

August 2021 Update on Kalamazoo Lake Levels- Past, Present and Future

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Introduction: This is an update to the April 2021 report of water levels in the Saugatuck and Douglas harbor area. Saugatuck and Douglas have continued to experience above-normal Kalamazoo Lake and River water levels through August 2021. However, the dry winter and spring, combined with the lack of a typical seasonal summer rise in water levels in Lakes Michigan and Huron has led to current water levels being down more than a foot from August 2020 (~16 inches). Note that the present water level (approximately 580.75 ft. msl) is still significantly higher (approximately 17 inches) than the long term mean August elevation of Lake Michigan (approximately 579.33 ft. msl). The lake level forecast provided by the US Army Corps of Engineers (USACE) indicates that the water level over the next 6 months will likely peak in the next month and then decline heading into the fall season. Many stakeholders are again asking what is going on and will the Lake level significantly go down? We will try to address these questions with this discussion, 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.

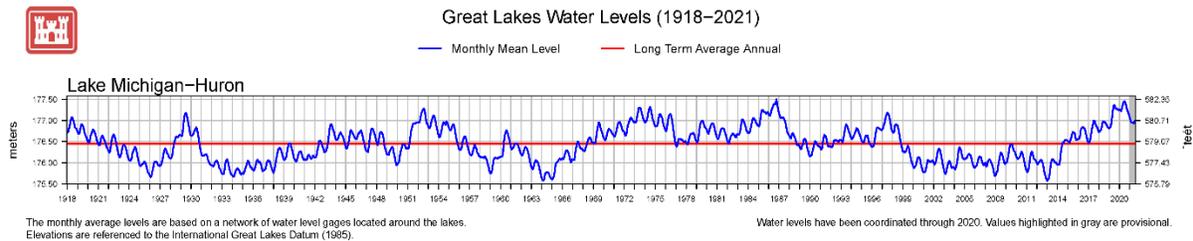


Figure 1: Historical Lake Michigan water levels

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. We are presently six years into this high water event and the plot shows we are trending downward. Good news.

Figure 2 shows in more detail the mean monthly water levels from 2020 and 2021 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 present value of approximately 580.75 ft. msl. This is down approximately 20 inches from the record highs of last summer, and 16 inches from the mean August 2020 levels, but still approximately 17 inches higher than the long term August mean.

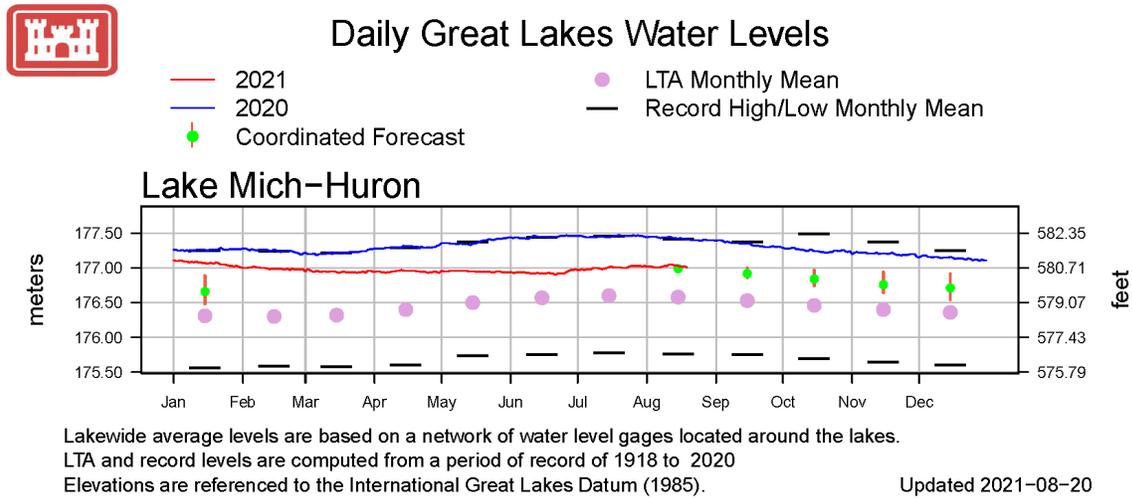


Figure 2: Mean Daily Lake Michigan water levels for 2020 and the first seven months of 2021 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).

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 580.75 ft. msl which is approximately 42 inches above the low water datum (LWD) value. Water level is down approximately 16 inches from the mean August 2020 level (which was a record high for August) and 20 inches from the record high set in July 2020. However, the water level today is still approximately 17 inches higher than the long term average. The water level will likely continue to decline into the fall as air temperatures decline and evaporation increases.

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 2021. Recall, three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS).

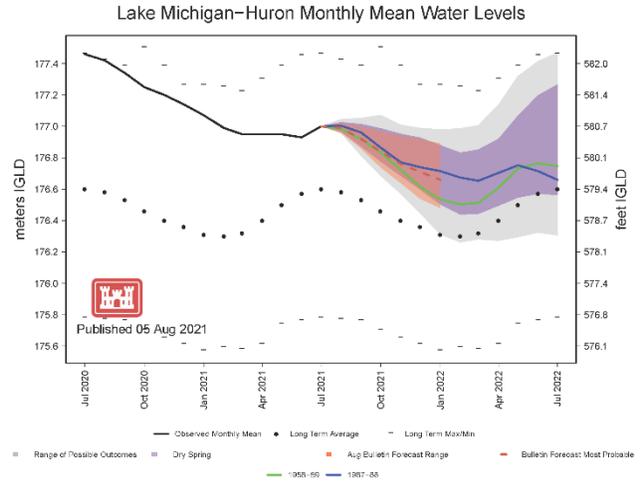


Figure 3: Prediction of Lake Level for Lake Michigan

Figure 3 shows projected water levels based on a range of scenarios. The purple envelope represents the range of likely water levels based on 12 years that also experienced dry conditions during the spring months similar to 2021. In this range of scenarios, the water level will continue to decline through the summer and fall, but there is a potential for increased water levels in 2022. However, this range of scenarios indicates that levels should remain below the 582 ft msl flooding threshold. The much wider gray area represents the range of possible modeling scenarios based on historical data from 1900 to 2020.

The two solid lines represent water level projections if NBS and hydrologic conditions (i.e. air temperature, winds, precipitation) are similar to those observed in two years that experienced dry springs after a period of high water levels, 1958-59 and 1987-88. Both scenarios resulted in a continued decline in water levels through spring 2022, with projected July 2022 levels 11-14 inches below the current water level.

The orange envelope represents a 6-month forecast range based on currently projected weather conditions, with the dashed orange line being the most probable forecast. This forecast would put the next six months between the 1958-59 and 1987-88 curves, representing a seasonal water level decline.

Summary: The high water levels of 2020 created problems and large expenses for the harbor stakeholders. The big question that we do not have 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. Last year (2020) the annual precipitation in the Saugatuck area was 39.2 inches, near the high. However, despite the 2020 La Niña event, we had a dry winter and spring, resulting in the continued reduction in water levels. Current forecasts suggest equal changes of above-average, normal, and below-average precipitation for the next few months. The takeaways are:

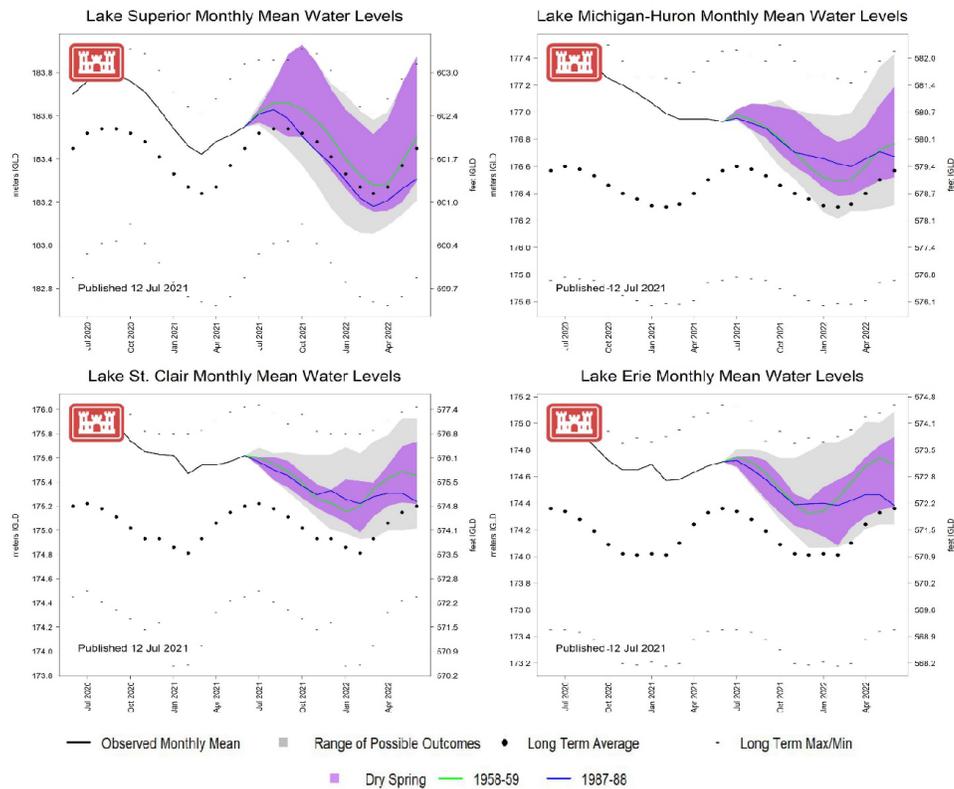
- 1) Kalamazoo Lake and Lake Michigan are hydrostatically connected, if Lake Michigan rises so does Kalamazoo Lake and River.
- 2) **Remember the number 582 ft. msl.** When the gauge at Holland reads 582 or higher we are going to get flooding.
- 3) Storm surge and seiche events on Lake Michigan will 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 24 July 2021: Dry Spring (March-May)



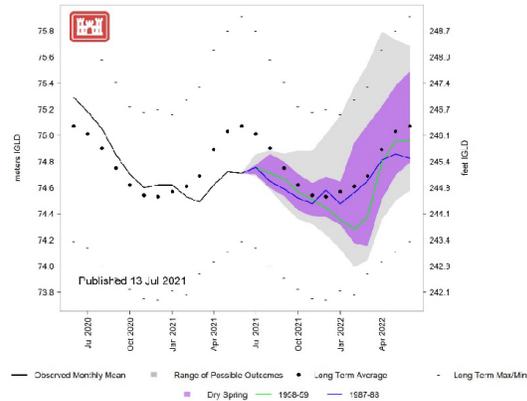
*At this time, water level outlooks for Lake Ontario are still under development due to complexities of its weekly regulation process. For the official 6-month forecast of all lakes, including Lake Ontario, see the [Monthly Bulletin of Great Lakes Water Levels](#).

Overview

Over the past few months, all the lakes except Lake Michigan-Huron, have been experiencing their seasonal rise in water levels. The predominantly drier conditions in the Lake Michigan-Huron basin led to a decline in water level through the month of June. All of the lakes continue to experience water levels below levels of a year ago and record high levels. Water levels on Lakes Superior to Erie remain above average, while water levels on Lake Ontario are below average. The recent 6-month forecast projects that the lakes will either reach their peak in the next month or two or begin their seasonal decline. Water levels follow a seasonal cycle where water levels typically rise in the spring due to increased precipitation and enhanced runoff from snowmelt. In the summer, water levels typically reach their peak level. In the fall, 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). During the spring months (March-May), very dry conditions were experienced throughout the Great Lakes basin, which has limited the seasonal rise in water levels on the lakes this year.

This edition of the Water Level Future Scenarios showcases a purple plume that represents twelve years that also were dry during the spring, similar to 2021. Two of the years within the plume have been called out to show the difference in hydroclimate conditions that could occur over the next 12 months. Both years also represent a time when water levels were in a period of transition out of high water and retreating to lower levels. Also, the gray shaded area on the plot represents the full range of possible outcomes using historical sequences of NBS from 1900 through 2020. 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 1900-2017.

Lake Ontario Monthly Mean Water Levels



Purple Plume: Dry Spring (March-May)

The purple plume represents twelve years that also had a dry spring, which was similar to what occurred in 2021. The twelve years were determined by using the Climate at a Glance tool at the following link: https://www.ncdc.noaa.gov/cag/regional/time-series/213/pcp/3/5/1900-2021?base_prd=true&begbaseyear=1901&endbaseyear=2000. The driest 12 years, with 2021 ranking 13th driest, were the years chosen for the plume. Please note that this ranking is only based on precipitation on the U.S. side of the border. The purple plume on Lakes St. Clair, Erie, and Ontario remains predominantly toward the bottom half of the full range of possible outcomes (gray shaded area). On Lakes Superior and Michigan-Huron, despite the prior dry spring conditions the purple plume range is towards the middle of the gray shaded area on Lake Michigan-Huron and towards the upper half of the gray shaded area on Lake Superior. Two years within the plume, 1958-59 and 1987-88 have been called out and represented by the green and blue lines. The 1958-59 scenario is shown by the green line and represents water levels that would occur if NBS was similar to the rest of 1958 through the first half of 1959. The 1987-88 scenario is represented by the blue line and indicates water levels that would occur if the NBS sequence for the rest of 1987 and early 1988 occurred.

1958-59 Scenario

The 1958-59 scenario shown by the green line depicts water levels if NBS and hydrologic conditions for the next 12 months are like what occurred during the rest of 1958 and first half of 1959. For the rest of the summer months and into September, precipitation would generally be above average across all the lakes. However, October and December would be drier, with evaporation also above average during these months. In the beginning of 1959, conditions would be slightly wetter on all the lakes, except Lake Superior. April and May were very wet in parts of the basin depending on the month, where in April precipitation was high on Lakes Michigan-Huron, St. Clair, and Erie, while in May the precipitation was high only on Lakes Superior and Michigan-Huron. The first month of summer in 1959 was quite dry with precipitation and runoff mainly below average. The generally wetter conditions in the beginning of the period would keep water levels toward the upper part of the purple plume on most lakes, followed by the seasonal declines in the fall and winter. The wetter spring conditions in the following year also aided in the seasonal rise on the lakes. This scenario would keep water levels above average on Lakes Superior, Michigan-Huron, St. Clair, and Erie. Lake Ontario would experience water levels below average over the next 12 months in this scenario.

1987-88 Scenario

The blue line represents water levels if NBS and hydrologic conditions over the next 12 months are similar to what occurred during the next six months of 1987 and first six months of 1988. Like 2021, the dry spring conditions were occurring directly after a year of record high water levels. For the rest of the summer in July and August, conditions would vary across the lakes. Precipitation was generally above average, but NBS was near to below average on all lakes, except Lake Erie which had slightly above average NBS in those two months. Despite higher precipitation, evaporation was above average, especially in August. September and October would be exceptionally dry for Lake Superior and aided in the sharp seasonal decline seen on the

lake. On the other lakes, NBS was closer to average in September and October, but still helped in the seasonal declines on the lakes, especially in October when evaporation was well above average. The last two months of the year would be slightly on the wetter side of average, with predominantly increased precipitation and runoff, especially in December. The beginning of 1988 would bring NBS near to below average across the lakes with evaporation well above average. The following spring was also very dry in 1988 and in fact is another year that was ranked in the twelve driest springs, which is part of the purple plume. The generally dry conditions throughout the next 12 months would lead to large seasonal declines and small seasonal rises on the lakes in the following year. This was especially true on Lake Superior, which would experience a steep seasonal decline that would bring water levels below average. Lake Ontario would experience one month of water levels above average in December but remain below average for the rest of the period.

Summary & Climatic Outlook

After analyzing the 12 driest springs, there didn't appear to be a consistent pattern of continued dry conditions. This was especially true for Lakes Superior and Michigan-Huron. On these two lakes the purple plume indicates that there is potential for wetter conditions over the next 12 months. It is noteworthy that the two scenarios shown, which reflect dry springs that were coming off periods of high water levels, similar to this year, did result in a general trend toward lower water levels over the next 12 months.

The Climate Prediction Center's seasonal forecasts for temperatures for the late summer and early fall (July, August, September) show a likelihood of above normal temperatures for the Great Lakes basin. The precipitation outlook for the same three-month period shows that the Lake Erie and Lake Ontario basins have a likelihood of above normal precipitation, while the other lake basins show equal chances. Equal chances indicate that there is an equal chance for above, below, or near normal conditions.