US Army Corps of Engineers
Detroit District

Great Lakes Update

Volume 199: 2017 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 2017.

Over the last year, all of the lakes have experienced above average water levels. The 2017 water levels surpassed those of 2016 by spring and remained at higher levels for the remainder of the year. Generally, water levels since the spring of 2017 have been near or above levels of the last high water period during the late 1990s.

Official water levels are based on monthly lake-wide averages from a network of individual gages around each lake. These data have been coordinated between the United States and Canada and elevations are referenced to the International Great Lakes Datum of 1985. It is important to note that Lake Michigan and Lake Huron are hydraulically treated as one lake due to their connection at the Straits of Mackinac. The period of record used for each of the lakes includes the years 1918 to 2016. All 2017 water levels will be officially coordinated and added to the historical record in the spring of 2018.

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

Seasonal changes in weather trends 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 liquid precipitation, increased runoff due to melting of accumulated snow, 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:

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

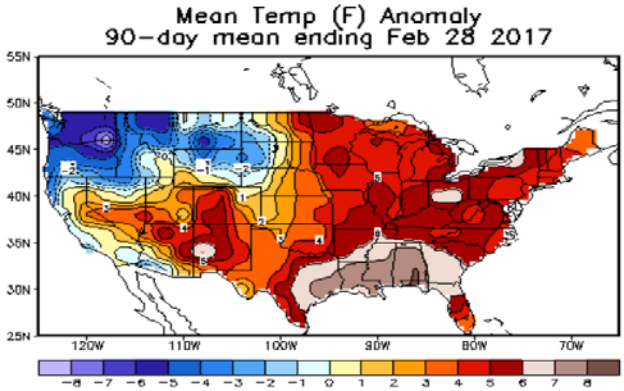
WL: Water Level Change
I: Connecting Channel Inflow
O: Connecting Channel Outflow
D: Diversion into (+) or out (-) of lake

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

Warm Winter, Wet Spring 2017

In the beginning of 2017, water levels across the Great Lakes remained fairly close to water levels

experienced in 2016. However, in the spring of 2017 water levels began to separate themselves and begin a higher track than the previous year's levels. In January and February, overall conditions were warmer than average. Last February, a week of record warmth throughout the basin allowed for some early thawing and snowmelt in the basin. Figure 1 shows the above normal temperatures during the winter, where temperatures were 3 to 7 degrees Fahrenheit warmer than normal.



http://www.cpc.ncep.noaa.gov/products/tanal/temp_analyses.php

Figure 1: 90-Day Anomaly in mean temperatures during the winter

Figure 2 shows the monthly precipitation during 2017 for each lake, which indicates the wet spring and early summer in the Great Lakes region. In March, cold temperatures throughout the basin and above average precipitation around the lower lakes allowed for snowpack to build especially in the Lake Ontario basin where a mid-month snowstorm brought 1 to 2 feet of snow to most of the basin. An exceptionally wet April along with above average runoff in May, began larger rises on the lakes. The Lake Ontario basin experienced record high precipitation during the month of May with precipitation for the month just shy of a total of 6 inches. The monthly average for Lake Ontario basin precipitation in May is 3.10 inches based on the period of record (1900-2016), which was surpassed in the first 6 days of May. This led to flooding along the Lake Ontario shoreline, shown in Figure 3. Lake Erie also had over 5 inches of

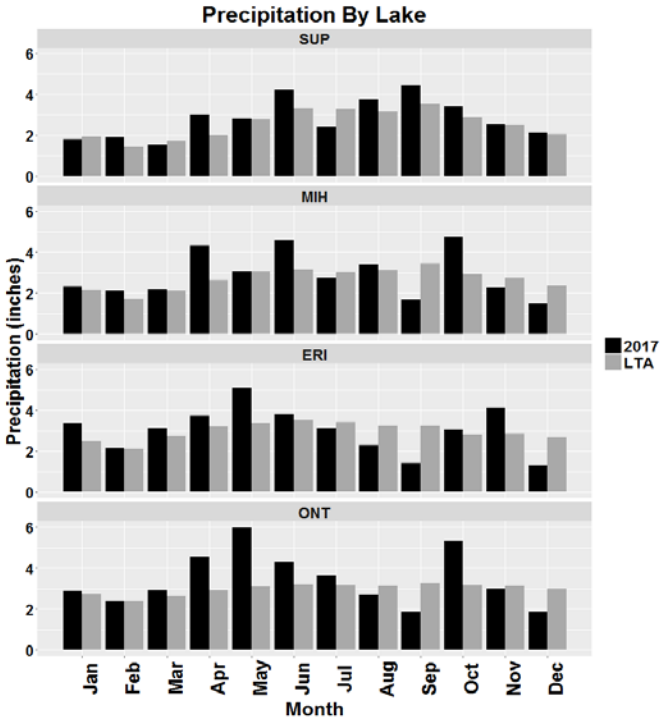


Figure 2: Monthly precipitation of 2017 compared to monthly average precipitation

rain in May contributing to the steep rise in lake level. For Lakes Superior and Michigan-Huron, May precipitation was just slightly above average, but April and June precipitation was well above average. This led to a rise in lake levels during these months that was greater than average and pushed lake levels above 2016 levels.

Figure 3: Flooding in Sackets Harbor, NY at the end of May 2017

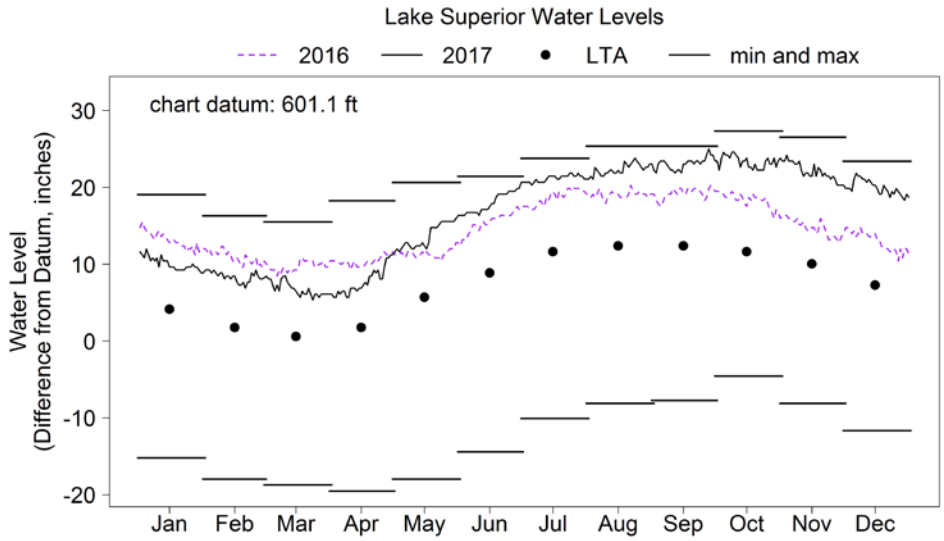


Figure 4: Lake Superior Water Levels

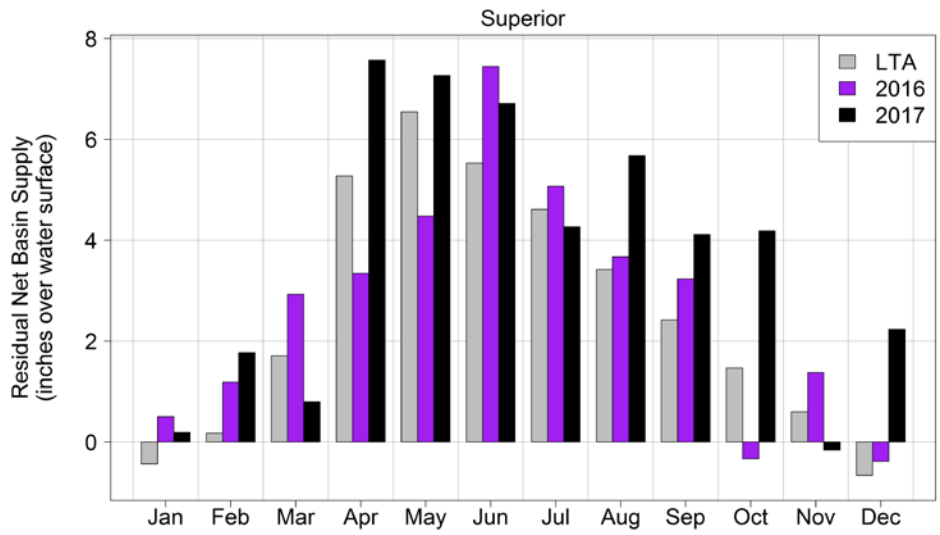


Figure 5: Lake Superior Residual Net Basin Supply

Lake Superior

Figure 4 shows the 2017 water levels of Lake Superior compared with the 2016 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 (or low water datum), which represents the value at zero. Chart datum for Lake Superior is 601.1 ft. The solid line in Figure 4 represents the daily 2017 water levels and the dashed line shows the 2016 levels. The LTA levels for each month are shown by the solid circles. Figure 5 shows residual net basin supply (NBS), which accounts for the contribution of precipitation, runoff, and evaporation to the lake.

Lake Superior started the year below water levels of 2016, but above the LTA levels. However, consecutive months of above average NBS in April, May, and June, led to a significant rise in Lake Superior water levels that brought water levels above 2016 levels.

Lake Superior's water level continued to rise until October when it reached its peak monthly average for the year at 603.05 feet. It's typical from September to October for Lake Superior to begin its seasonal decline, but October experienced high monthly NBS, which was also preceded by above average supplies in August and September. The period of higher than average NBS between August and October was a result of above average precipitation and runoff during this time.

Since June, Lake Superior monthly average levels have been 9 to 13 inches above LTA and 2 to 4 inches below its monthly record high water levels. Subsequently, the monthly average water levels from October to December were the highest water levels that have occurred since record high levels in 1985.

Lake Michigan-Huron

Lake Michigan-Huron water levels remained above average throughout 2017, shown in Figure 6. The lake started off the year below 2016 levels, but by June 2017 water levels surpassed 2016 levels and it remained that way through December.

Lake Michigan-Huron was 3 to 4 inches below 2016 levels from January to April, but finished the year in December 11 inches above the 2016 level and 18 inches above the LTA level. The water levels from July to November were the highest water levels since the last period of high water in 1997. The December 2017 water level of 580.02 feet was the highest water level in this month since the record high December level in 1986.

From January (578.97 ft.) to August (580.71 ft.), Lake Michigan-Huron rose 21 inches - 10 inches more than the average rise that typically takes place from February to July. Figure 7 illustrates that during the time period from January to July NBS was above the LTA, and especially high during April, May, and June, which helped to amplify the seasonal rise on the lake.

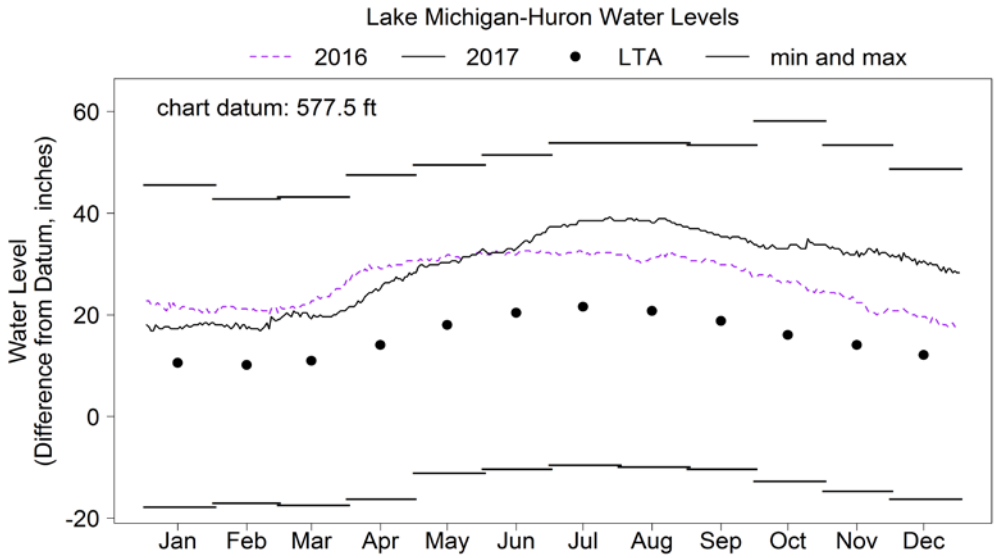


Figure 6: Lake Michigan-Huron Water Levels

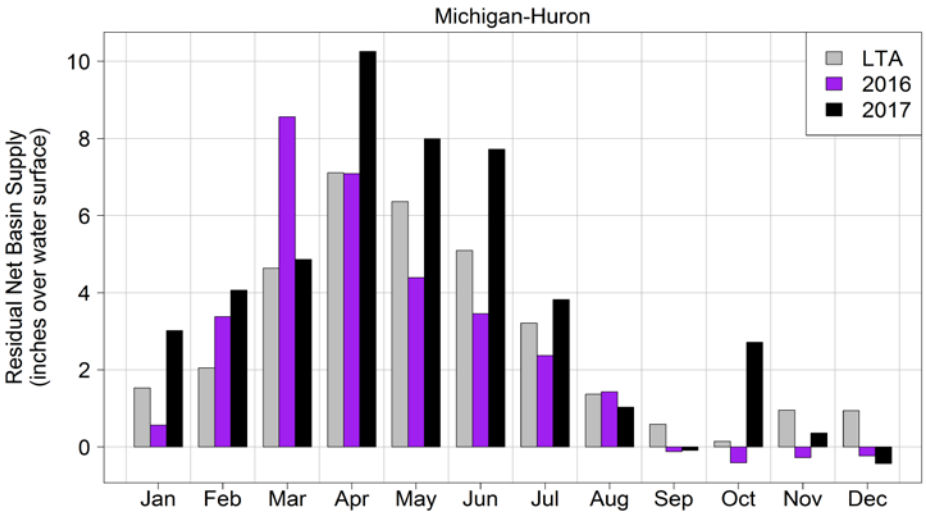


Figure 7: Lake Michigan-Huron Residual Net Basin Supply

Lake St. Clair

Figure 8 shows the water levels of Lake St. Clair in 2017 compared to 2016 and the LTA levels. From January to April, the lake was within 2 inches of 2016 levels. However, in May the water level climbed to 4 inches above its 2016 level and 19 inches above the LTA. Since May, water levels have continued to stay above 2016 levels and 18 to 21 inches above LTA levels. Lake St. Clair reached its seasonal low in December of 2016 at 574.54 feet. During 2017, the lake rose 23 inches to its seasonal peak in July to 576.44 feet. The average seasonal rise on Lake St. Clair is 16 inches, which typically occurs between February and July, but above average NBS in January and February contributed to an earlier rise in 2017.

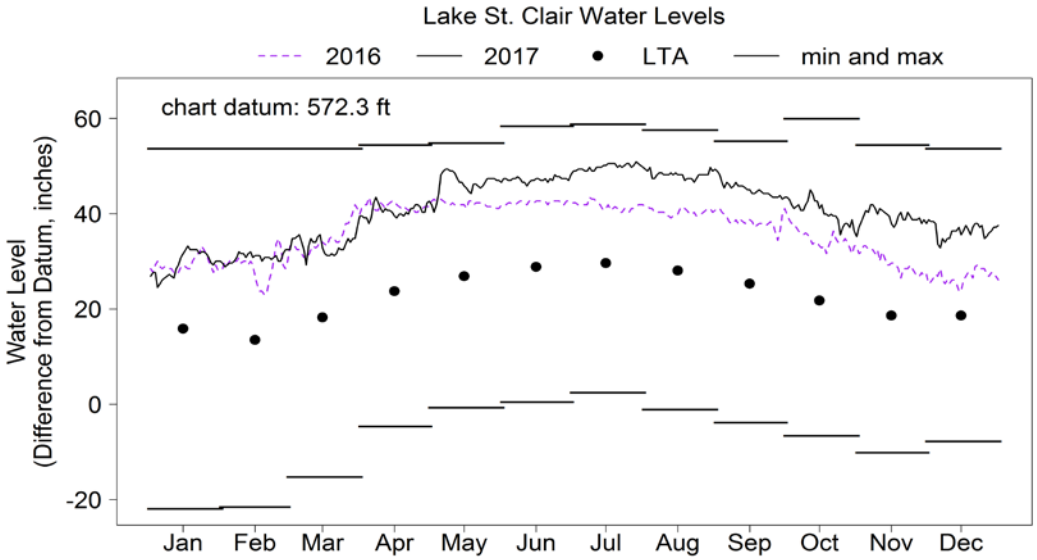


Figure 8: Lake St. Clair Water Levels

Lake Erie

Lake Erie also experienced similar water levels to 2016 in the beginning of 2017, and in early May saw a rapid rise in water level (Figure 9). In May, NBS was well above average and a precipitation event early in the month caused the level to rise quickly over a few days. Since May, Lake Erie water levels have been 6 to 11 inches above 2016 levels and 16 to 20 inches above LTA levels.

The seasonal rise on Lake Erie took place between December 2016 and June of 2017, rising 26 inches from 571.42 ft. to 573.59 ft. The typical rise between December and June is 14 inches. The remarkable rise of 26 inches was 12 inches more than average because of the wet spring that caused water levels to jump significantly. Precipitation and runoff were much greater than average in January and May resulting in higher than average NBS, as shown in Figure 10.

In November, NBS was also well above average as a result of wetter than normal conditions in the basin. These generally wet conditions since the spring kept the lake above 2016 and LTA levels.

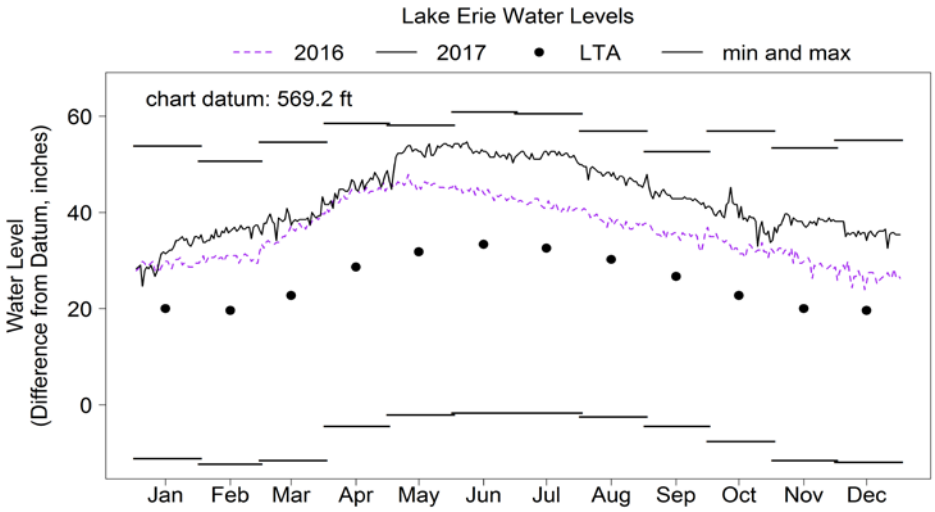


Figure 9: Lake Erie Water Levels

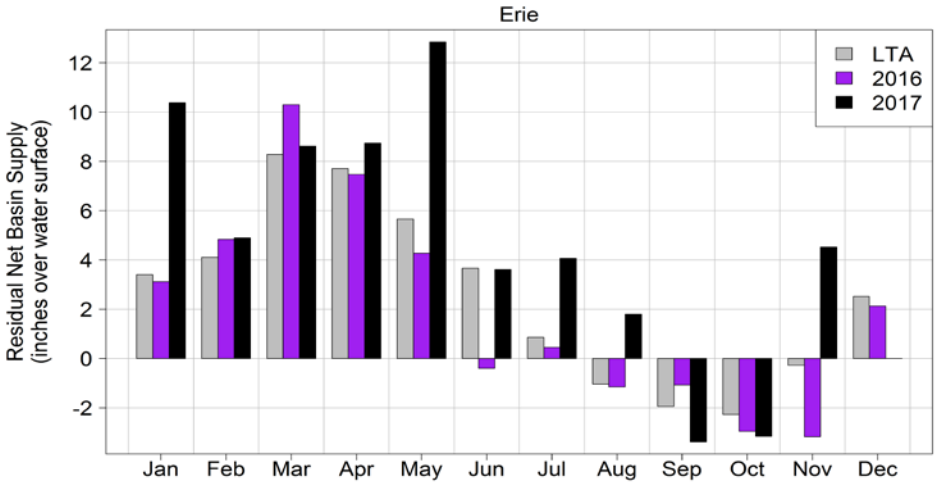


Figure 10: Lake Erie Residual Net Basin Supply

Lake Ontario

Figure 11 shows Lake Ontario water levels relative to the chart datum of 243.3 ft. Lake Ontario started the year within 1 inch of 2016 water levels, but in April Lake Ontario began a steep rise that would lead to record high water levels in the spring and early summer.

From December 2016 to June 2017 the level of Lake Ontario rose 53 inches. This was the largest seasonal rise on the lake in the period of record (1918-2016). Above average precipitation of over 10 inches between April and May (Figure 2) along with rapid snowmelt during April due to warmer than normal temperatures led to the rapid rise in water levels during April and May. Figure 12 shows the 2017, 2016, and LTA NBS for Lake Ontario. Overall, well above average NBS between April and July led to record high water levels in May, June, and July. This can be seen in Figure 11 where the line representing 2017 water levels surpasses the horizontal lines representing record high water levels during these three months. In May, the monthly mean level of 248.69 feet surpassed the previous May record high in 1973 by 3 inches. The highest monthly average level for all months in the period of record occurred in June at 248.72 feet, surpassing the old record by 2 inches, which occurred in 1952. During this time of record high water levels, flooding and erosion were significant concerns along the Lake Ontario shoreline (Figure 3) as well as along the St. Lawrence River and in the Ottawa River basin.

The seasonal decline on Lake Ontario between June 2017 and December 2017 was 41 inches, which is almost double the average decline during this time period. In June, July, and August, monthly averaged outflows out of Lake Ontario into the St. Lawrence River were above monthly record highs.

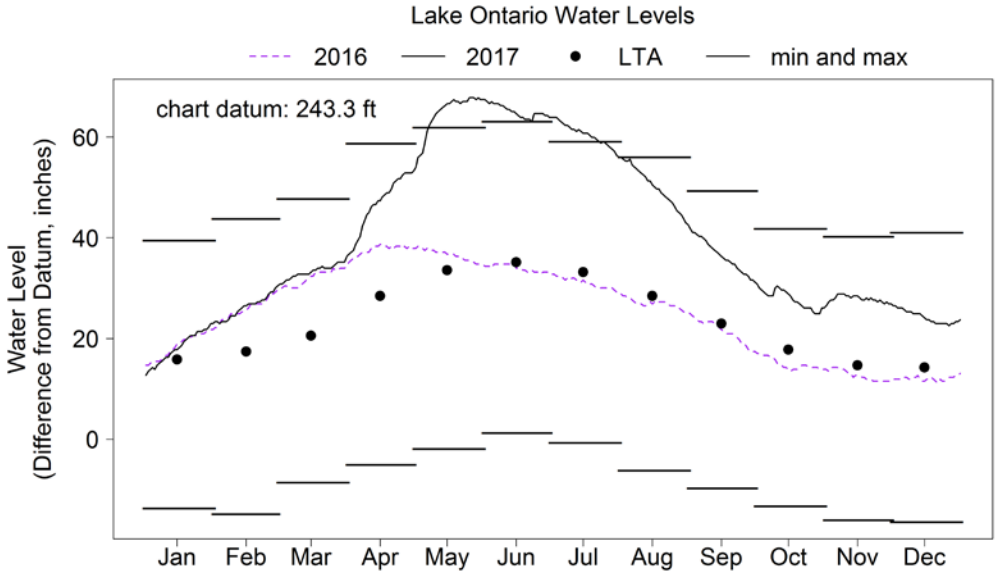


Figure 11: Lake Ontario Water Levels

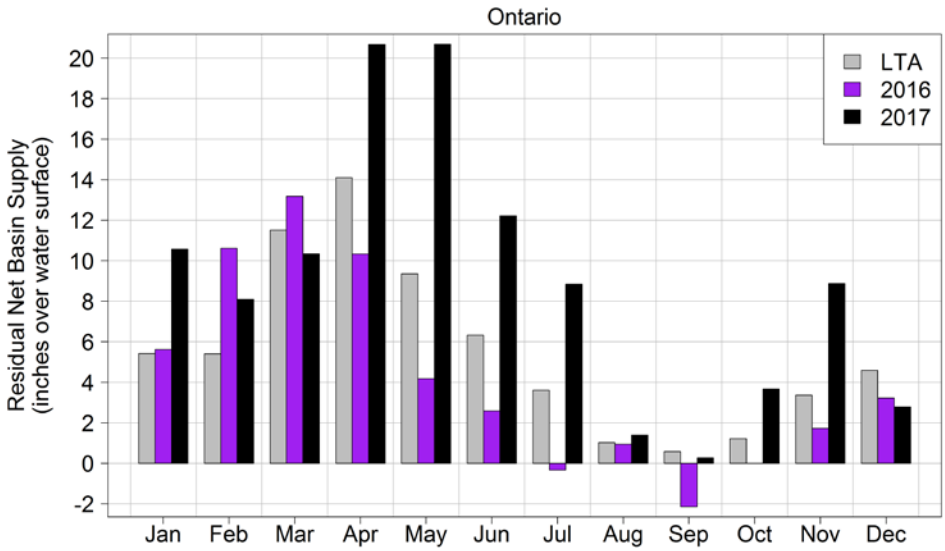


Figure 12: Lake Ontario Residual Net Basin Supply

More Information

Update articles are included periodically in the *Monthly Bulletins* highlighting topics and explanations relevant to Great Lakes water levels. February's *Monthly Bulletin* typically includes an annual summary from the year before.

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. Additionally, a one year *Great Lakes Water Level Outlook* is produced once every three months. All forecast products are 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

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-EHW
477 Michigan Avenue
Detroit, MI 48226