

September 2022 Update on Kalamazoo Lake Levels- Past, Present and Future

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September 2022

Introduction: This is an update to the May 2022 report of water levels in the Saugatuck and Douglas harbor area. Water levels in Saugatuck and Douglas have continued to recede toward the long-term average, having dropped significantly from the record high levels observed in summer 2020. The mean August 2022 water level in Lake Michigan (580.02 ft. msl) was approximately 25 inches below the summer 2020 peak, 9 inches below the August 2021 water level, and 8 inches higher than the long term mean August elevation. The lake level forecast provided by the US Army Corps of Engineers (USACE) indicates that the water level will decline through the next six months as part of the typical seasonal cycle, likely remaining above the long-term average but well below the record levels observed in 2020. This report will summarize the current state of the lake levels and look ahead to the forecasted levels, but note the predictions on future lake level are educated guesses by NOAA and USACE scientists and engineers based on modeling Mother Nature.

First point to reemphasize: Kalamazoo Lake and Lake Michigan are hydrostatically connected! This means that as Lake Michigan rises, so does the Kalamazoo Lake and River. Kalamazoo Lake is what is referred to as a drowned river mouth.

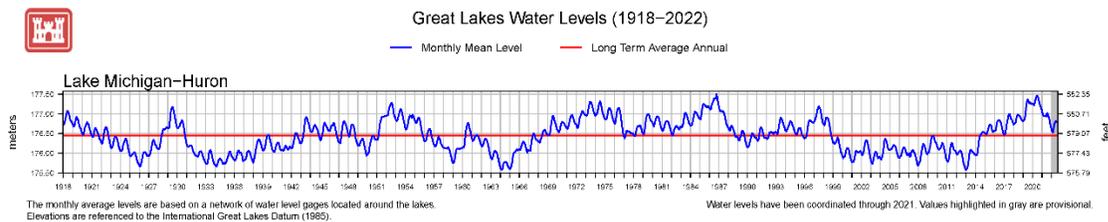


Figure 1: Historical Lake Michigan water levels

Historical Lake Levels: Let's again look at the updated historical Lake Michigan water levels going back to the year 1918 (Figure 1). As discussed in prior reports, Lakes Michigan and Huron are also hydrostatically connected by the Straits of Mackinac. The time history in Figure 1 shows at least six periods of high water and five low water level events, with a near record low occurring in 2013 (remember all the dredging concerns). Some modelers see a periodicity in high to low water levels of eight to fifteen years, but suffice to say the water level goes up and it goes down at least each decade. If we examine the length of high water events during the entire record we observe high water events as short as one year and as long as approximately eight years. The average duration of high water events is approximately four years. After an approximately eight year high water event, it appears that Lake Michigan water levels are now trending downward. Good news.

Figure 2 shows in more detail the mean monthly water levels from 2021 and 2022 relative to the historic maximum, minimum, and mean water levels. After water levels reached a record high in July-August 2020 (~582.4 ft. msl, 7.3 inches higher than the previous maximum), the water has steadily declined to a mean August level of approximately 580.02 ft. msl. This is down over 2 feet from the record highs of 2020, and 9 inches from the mean August 2021 levels, but still approximately 8 inches higher than the long term August mean.

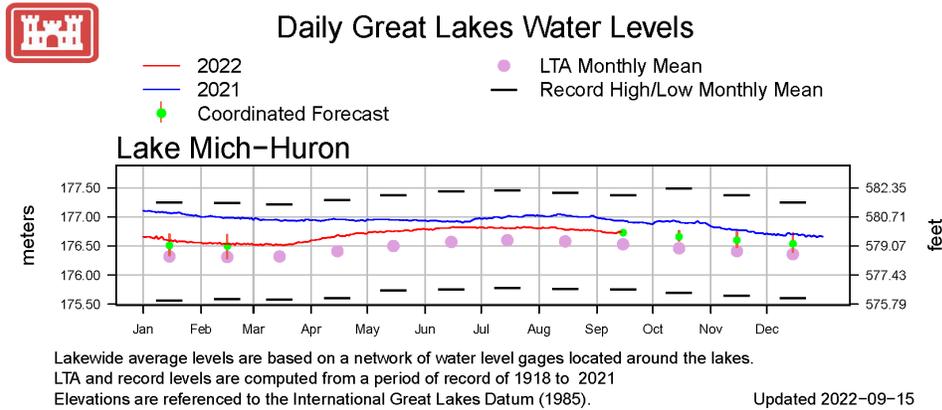


Figure 2: Mean Daily Lake Michigan water levels for 2021 and the first eight months of 2022 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).

The top of the seawall at East Shore Harbor Condos (ESHC) is at approximately 582 ft. msl, thus any Lake Michigan water level above 582 ft results in flooding. The 582 ft. msl is representative of the height of other seawalls in the areas, thus if there is flooding at ESHC flooding will be occurring in other parts of the harbor. The mean daily water level for Lake Michigan exceeded 582 ft every day from May 20, 2020 through early September. After that point, the average monthly water level has not exceeded 581.5 ft. msl, thus no flooding. The Lake Michigan water level gauge at Holland can be easily accessed (see <https://tidesandcurrents.noaa.gov/waterlevels.html?id=9087031>) to ascertain whether flooding of the shore is occurring. Just remember ~582 ft. msl or lower equals no flooding.

Present Lake Level and Near Term Trends:

Presently Lake Michigan and thus Kalamazoo Lake are at 579.86 ft. msl which is approximately 32 inches above the low water datum (LWD) value. Water level is down approximately 9 inches from the mean August 2021 level and 25 inches from the record high set in 2020. However, the water level today is still approximately 8 inches higher than the long term average. The water level will likely decrease over the next six months before beginning to increase again in Spring 2023.

Future Lake Levels:

The US Army Corps of Engineers, NOAA, and various Canadian government organizations all monitor the water level in the Great Lakes and make predictions as to future water levels. Some predictions look a few months into the future while others predict next year or five and ten years out. For this discussion we are presenting the USACE water level forecast for a 12 month period starting from August 2022. Recall, three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS).

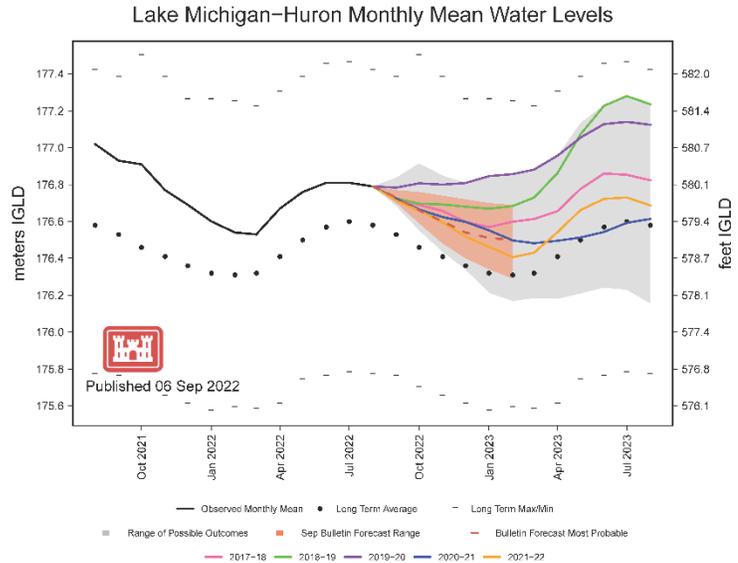


Figure 3: Prediction of Lake Level for Lake Michigan

Figure 3 shows projected water levels based on a range of scenarios. The grey envelope represents the range of possible modeling scenarios based on historical data from 1900 to 2020, while the red envelope represents the more probable range of water levels over the next six months. The five solid lines represent the forecasted water levels if the water supply in the coming months is similar to what was observed in each of the last five years. If conditions remain dry like the last two years, summer 2023 water levels could continue to decline towards the long term average. However, if we see wet conditions comparable to what was observed from 2018-2020, summer 2023 levels could increase by over 1 foot from current levels. Note that all of these projections forecast water levels below the 582 ft msl flooding threshold.

Summary: The high water levels of 2020 created problems and large expenses for the harbor stakeholders. The question that we have not had a reliable answer for is, when if ever will the water return to normal (i.e. is near average value). It really is mostly about the precipitation and evaporation. The average annual precipitation in the Michigan watershed basin is approximately 32 inches, with a high value of 40 inches occurring in 1985 and a low of 21.6 inches in the year 2016. The annual precipitation in 2020 in the Saugatuck area was 39.2 inches, near the high, resulting in the record-breaking water levels and regional flooding. However, a comparatively dry 2021 resulted in a steep reduction in water levels. Current forecasts from NOAA's Climate Prediction Center (<https://www.cpc.ncep.noaa.gov/>) suggest a small likelihood of above normal temperatures in the next 3 months and equal chances of above, below, or near-normal precipitation. Depending on the precipitation levels over the next several months, summer 2023 water levels could increase toward the recently observed record levels or continue to revert toward the historical mean. The takeaways are:

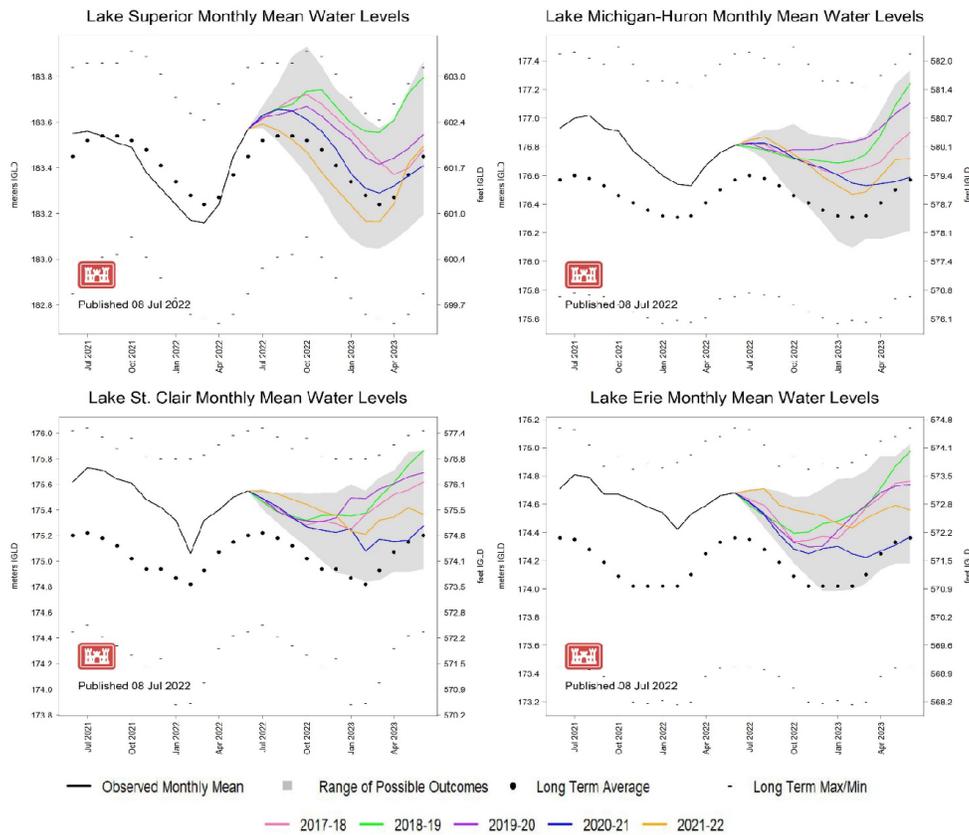
- 1) Kalamazoo Lake and Lake Michigan are hydrostatically connected, if Lake Michigan rises so does Kalamazoo Lake and River.
- 2) **Remember the number 582 ft. msl.** When the gauge at Holland reads 582 or higher we are going to get flooding.
- 3) Storm surge and seiche events on Lake Michigan will still occur and result in local flooding due to the high water, in normal times we barely notice these occurrences.
- 4) The future lake level is all about NBS, really it translates into rain and snow fall. Above average precipitation in the Great Lakes Basin spells trouble.



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Great Lakes Water Level Future Scenarios

Volume 28 July 2022: Recent Years of Net Basin Supply



*At this time, water level outlooks for Lake Ontario are still under development due to complexities of its weekly regulation process. For the official 6-month forecast of all lakes, including Lake Ontario, see the [Monthly Bulletin of Great Lakes Water Levels](#).

Overview

Over the last three months, conditions across the Great Lakes basin were variable from the western to eastern sections. The Lake Superior basin was quite wet, especially in April and May, which brought water levels from below to above long-term average levels. However, in the Lake Erie and Ontario basins conditions have been drier in recent months. Water levels follow a seasonal cycle where during the spring water levels typically rise due to increased precipitation and enhanced runoff from snowmelt. In the fall and early winter, the lakes generally decline due to an increase in evaporation as temperatures decline and cold air moves over the relatively warm lake waters. We refer to the combined effect of precipitation over the lake, evaporation from the lake, and runoff to the lake as Net Basin Supply (NBS).

This edition of the Water Level Future Scenarios showcases the potential water levels if the water supplies that were received in each of the last 5 years occurred. In the last 5 years we have seen variable conditions throughout the Great Lakes, including very wet water supplies that led to record high water levels and in the most recent years some drier conditions that transitioned water levels to near or below average. The latest water level scenario product begins in July and stretches through June of the following year. The most recent 5 one-year periods analyzed are 2017-18, 2018-19, 2019-20, 2020-21, and 2021-22. Also, the gray shaded area on the plot represents the full range of possible outcomes using historical sequences of NBS from 1900 through 2021. This version also incorporates an experimental version of a Lake Ontario graphic. For Lake Ontario, the range of possible outcomes (gray shaded area) is based on historical NBS from 1900-2019 (Figure 1). Also, given the historical period of record for the experimental product, only the 2017-18, 2018-19, and 2019-20 scenario years are shown.

Figure 2 shows the last 5 years of provisional monthly NBS to each lake basin. Red bars indicate NBS below average and blue bars indicate NBS above average. For much of the beginning of the

period blue bars dominate, indicating NBS above average. In 2020, conditions turned drier especially in the Erie and Ontario basins. The persistent dry conditions throughout the Great Lakes basin led to the development of drought conditions later in 2021 in some areas.

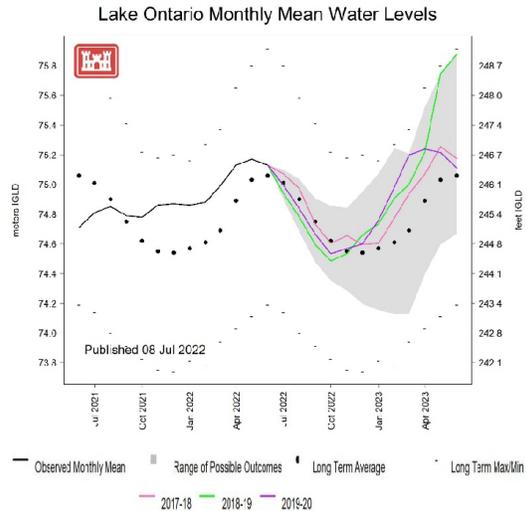


Figure 1: An experimental version Lake Ontario graphic with the new future scenario reflected.

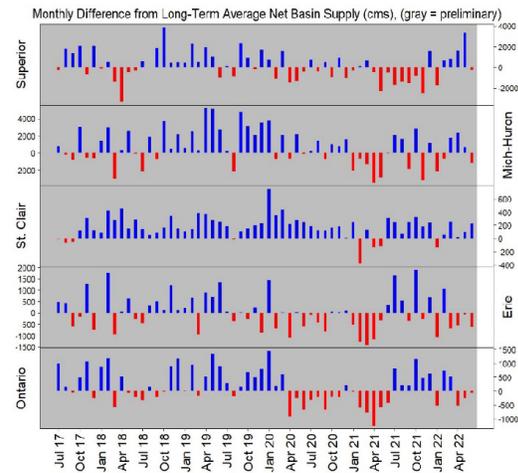


Figure 2: Provisional Monthly Net Basin Supply for all lakes over the last 5 years.

Recent Year Scenarios

Since 2017, conditions in the Great Lakes have been variable and there have been differences in individual lake basins (Figure 2).

Lake Superior

For Lake Superior, of the most recent years the wettest NBS over the next 12 months was 2018-19, represented by the green line. This represents the water levels that would occur if a similar NBS sequence were to happen. A wet end to 2018 and beginning of 2019 would cause water levels to creep back-up to near record high water levels. The 2017-18 and 2019-20 scenarios experienced both above and below average NBS in certain months throughout the scenario period, but under both scenarios water levels would remain above average. The most recent 2 years in the Lake Superior basin have been generally drier, especially in 2021. From April to November 2021 NBS was below average (Figure 2), 8 straight months, which led to drought conditions to develop in the spring and summer of 2021. However, in the spring of 2022 wet conditions have been dominant and brought water levels back up above average, after falling below average in the fall of 2021. The 2021-22 NBS sequence would result in water levels falling back below average this fall, while the 2020-21 NBS sequence would result in water levels staying above average for most of the 12-month period.

Lake Michigan-Huron

Lake Michigan-Huron's NBS sequences of the last 5 years indicate that if any of these sequences were to occur over the next year water levels would remain above average. However, there are differences in how much above average water levels would be toward the end of the period, depending on the sequence. The two wettest scenarios of the last 5 years for Lake Michigan-Huron were 2018-19 (green line) and 2019-20 (purple line). Especially, in 2019 when very wet conditions occurred in the fall, which led to water levels not going through their typical seasonal decline. Under these NBS scenarios, the water level outcomes would be toward the top of the

range of possible outcomes, but below record high water levels. On the contrary, the beginning of 2021 was very dry, which was reflected in the 2020-21 NBS sequence leading to water levels getting close to average by the end of the period.

Lake St. Clair

Of the most recent 5 one-year NBS sequences, the 2018-19 sequence would end the 12-month period at the top of the range of possible outcomes (gray band), due to the wet conditions in the spring of 2019. However, the beginning of 2021 brought drier conditions to the basin, which would lead to water levels in the 2020-21 (blue line) scenario to become close to average. The NBS sequences of 2017-18 (pink line) and 2019-20 (purple line), would also lead to water levels toward the upper part of the range of possible outcomes, but still below record high levels.

Lake Erie

Similarly to Lake Superior, Lake Erie experienced a wide range of conditions over the last five years. The first three of the five NBS one-year sequences, 2017-18 (pink line), 2018-19 (green line), and 2019-20 (purple line) all end the 12-month period toward the top of the range of possible outcomes (gray band). This was a result of predominantly NBS above average conditions during this time. However, during 2020 and into 2021, conditions became more persistently dry in the Lake Erie basin, which would result in the 2020-21 NBS sequence reaching near average water levels by the end of the next 12 months. Another transition occurred in the summer and fall of 2021 when conditions became wet again, which would lead to higher water levels in the beginning of the period in the 2021-22 scenario.

Lake Ontario

As shown in Figure 1, the experimental Lake Ontario graphic shows the first three scenario years, 2017-18, 2018-19, and 2019-20. The most notable NBS sequence is the 2018-19 scenario (green line), which includes the very wet spring and early summer of 2019. If this scenario were to occur, the large water level rise during 2019 would

lead to water levels toward the top of the range of possible outcomes by the end of the period, but below record high levels. However, the other two NBS scenarios, 2017-18 and 2019-20, would result in water levels closer to average for most of the next 12 months.

Summary & Climatic Outlook

Overall, this edition of the Water Level Future Scenarios product shows the variability in conditions in recent years of wet conditions that were associated with record high water levels, and the drier conditions that have occurred to bring

water levels back closer to average. However, it is worth noting that if any of these one-year NBS sequences were to occur over the next year water levels would remain below record high water levels.

The Climate Prediction Center’s seasonal forecasts (Figure 3) for temperatures for the spring and early summer (July, August, and September) show a likelihood of above normal temperatures for all lake basins. The precipitation outlook for the same three-month period shows most of the Great Lakes basin with equal chances for above, below, or near normal precipitation.

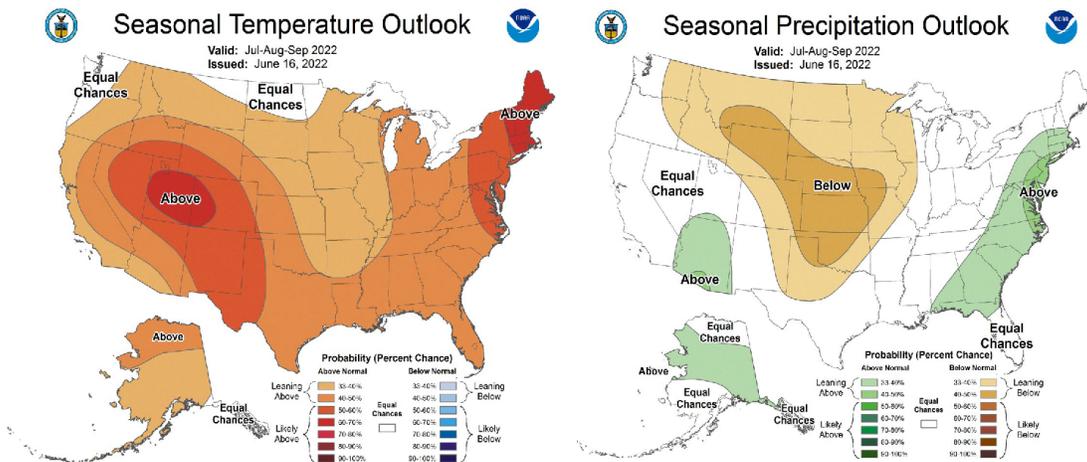


Figure 3. Temperature and Precipitation 3-month Seasonal Outlooks for July, August, and September. From: The Climate Prediction Center