GREAT LAKES WATER LEVELS

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Great Lakes
Hydraulics and Hydrology
USACE Detroit District
11 December 2019

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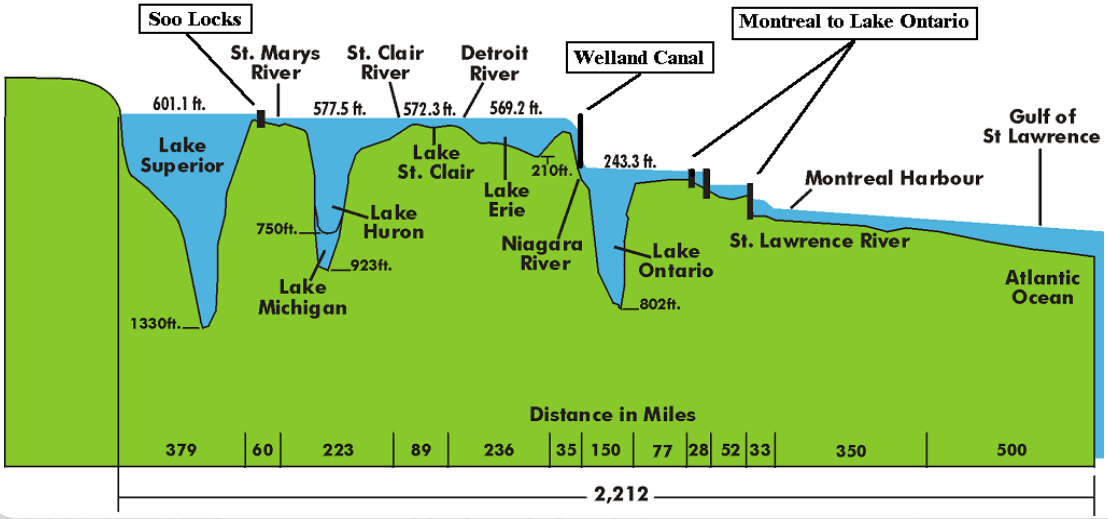
MONITORING GREAT LAKES WATER LEVELS

The Great Lakes Basin

- 14,000 miles of shoreline
- 95,000 square miles of water
- 200,000 square miles of land
- 8 States & 2 Provinces



100 years of coordinated water level data

Forecasting since the 1950s

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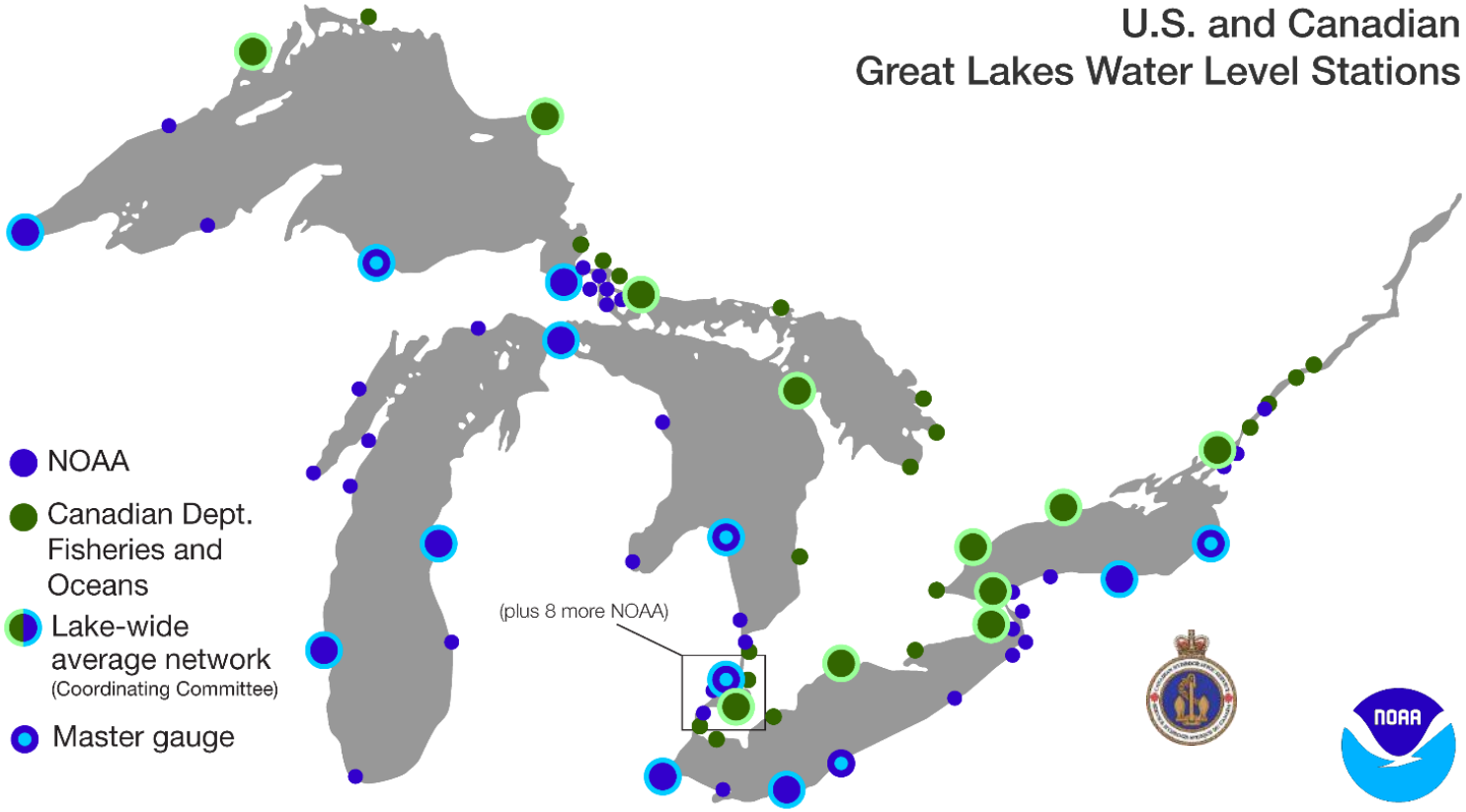
MONITORING GREAT LAKES WATER LEVELS



Daily Average Water Levels Based on Lake-Wide Average Network

- **Lake Superior:** Duluth, Marquette, Pt. Iroquois, Thunder Bay, Michipicoten
- **Lakes Michigan-Huron:** Harbor Beach, Ludington, Mackinaw City, Milwaukee, Tobermory, Thessalon
- **Lake St. Clair:** St. Clair Shores, Belle River
- **Lake Erie:** Toledo, Cleveland, Port Stanley, Port Colborne
- **Lake Ontario:** Oswego, Rochester, Toronto, Kingston, Port Weller, Cobourg

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NOTES ABOUT GREAT LAKES WATER LEVELS

- Not a depth, but an elevation above sea level
- International Great Lakes Datum of 1985
- Michigan and Huron = One lake
- Lake-wide daily means → Lake-wide monthly means
- Based on still water, not influenced by meteorological forcing
- Based on a network of water level gauges
- Detroit District Corps of Engineers = keeper of official monthly water level statistics from 1918-2018
- Coordination occurs with Environment and Climate Change Canada

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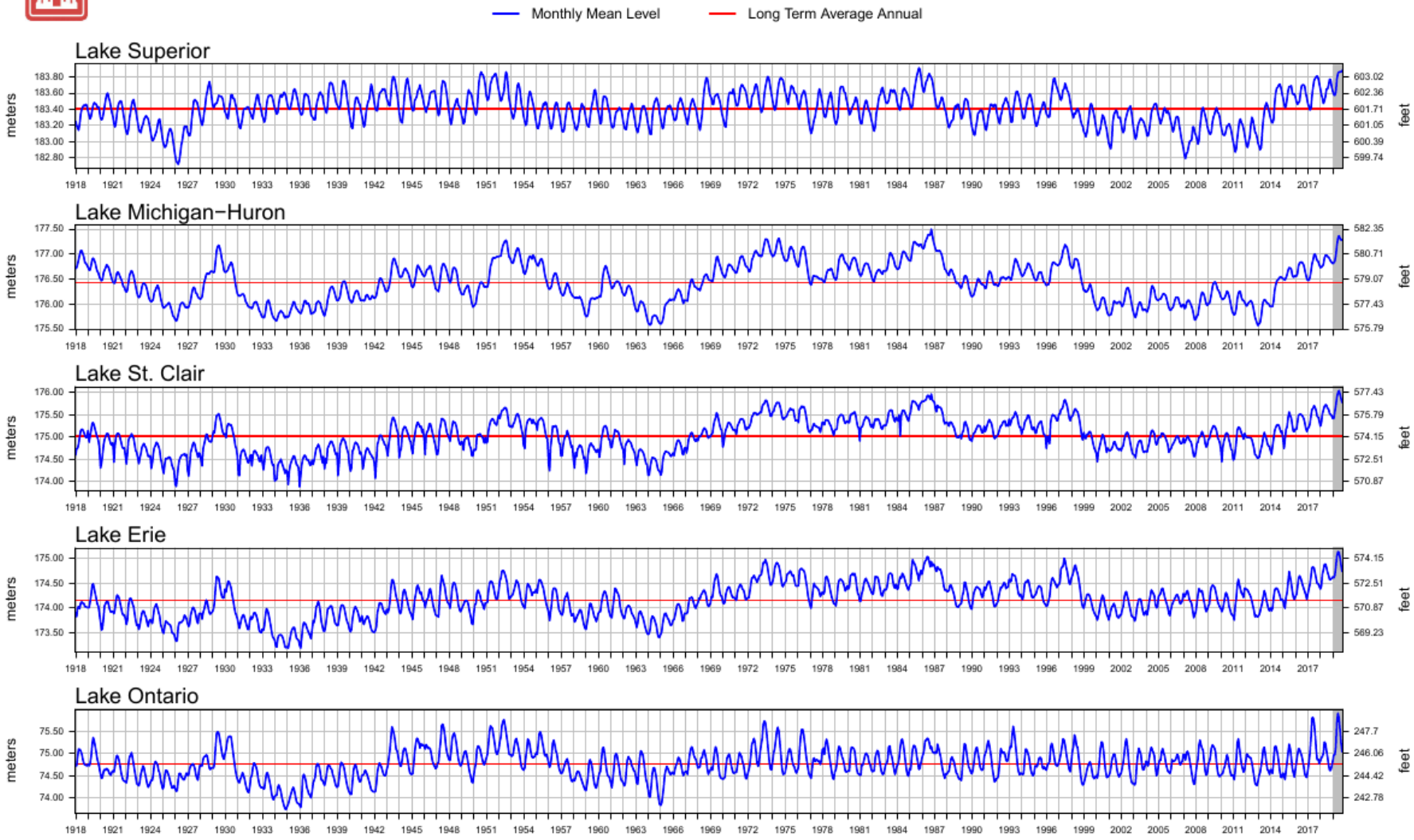
Great Lakes Water Levels (1918–2019)



The monthly average levels are based on a network of water level gages located around the lakes.
Elevations are referenced to the International Great Lakes Datum (1985).

Water levels have been coordinated through 2018. Values highlighted in gray are provisional.

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What Impacts Water Levels?

Forces of Nature

- Precipitation, runoff, evaporation
- Inflow & outflow
- Groundwater
- Ice & vegetation
- Wind, Storms
- Crustal movement

FEET

Human Influences

- Diversions
- Regulation
- Dredging
- Consumptive Uses

INCHES

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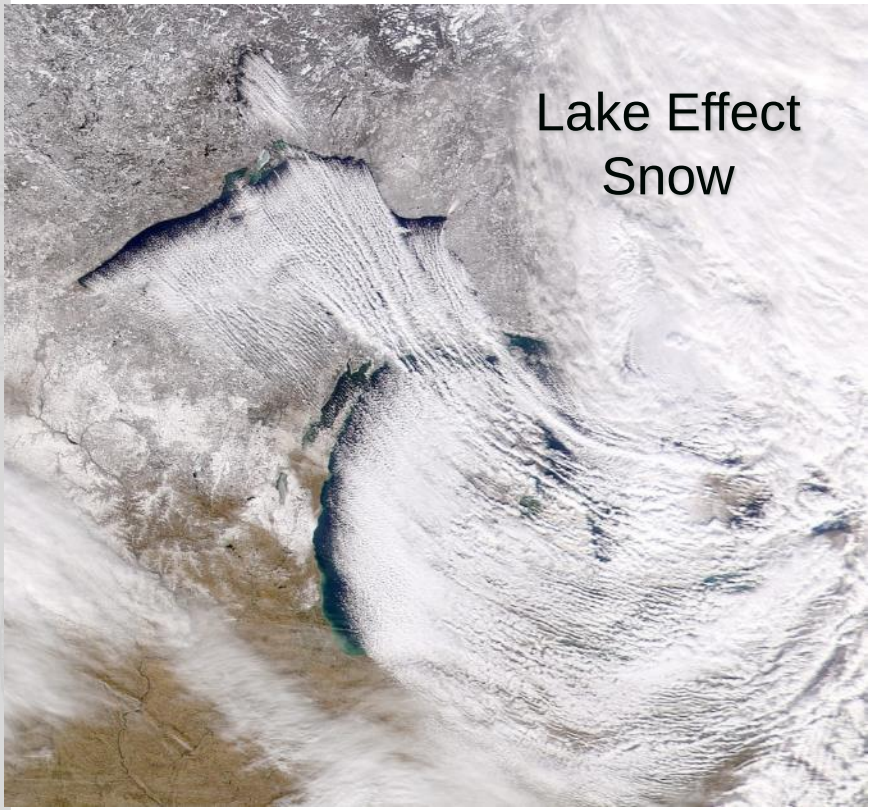
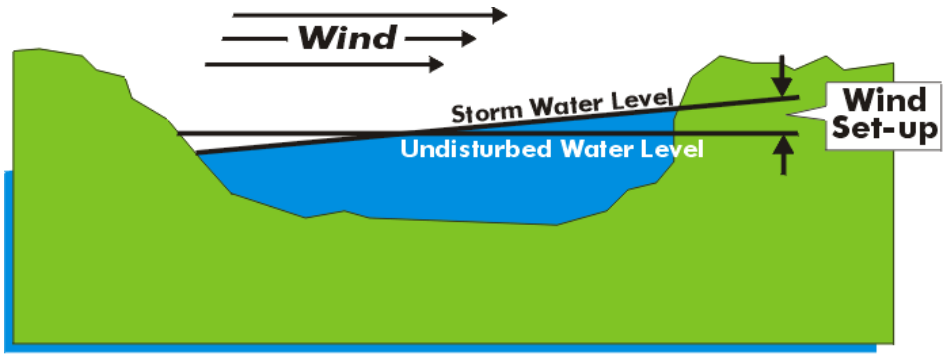
Forces of Nature

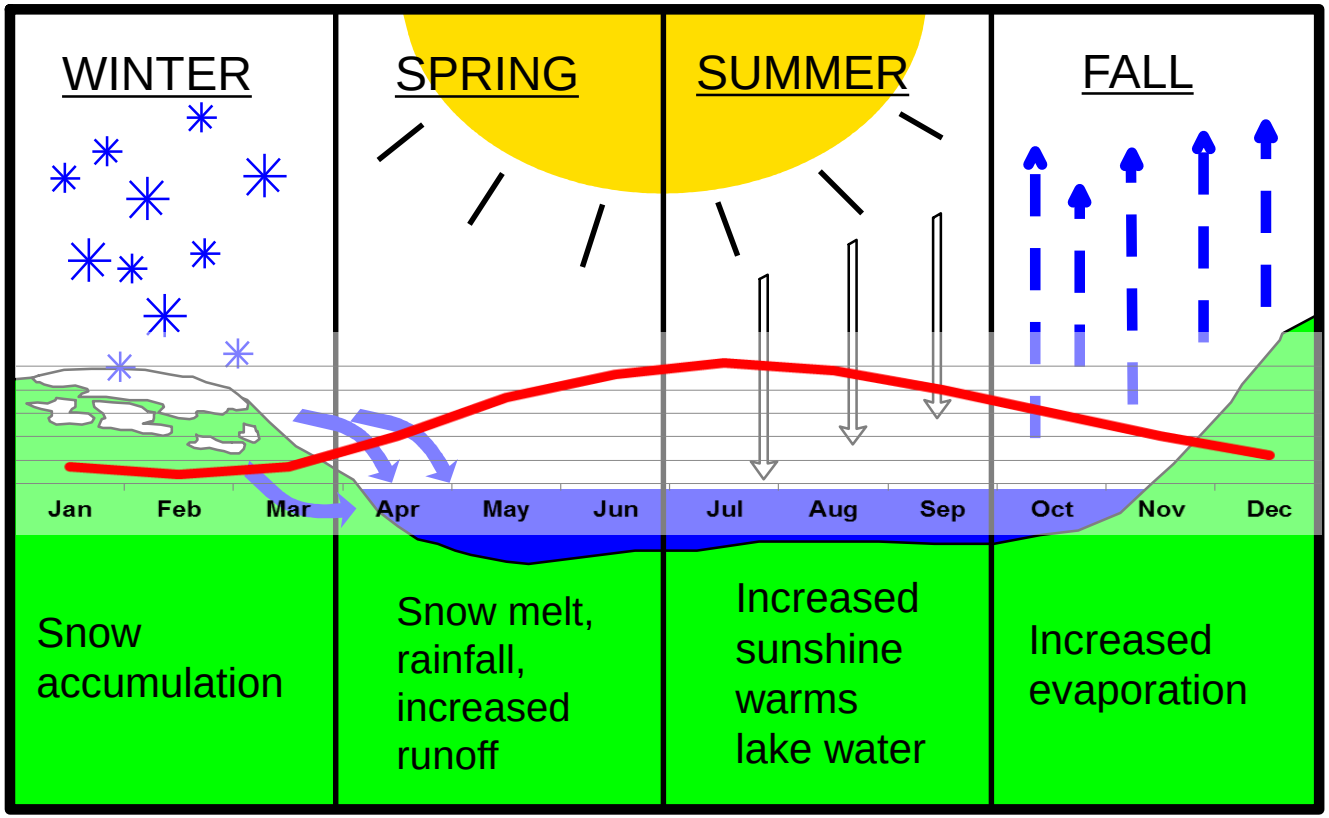


Surge/Seiche and Set-down



Lake profile showing wind set-up

ANNUAL WATER LEVELS AND THE HYDROLOGIC CYCLE



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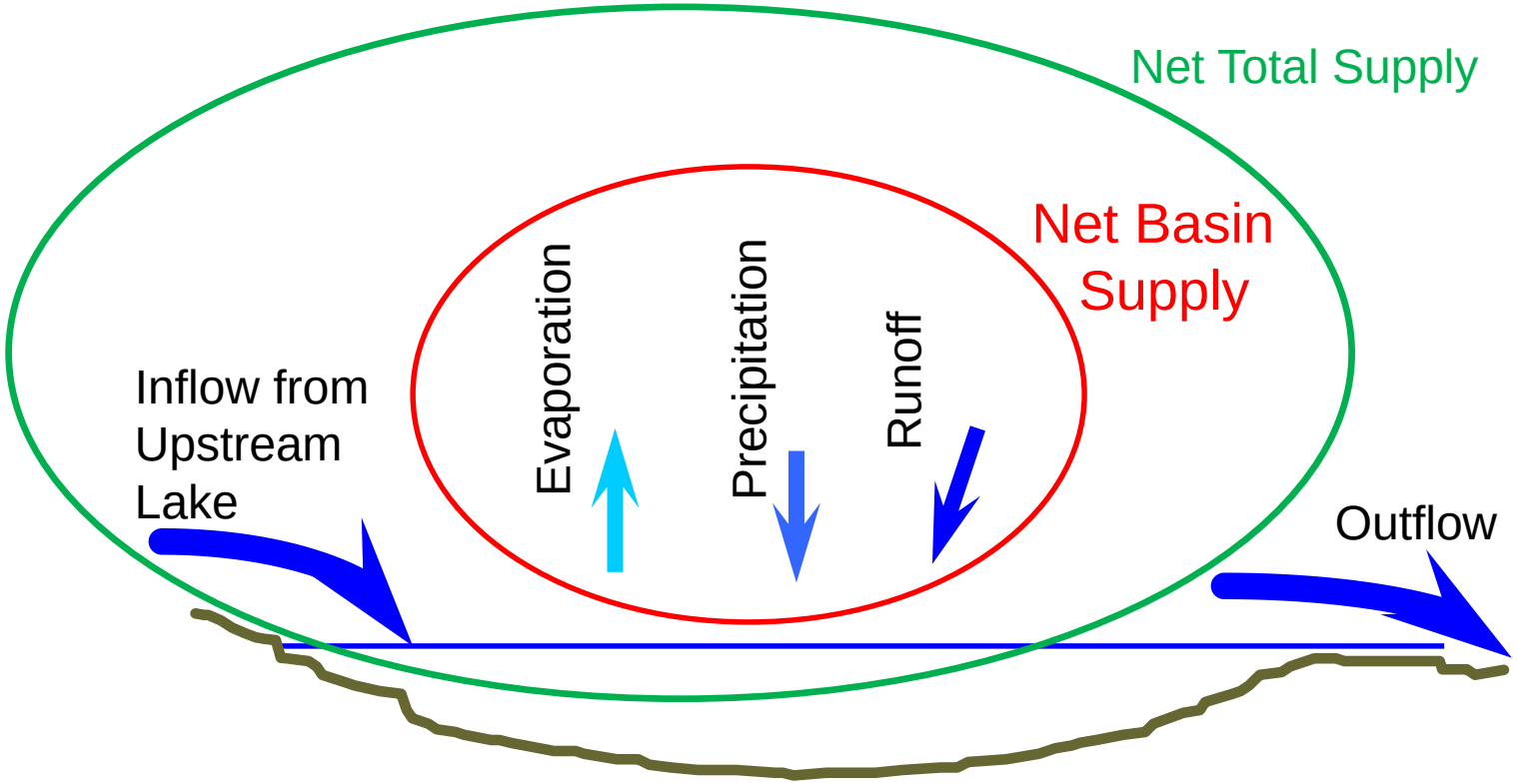
FACTORS IMPACTING WATER LEVELS



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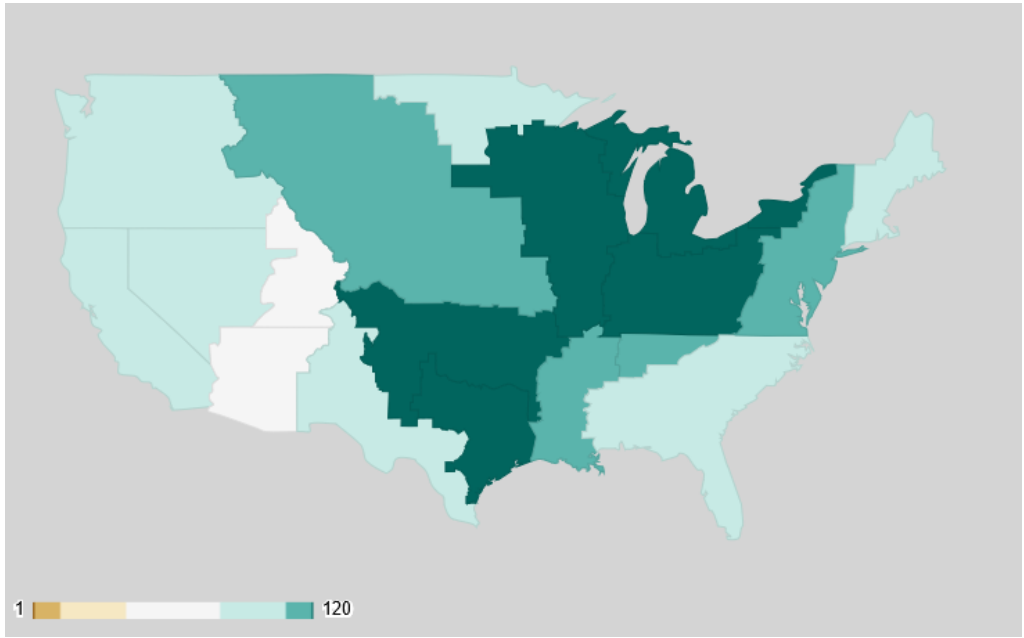
60 MONTH PRECIPITATION RANKS



The 60 month period ending 31 OCT was the wettest in 120 years of record for the Great Lakes Basin

NOAA National Centers for Environmental information, Climate at a Glance: Regional Mapping, published October 2019, retrieved on November 4, 2019 from https://www.ncdc.noaa.gov/cag/

REGION	VALUE	RANK (120 YEARS)	1901-2000 MEAN	ANOMALY
Great Lakes Basin	190.16"	120	163.87"	26.29"

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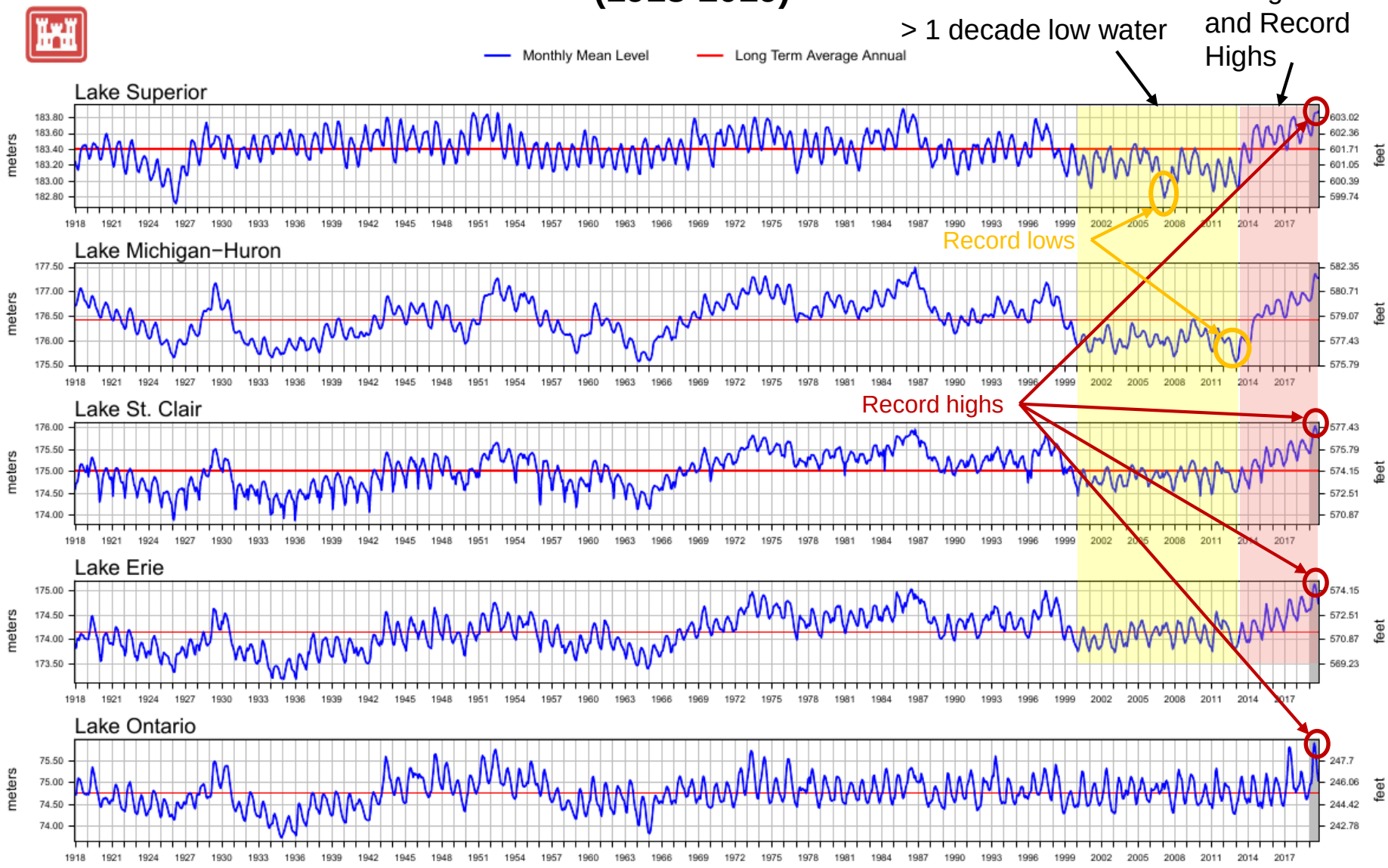
GREAT LAKES WATER LEVELS (1918-2019)



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Elevations are referenced to the International Great Lakes Datum (1985).

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2012 VS. 2019 ON THE ST. CLAIR RIVER

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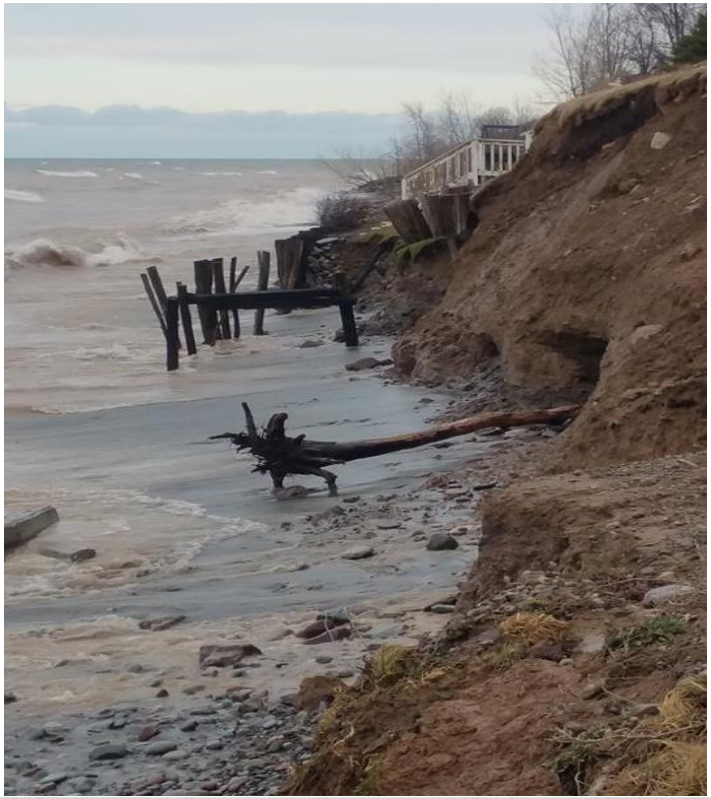
HIGH WATER LEVEL IMPACTS

- Shoreline erosion
  - Less beach
- Property damage
- Greater impact from seiche (wind) events
- Ice jams produce greater chance for flooding

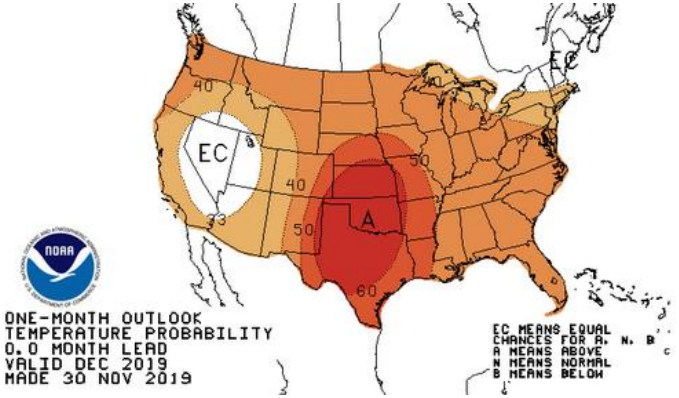


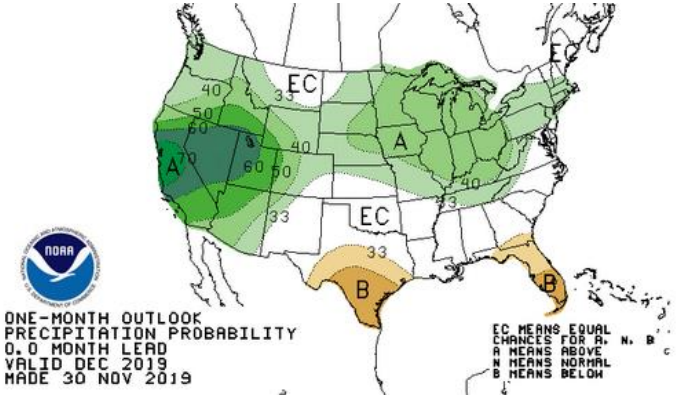
LOOKING AHEAD…WETTER THAN NORMAL

TEMPERATURE

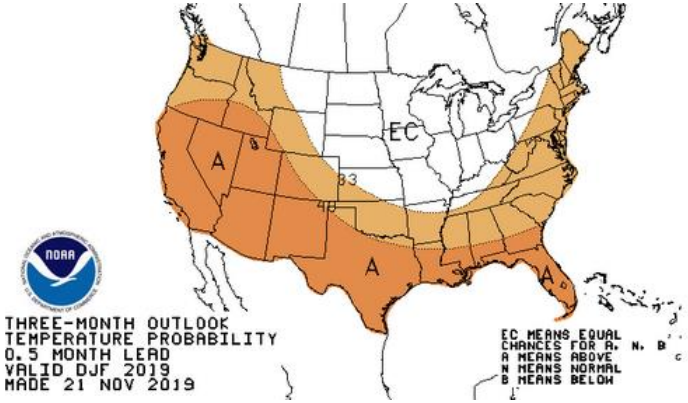
PRECIPITATION

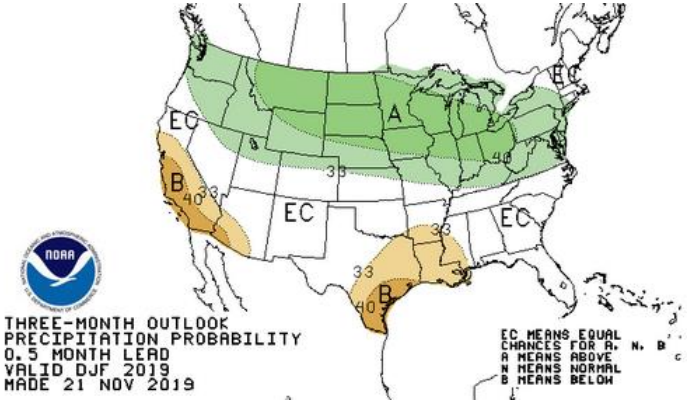
ONE MONTH OUTLOOK





THREE MONTH OUTLOOK





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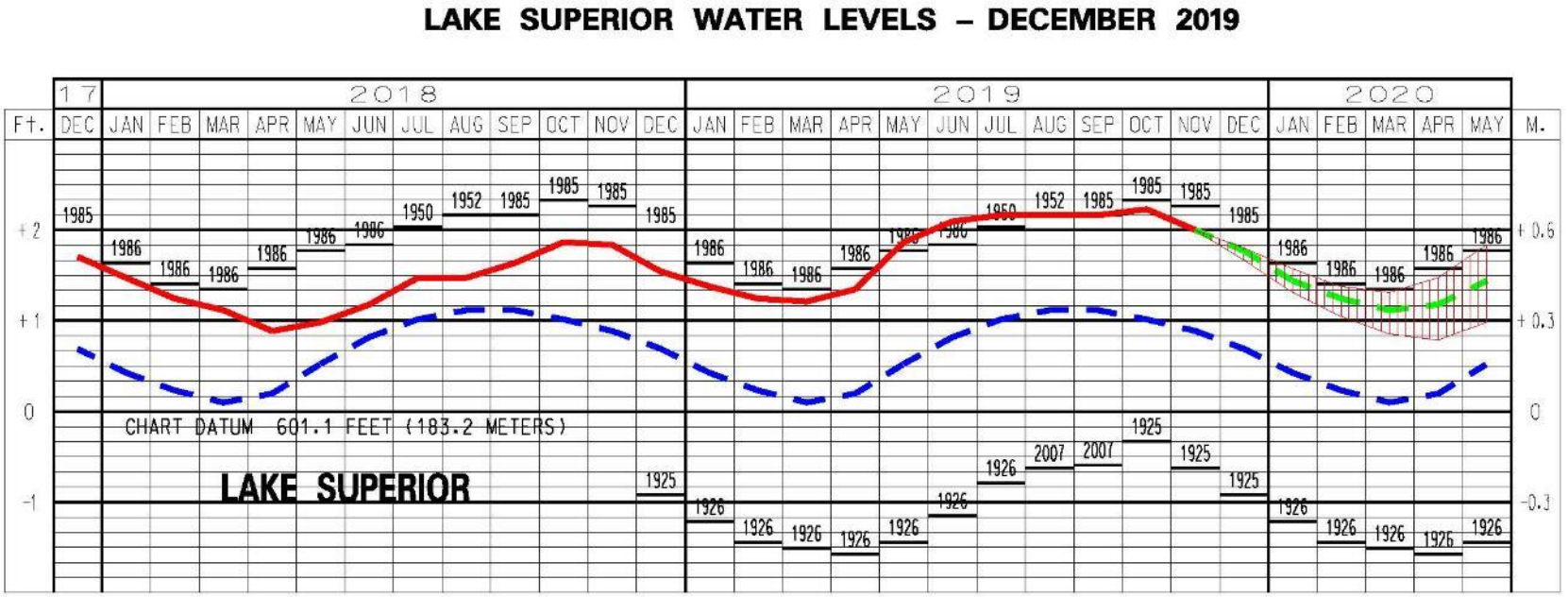
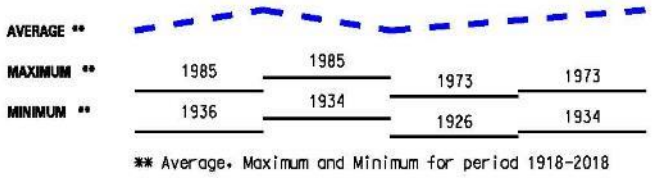
WHAT COULD HAPPEN IN THE NEXT 6 MONTHS?





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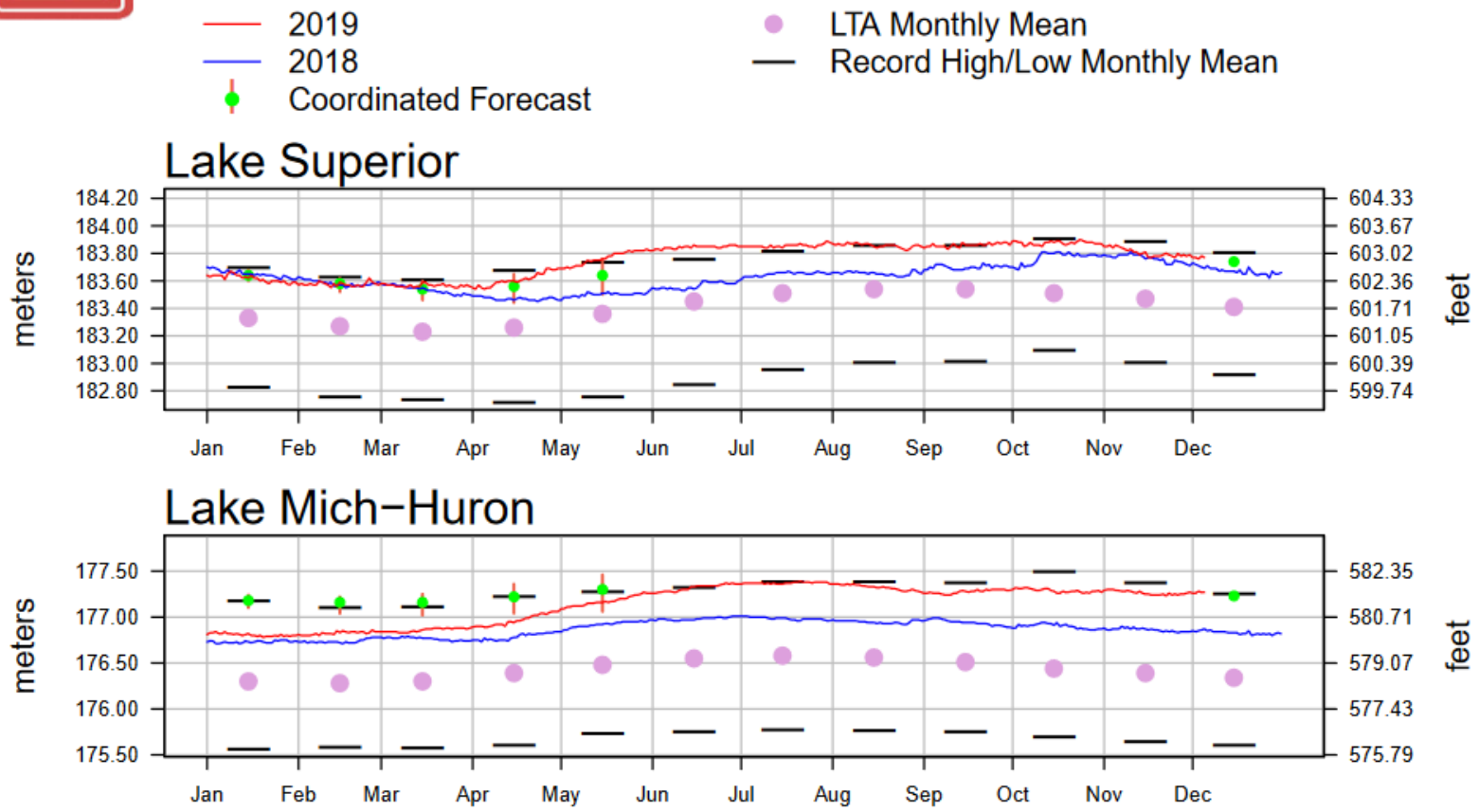
Daily Great Lakes Water Levels



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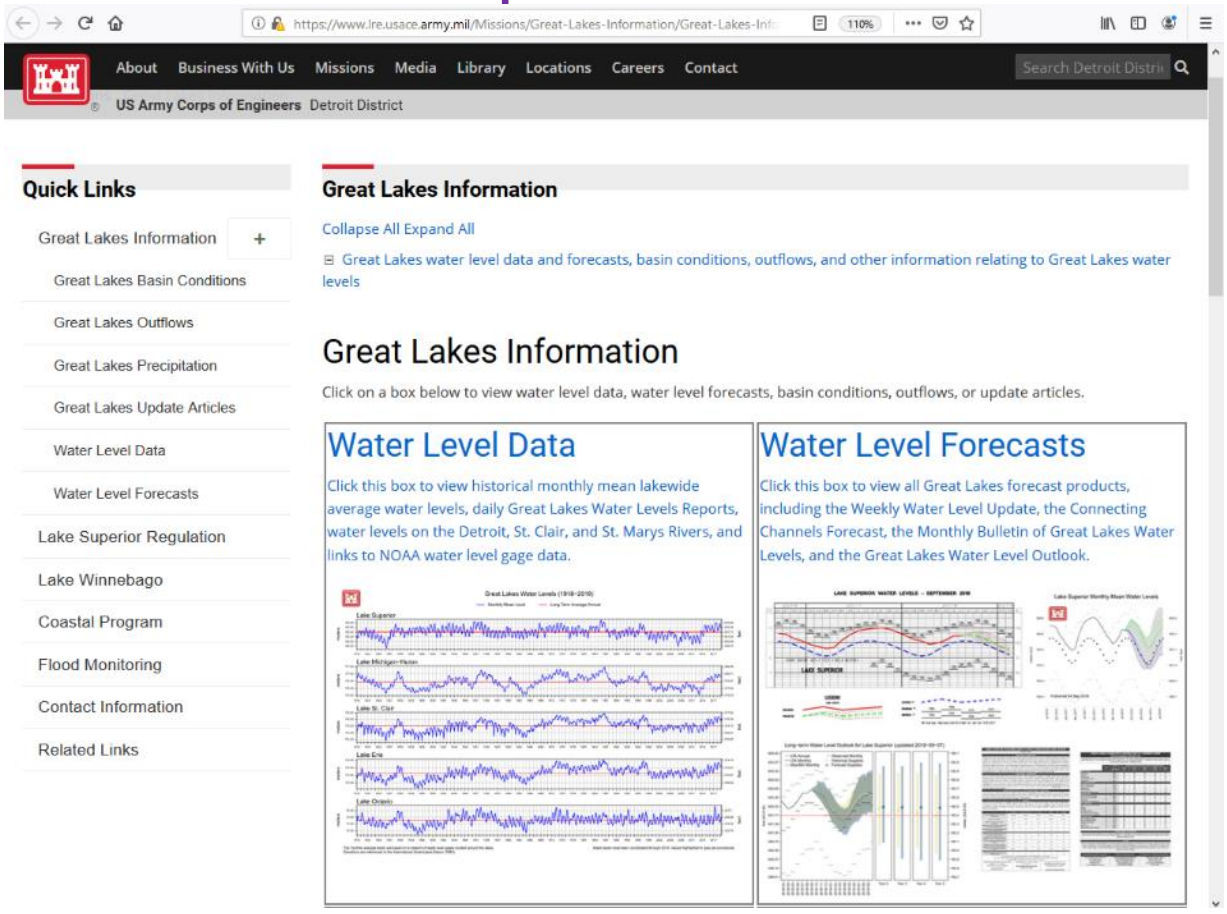
LATEST WATER LEVEL INFORMATION

https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Information.aspx



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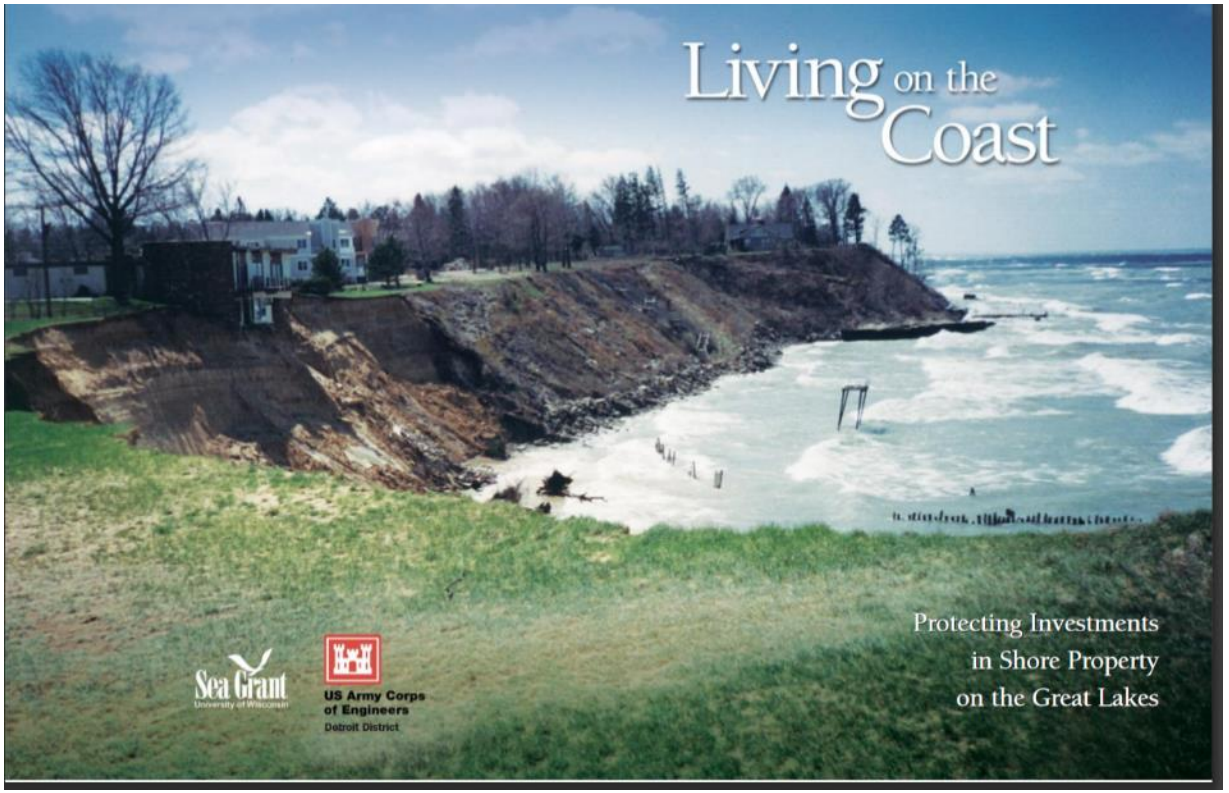
LIVING ON THE COAST

https://ijc.org/en/glam/watershed/questionnaire/high-water-levels-2019



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QUESTIONS?

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EXTRA SLIDES

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ST. CLAIR RIVER ICE JANUARY 6, 2018

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ST. CLAIR RIVER ICE JAM IMPACTS JANUARY 6, 2018

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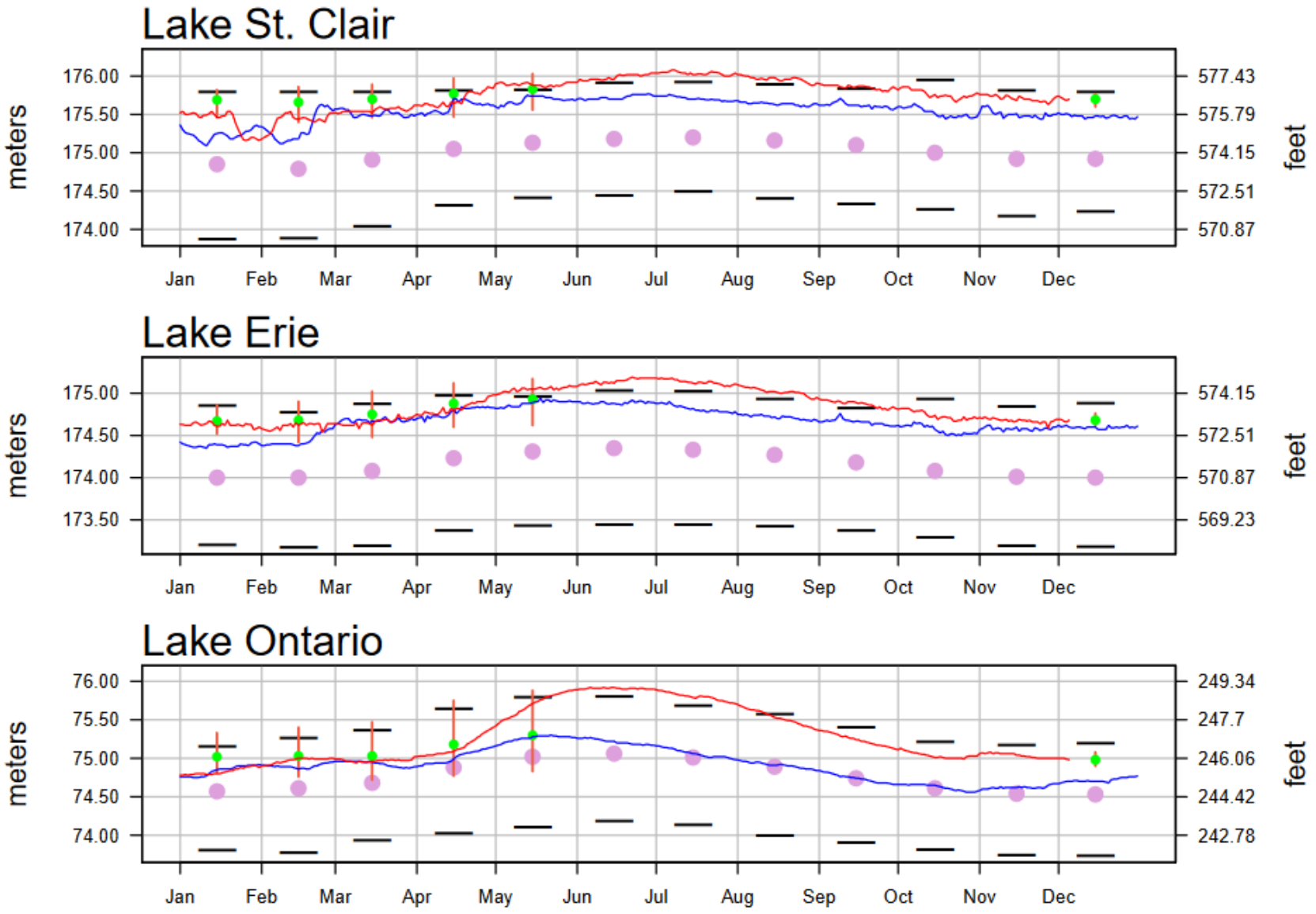

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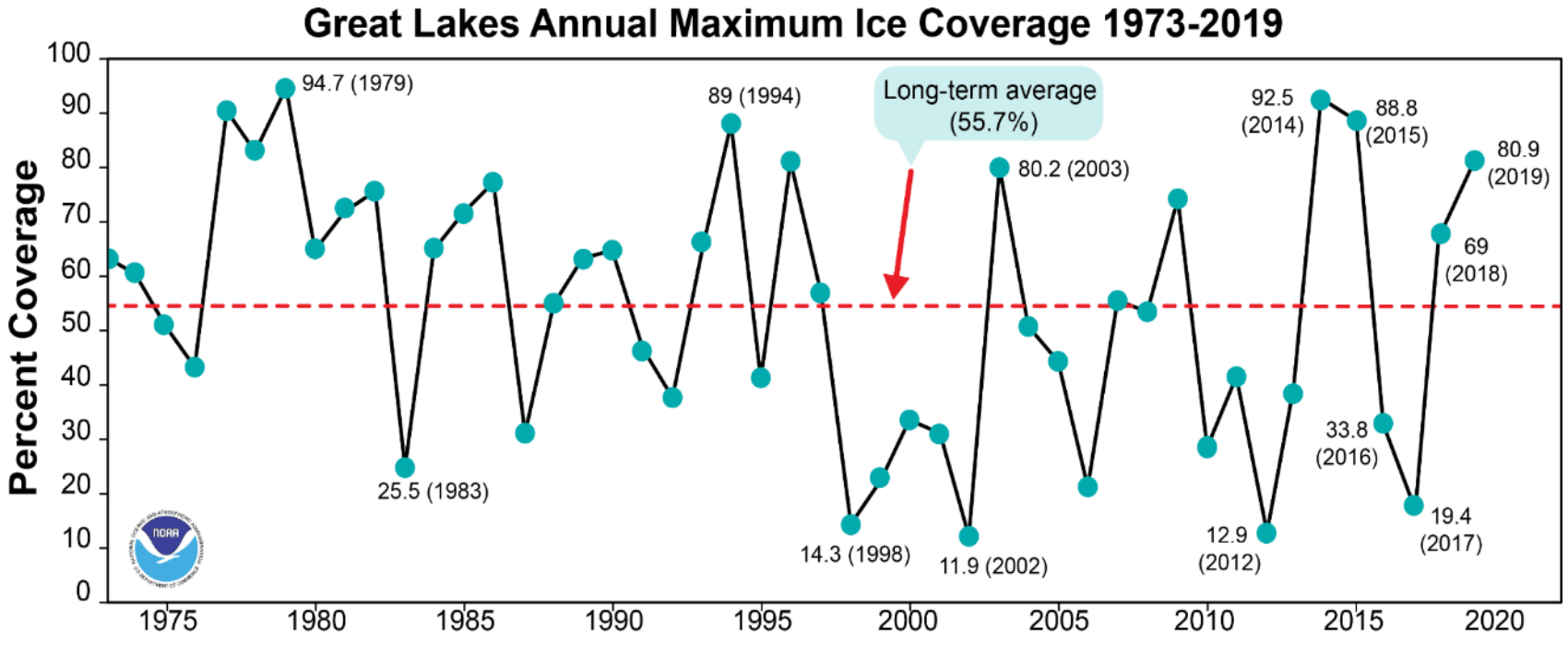
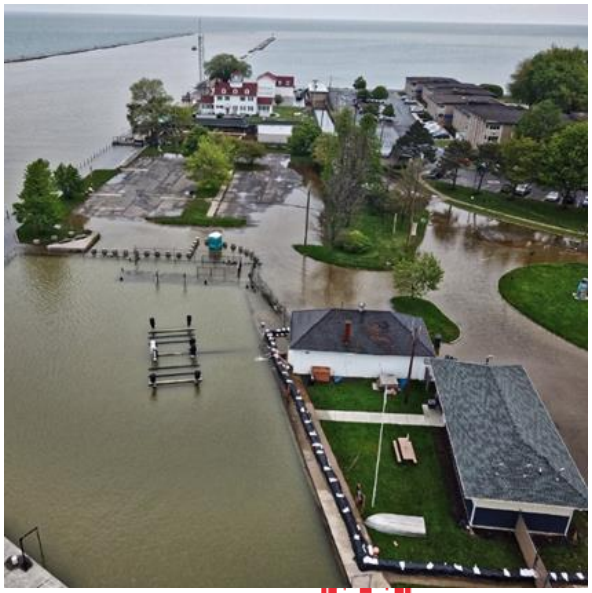

Great Lakes Annual Maximum Ice Coverage 1973-2019
Percent Coverage
100
90
80
70
60
50
40
30
20
10
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
94.7 (1979)
25.5 (1983)
89 (1994)
14.3 (1998)
11.9 (2002)
Long-term average
(55.7%)
80.2 (2003)
92.5
(2014)
12.9
(2012)
88.8
(2015)
33.8
(2016)
19.4
(2017)
69
(2018)
80.9
(2019)
NOAA

HIGH WATER PHOTOS



Courtesy of USCG and the Port of Monroe, MI

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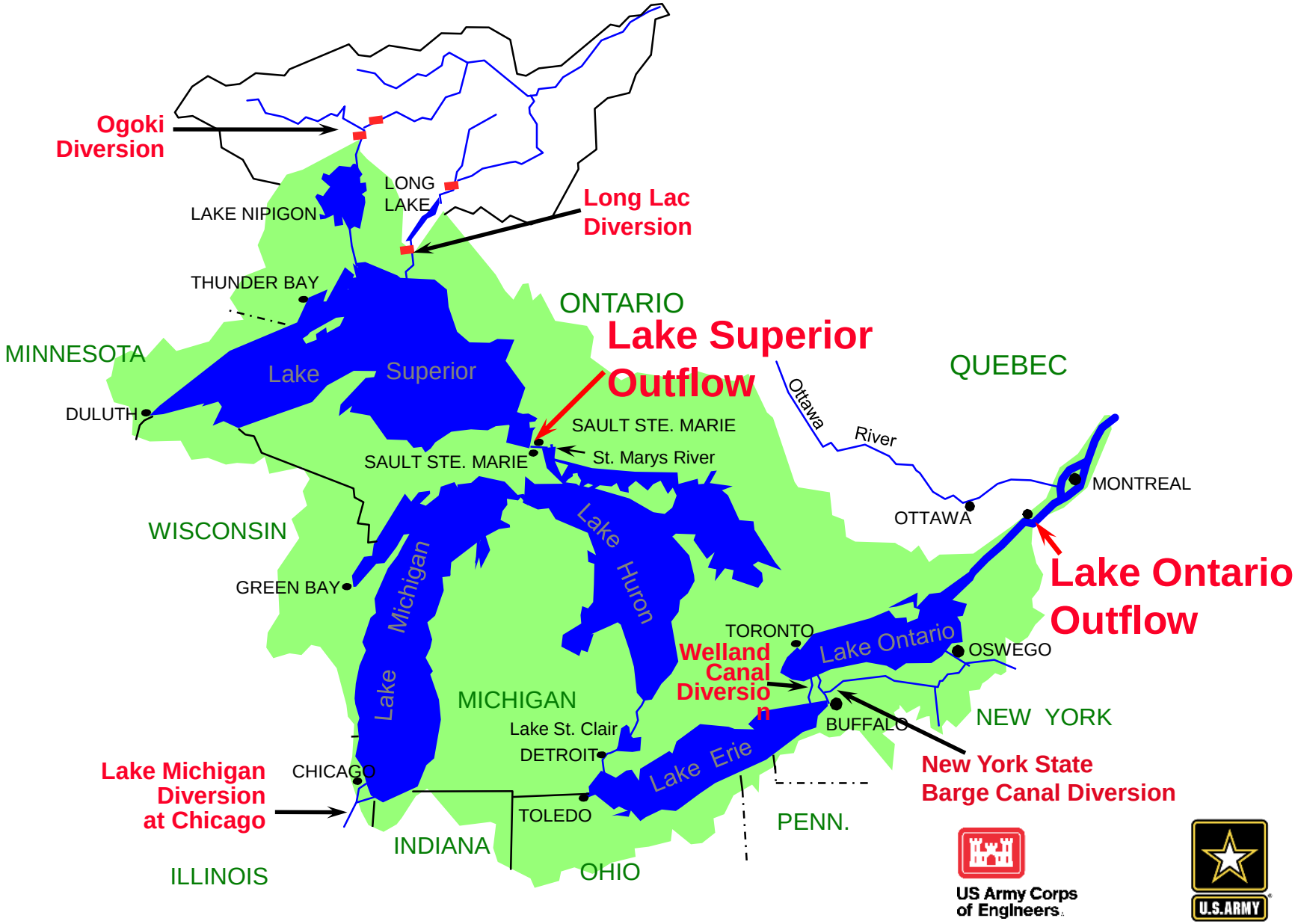
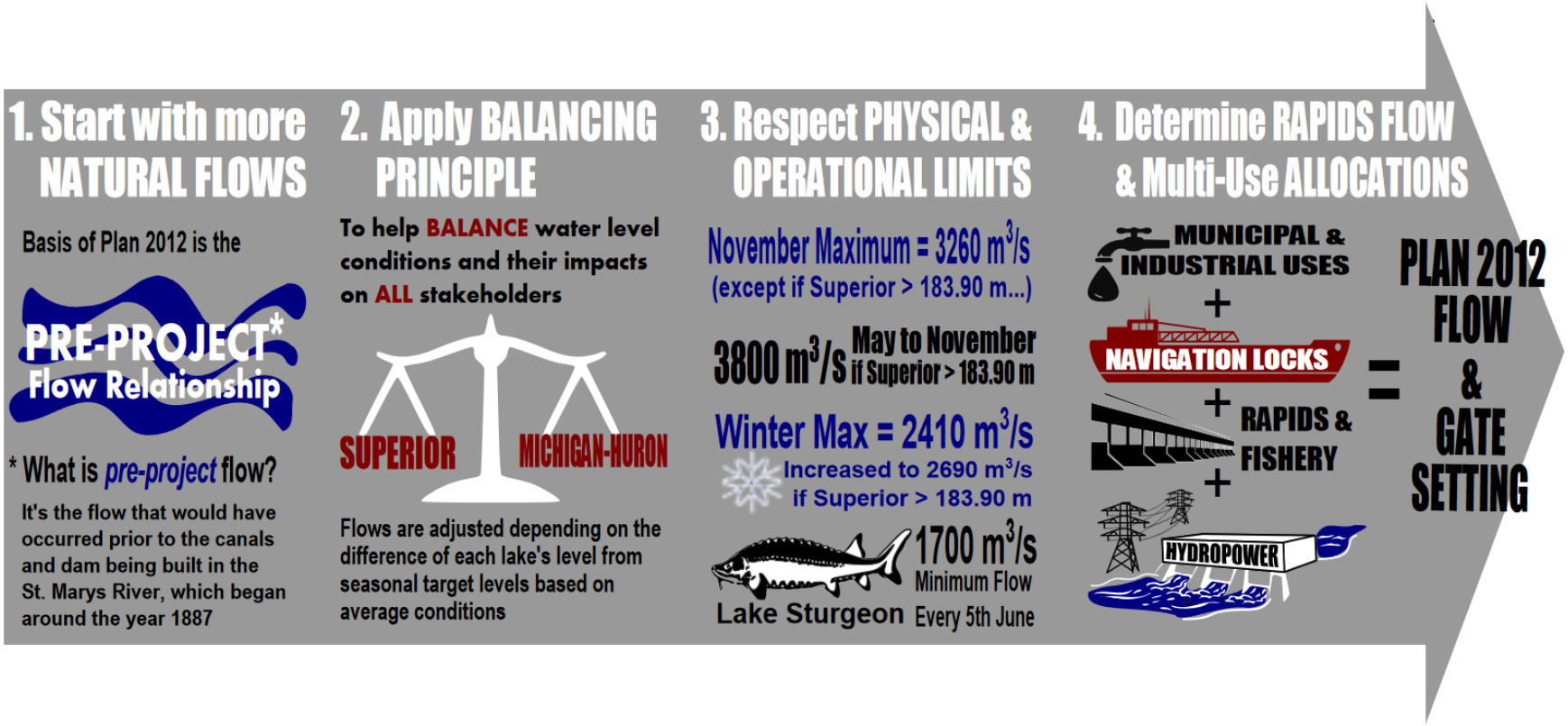
Great Lakes Regulation and Diversions



PLAN 2012



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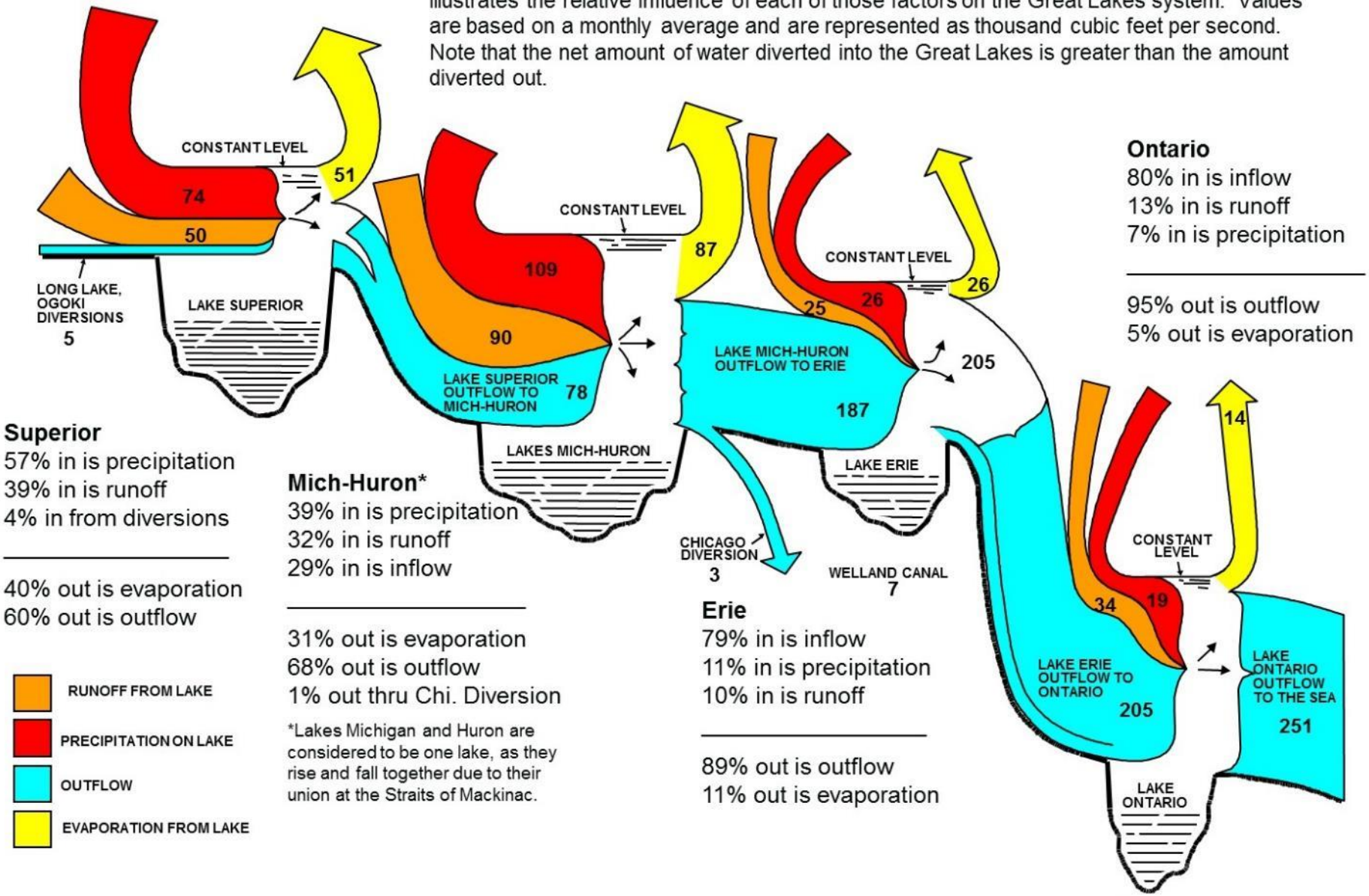
Hydrologic Components

Flow from upstream lakes, evaporation and precipitation influence lake levels. This graph illustrates the relative influence of each of those factors on the Great Lakes system. Values are based on a monthly average and are represented as thousand cubic feet per second. Note that the net amount of water diverted into the Great Lakes is greater than the amount diverted out.



Superior
57% in is precipitation
39% in is runoff
4% in from diversions

40% out is evaporation
60% out is outflow

Mich-Huron*
39% in is precipitation
32% in is runoff
29% in is inflow

31% out is evaporation
68% out is outflow
1% out thru Chi. Diversion

*Lakes Michigan and Huron are considered to be one lake, as they rise and fall together due to their union at the Straits of Mackinac.

Erie
79% in is inflow
11% in is precipitation
10% in is runoff

89% out is outflow
11% out is evaporation

Ontario
80% in is inflow
13% in is runoff
7% in is precipitation

95% out is outflow
5% out is evaporation

CURRENT WATER LEVELS

Great Lakes
Water Levels (Feet)

Great Lakes Water Levels

The United States Army Corps of Engineers collects and disseminates this water level data in cooperation with NOAA and the Canadian Hydrographic Service. All data are provisional and are referenced to IGLD 1985. Blanks indicate data that are missing or not yet available.

Date	Superior*	Michigan Huron*	St. Clair*	Erie*	Ontario*
	Daily Mean	Daily Mean	Daily Mean	Daily Mean	Adj. Daily Mean
01-AUG-2019	603.25	581.90	577.52	574.47	248.34
02-AUG-2019	603.23	581.89	577.50	574.44	248.30
03-AUG-2019	603.25	581.88	577.45	574.40	248.26
04-AUG-2019	603.23	581.87	577.44	574.38	248.21
05-AUG-2019	603.22	581.87	577.42	574.37	248.16
06-AUG-2019	603.28	581.88	577.37	574.36	248.12
07-AUG-2019	603.25	581.87	577.38	574.37	248.13
08-AUG-2019	603.26	581.87	577.30	574.32	248.12
09-AUG-2019					
Mean:	603.25	581.88	577.42	574.39	248.21

August Statistics	*Historic Water Levels*				
	Superior	Michigan Huron	St. Clair	Erie	Ontario
Avg Last Month	603.20	581.93	577.56	574.59	248.69
Avg Last Year	602.54	580.54	576.24	573.22	245.76
Minimum	600.43 (2007)	576.67 (1964)	572.21 (1934)	569.00 (1934)	242.78 (1934)
Maximum	603.22 (1952)	581.99 (1986)	577.10 (1986)	573.95 (1986)	247.97 (1947)
Long Term Avg**	602.17	579.27	574.67	571.75	245.70

* Mean levels are calculated by averaging the best available gage data at report generation and are subject to change.
** Period of Record 1918 - 2018

NOTES ABOUT WATER LEVELS

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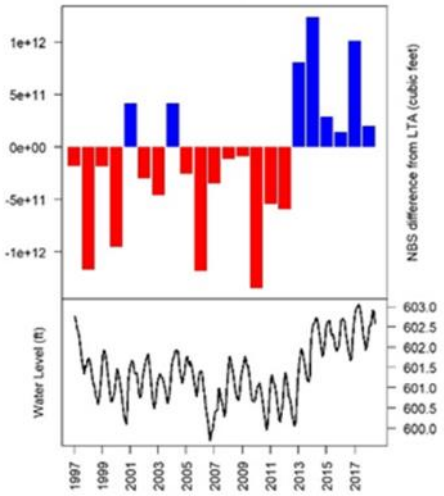
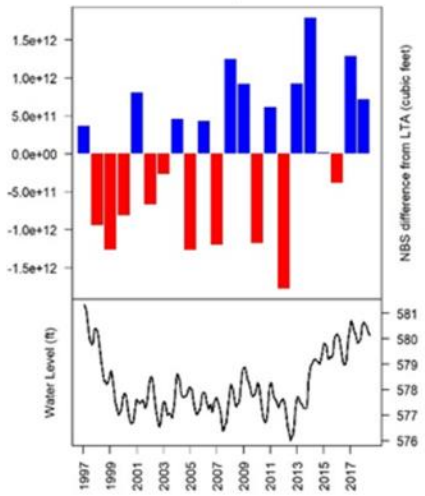
CONSECUTIVE YEARS OF ABOVE AVERAGE NET BASIN SUPPLY

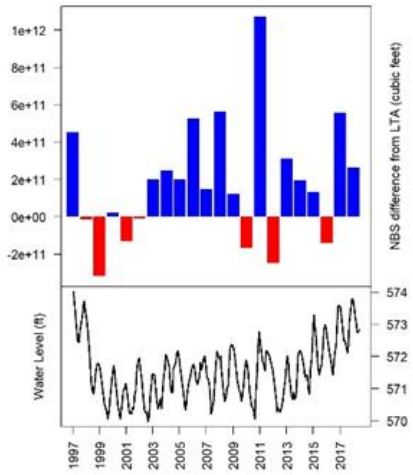
Lake Superior



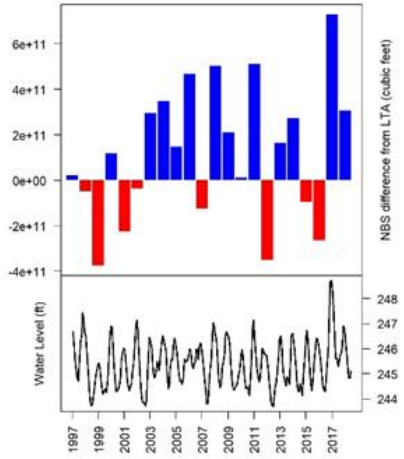
Lake Michigan-Huron



Lake Erie



Lake Ontario



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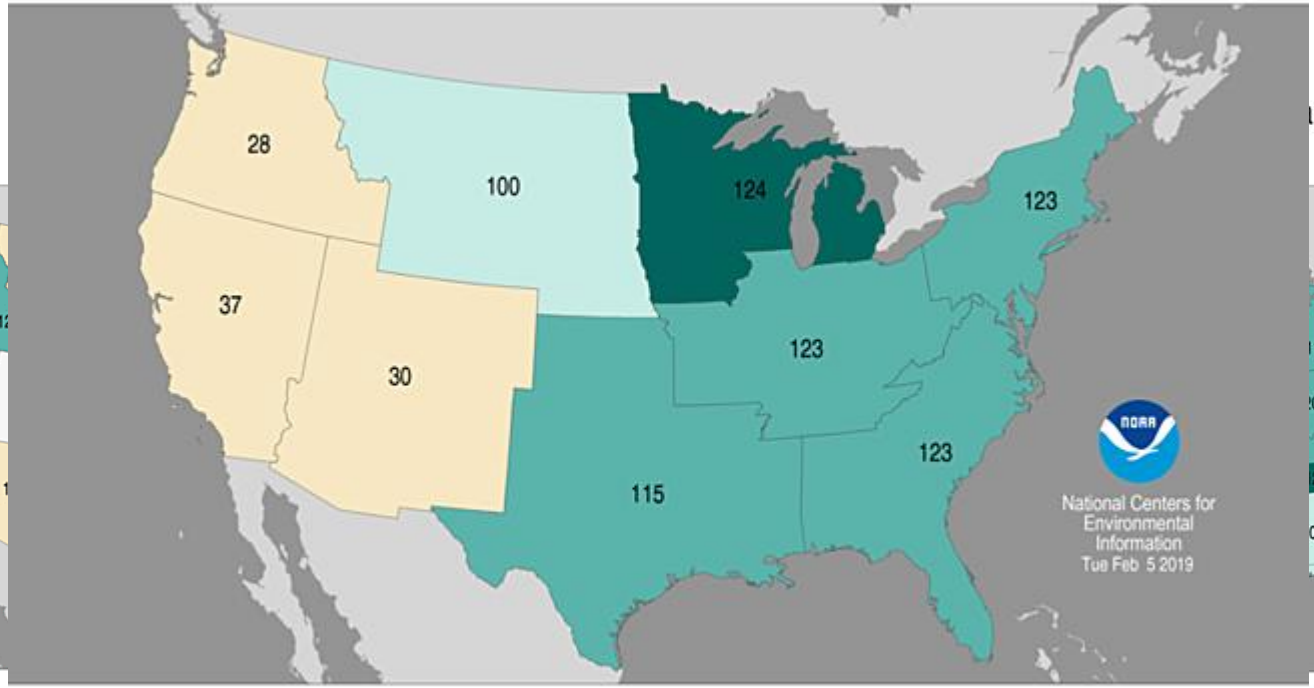
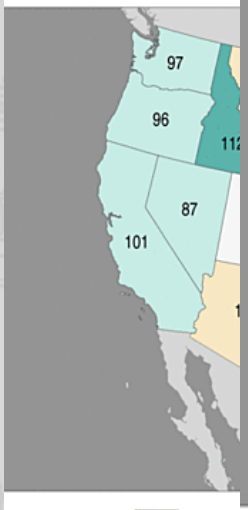
WET AGAIN IN 2017 AND 2018

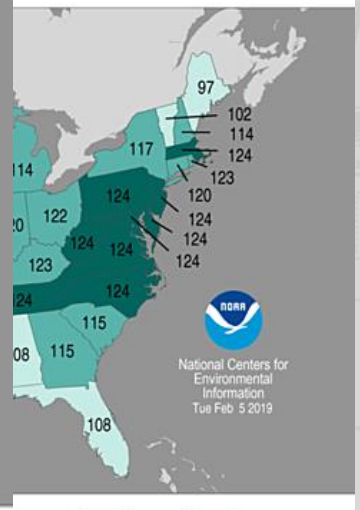
- 2017 was

est years on

nks







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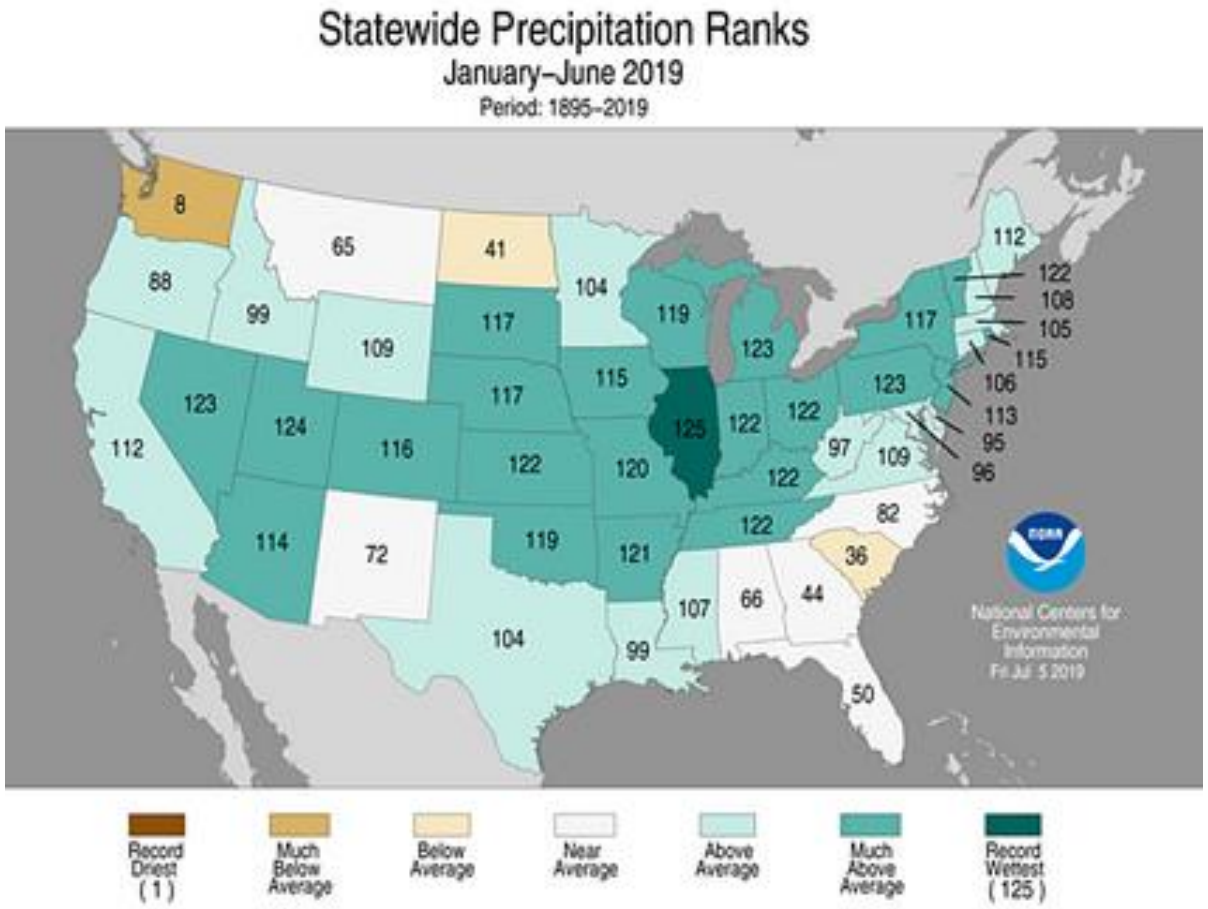
2019 THUS FAR…



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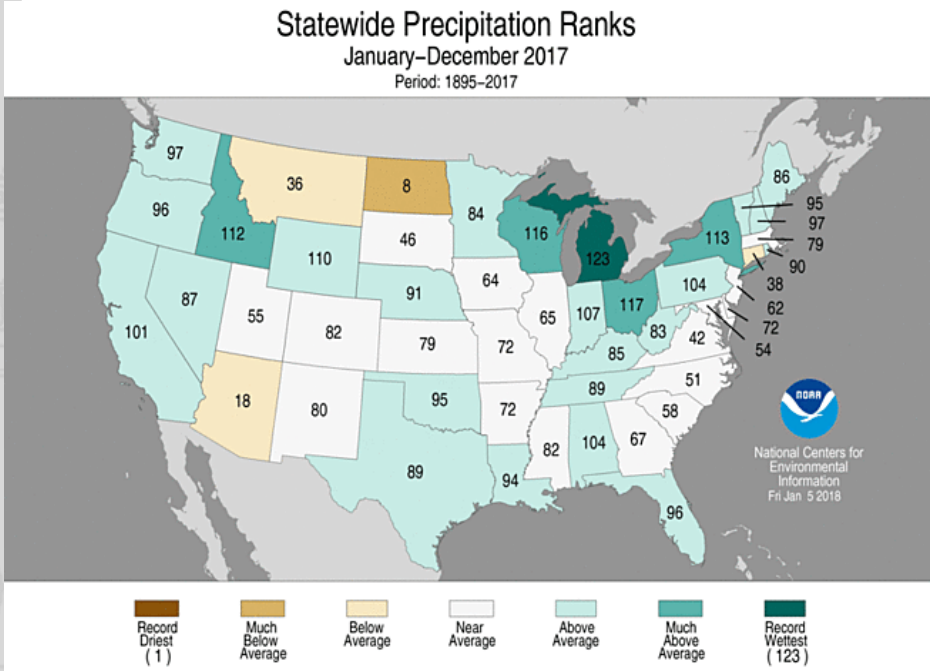
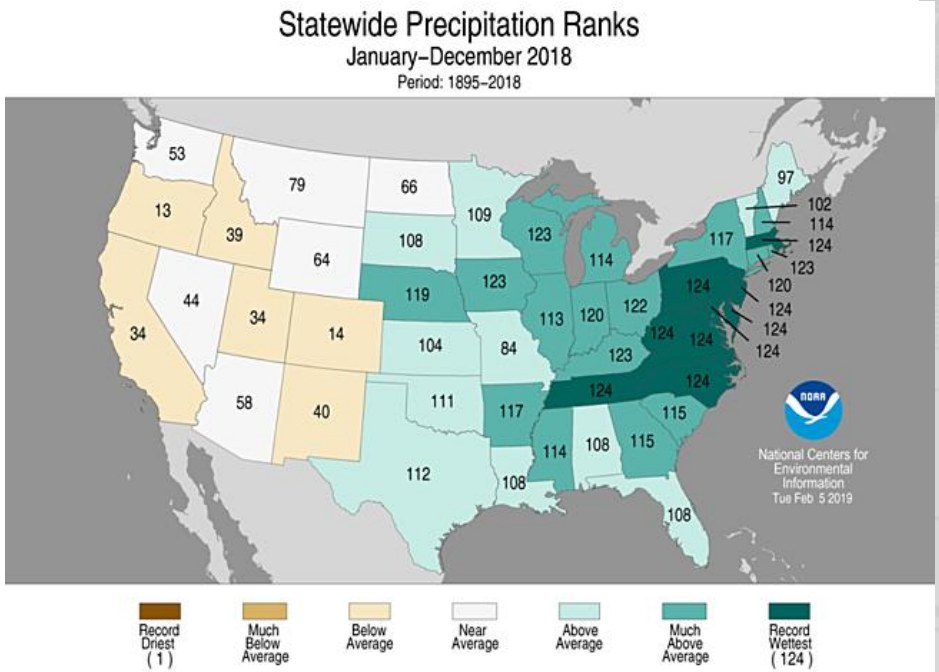
Wet again in 2017 and 2018

- **2017 was again wettest year on record in Michigan**
- **2018 was again one of the wettest years on record**





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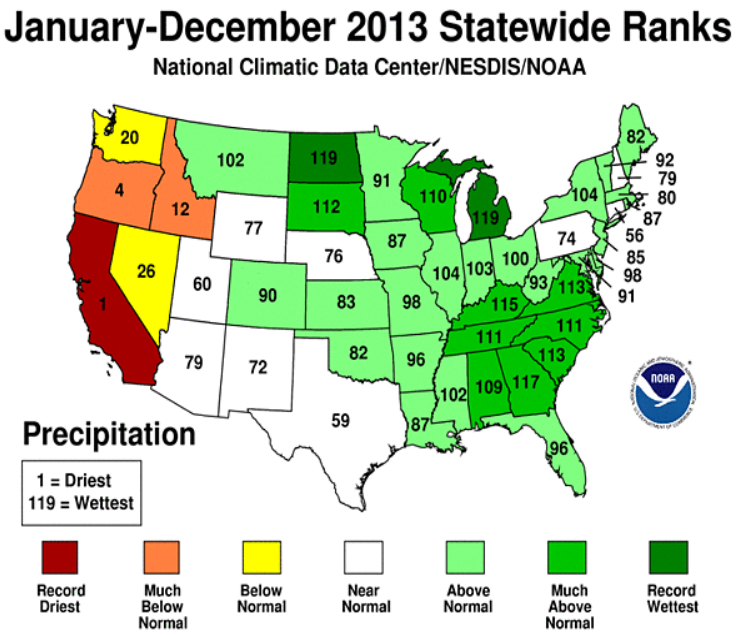
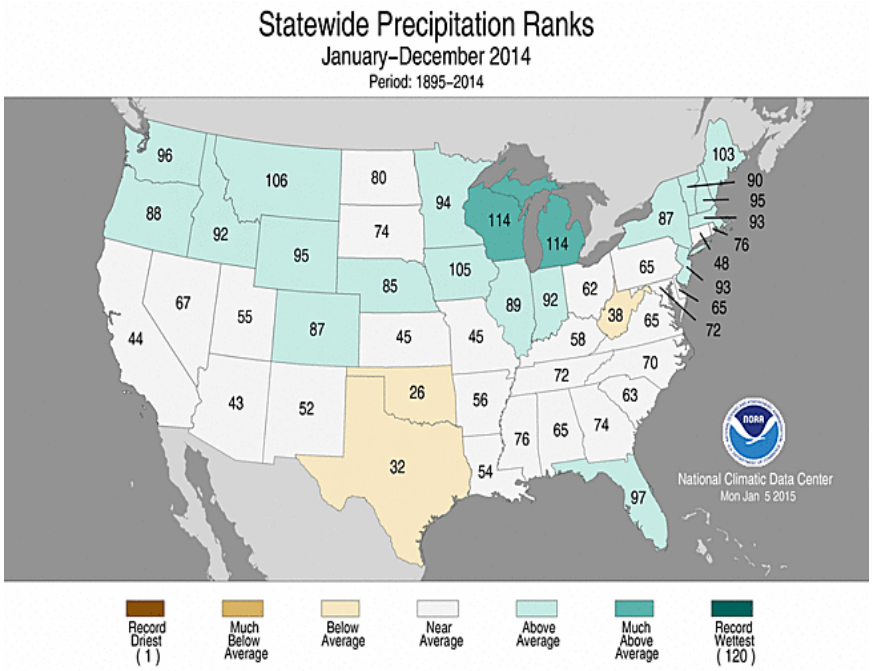
WET 2013, COLD AND SNOWY 2014

- 2013 was the wettest year on record for the state of Michigan



- 2013 was followed by a well above average wet 2014



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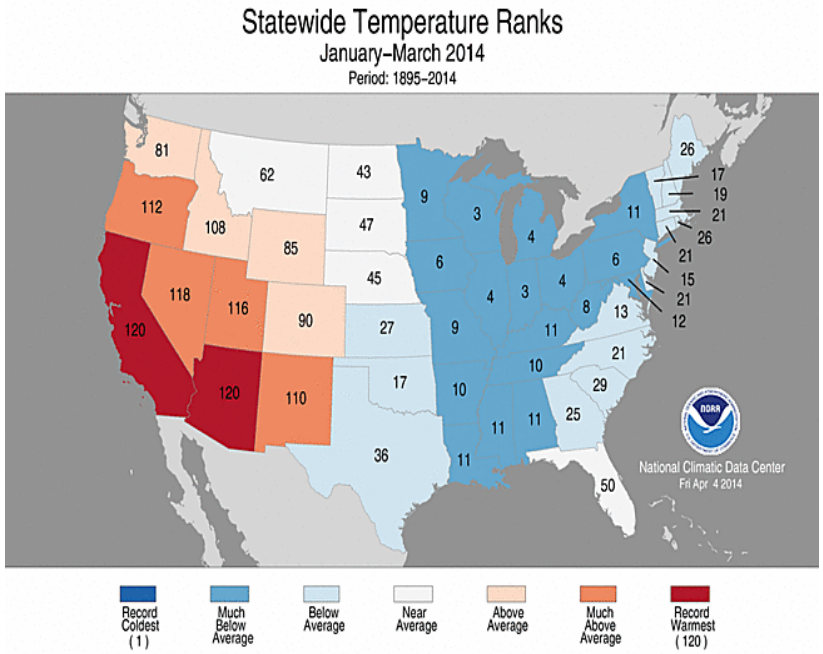
WET 2013, COLD AND SNOWY 2014

- Below average air temperatures during the winter of 2014



- Near record high ice cover throughout the Great Lakes in 2014

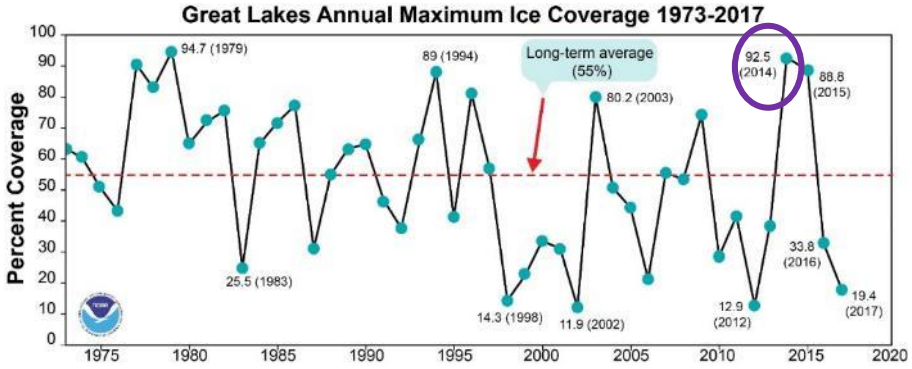


Photo credit: NASA

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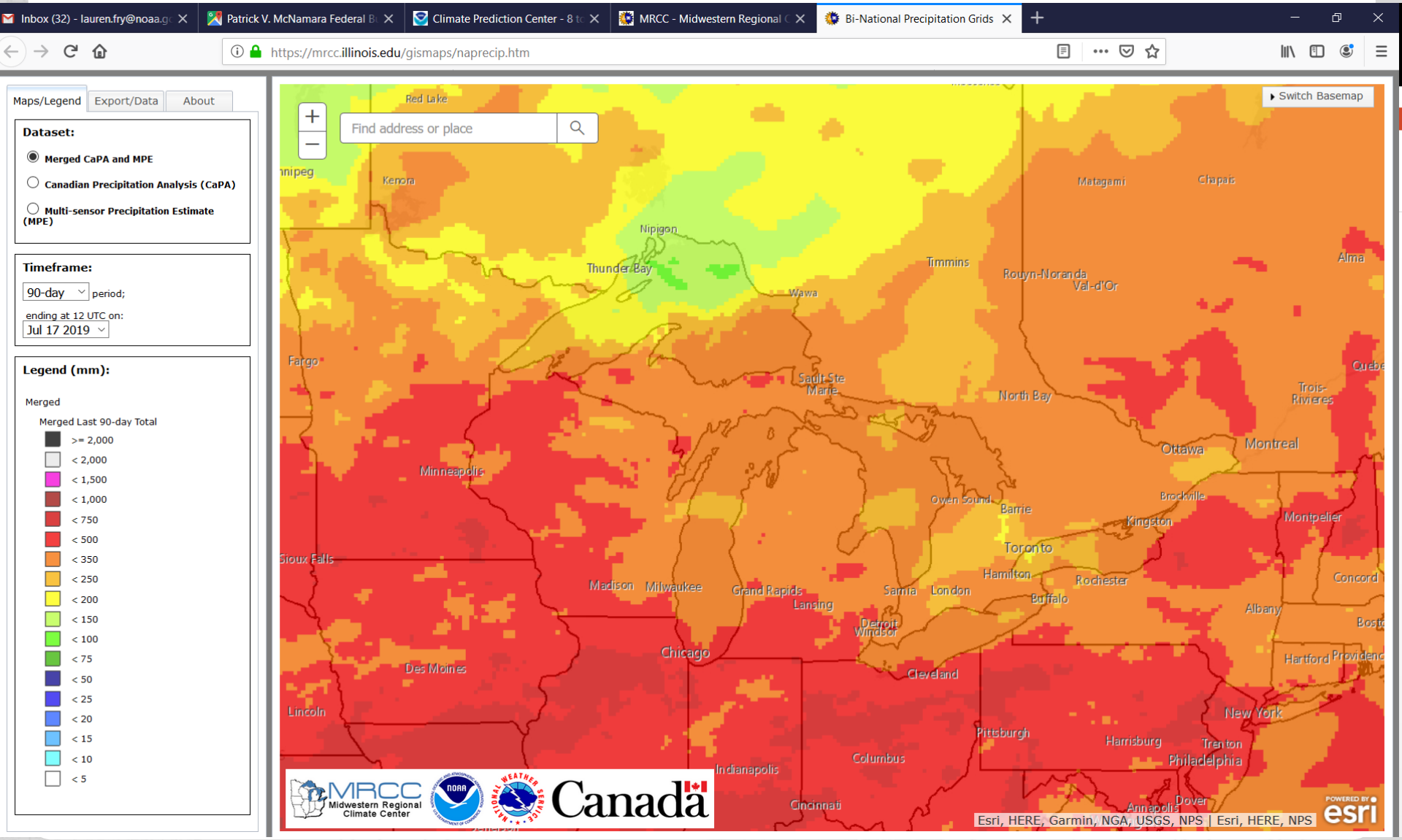
AND NOW, 2019…


Inbox (32) - lauren.fry@noaa.g
Patrick V. McNamara Federal B
Climate Prediction Center - 8 to
MRCC - Midwestern Regional C
Bi-National Precipitation Grids
https://mrcc.illinois.edu/gismaps/naprecip.htm
Maps/Legend
Export/Data
About
Dataset:
Merged CaPA and MPE
Canadian Precipitation Analysis (CaPA)
Multi-sensor Precipitation Estimate (MPE)
Timeframe:
90-day period;
ending at 12 UTC on:
Jul 17 2019
Legend (mm):
Merged
Merged Last 90-day Total
>= 2,000
< 2,000
< 1,500
< 1,000
< 750
< 500
< 350
< 250
< 200
< 150
< 100
< 75
< 50
< 25
< 20
< 15
< 10
< 5
Find address or place
Switch Basemap
Red Lake
Kenora
Nipigon
Thunder Bay
Wawa
Timmins
Matagami
Chapais
Rouyn-Noranda
Val-d'Or
Alma
Fargo
Sault Ste Marie
North Bay
Trois-Rivieres
Ottawa
Montreal
Minneapolis
Owen Sound
Barrie
Brockville
Kingston
Montpelier
Toronto
Sioux Falls
Madison
Milwaukee
Grand Rapids
Lansing
Hamilton
Rochester
Sarnia
London
Buffalo
Concord
Albany
Detroit
Windsor
Chicago
Des Moines
Cleveland
Hartford
Lincoln
New York
Pittsburgh
Harrisburg
Trenton
Philadelphia
Columbus
Indianapolis
Cincinnati
Annapolis
Dover
MRCC Midwestern Regional Climate Center
Canada
Esri, HERE, Garmin, NGA, USGS, NPS | Esri, HERE, NPS
POWERED BY esri

Credit: Brian Allnutt, Curbed Detroit

~ 5ft difference between Jan 2008 and May 2019

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Credit: newyorkupstate.com
- Maureen Morgan Whelan

Credit: The C
- Tom Hawley

Credit

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EMERGENCY RESPONSE

33 U.S.C. 701n (commonly referred to as Public Law (PL) 84-99):

USACE can support local natural disasters **supplementing** local resources just prior to or during an event.

Technical Assistance: Technical expertise in review of and recommendations in support of state and local efforts, and helping to determine feasible solutions.

Direct Assistance: Sandbags, plastic sheeting, HESCO barriers, for protection of **public infrastructure**

Currently providing Technical Assistance to the City of Detroit, Wayne County, Macomb County, and St. Clair County.

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LOW WATER IMPACTS

- Access issues
  - Boat docks, boat launches, and piers
- Navigation
  - Carry lighter loads
  - Groundings
- Increase in beach vegetation
- Increase dredging desired
- Less hydropower generation

Photo: National Geographic Blog Lisa Borre

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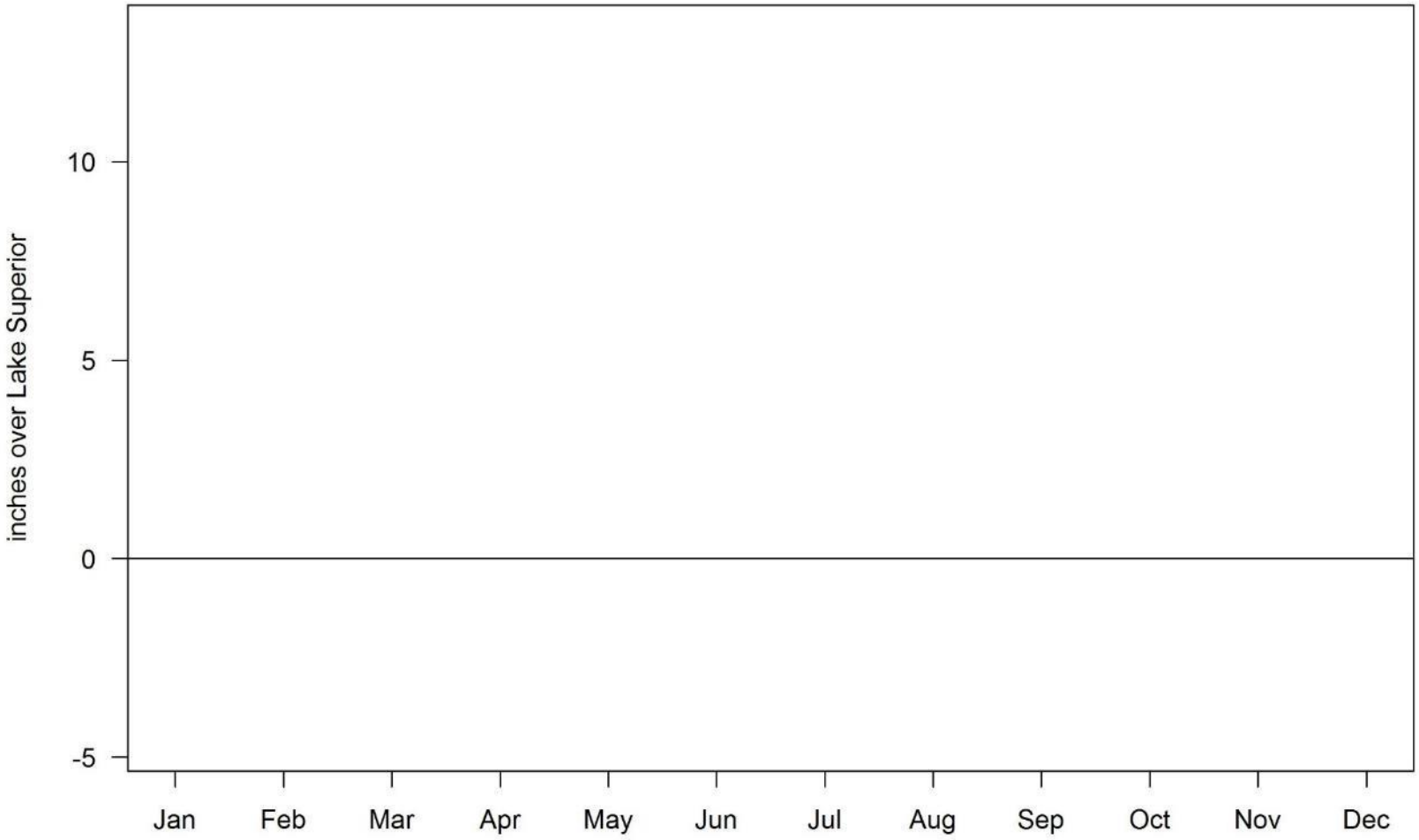
Lake Superior Inflows and Outflows



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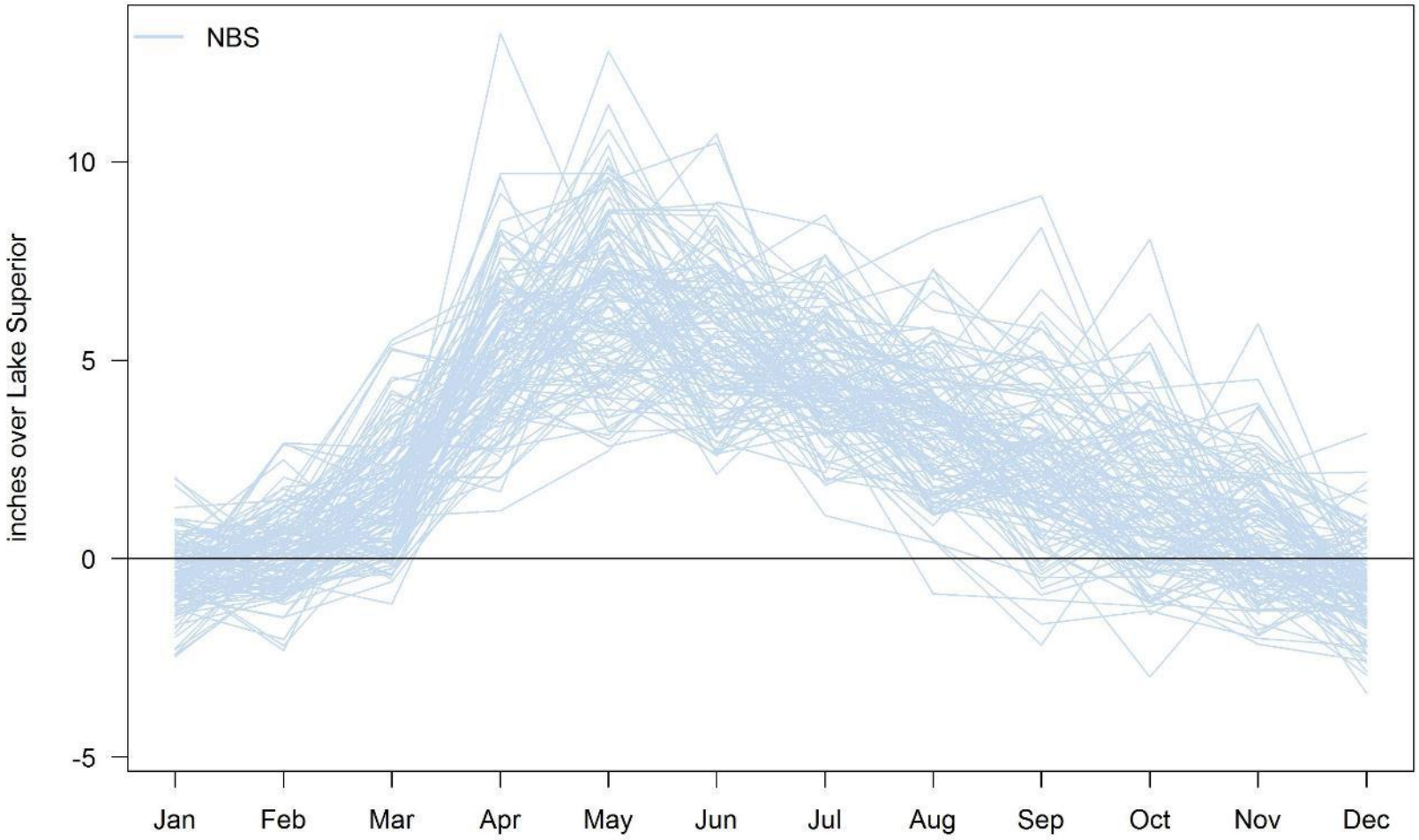
Lake Superior Inflows and Outflows



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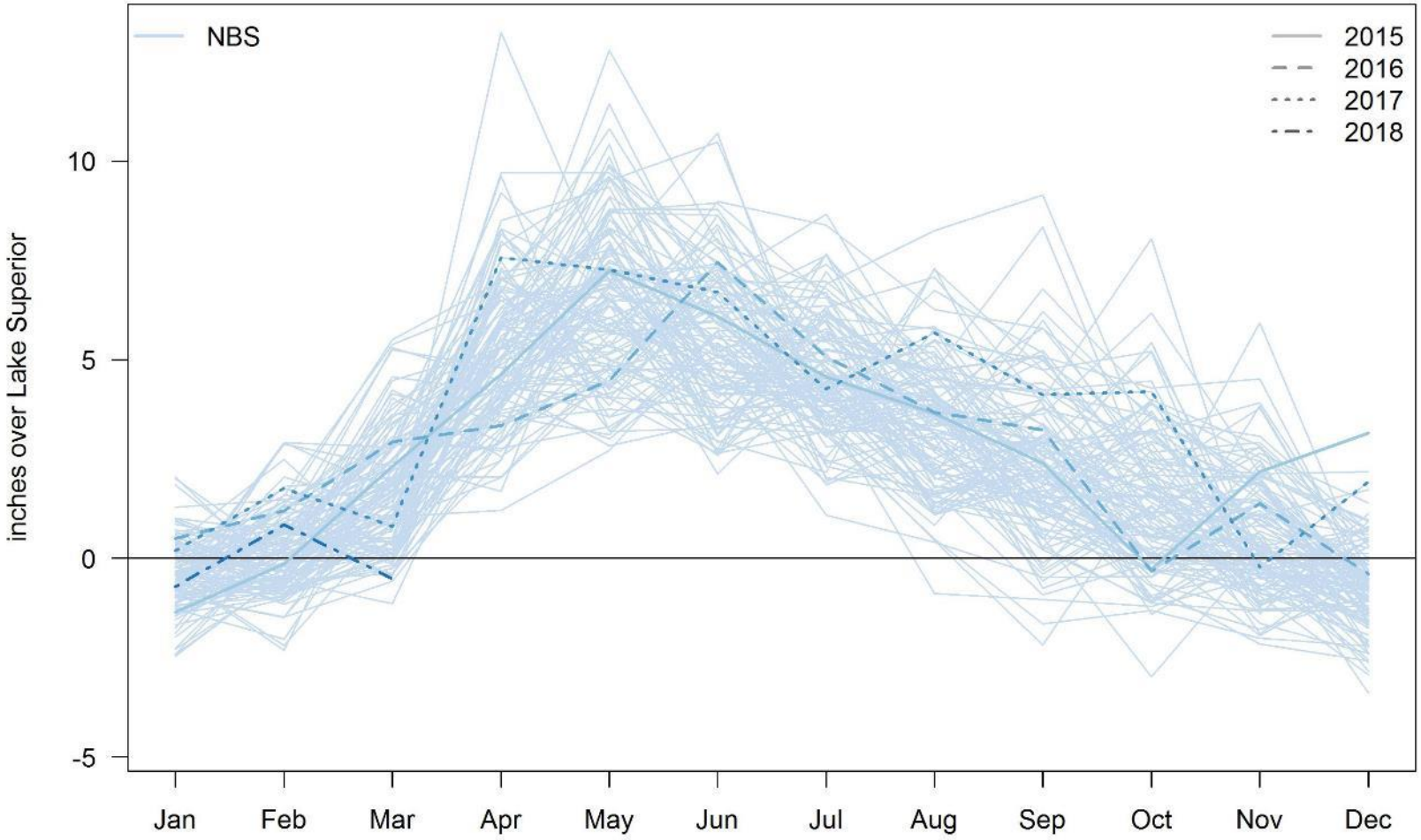
Lake Superior Inflows and Outflows



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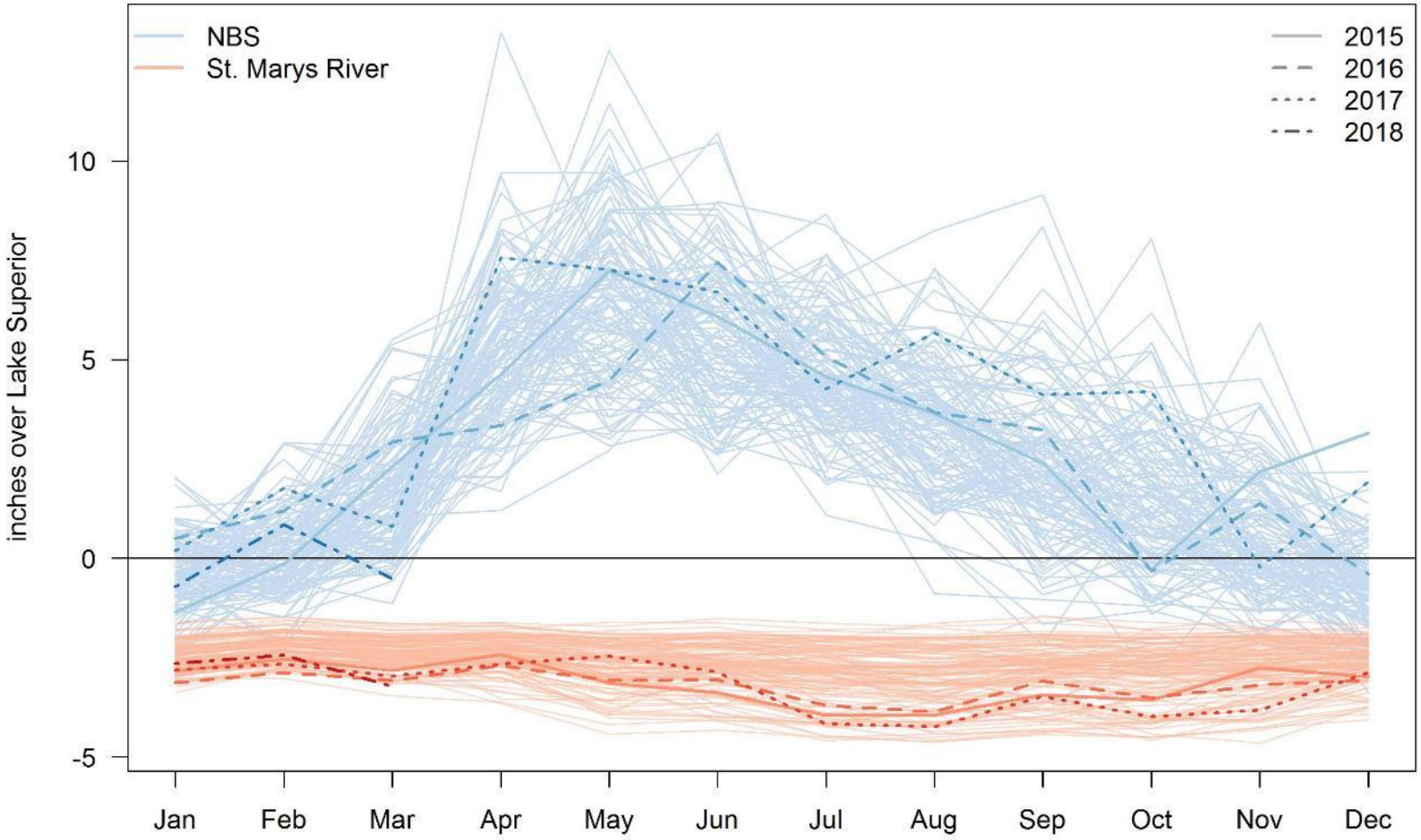
Lake Superior Inflows and Outflows



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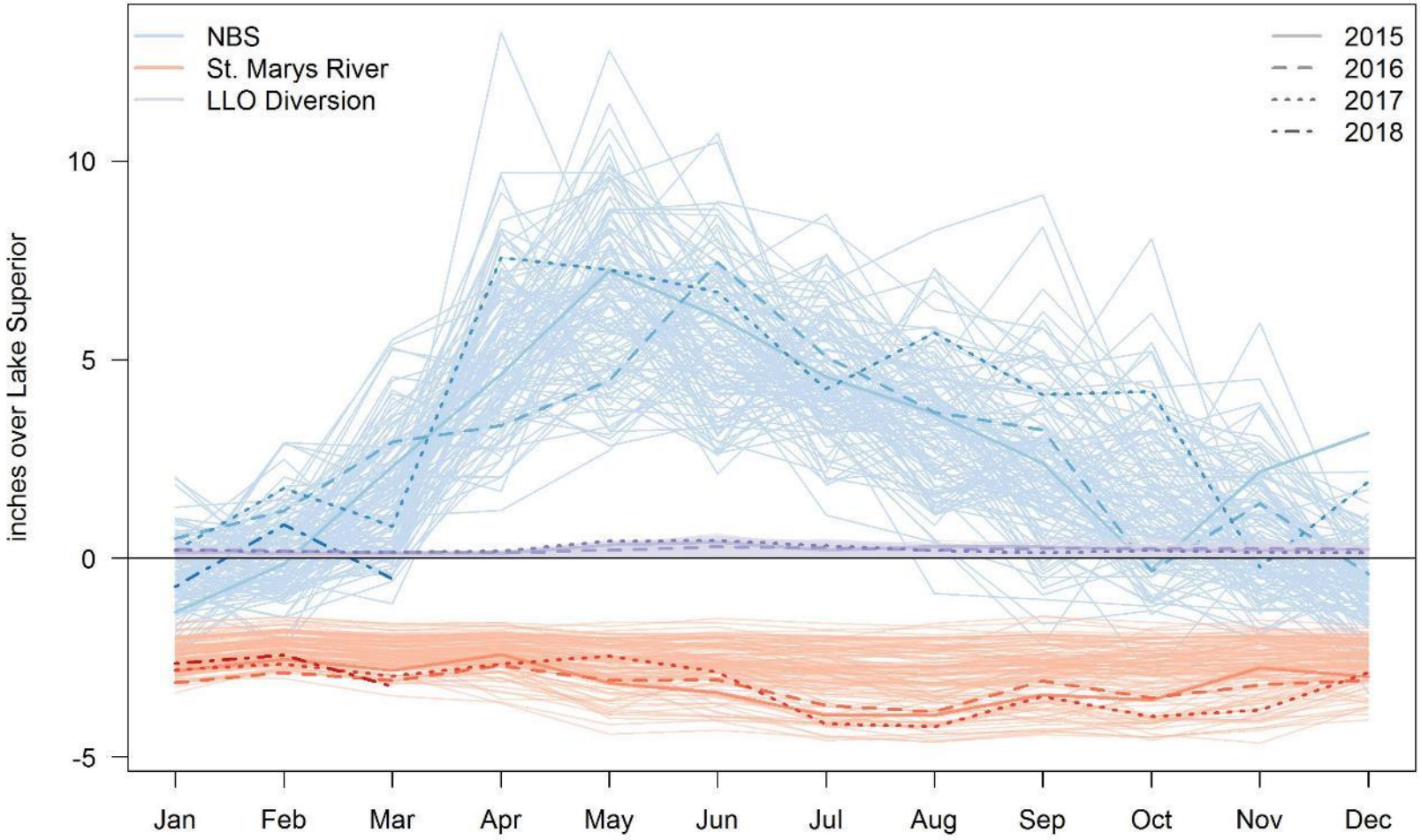
Lake Superior Inflows and Outflows



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