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

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Introduction: This is an update to the November 2021 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 April 2022 water level (579.6 ft. msl) is approximately 25 inches below the summer 2020 peak, and approximately 10 inches higher than the long term mean April elevation of Lake Michigan (approximately 578.77 ft. msl). The lake level forecast provided by the US Army Corps of Engineers (USACE) indicates that the water level will increase through summer as part of the typical seasonal cycle, but will likely remain below the levels observed last year and may fall below the long-term average over the next 12 months. 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.

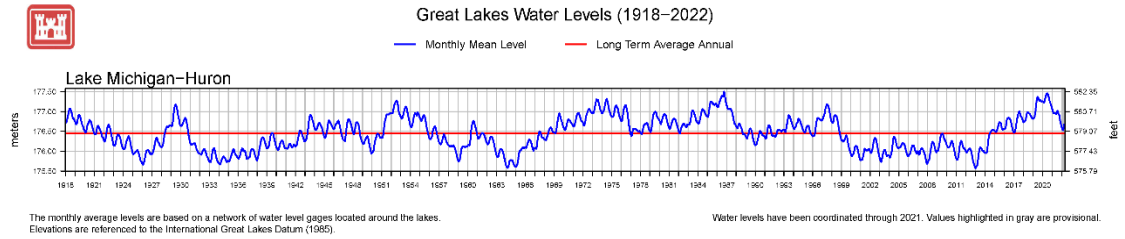


Figure 1: *Historical Lake Michigan water levels*

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 early-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 April level of approximately 579.63 ft. msl. This is down over 2 feet from the record highs of 2020, and 11 inches from the mean April 2021 levels, but still approximately 10 inches higher than the long term April mean.

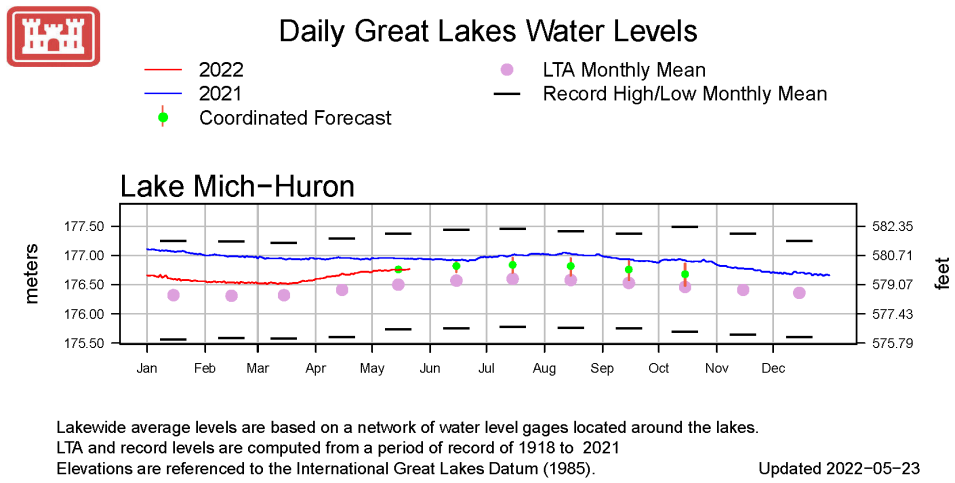


Figure 2: *Mean Daily Lake Michigan water levels for 2021 and the first four months of 2022 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).*

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 579.95 ft. msl which is approximately 32 inches above the low water datum (LWD) value. Water level is down approximately 11 inches from the mean April 2021 level and 25 inches from the record high set in July 2020. However, the water level today is still approximately 10 inches higher than the long term average. The water level will likely increase over the next few months before declining again in the fall and winter.

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 May 2022. Recall, three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS).

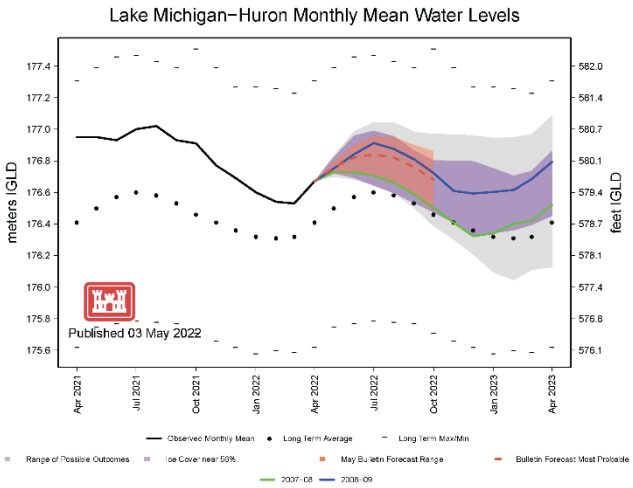


***Figure 3**: Prediction of Lake Level for Lake Michigan*

Figure 3 shows projected water levels based on a range of scenarios. The purple envelope represents the range of likely water levels based on 9 years that experienced similar maximum Great Lakes ice cover to the winter of 2021-2022 (ice cover was slightly above the long-term average). In this range of scenarios, the water level will likely rise through July 2022 before decreasing through the fall and early-winter. This range of scenarios indicates that levels will most likely remain below the elevated levels observed in recent years, and well 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 of the 9 elevated ice cover years: 2007-2008 and 2008-2009. The 2007-2008 projection would lead to a minimal summer increase and water level declines back toward the long-term average. The 2008-2009 projection would result in a greater summer water level increase, but remaining below the elevated levels observed in recent years.

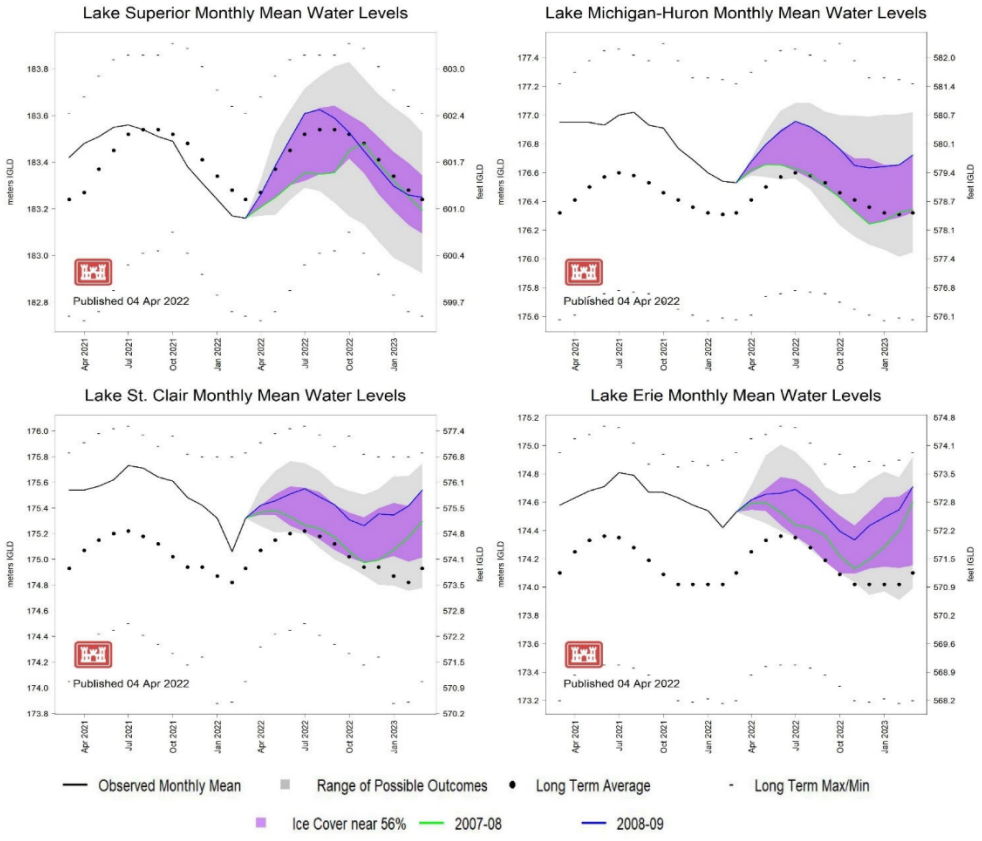
Summary: The high water levels of 2020 created problems and large expenses for the harbor stakeholders. The question that we have not had a reliable answer for is, when if ever will the water return to normal (i.e. is near average value). It really is mostly about the precipitation and evaporation. The 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 suggest a likelihood of above normal temperatures and precipitation in the coming months, with water levels likely remaining above the long-term average. However, if drier conditions continue, Lake Michigan's water levels may approach the long-term average by summer 2022. 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.

US Army Corps of Engineers ®
Detroit District

Great Lakes Water Level Future Scenarios

Volume 27 April 2022: Maximum Great Lakes Ice Cover near 56%



*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 in the Great Lakes basin were variable. In January, it was cold and dry across the region. February brought above average precipitation for most lake basins, but temperatures remained cold. In March, conditions varied across the region for both temperatures and precipitation. The lakes are currently either beginning or continuing their seasonal rise in water levels, which is typical for this time of year. 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 a purple plume that represents nine years that the maximum Great Lakes total ice cover was near 56%. During the winter of 2021-2022, the maximum ice cover for the Great Lakes was 56%, which is just slightly above the long-term average of 53.1%. 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. These two scenario years are 2007-08 and 2008-09. 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 1900-2017 (Figure 1).

After a warm beginning to the winter during the month of December, January and February were quite cold across the Great Lakes region, leading to increases in ice coverage on the lakes and evaporation as the frigid air moved over the relatively warm lake surfaces. Total Great Lakes ice cover at the beginning of January was close to 2%, but by the end of the month the ice cover had climbed to 40%. The continued cold in February led to the total maximum ice cover of 56.1% for the Great Lakes to occur on February 26th (Figure 2). Also, there was a large swing in surface water temperatures from December to February due to the significant change in air temperatures during this time (Figure 3).

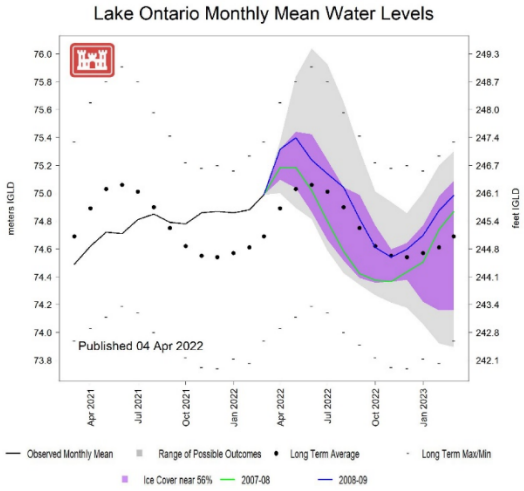


Figure 1: An experimental version Lake Ontario graphic with the new future scenario reflected.

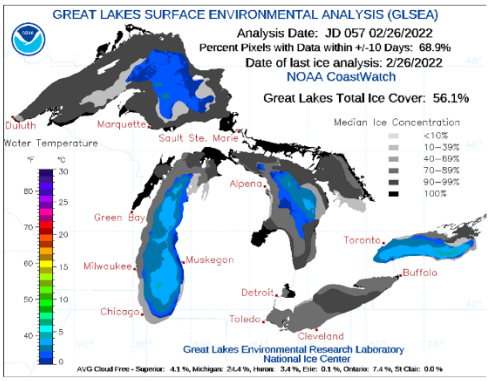


Figure 2: Great Lakes total maximum ice cover of 56.1% on February 26th.

In Figure 3, surface water temperatures are shown for the current year, 2021-22, and the scenario

years 2006-07, 2007-08 (note: historical data lags a year behind future scenario call outs). Each of the scenario years has some common characteristics of the current year. In 2006-07, the fall months were colder, but surface water temperatures did follow a similar trajectory come the winter months, with a warmer December and a drop in temperatures during January and February. In 2007-08, surface water temperatures were similar to the current year in the fall with warm surface water temperatures. However, the transitions to colder surface water temperatures started earlier in the winter.

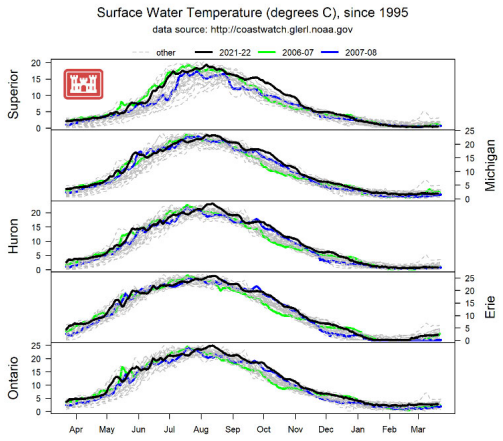


Figure 3: Surface water temperatures since 1995, highlighting 2021-22, 2006-07, and 2007-08.

Purple Plume: Ice Cover near 56%

The purple plume represents nine years that experienced total maximum Great Lakes ice cover near 56%. Two years within the plume, 2007-08 and 2008-09 have been called out and represented by the green and blue lines. The 2007-08 scenario (55.2%) is shown by the green line and represents water levels that would occur if NBS over the next 12 months is similar to the next 9 months of 2007 and first three months of 2008. The 2008-09 scenario (53.7%) is represented by the blue line and indicates water levels that would occur if the NBS sequence during the next 9 months of 2008 and first three months of 2009 occurred.

2007-08 Scenario

The 2007-08 scenario shown by the green line depicts water levels if NBS and hydrologic conditions for the next 12 months are like what occurred from April to December of 2007 and January to March of 2008. This scenario had a total Great Lakes maximum ice cover of 55.2%. Also, as shown in Figure 3, the surface water temperatures were similar during the winter as it was in 2021-22. This included the warmer December and then a transition towards colder surface water temperatures in January and February. This also translated to above average evaporation during January and February due to the colder temperatures in the region. Given these similar prior conditions, looking into the future for what water levels could be for the next 12 months, the green line tends to be a drier scenario and toward the bottom of the purple plume. Net basin supplies during the spring and summer months would be predominantly near to below average across the Great Lakes. Lake Superior did experience a wetter September and October with well above average precipitation, which would bring water levels back towards average. On Lake Michigan-Huron, the drier spring and early summer in the 2007-08 scenario, would lead to water levels transitioning to near average. On Lakes St. Clair, Erie, and Ontario, water levels also experienced a smaller seasonal rise in the late spring and summer but saw a rise in water levels toward the end of the outlook period between December and March due to increased precipitation and runoff during this time.

2008-09 Scenario

The blue line represents water levels if NBS and hydrologic conditions over the next 12 months are similar to what occurred in next nine months of 2008 and first three months of 2009. This scenario had a total Great Lakes maximum ice cover of 53.7% for the winter. Surface water temperatures were similar to 2021 during the fall, but during the winter months water temperatures were colder in this scenario. However, evaporation was still high during the winter months due to the transition from very warm surface water temperatures to cold.

Contrary to the 2007-08 scenario, the blue line representing the 2008-09 scenario is toward the top of the purple plume on each lake, indicating wetter conditions over the next 12 months. On Lakes Superior and Michigan-Huron, a wet late spring and early summer with increased precipitation and runoff would lead to large seasonal rises on the lakes, which is shown by the blue lines towards the top of the purple plume. This predominantly wet period would also lead to decent seasonal rises on the other lakes, which kept water levels above average during this time. August and October precipitation was predominantly below average across all lakes, besides Lake Ontario, which experienced above average precipitation in these months. This would lead to NBS also being below average and contribute to the seasonal decline on the lakes. Although wetter conditions were experienced on Lake Ontario, water levels still underwent a seasonal decline during the late summer and fall. The end of this outlook period between December and March was also rather wet across the Great Lakes basin. This was mainly driven by well above average precipitation and runoff. This was especially true on Lakes St. Clair, Erie, and Ontario, which experienced large seasonal rises toward the end of the 12-month outlook.

Summary & Climatic Outlook

Overall, the purple plume that represents years with Great Lakes total maximum ice cover near 56% predominantly stays within the middle section of full range of possible outcomes (gray shaded area) of water levels for each lake. An exception, being Lake St. Clair and Lake Erie during the late summer and early fall when the purple plume is toward the bottom of the full range. The two call-out scenarios show the differences in hydrologic and weather conditions that could occur over the next 12 months, given similar prior conditions to current conditions in the Great Lakes basin.

The purple plume indicates that water levels on Lakes Michigan-Huron, St. Clair, and Erie could potentially be near average by July, if drier hydrologic conditions occur. However, it's likely water levels will stay above average on these lakes. Lake Superior's water levels will likely remain near to below average into the summer months and then the purple plume is mostly equally spread around the average line, with some scenarios falling above and some below. Lake Ontario's purple plume also straddles equally around the average line for most of the next 12 months and could experience water levels above or below average depending on the weather and hydrologic conditions that occur.

The Climate Prediction Center's seasonal forecasts for temperatures for the spring and early summer (April, May, and June) 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 leaning toward above normal precipitation with exclusions in the far eastern and western portions of the basin where equal chances is forecast for above, below, or near normal precipitation.