US Army Corps of Engineers Detroit District

Great Lakes Update

2011 Annual Summary

This article will summarize water level and overall basin conditions during 2011. Precipitation, runoff and evaporation are the largest contributors to water level fluctuation and 2011 saw interesting patterns for each variable. This article will also summarize Lake Superior regulation decisions, including a short explanation of experiments done to study sea lamprey mating habits near the regulation structures on the St. Marys River. The regulation of Lake Ontario and some other relevant Great Lakes topics will be discussed.

The Great Lakes – St. Lawrence River system extends southerly and easterly from the headwaters of tributary streams in northern Minnesota and western Ontario, to the Gulf of the St. Lawrence in the Atlantic Ocean. The drainage basin, (figure 1) which includes the surrounding land and water surface, covers more than 400,000 square miles from Duluth, Minnesota in the west to Trois Riviéres, Quebec on the St. Lawrence River. Eight U.S. states and two Canadian provinces border on the Great Lakes – St. Lawrence River system.

The U.S. Army Corps of Engineers is tasked with various missions relating to the Great Lakes. Water level forecasting, data collection and analysis, Lake Superior regulation out of the Detroit District and Lake Ontario regulation out of the Buffalo District are just a few of the water management missions.

Figure 1: The Great Lakes – St. Lawrence River Basin

2011 Water Level and Basin Summary

All water levels mentioned in this article are monthly mean surface elevations in feet on the International Great Lakes Datum of 1985 (IGLD 85). All values shall be considered preliminary until final levels are coordinated between U.S. and Canadian agencies, sometime in early 2012. The official period of record for Great Lakes water levels is 1918 – 2010. Official water level statistics and historical water levels are located on the internet at the following address.

http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/historicdata/

At the end of this article are a series of charts showing 2011 monthly mean water levels compared to long-term averages.

Water levels on Lake Superior remained below their long-term averages in 2011. In fact Lake Superior is in its longest stretch of continuously below average water levels. The last time Lake Superior was at or above a monthly mean was April of 1998.

In January 2011, Lake Superior was at 600.4 ft, or thirteen inches below its long term average and in the midst of its seasonal decline. Its decline continued through March, when the level was 600.0 feet and thirteen inches below average. The total decline from September 2010 to March 2011 was thirteen inches, which is the average decline in a given season.

Lake Superior reached its 2011 seasonal peak in August, at 601.3 ft. Lake Superior's annual rise was sixteen inches, when on average it rises thirteen inches. Lake Superior's December 2011 monthly mean was 600.7 ft, or twelve inches below its long-term average.

Evaporation from Lake Superior during the fall of 2011 was below average. The autumn (Sept, Oct, Nov) months often see significant evaporation rates from all the Great Lakes, since water temperatures can be much warmer than the overriding air temperature.

See Figure 2 for autumn 2011 modeled evaporation totals compared to average for all of the Great Lakes. Note that all the Great Lakes had below average modeled evaporation rates during the fall of 2011.

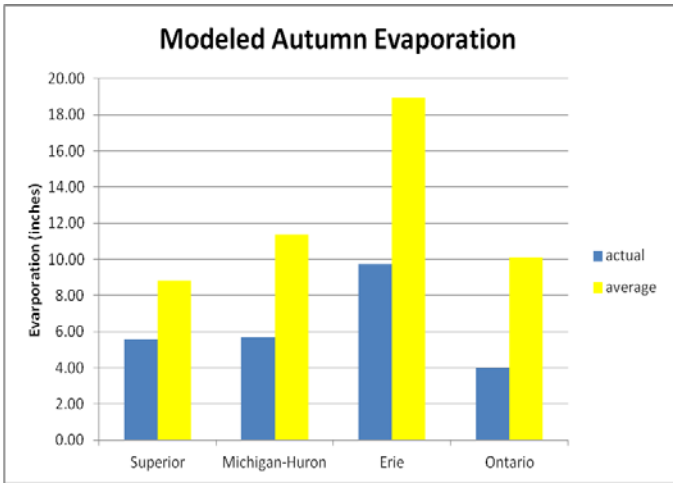

Figure 2: Autumn 2011 Evaporation

Precipitation in the Lake Superior basin was below average in 2011, with the majority of the year's precipitation falling in the spring (March, April and May) months. See figure 3 for the 2011 precipitation for each Great Lake precipitation compared to average.

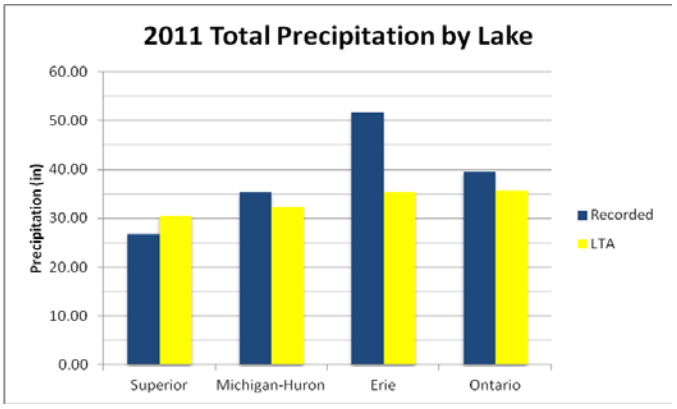

Figure 3: Great Lakes 2011 precipitation

Lake Michigan-Huron, considered one lake hydraulically due to the Straits of Mackinac, is also in its longest stretch of continuously below average water levels. Levels on Lake Michigan-Huron ranged from twelve to twenty inches below average in 2011. The last time Lake Michigan-Huron recorded a monthly mean at or above a monthly mean was 1998.

January 2011 saw a mean level of 576.8 ft on Lake Michigan-Huron. This level was nineteen inches below average. From July 2010 to February of 2011, the lake declined eighteen inches, while its average seasonal decline is eleven inches.

After reaching its seasonal low of 576.7 ft in February, Lake Michigan-Huron rose nineteen inches to a seasonal peak of 578.3 ft in July. On average, Lake Michigan-Huron rises eleven inches during the spring. Following a fall with lower than average evaporation, Lake Michigan-Huron's monthly mean in December was 577.6 ft, or eleven inches below its long-term average.

Precipitation in 2011 was above average in the Lake Michigan-Huron basin. Spring saw 139% of average precipitation, which led to the above average spring rise.

Snow water equivalent across the northern Great Lakes was estimated to be near average in the spring of 2011. Figure 4 shows the estimated snow water equivalent across the northern Great Lakes near the end of March. Runoff from snowmelt provides a large percentage of the water supply to the Great Lakes during their periods of seasonal rise.

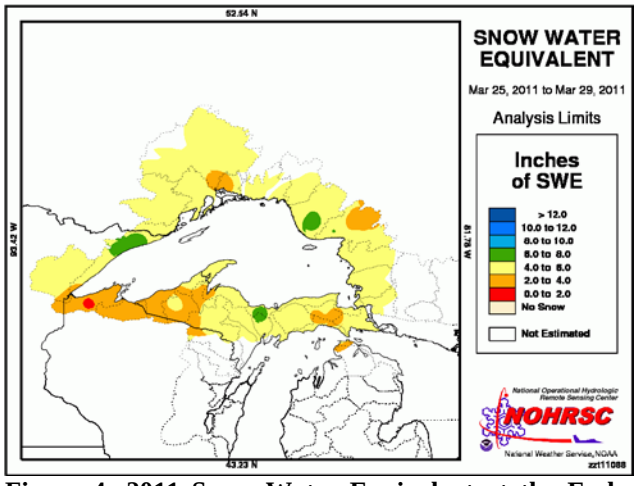

Figure 4: 2011 Snow Water Equivalent at the End of March

Lake St. Clair began 2011 at 572.4 ft, or fourteen inches below average. Levels in January and February were impacted by an ice jam in the St. Clair River. Ice often hinders the natural flow of water in the delta of the St. Clair River, which causes the water level of Lake St. Clair to fall dramatically. While the level of Lake St. Clair drops, levels upstream of the ice jam rise quickly. Once the ice jam breaks, water level conditions often return to pre jam conditions. Figure 5 shows ice conditions near St. Clair, Michigan in early March.

Figure 5: St. Clair River Ice

Heavy spring rainfall led to a drastic rise in water level beginning in March. In total, Lake St. Clair rose thirty inches in 2011, to a June peak of 574.9 ft. Lake St. Clair's average rise in a given year is sixteen inches. By December, Lake St. Clair was at a level of 574.4 ft or seven inches above its long-term average.

Below average water level conditions on Lake Erie existed in early 2011. January's level was 570.3 ft, or six inches below the long-term average. After reaching its seasonal low of 570.1 ft in February, Lake Erie began a substantial rise. Bolstered by intense rainfall and a large amount of snowmelt runoff, Lake Erie rose thirty three inches in 2011. Lake Erie's normal rise is close

to twelve inches. At the seasonal peak in June, Lake Erie was ten inches above average.

The December lake wide mean water level of Lake Erie was 572.2 ft. This level was seventeen inches above the December long term average.

Precipitation in the Lake Erie basin in 2011 was 145% of average. Over twelve inches of precipitation fell during the months of April and May alone. Then in the fall, over fifteen inches of precipitation were recorded in September through November.

The water level of Lake Ontario began 2011 at 244.4 feet, which was three inches below average. After reaching its seasonal low of 244.1 ft in February, Lake Ontario began a very steep seasonal rise, again due to increased snowmelt runoff and heavy rainfall.

By June, Lake Ontario was at 247.2 ft, or eleven inches above average. The lake rose three feet from February to June compared to an average rise of about a foot and a half.

During the spring months, the Lake Ontario basin received 155% of its average precipitation and in April alone, over five inches of precipitation fell. Based on provisional data, the April precipitation on the Lake Ontario basin is a new all time maximum for the month. By September, the water level of Lake Ontario had returned to near its long-term average. Lake Ontario ended 2011 at 244.8 ft or four inches above its long-term December average.

Lake Ontario's outflow is regulated on a weekly basis. Representatives of the Corps of Engineers Buffalo District and Environment Canada recommend outflow strategies based on current water levels and basin conditions. Recommendations are made to the International St. Lawrence River Board of Control, which operates under the auspices of the International Joint Commission (IJC).

More information on Lake Ontario regulation activities can be found here.

http://ijc.org/conseil_board/islrbc/en/main_accueil.htm

Lake Superior Regulation

The Detroit District also advises the Lake Superior Board of Control (Board) on regulation activities in the St. Marys River. The Board is a bi-national body that reports to the IJC on boundary water management issues including Lake Superior outflows. The regulation of the outflow of Lake Superior is governed by Orders of Approval from the IJC.

Near the beginning of each month, a coordinated outflow recommendation is determined between representatives of the Detroit District and Environment Canada. This outflow is determined following guidelines in Plan 1977-A for the regulation of Lake Superior. The plan's aim is to balance the levels of Lake Superior and Lake Michigan-Huron with respect to their long-term averages. Flow changes resulting from monthly Lake Superior regulation are accomplished by varying the amount of water allocated to hydropower production and, when necessary, opening or closing gates in the Compensating Works at the head of the St. Marys Rapids.

During 2011 Lake Superior water levels ranged from ten to fourteen inches below LTA. Due to the persistent lower than average water levels on Lake Superior, the regulated outflow was at the minimum allowed by Plan 1977-A for most of the year. See figure 6 for 2011 Lake Superior outflows compared to long-term average.

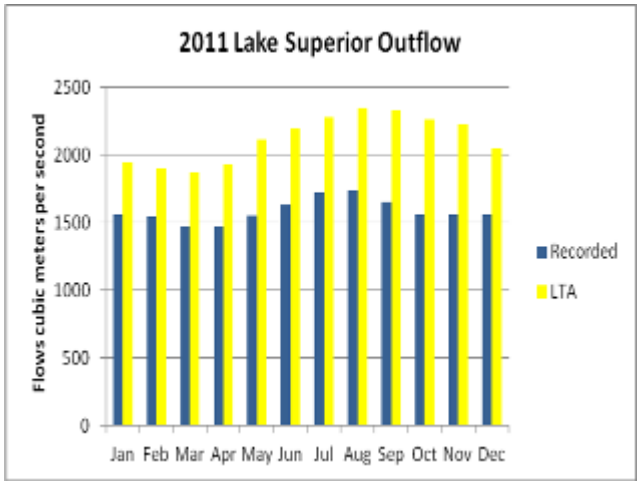

Figure 6: 2011 Lake Superior Outflow

Special outflow strategies existed during the summer months to aid in a sea lamprey trapping experiment performed by the U.S. Fish and Wildlife Service. Sea lampreys are an invasive species and nearly decimated the sport fish population in the Great Lakes. Trapping efforts during the past several decades have allowed predatory fish populations to grow, while lamprey populations continue to decline.

During the experiment, the Brookfield Renewable Power's hydropower plant in Canada and the Cloverland Electric Cooperative's hydropower plant in the U.S. alternated high and low flows during evening hours. Odd numbered days saw high flows, while the even days saw lower flows. Normal operations at the power plants call for lower flows during overnight hours, to match low demand for electricity.

It was hypothesized that high flows during the night attracted more sea lamprey to the traps near the plants. Preliminary results were positive and showed a larger number trapped sea lampreys.

Because of the plants' need to pass higher flows during overnight hours, the IJC granted special permission to the Board to allocate extra water for hydropower production in June. The extra flow allocation was small and had a negligible effect on the water level of Lake Superior. The experiment continued in July, but conditions allowed the hydropower companies to meet the experiment requests without an extra allocation.

Water Level Forecast

La Nina conditions are again expected across the Great Lakes basin this winter, which may bring increased snowfall and periods of very cold temperatures. Figure 7, (credit to NOAA) shows forecasted precipitation chances through February of 2012. According to NOAA, the Great Lakes region has a better chance for increased precipitation this winter.

Figure 7: Winter Precipitation Forecast

As mentioned earlier in the article, all of the Great Lakes experienced higher than average seasonal rises in the spring of 2011, due to wet conditions and a significant snowpack. If similar conditions are realized this winter and spring, the Great Lakes could again see larger than average seasonal rises.

The latest *Monthly Bulletin of Water Levels for the Great Lakes*, which accompanies this article projects water level through June 2012.

The upper and lower boundaries represent the possible range of water levels that could occur if the lake were to receive water supply much above or much below the averages usually expected each month. These upper and lower boundaries are based on actual past water supply records, and represent very wet and very dry conditions.

The best estimate or most probable water level forecast is primarily based on the current hydrologic conditions in the drainage basin. Key pieces of environmental data used in the forecast include recent precipitation, amount of water in the snow pack, frost depths, status of the groundwater table and air/water temperatures. One and three month forecasts of temperature and precipitation are also used. These forecasts are provided by the National Weather Service.

The January version of the *Monthly Bulletin* projects monthly mean water levels through June 2011. The water levels making up the by most probable forecast are shown in the following tables. For comparison purposes, the corresponding 2011 monthly mean water levels and long-term averages also shown.

Lake Superior Most Probable Forecast

	Jan	Feb	Mar	Apr	May	Jun
2012	600.5	600.3	600.2	600.3	600.6	601.0
2011	600.4	600.2	600.0	600.1	600.5	600.9
LTA	601.5	601.3	601.2	601.3	601.6	601.9

Lake Michigan-Huron Most Probable Forecast

	Jan	Feb	Mar	Apr	May	Jun
2012	577.4	577.4	577.4	577.6	577.9	578.1
2011	576.8	576.7	576.8	577.1	577.8	578.1
LTA	578.4	578.4	578.4	578.7	579.0	579.2

Lake St. Clair Most Probable Forecast

	Jan	Feb	Mar	Apr	May	Jun
2012	574.1	574.0	574.0	574.3	574.3	574.5
2011	572.4	572.5	573.1	573.8	574.6	574.9
LTA	573.6	573.5	573.8	574.3	574.5	574.7

Lake Erie Most Probable Forecast

	Jan	Feb	Mar	Apr	May	Jun
2012	572.0	571.9	571.9	572.1	572.2	572.2
2011	570.3	570.1	571.0	571.5	572.4	572.8
LTA	570.8	570.8	571.1	571.6	571.9	572.0

Lake Ontario Most Probable Forecast

	Jan	Feb	Mar	Apr	May	Jun
2012	245.1	245.5	245.7	246.2	246.4	246.4
2011	244.4	244.1	244.8	245.6	246.8	247.2
LTA	244.6	244.8	245.0	245.7	246.1	246.2

2011 Update Articles

Update articles like this one are issued four times per year. In 2011 topics covered in the updates included:

January 2011 – 2010 Annual Summary
Mar 2011 – Lake Winnebago Regulation
July 2011 – Great Lakes Spring Summary
October 2011 – Great Lakes Data Coordination

Past Update Articles going back to the 1980s are available here:

http://www.lre.usace.army.mil/greatlakes/hh/newsandinformation/pastupdatearticles/

Delivery of the Monthly Bulletin

The *Monthly Bulletin* can be viewed in few different ways. The first of which is by postal mail. Over 4000 *Bulletins* are mailed out each month to locations across the United States. The mailed version is black and white and usually arrives to the subscriber by the middle of the month. A smaller graphic of each lake is shown on an 11 by 17 folded newsletter. Also included is a look at the past month and past 12-month precipitation, outflow in the connecting channels and water supply information.

Another method of getting the *Bulletin* is by email subscription. The Detroit District of the Corps of Engineers posts a full color version of the *Bulletin* to its website once it is completed, usually in the first few days of the month. A user can download the 11 by 17 product or a full one page look at an individual lake. The webpage is:

http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/monthlybulletinofgreatlakeswaterlevels/

If you wish to remove yourself from the postal mail subscription list, change your address or to add your email address to our online database please send an email with your name information to hhpm@usace.army.mil.

In addition to the *Monthly Bulletin*, the Detroit District issues the *Weekly Great Lake Water Level Update* and the *Weekly Great Lakes Connecting Channels and Depths*. Both products are updated each Thursday and can be located here:

http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/

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.

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