US Army Corps
of Engineers
Detroit District

Great Lakes Update

Volume 190: 2013 Annual Summary

Background

The U.S. Army Corps of Engineers (USACE) tracks and forecasts the water levels of each of the Great Lakes. This report is primarily focused on summarizing the hydrologic conditions of the Great Lakes basin in 2013.

At the beginning of 2013 all of the Great Lakes water levels were well below their long-term averages following dry conditions during 2012. Lake Michigan-Huron's January 2013 monthly mean water level set an all-time record low of 576.02 ft. At the beginning of 2014, all of the Great Lakes are at a higher level than at the beginning of 2013. A summary of 2013 Great Lakes water levels is discussed below in the lake-by-lake sections.

Official water levels are based on monthly lake-wide means and the period of record used for each of the lakes includes the years 1918 to 2012. This data has been coordinated between the United States and Canada. All 2013 water levels will be officially coordinated and added to the historical record in the spring of 2014. The elevations used are referenced to the 1985 International Great Lakes Datum. The water level of each lake is averaged from a network of individual gages around each lake. Also of note is that Lake Michigan and Lake Huron are hydraulically treated as one lake due to their connection at the Straits of Mackinac.

The Great Lakes are very large and behave differently than smaller, inland lakes. In general, Great Lakes water levels do not rise and fall with individual storms, but rather significant water level fluctuations require multiple months, seasons, or years of wet or dry conditions.

Seasonal changes in the weather patterns typically cause an annual pattern of rising and falling of Great Lakes water levels. Each of the Great Lakes typically exhibits a seasonal rise in the spring primarily caused by an increase in precipitation, the melting of accumulated snow, an increase in runoff, and low evaporation rates. The typical seasonal decline of the water levels in the fall and winter is primarily caused by an increase in evaporation, a decrease in precipitation, and the accumulation of snowpack on the land area.

The Net Basin Supply (NBS) is an important quantity for understanding the amount of water which arrives to the lake. USACE uses the residual method to compute NBS, shown below:

Residual Method Net Basin Supply:

$$NBS = WL - I - D + O$$

WL:	Water Level Change
I:	Connecting Channel Inflow
O:	Connecting Channel Outflow
D:	Diversion into(+) or out(-) of lake

Altogether, NBS represents the combined effects of precipitation, runoff, and evaporation. NBS is far and away the main driver of water levels, and is also discussed in more detail in the following sections for each lake.

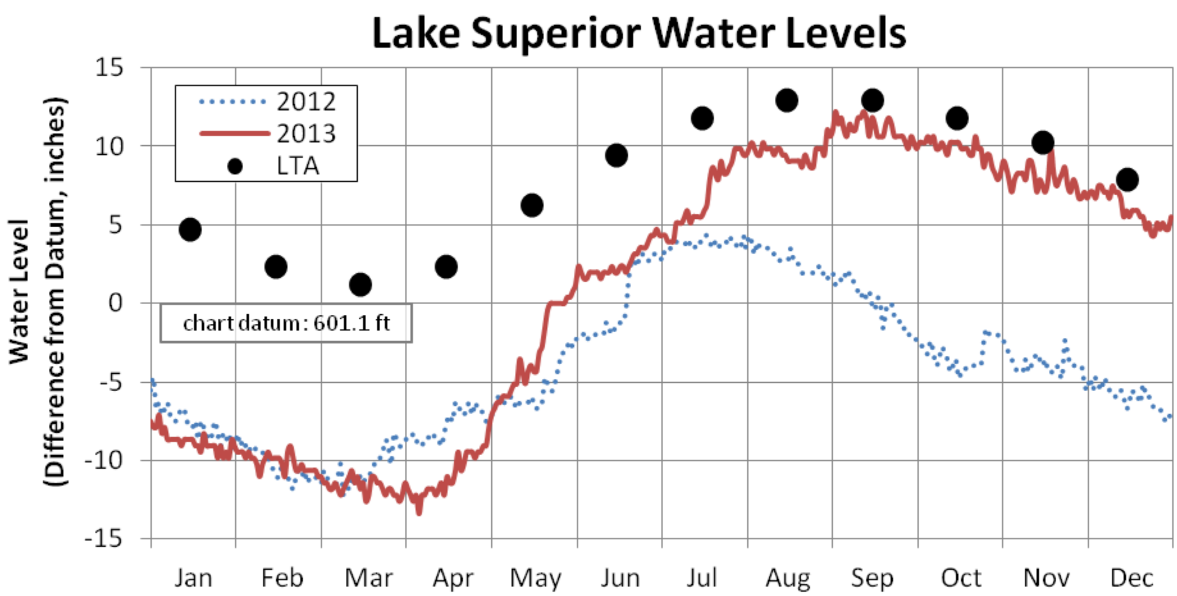

Figure 1: Lake Superior Water Levels

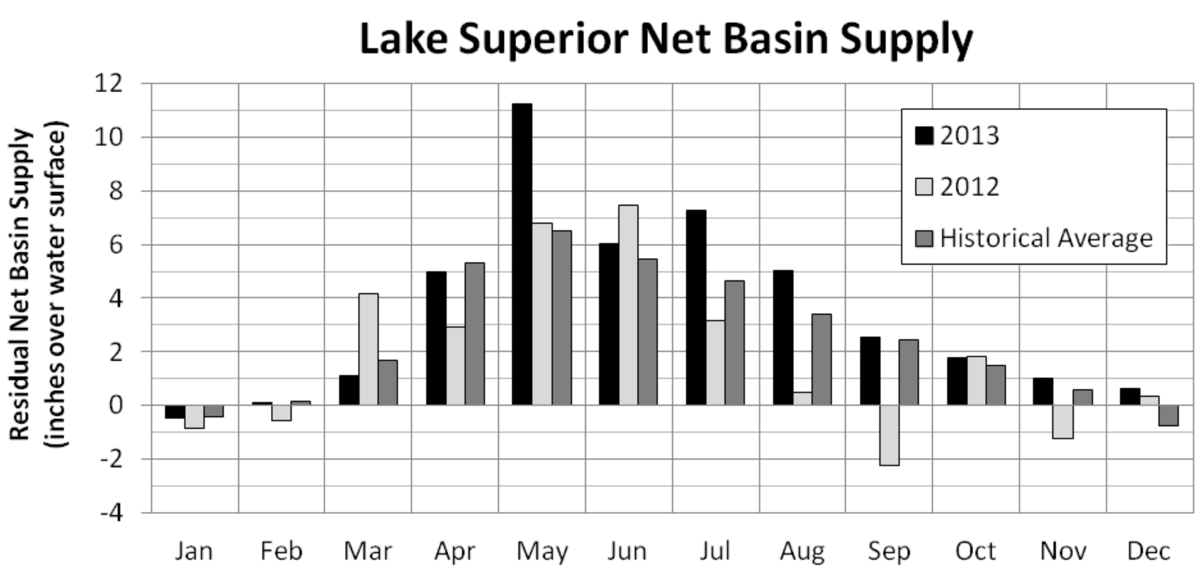

Figure 2: Lake Superior Residual Net Basin Supply

Lake Superior

Figure 1 above shows the 2013 water levels of Lake Superior compared with the 2012 levels and the monthly long-term average (LTA) levels. A similar figure is shown for each lake in the following sections. Each lake's data has been plotted relative to chart datum (a.k.a. low water datum), which represents the horizontal line at a value of zero. Chart datum for Lake Superior is 601.1 ft. The solid line in Figure 1 represents the 2013 water levels and the dotted line shows the 2012 levels. The LTA levels for each month are shown by the solid circles.

Lake Superior started off 2013 well below average and also below the January 2012 levels. However, from March's monthly mean to September's monthly mean, Lake Superior had a 2013 seasonal rise of 23 inches, compared to an average seasonal rise of 12 inches. During that time period, Lake Superior moved from 13 inches below LTA to only 2 inches below LTA. For the time period from September through December, Lake Superior remained 2 inches below LTA.

The January 2014 monthly mean water level was 601.35 ft, which represents a year-to-year rise of 12 inches and is only 1 inch below LTA. The large water level rise during 2013 was caused by wetter than average basin conditions. The total precipitation and total runoff for 2013 were both above average. As mentioned above in the Background section, the net basin supply (NBS) is an important quantity for explaining basin conditions. Figure 2 shows the Lake Superior NBS for each month in 2013 compared to both the 2012 NBS and the historical average NBS. A negative NBS is caused by the evaporation from the lake surface being greater than the combined precipitation on the lake and runoff flowing to the lake. Here in Figure 2, the NBS has been converted to an equivalent depth of water over the lake surface for each month.

Lake Superior's NBS was the second highest ever for the month of May in 2013. These extremely wet conditions can clearly be seen in the behavior of the 2013 water levels for Lake Superior through the month of May. Since May of 2013, the monthly NBS has consecutively been above average each month.

Lake Michigan-Huron

For Lake Michigan-Huron, the wet conditions in 2013 essentially caused the water level to make up all of the ground lost from the historic dry conditions of 2012. The January 2013 Lake Michigan-Huron water level of 576.02 ft was lower than any other month in the entire period of record, dating back to 1918. The previous all-time record low was 576.05 ft, set in March 1964. The Michigan-Huron water level rose 15 inches from January 2013 to January 2014, as shown in Figure 3. Water levels in Figure 3 are relative to the Lake Michigan-Huron chart datum level of 577.5 ft.

The 2013 seasonal rise for Michigan-Huron was 20 inches from January through July, compared to an average seasonal rise of 11 inches. In the short period from March to May, Lake Michigan-Huron's monthly mean water levels moved 10 inches closer to the 2012 levels and gained 5 inches on the LTA.

The seasonal decline from the fall of 2013 into the early part of 2014 has been much less than average. Michigan-Huron has fallen only 5 inches from July 2013 to January 2014, compared to a typical fall of 11 inches during that time period. This can be seen in Figure 3 by the relatively low slope at the end of 2013 compared to the steep decline in the last half of 2012 and the typical decline of the LTA. Despite the significant rise in 2013 and the relatively smaller decline this winter thus far, Michigan-Huron was still 13 inches below its LTA in January 2014.

Figure 4 shows the 2013 NBS for Lake Michigan-Huron compared to the 2012 NBS and the historical averages. The NBS was the second highest ever for the month of April in 2013. Basin conditions for the single month of April supplied the equivalent of 12 inches of water to the lake. This high NBS in April caused a steep rise of the water level, as can be seen in Figure 3. Total precipitation over the lake and total runoff flowing to the lake were both above average in 2013 for Michigan-Huron. The NBS was above the historical average for 9 out of 12 months in 2013 and above the 2012 NBS for 10 out of 12 months.

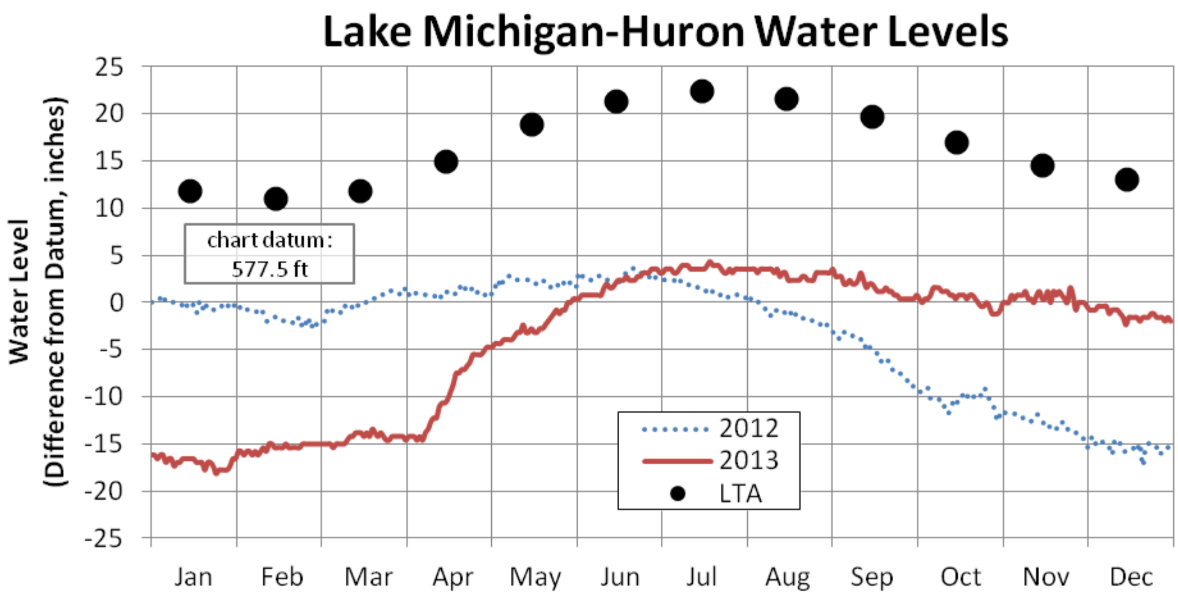

Figure 3: Lake Michigan-Huron Water Levels

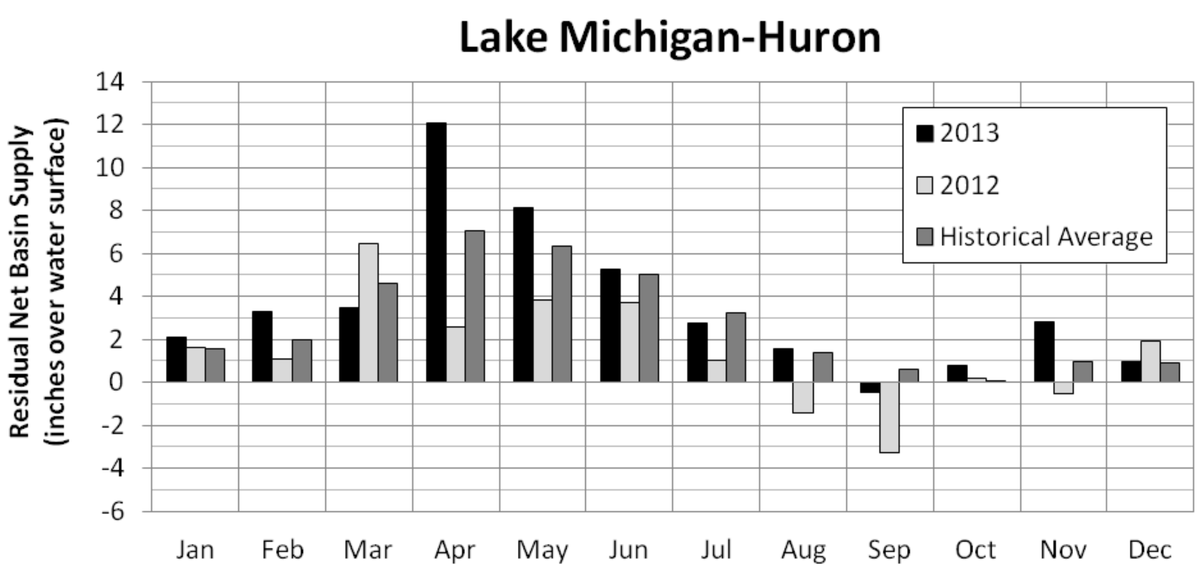

Figure 4: Lake Michigan-Huron Residual Net Basin Supply

Lake St. Clair

As seen in Figure 5 below, the Lake St. Clair water levels have a tendency to exhibit more short-term fluctuation than lakes Superior, Michigan-Huron, Erie, or Ontario because of the smaller size of Lake St. Clair. The smaller size causes the connecting channels (the St. Clair River upstream and the Detroit River downstream) to have a large influence on the Lake St. Clair water levels. Wind, ice, and other climate variations can cause fluctuations in the hydraulic behavior through the St. Clair River, Lake St. Clair, and Detroit River system.

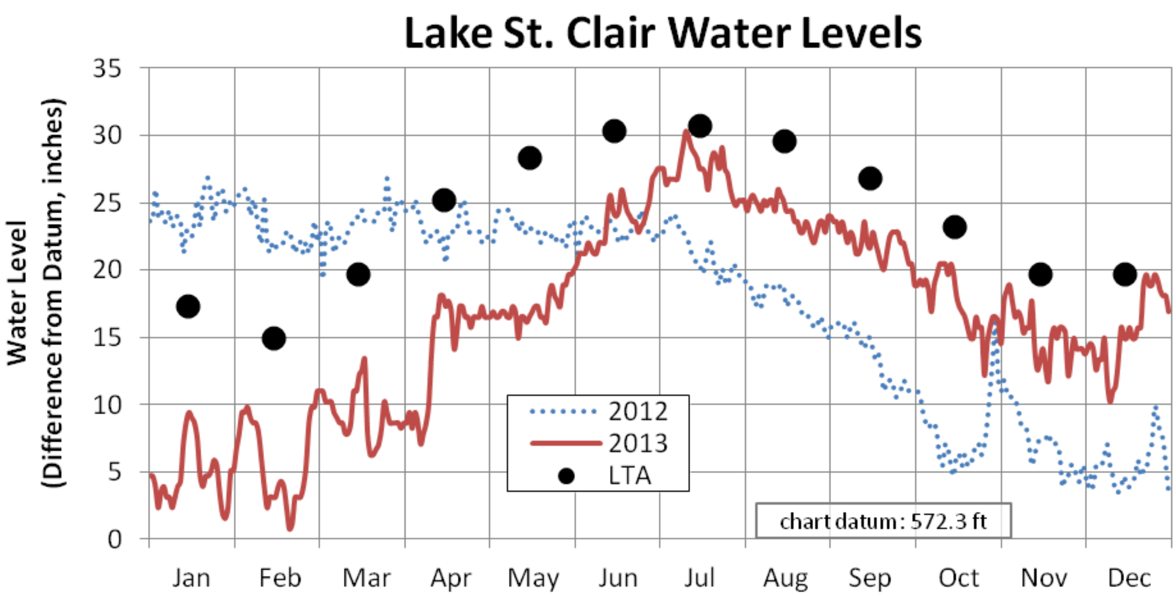

Figure 5: Lake St. Clair Water Levels

The Lake St. Clair water level is starting 2014 much higher than 2013 due to the 7 inch rise from January 2013 to January 2014. As seen by Figure 5, Lake St. Clair did not exhibit a seasonal rise at all in 2012. The 2013 water level gained rapidly on the 2012 levels in the first half of the year and rose above the 2012 levels in June. The steep rise in June was caused by the highest NBS on record for Lake St. Clair for the month of June. Monthly means since July 2013 have remained above 2012 levels and between 3 and 6 inches below LTA.

Lake Erie

The water level behavior of 2012 was unlike any other year in the period of record for Lake Erie, because it exhibited no seasonal rise. Figure 6 shows the Lake Erie water levels relative to the Lake Erie chart datum of 569.2 ft. The water level plummeted 22 inches from January 2012 to January 2013 due to extremely dry conditions during the year of 2012. During the first six months of the year, the 2013 levels gained ground and rose above the 2012 levels in June.

From May through July the Lake Erie water level rose significantly. The monthly mean in May 2013 was 8 inches below LTA and July's monthly mean was 2 inches above LTA. The explanation for this large rise relative to LTA can be seen by the high NBS shown in Figure 7 for the months of June and July. The June 2013 NBS was the highest ever recorded for Lake Erie for the month of June. The amount of precipitation received by the Lake Erie basin in June 2013 was 144% of the average precipitation for June. Lake Erie also had much larger than average NBS in the months of February, April, July, and December in 2013. Since July 2013, the Lake Erie monthly mean water levels have remained within 2 inches of LTA.

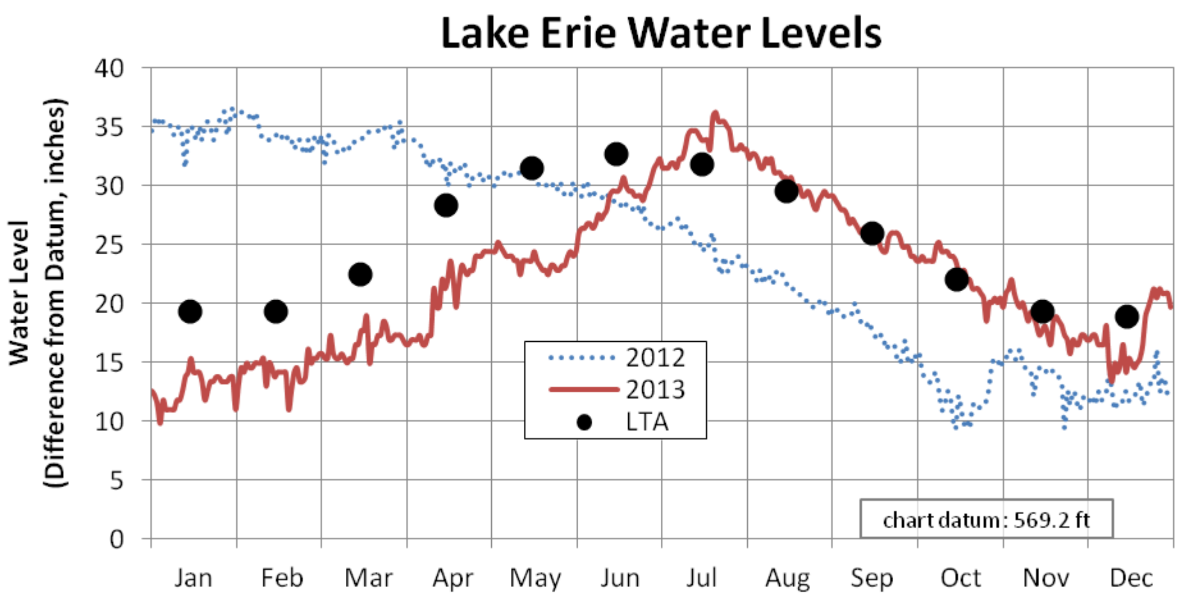

Figure 6: Lake Erie Water Levels

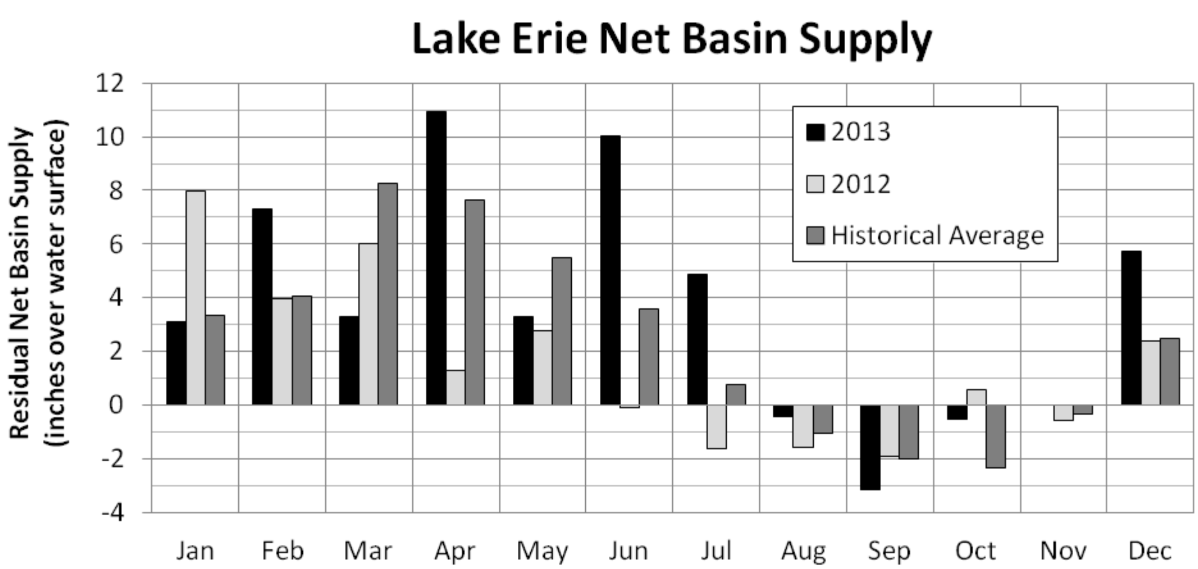

Figure 7: Lake Erie Residual Net Basin Supply

Lake Ontario

Lake Ontario water levels also rose during the course of 2013, as shown in Figure 8. From the monthly mean of January 2013 to January 2014, the water level rose 10 inches. Lake Ontario started 2013 below LTA and then rose above LTA in June. Since June 2013, the Lake Ontario monthly mean water levels have remained 0 to 6 inches above LTA.

Figure 9 shows the Lake Ontario NBS for 2013 in comparison to the 2012 NBS and the historical averages. The month which stands out the most is June. Lake Ontario received the fourth highest NBS on record for the month of June in 2013. During the month of June 2013, precipitation was 152% of the average for the month. During that same month, the water levels climbed well above LTA. Overall, the Ontario NBS was near or above average for 9 out of 12 months of 2013.

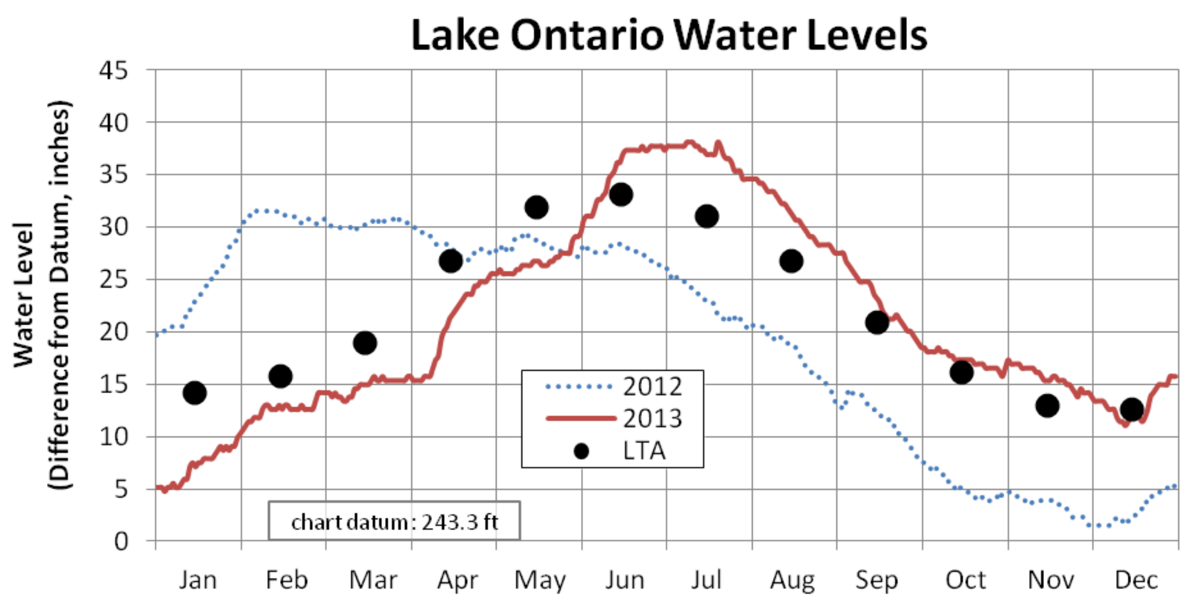

Figure 8: Lake Ontario Water Levels

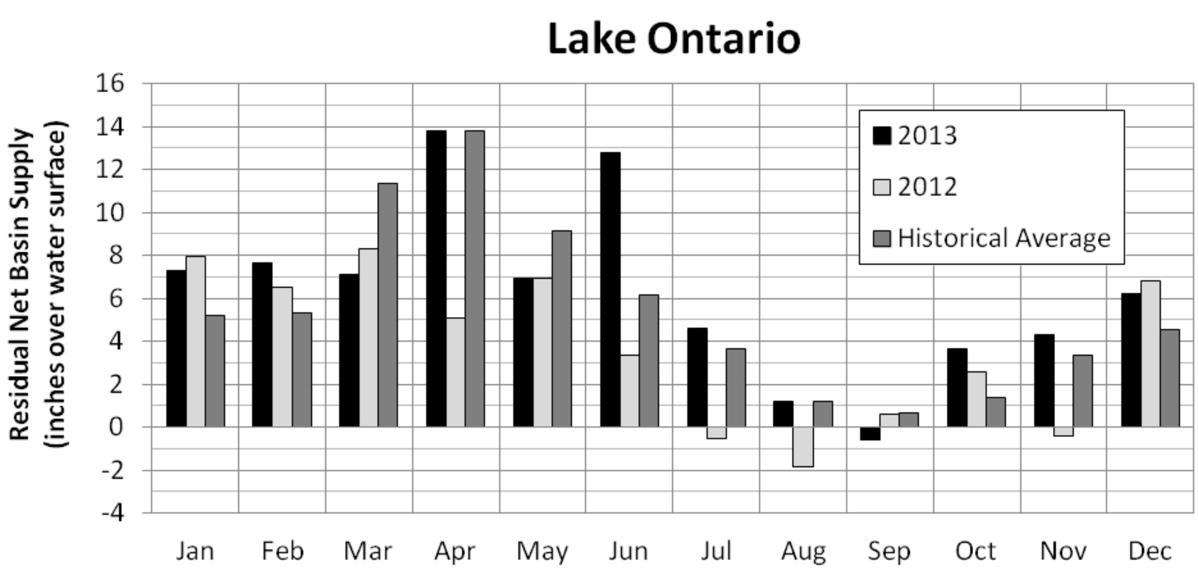

Figure 9: Lake Ontario Residual Net Basin Supply

Great Lakes Physical Characteristics

The physical characteristics of the Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) are enormous. The total surface area of the Great Lakes is over 94,000 square miles (244,000 square kilometers) and the total volume is over 5,400 cubic miles (22,700 cubic kilometers). Figures 10 and 11 show the water surface area and volume comparisons among the Great Lakes.

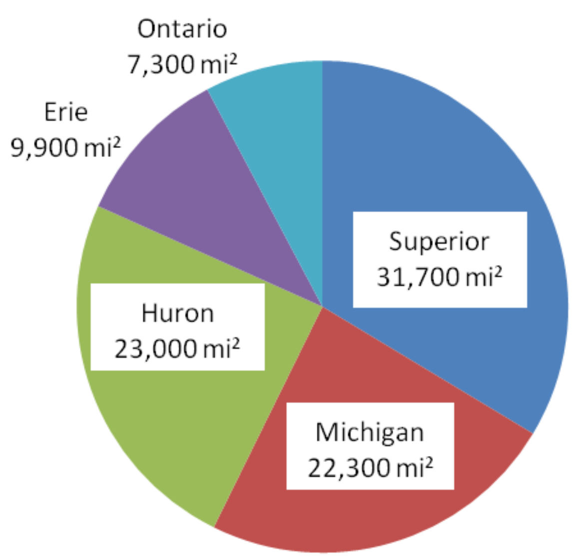

Figure 10: Great Lakes Water Surface Areas

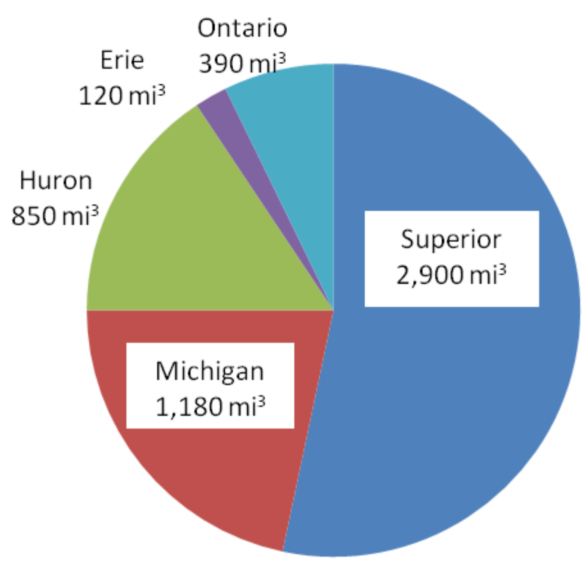

Figure 11: Great Lakes Water Volumes

More Information

Update articles are included in the February and August *Monthly Bulletins* highlighting topics and explanations relevant to Great Lakes water levels. February's *Monthly Bulletin* will typically include an annual summary from the year before and each August *Monthly Bulletin* will typically include a summary of the first six months of the year.

The *Monthly Bulletin* is sent by postal mail. To be added to the postal mailing list, please send an email to hhpm@usace.army.mil or call 1-888-694-8313 and select option 1. Alternatively, the Monthly Bulletin can be viewed on our website. The home page is: http://www.lre.usace.army.mil. In addition to the *Monthly Bulletin*, the Detroit District issues the *Weekly Great Lakes Water Level Update* and the *Weekly Great Lakes Connecting Channels Water Levels and Depths*. Both products are updated each Thursday and can be located here:

http://www.lre.usace.army.mil/Missions/GreatLakesInformation/GreatLakesWaterLevels/WaterLevelForecast.aspx

The Detroit District also has a Facebook page which can be found here:

https://www.facebook.com/pages/Detroit-District-US-Army-Corps-of-Engineers/144354390916

The Detroit District welcomes comments on all of our forecast products. Please email questions and comments to hhpm@usace.army.mil. To contact the District by phone call toll free 1-888-694-8313 and select option 1. The Detroit District's mailing address is:

Department of the Army
Detroit District Corps of Engineers
ATTN: CELRE-HH-W
477 Michigan Avenue
Detroit, MI 48226