL Conclusion

“We need water and coastal management policies that are adaptable to both high- and low-level conditions. In the past 30 years, we have had a lot of experience with high lake levels, but relatively little experience managing low-level conditions. We need to consider the fact that these lakes change over time, and we are still learning about how they change. Until we understand the process better, assuming we know enough already could be costly to both the environment and our wallets.”

-- Frank Quinn

Senior Research Hydrologist at NOAA GLERL  
(Great Lakes Environmental Research Laboratory)

NOAA Report, August 2000



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Note: All quotes in the slides were from *Living With Lakes*, unless otherwise noted.