

Supplementary Information for Inter-Agency Briefing on Great Lakes Water Levels

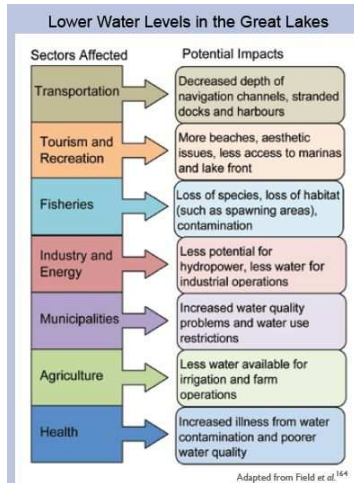
Silver Spring, Maryland - November 20, 2013



Outline

- 1 Supplementary information: economy and other background
- 2 Supplementary information: water level monitoring and data
- 3 Supplementary information: modeling and projections
- 4 Supplementary information: history and impacts of dredging
- 5 Supplementary information: additional references

Great Lakes economy and ecosystems



Great Lakes economy and ecosystems: commerce overview

Great Lakes economy and ecosystems: commerce overview

- 50% of U.S. steel-making capacity
- 70% of U.S. auto manufacturing
- 55% of all manufacturing
- Shipping is an integral component. . .

Source: Great Lakes Maritime Task Force 2013



Great Lakes economy and ecosystems: shipping

Great Lakes shipping integral to U.S. and Canadian economies.

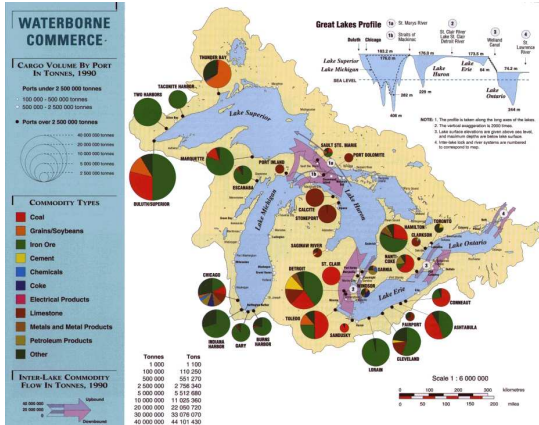
It creates:

- 227,000 jobs
- \$33.5 billion in business revenue
- \$14.1 billion in annual personal income
- \$6.4 billion in local purchases
- \$4.6 billion in tax revenue
- \$3.6 billion in transportation rate savings

Source: Great Lakes Maritime Task Force 2013



Great Lakes economy and ecosystems: shipping



GLERL
Great Lakes Environmental Research Laboratory



Great Lakes economy and ecosystems: shipping

U.S.-flag trade = 115 million tons:

- Mostly U.S. to U.S. within the upper four Lakes
- Cargo typically includes iron ore, coal, and limestone

Canadian-flag trade = 65 million tons:

- Trade between Duluth/Superior and Sept Iles
- Inbound ore from Gulf of St. Lawrence, grain backhaul
- 82% of “Cross-lake” (U.S.-Canada) trade
- 52% of total is to or from U.S.

Oceangoing or “salty” trade - 17 million tons:

- Import specialty and finished steel products
- Export grain
- Canadian-owned; flagged foreign with international crews



Great Lakes economy and ecosystems: shipping



Great Lakes economy and ecosystems: shipping

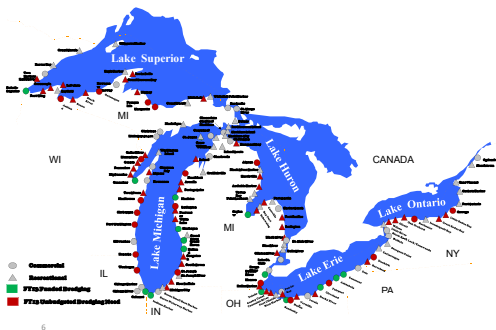
Every inch counts:

- 56 “Lakers” are enrolled in Lake Carriers Association (LCA)
- Fleet forfeits 8,000 tons/trip per inch of draft “lost”

Source: Great Lakes Maritime Task Force 2013

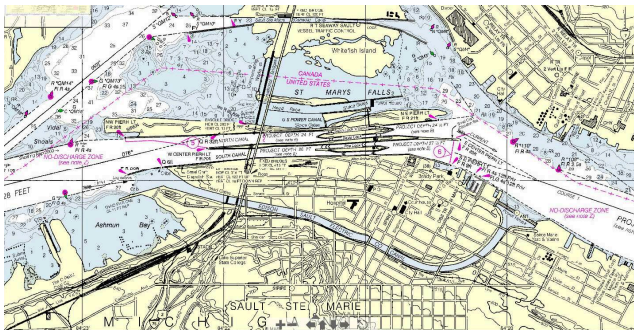
Great Lakes economy and ecosystems: shipping

FY13 Dredging Requirements



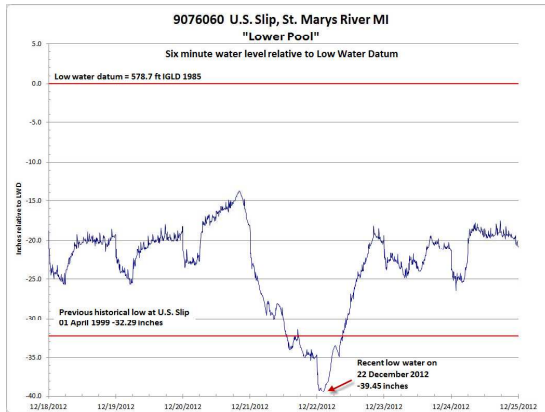
Source: Great Lakes Maritime Task Force 2013

Great Lakes economy and ecosystems: shipping

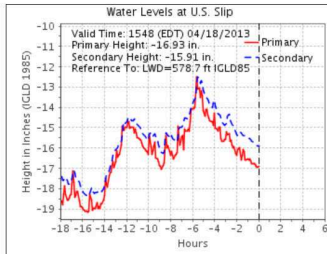
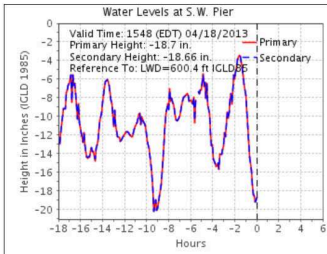


- Levels below Chart Datum could limit use of Sault St. Marie for deep draft vessels
- Maximum project depths are 28 feet

Great Lakes economy and ecosystems: shipping



Great Lakes economy and ecosystems: shipping



Recent conditions: locks at St. Marys Falls canal (levels below chart datum)

Source: NOAA NOS COOPs physical oceanographic real-time system (<http://tidesandcurrents.noaa.gov>)



Great Lakes economy and ecosystems: nearshore habitat

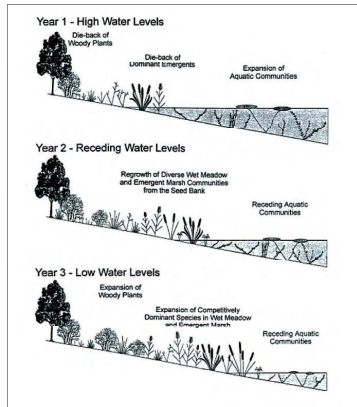


Figure 11. Simplified diagram of the effects of water-level fluctuations on coastal wetland plant communities (from Maynard and Wilcox, 1997).



Great Lakes economy and ecosystems: property and recreation



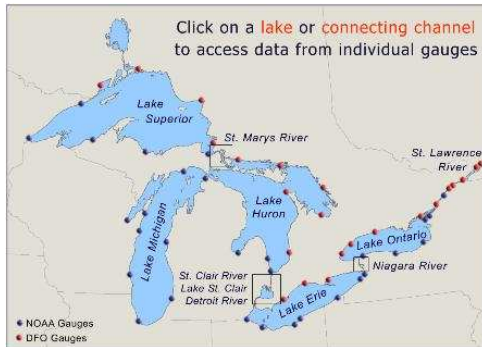
Source: IJC adaptive management task team



Outline

- 1 Supplementary information: economy and other background
- 2 Supplementary information: water level monitoring and data**
- 3 Supplementary information: modeling and projections
- 4 Supplementary information: history and impacts of dredging
- 5 Supplementary information: additional references

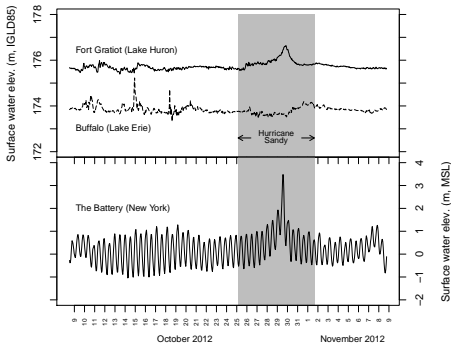




Source: Great Lakes information network (GLIN)



Water level dynamics: short-term





Great Lakes Water Levels

Seasonal dynamics

Tue Nov 19 2013 11:17:05 PM



■ Preliminary avg for month from coordinated gauges
■ Lakewide period of record average (1918-present)
■ Lakewide annual average (1918-Present)
■ Lakewide monthly average (1918-present)

Water level dynamics: paleoclimate

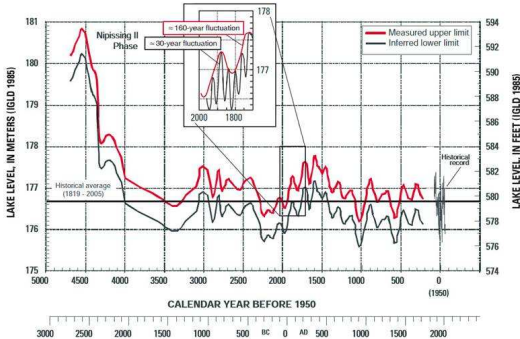


Figure 8. Hydrograph of late Holocene lake level and historical lake level for Lake Michigan-Huron. The red line is interpreted from beach-ridge studies, whereas the lower black line is an inferred lower limit using the range of the historical record as a guide.

Outline

- 1 Supplementary information: economy and other background
- 2 Supplementary information: water level monitoring and data
- 3 Supplementary information: modeling and projections**
- 4 Supplementary information: history and impacts of dredging
- 5 Supplementary information: additional references



Water level projections: short-term

Water level models (short-term)

LMOFS

Home Products Programs Partnerships Education Help

Time Series

Water Level

- Holland, MI
- Ludington, MI
- Port Huron, MI
- Mackinaw, MI
- Calumet Harbor, IL
- Kaukaunee, WI
- Milwaukee, WI
- S. Michigan (45007)
- N. Michigan (45002)

Water Temperature

- S. Michigan (45007)
- N. Michigan (45002)

Map Animations

Water Level

- Nowcast
- Forecast Guidance

Currents

- Stations Nowcast
- Stations Forecast Guidance
- Field Nowcast
- Field Forecast Guidance

Wind

- Wind Nowcast
- Wind Forecast Guidance

Water Temperature

- Nowcast
- Forecast Guidance

LMOFS Model Graphics Archive

Model WECDF archive - CD-OPS Chequamegon server

Model Status

Return to GLOFS

Return to Operational Forecast

Lake Michigan Operational Forecast System (LMOFS)

(Please click on the map pins below to access the time series plots)

Map Satellite Hybrid

Water Level Wind Currents Water Temperature

(Please click on the categories below to access animated map plots)

Nowcast	Nowcast	Stations Nowcast	Nowcast
Forecast	Forecast	Stations Forecast	Forecast
Guidance	Guidance	Guidance	Forecast Guidance
		Field Nowcast	
		Field Forecast Guidance	

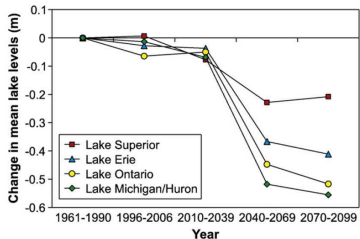
The Lake Michigan Operational Forecast System (LMOFS) is a NOAA project aimed at providing improved predictions of water levels, currents and water temperatures in Lake Michigan to the user communities. Similar systems are operational in the other 4 Great Lakes as well. Collectively these form the Great Lakes Operational Forecast System (GLOFS). The objective of GLOFS is to produce nowcast and forecast guidance (displayed out to 24 hours) of total water level, current velocity, and water temperatures in the Lakes to be used by the commercial shipping, recreational boating and emergency response communities. GLOFS nowcast and forecast guidance will provide an increased margin of safety and maximize the efficiency of commerce throughout the Lakes. For more information, please click here.

Home | products | programs | partnerships | education | help

Schwab and Bedford (1999), *Coastal Ocean Prediction*

Anderson, Schwab, and Lang (2010), *Journal of Hydraulic Engineering*.

Water level projections: decadal

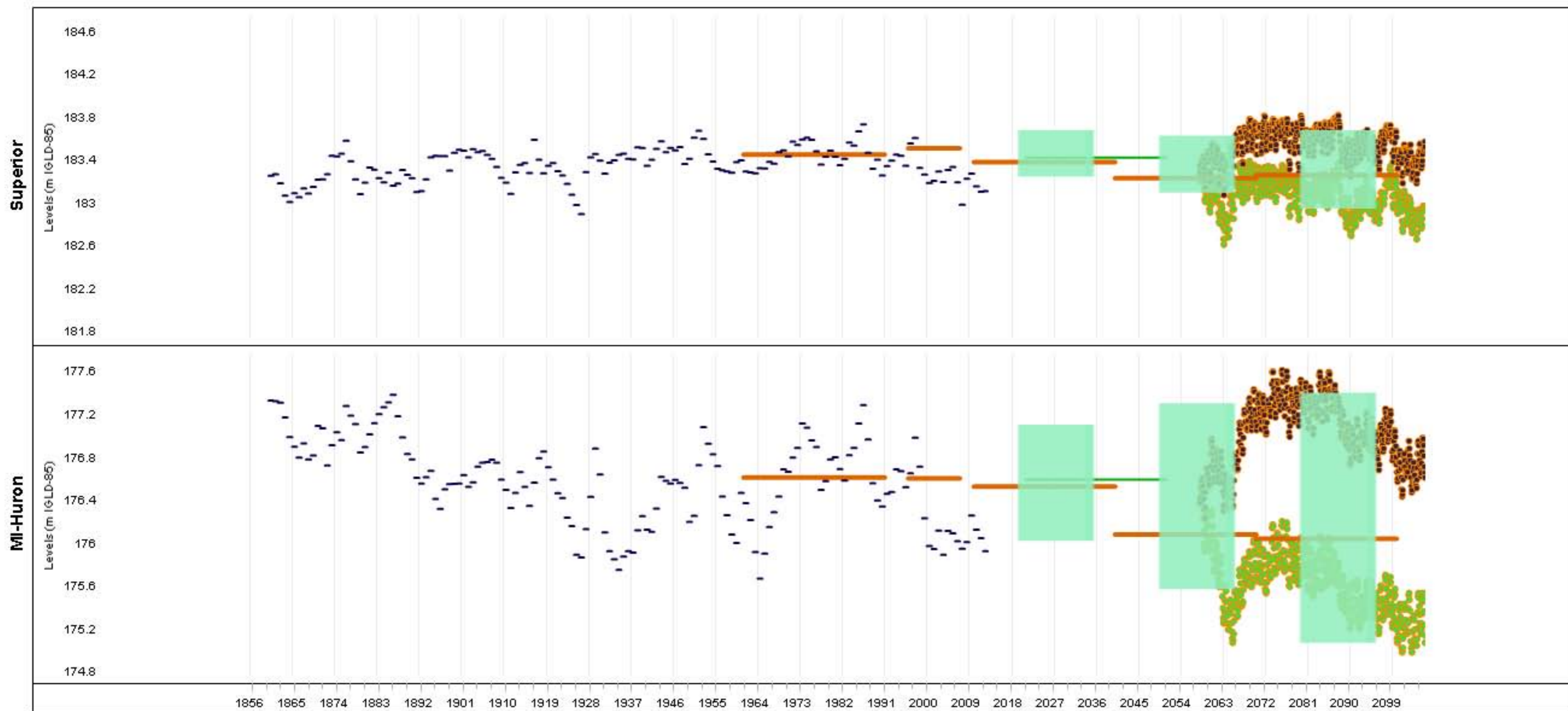


From:

- Hayhoe, VanDorn, Croley II, Schlegal, and Wuebbles (2010), *JGLR*

See also:

- Lofgren, Hunter, and Wilbarger (2011), *JGLR*
- Lofgren and Gronewold (2013), *BAMS*
- Gronewold, Clites, Smith, Hunter (2013), *EMS*



■ MacKay and Seglenieks (2012): A2 - CGCM3
 ■ Lofgren et al. (2011): A1B - GFDL20 - EA
 ■ Lofgren et al. (2011): A2 - CGCM3 - EA
 ■ Hayhoe et al. (2010): A1fi - AOGCM
 ■ Angel et al. (2010) A2 - multi-GCM
 ■ Master gauge annual average (1860-present)







Outline

- 1 Supplementary information: economy and other background
- 2 Supplementary information: water level monitoring and data
- 3 Supplementary information: modeling and projections
- 4 Supplementary information: history and impacts of dredging**
- 5 Supplementary information: additional references



Great Lakes economy and ecosystems: shipping

Impact of Dredging Crisis on Per-Trip Carrying Capacity Major Great Lakes Vessel Classes

Major Great Lakes Vessel Classes	Vessel Length (feet)	Per-Trip Carrying Capacity (net tons)	Capacity Per Foot Of Draft (net tons)
	1,000	69,664	3,204
	806	34,720	1,752
	767	28,336	1,524
	730	27,558	1,380
	635	22,064	1,284
	501	13,776	852

Source: Great Lakes Maritime Task Force 2013

Outline

- 1 Supplementary information: economy and other background
- 2 Supplementary information: water level monitoring and data
- 3 Supplementary information: modeling and projections
- 4 Supplementary information: history and impacts of dredging
- 5 Supplementary information: additional references**

Additional references:

- Holman, Gronewold, Notaro, and Zarrin (2012), *Geophysical Research Letters*.
- Gronewold, Stow, Crooks, and Hunter (2012), *Int'l Journal of Climatology*.
- Spence, Blanken, Hedstrom, Fortin, and Wilson (2011), *Journal of Great Lakes Research*.
- Fry, Hunter, Phanikumar, Fortin, and Gronewold, (2013), *Water Resources Research*.
- Kult, Fry, Gronewold, and Choi, (*In revision with Journal of Hydrology*).
- Gronewold and Fortin (2012), *Bulletin of the American Meteorological Society*.

Supplementary Information for Inter-Agency Briefing on Great Lakes Water Levels

Silver Spring, Maryland - November 20, 2013

