INFLOW, OUTFLOW AND DIVERSIONS

The second most influential impacts on Georgian Bay water levels are inflows, outflows and human made diversions.

NATURAL INFLOW

- Water flows into the Great Lakes from thousands of streams and rivers covering a watershed area of approximately 520,587 square kilometres (201,000 square miles).
- The flow of water in the Great Lakes system moves from one lake to another eastward, ultimately flowing into the Atlantic Ocean.
- A single drop of water will take 200 years to move through this system:
  - From Lake Superior, water drains into the St. Mary's River and flows into Lake Huron
  - Lake Huron and Lake Michigan are connected directly by the Straits of Mackinac
  - Lake Huron waters flow into the St. Clair River, which drains into Lake St. Clair
  - Lake St. Clair, in turn, drains into the Detroit River, and empties into Lake Erie
  - At the end of Lake Erie, water flows into the Niagara River, dropping 52 meters (170 ft) as it flows over Niagara Falls and into Lake Ontario
  - From Lake Ontario, water flows into the St. Lawrence River and ultimately runs out the Atlantic Ocean

NATURAL OUTFLOW

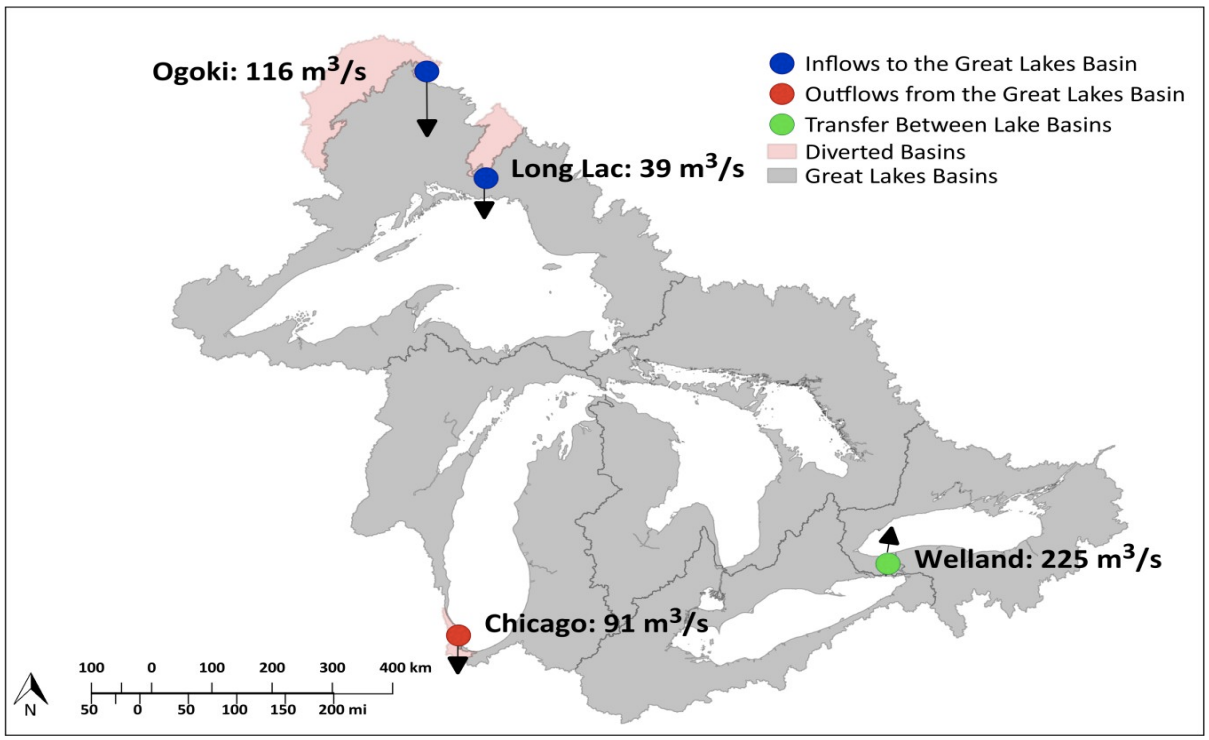
- But here's a fact that may be surprising: The Great Lakes are an essentially closed system.
- Outflows from the Great Lakes are very small in comparison to their total volume: each year, less than 1% of the volume of the water in the Great Lakes flows out the St. Lawrence River.
- For Lake Michigan Huron, that 1% is equal to the top 1m of water.
- Perhaps what's even more impressive than the flow of water through this complex interconnected system is how relatively little water actually leaves the Great Lakes

Watershed each year. Great Lakes water is only replenished by 1% annually; the remaining 99% is a one-time gift from melting glaciers

ALSO NATURAL - What is the Glacial Isostatic Rebound?

- Another reason for elevated water levels is Glacial Isostatic Rebound; the rise of land masses that were depressed by the huge weight of ice sheets during the ice age.
- Around the Great Lakes, the surface is tilting southward so that land levels in the northern are rising about one foot per century while those in the south are dropping which will have an impact on shipping, recreation and shorelines.
- Also, as water levels increase, the added weight in the lake causes the lakebed to sink.
- This is discussed further in "Rise of Great Lakes Surface Water, Sinking of the Upper Midwest of the United States, and Viscous Collapse of the Forebulge of the former Laurentide Ice Sheet" by Donald Argus. (hot link "Donald Argus" to this https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020JB019739 and https://www.ontariobeneathourfeet.com/rising-land-isostatic-rebound)

WATER FLOW CONTROL SYSTEMS - DIVERSIONS



Because of the enormity of the Great Lakes system, decisions have been made for many reasons over the years to add to or to take away water from the system.

- The major diversions in the Great Lakes basin that affect water levels are diversions into Lake Superior at Long Lac and Ogoki, the Chicago diversion out of Lake Michigan, a diversion between lakes Erie and Ontario through the Welland Canal and the control structure in the St. Mary's River in Sault Ste. Marie.
- These diversions have a much smaller impact on water levels than evaporation or precipitation.
- The **Long Lac and Ogoki diversions**, located in northern Ontario, divert water from a portion of the Hudson Bay watershed into the Lake Superior basin. The Long Lac diversion began in 1939 and the Ogoki diversion began in 1943 for hydro-electric power generation. Often times these two diversions are considered as one because they are both diverting flows from the same watershed. They are operated by Ontario Power Generation.
- The **Chicago diversion**, located in Chicago, Illinois, diverts water from the Lake Michigan watershed into the Upper Mississippi River basin. The Chicago diversion began in the early 1800s and increased in 1900 after the Chicago Sanitary and Ship Canal was completed to prevent sewage from mixing into the drinking water supply and to facilitate commercial goods transport from the Mississippi river. The first US Supreme Court decree in limiting the Chicago diversion was effective in 1925, and the latest decree of 1967, modified in 1980, limits the annual diversion to 91 cubic meters per second (3,200 cubic feet per second). It is operated by the US Army Corps of Engineers.
- The **Welland Canal** is a navigation route which bypasses Niagara Falls and diverts water from Lake Erie to Lake Ontario. The first canal was built in 1829 and was steadily improved over the years, including the addition of diversions for hydropower. The present configuration was set as a result of the 1950 Niagara Treaty. It is operated by the St. Lawrence Seaway Management Corp.
- Control structures in the **St. Mary's River** were built in the late 1800s. These were created to produce hydroelectric energy to power heavy industry in the Sault Ste. Marie area on both sides of the border. These structures divert water from the river into three side canals feeding one Canadian and two US power plants. Additionally, these structures can be opened or closed to compensate for increases or decreases in water levels and usages for power. In this same area, there are also two major shipping locks on the US side of the river and one smaller lock on the Canadian side. These control structures are the only water levels management structure in the upper Great Lakes.

The St. Clair River

- A point of contention for many Georgian Bay property owners is the historical dredging of the **St. Clair River** for shipping on the St Lawrence Seaway. This began in the mid-1800s and has occurred many times since then. There was also significant sand and gravel mining in the early part of the 20th century.
- Federal officials have long acknowledged that dredging and riverbed mining in the St. Clair dropped the long-term average of Great Lakes Huron and Michigan by about 16 inches. A bi-national Great Lakes water-level study concluded in 2013 that unexpected erosion since the last major St. Clair dredging project in the early 1960s has dropped the lakes' long-term average by an additional 3 to 5 inches.

- Today, these lakes are nearly 2 feet lower than before human modifications to the riverbed of the St. Clair River. This record low raised concerns about the long-term health of the lakes.
- Regarding the question of future dredging the St. Clair River, the US Army Corps of Engineers (USACE) carries out annual maintenance in the St. Clair River that includes dredging where needed. This however has little impact on flow rates as over-dredging would negatively impact the ability to retain water during the next low water cycle.
- Currently the changes in the St Clair River bed are being continuously monitored by the USACE and flow rates are measured at the mouth of the River using Doppler velocity sonar tools.

Online resources used for this article:
- https://ijc.org/en/lsbc/watershed/great-lakes-diversions
- https://en.wikipedia.org/wiki/St._Clair_River
- Map of Great Lakes connected system from https://greatlakes.guide/ideas/are-the-great-lakes-connected
- Map of inflows and outflows from https://ijc.org/en/lsbc/watershed/great-lakes-diversions

Next week, a word about Regulation and the International Joint Commission. Does anyone control this massive system??