US Army Corps
of Engineers
North Central Division

GREAT LAKES LEVELS

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Ice booms are vital to winter operations on the Great Lakes

This month's feature topic is ice booms. They are used on the St. Marys River, at Lake Erie's outlet (at the head of the Niagara River), and on the St. Lawrence River. We will discuss ice booms, why they are used, and their estimated effect on the environment and the economy.

An ice boom basically is a series of floating timbers linked together and anchored to the bottom of a river or lake. Figure 1 shows the primary components of the ice boom which is installed at the head of the Niagara River each year. The only permanently installed components are the bottom anchors; all other appurtenances are installed each fall and removed the following spring.

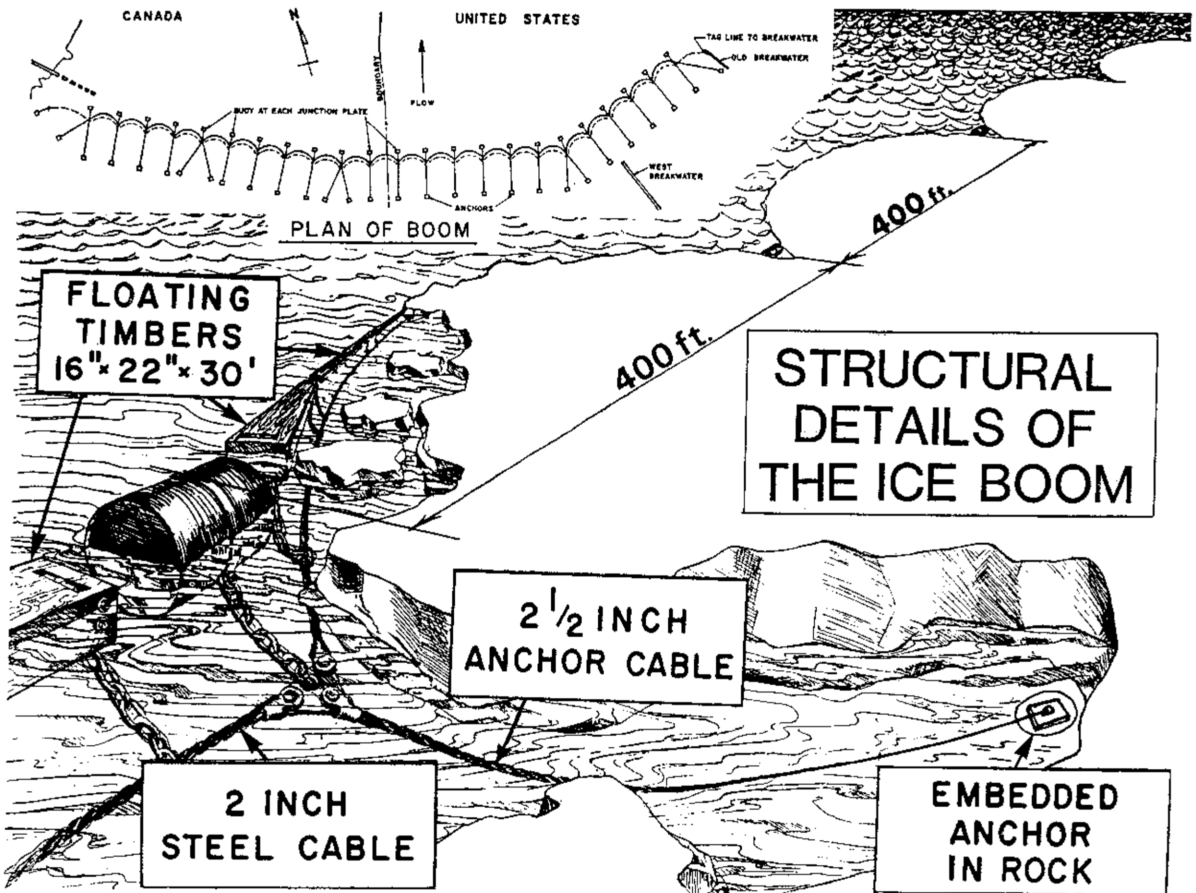

Figure 1 - A sketch of the ice boom's structural details. The upper left corner shows the plan view.

The primary purpose of an ice boom is to assist in the formation of a stable ice cover. It does this by accelerating the formation of the natural ice arch that normally forms in the river or lake. Pieces of floating ice are stopped by the boom and then freeze together into a solid, single unit of ice. Once the ice arch is formed, (see figure 2) it can bear the pressure of upstream ice on its own, and the boom is no longer needed for ice formation. When the ice cover becomes broken during severe storms and is forced up against the ice boom, the boom will submerge and resurface when the storm passes. It then helps the remaining broken pieces to again freeze together. During the spring ice dissipation period, the ice arch is not expected to reform if broken. The boom then limits the duration of ice runs to periods of high winds.

As a consequence, ice booms reduce the frequency, severity, and duration of ice runs in the rivers. Heavy ice runs in the Niagara and St. Lawrence Rivers have significantly reduced flow to the hydropower plant intakes and caused flooding and damage to docks, boathouses, and other riverine structures. Both studies and operational experiences have shown that ice booms also increase the discharge capacity of the rivers by producing a smoother ice cover and reducing hanging ice dams. The ice boom on the St. Marys River helps prevent flooding in the Soo Harbor and the powerhouses there, as well as helping in the operation of a ferry between the mainland and Sugar Island.

The remainder of this article will focus on the Lake Erie-Niagara River and St. Lawrence River ice booms.

These ice booms fall under the jurisdiction of the International Joint Commission (IJC). The IJC has granted permission to the Power Entities (Ontario Hydro and New York Power Authority) to use ice booms on the Niagara and St. Lawrence Rivers. Permission for the Lake Erie-Niagara River ice boom was first granted by an Order of Approval in June 1964, with the latest amendment in January 1984. The IJC has delegated responsibility for monitoring the ice boom's installation and removal to the International Niagara Board of Control (Niagara Board). The ice booms for the St. Lawrence River are considered to be part of the hydropower operations and no special Order of Approval has been issued for their use.

Figure 2 - View of Lake Erie-Niagara River ice boom.

Figure 3 - Installing the St. Lawrence River ice boom.

The IJC's current Order of Approval for the Lake Erie-Niagara River ice boom specifies that installation of the floating sections of the boom shall not commence until the water temperature at the Buffalo water intake reaches 4°C (39°F) or such other date determined by the IJC. Under this criterion, installation historically has taken place, on average, during the last two weeks of December. It usually takes 3-4 days to completely install the floating sections of the ice boom. Under ideal conditions it can be installed in as few as 2 days.

The two main ice boom sections on the St. Lawrence River (which span the navigation channel at Ogdensburg and Galop) are installed after the last commercial navigation vessel leaves that area. Installation (see figure 3) is made more difficult when ice begins forming due to early periods of cold weather while navigation is continuing. Complete closure of the ice booms is usually accomplished during the last week of December or first week of January. Ice flowing through the St. Lawrence River navigation channel during the early winter carries the risk of causing ice jams and reduced flows for hydropower. This situation is more risky during high water periods.

In the spring, the floating sections of the Lake Erie-Niagara River ice boom are required by the IJC to be opened by April 1, unless ice cover surveys on or about that date show there is more than 250 square miles of ice on the lake east of a line between Erie, Pennsylvania, and Long Point, Ontario. Complete disassembly and removal of all remaining flotation equipment are usually completed within 2 weeks after the boom opening date. There is no comparable opening date criterion for the St. Lawrence River ice booms. However, they are usually open for the beginning of the navigation season, about the first of April.

If the Lake Erie-Niagara River ice boom is removed too early, there could be an increased risk of large-scale ice runs out of the lake and into the Niagara River during storm conditions. In the past, large ice runs have caused extreme cutbacks in hydropower generation, damage to the Ontario Power Generating Station and other property in the lower Niagara River, as well as flooding and ice damage in the upper Niagara River.

Serious Niagara River flood damages occurred in 1938, 1955, 1962, and 1985. However, no complete account, in terms of dollars, has been made of these damages. Since the use of the boom began in the winter of 1964-65, there had not been any serious Niagara River damage reported until January 20, 1985.

While power loss reductions are desirable, the ice boom's major value lies in the limited protection it offers against large and adverse impacts to the Niagara and St. Lawrence Rivers' hydropower systems. Ontario Hydro's Ontario Power Generating Station, located adjacent to the Niagara Falls, has been flooded with ice twice in its 78-year history. The power entities believe that the possibility of such devastating ice runs is greatly reduced with the boom in place. The ice booms on both rivers provide "low-cost insurance" against the tens of millions of dollars of potential damages that could occur. Thus, the ice boom's value lies in significantly reducing the probability of such events.

The area of the entire Niagara River is only 23 square miles. Because of this and other physical limitations, the Niagara River can only carry an extremely small amount of ice from Lake Erie. Estimates show that the maximum short-term rate of ice discharge from the lake is about 20 square miles per day under extreme conditions, i.e., with strong southwest winds. Recorded ice runs of this magnitude have caused severe ice jams. Under average conditions with the boom removed, the rate of ice transport is about 5 square miles per day.

The Niagara Board, the National Research Council, and other independent researchers found in their studies that the length of the ice season is not increased due to the ice boom. The studies have found that Buffalo, as well as other cities 300 miles away, have experienced colder winters in the past several years, reflecting a general colder climate trend in this part of North America. This trend to colder winters occurred prior to the installation of the boom.

Niagara River flow utilization for power has increased by about 12 percent in January and February, as a result of the use of the Lake Erie-Niagara River ice boom over the past few years. For average river flows, this increased flow utilization is equivalent to 414,000 megawatt-hours of hydropower energy and represents a total saving, annually, of 170,000 tons of coal or 760,000 barrels of oil.

The annual ice boom installation and removal cost is approximately $70,000 to $100,000, which is shared by the power entities. When compared to the ice boom's economic benefits to the power entities and their customers, the cost is repaid many times over.

Further details on the St. Marys River ice boom, as well as a proposed ice boom study for the St. Clair River, will be provided in a future update.

Great Lakes basin rain report for November

Great Lakes basin precipitation has been above average for 9 months this year, with only March and August having less than average. The following tables show estimated precipitation for November and for the year to date.

During the past 12 months (December, 1989 - November, 1990), total precipitation on the Great Lakes basin has been about 4.6 inches (14 percent) above average. Lakes Superior, Michigan-Huron, Erie, and Ontario have had total precipitation of 2.2 inches (7 percent), 5.1 inches (16 percent), 8.5 inches (25 percent), and 4.1 inches (12 percent), respectively, above average.

The National Weather Service is forecasting basin-wide precipitation during December to be slightly below average, with temperatures also expected to be below average.

Basin	November				Year-to-Date			
	1990*	Average**	Diff.	% of Average	1990*	Average**	Diff.	% of Average
Superior	1.9	2.5	-0.6	76%	30.3	28.1	+2.2	108%
Michigan-Huron	4.5	2.7	+1.8	167%	35.0	29.4	+5.6	119%
Erie	2.9	2.8	+0.1	104%	41.0	31.8	+9.2	129%
Ontario	2.5	3.0	-0.5	83%	37.0	31.9	+5.1	116%
Great Lakes	3.4	2.7	+0.7	126%	34.8	29.7	+5.1	117%

* *Estimated* ** *1900-89 Average*

Lake Superior's December prescribed outflow is 60,000 cubic feet per second (cfs), 6,000 cfs less than last month. In November, the International St. Lawrence River Board of Control exercised its discretionary authority for Lake Ontario. The Board authorized discharging less than the Plan 1958-D flow from 7-30 November, thereby storing water on Lake Ontario. It took the opportunity to store water as no interest was adversely affected by this action and the water can be used more efficiently at a later time.

The water level of Lakes Michigan-Huron was steady in November in response to the heavy precipitation. The other Great Lakes levels declined slightly. All of the lakes are normally in their seasonal decline.

Last May the Corps of Engineers, Great Lakes Commission, and the Great Lakes Environmental Research Laboratory jointly sponsored a symposium on Great Lakes water level forecasting and statistics. The Proceedings for the symposium are now available at a cost of $20.00. To obtain a copy, please contact: The Great Lakes Commission, Argus Building II, 400 Fourth Street, Ann Arbor, MI 48103-4816.

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