

Seasonal Summary

Great Lakes
Winter 2013-2014



By the North American Ice Service

Summary for the Great Lake

The 2013-2014 winter was cold over the Great Lakes, as air temperatures from Nov 1 2013 to May 15 2014 averaged about 2°C to 3.5°C below normal (Fig 1).

Ice formation started in the last week of November and from then onward the winter was relentless (see Fig 2 and Fig 3 for another look at winter temperatures). The Historical Total Accumulated Ice Coverage for the season, an average of the weekly ice coverages from November 5 to May 14, reached a new record high of 39.1%. The previous high in our records (1972/73 to 2013/14) had been established in 1977 at 37.1% (Fig. 5). The Historical Total Accumulated Ice Coverage was at a record high for Lake Superior and Lake Huron, it was the second highest on record for Lake Michigan and Lake Erie and the fifth highest on record for Lake Ontario. The maximum ice coverage on the Great Lakes was reached in the first week of March at 91.2% (see Fig. 17), the second highest on record. The highest in our records was reached in the third week of February 1979 at 93.9%.

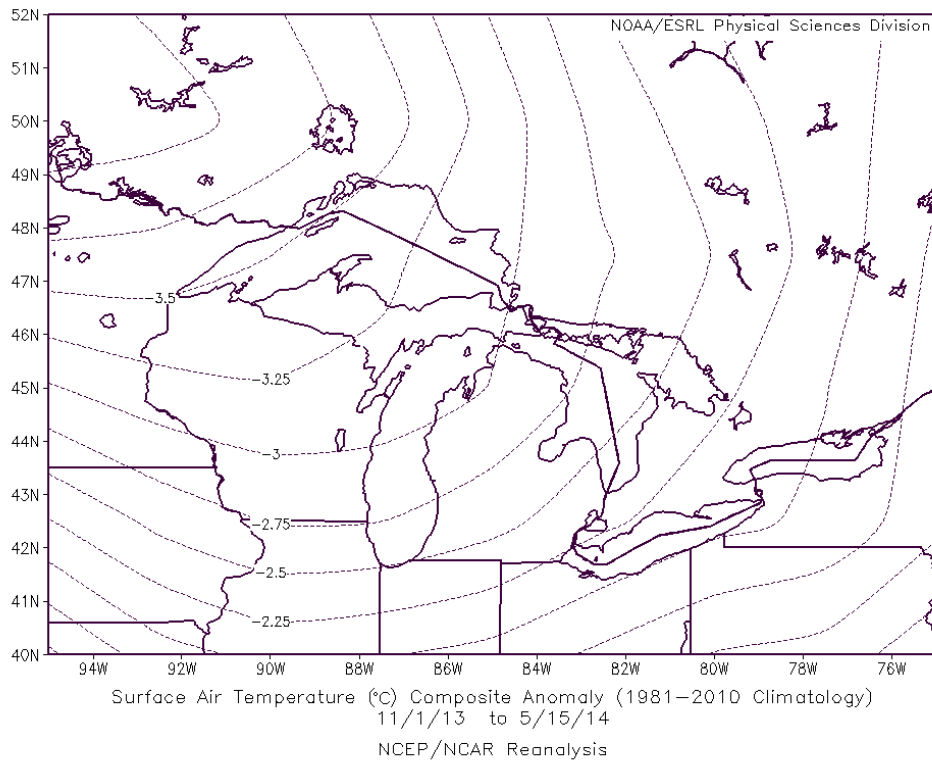
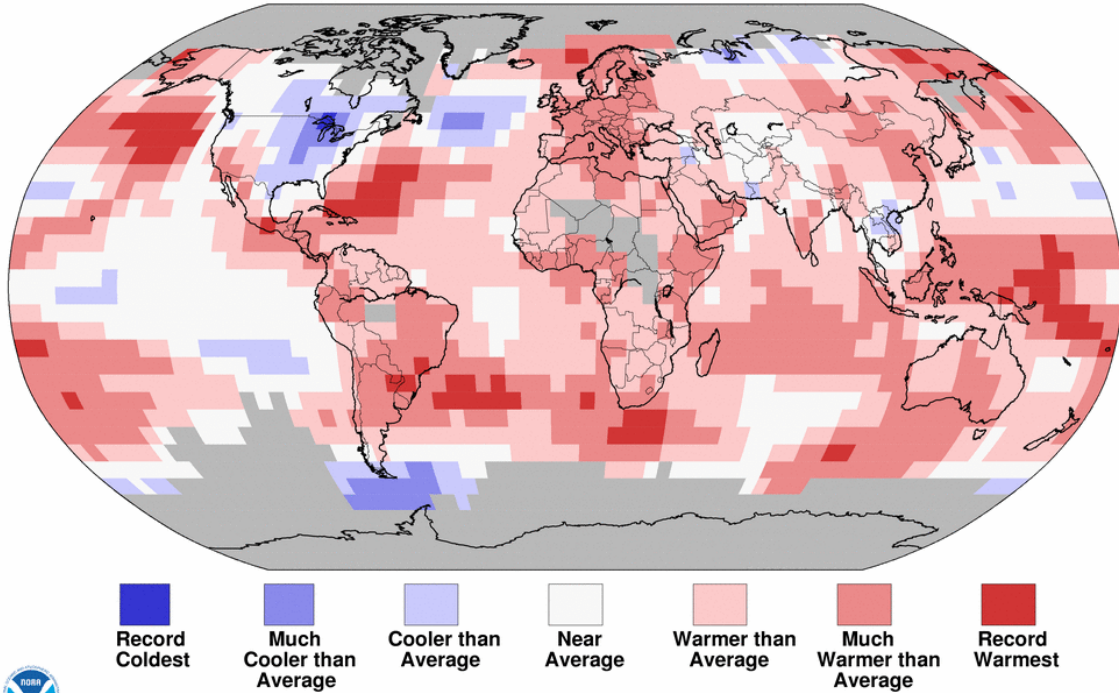


Figure 1: Surface Air Temperature Anomaly November to mid-May (NOAA NCEP/NCAR Reanalysis)

Land & Ocean Temperature Percentiles Dec 2013–Feb 2014

NOAA's National Climatic Data Center

Data Source: GHCN–M version 3.2.2 & ERSST version 3b



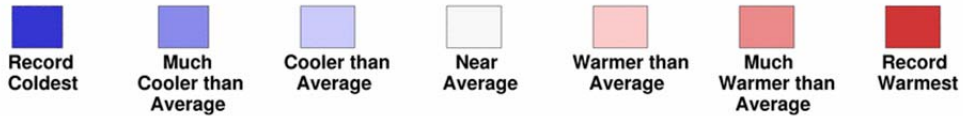
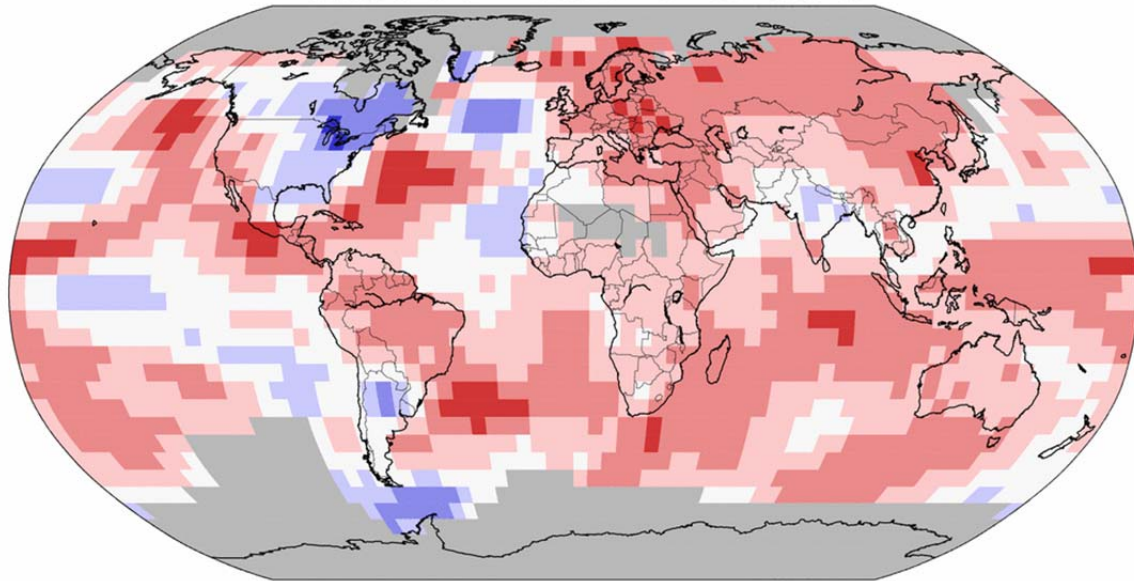
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Figure 2: Temperature Percentiles December 2013 to February 2014 - Record coldest over Lake Superior (NOAA National Climatic Data Center)

Land & Ocean Temperature Percentiles Mar 2014

NOAA's National Climatic Data Center

Data Source: GHCN-M version 3.2.2 & ERSST version 3b



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NOAA NCDC @NOAANCDC · 23h

March 2014 combined global avg temp was 1.28°F above avg #StateOfClimate 1.usa.gov/1eRbpHE | pic.twitter.com/iP6R5MOnz1

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Figure 3: Temperature Percentiles March 2014 - Record coldest over parts of the Great Lakes (NOAA National Climatic Data Center)

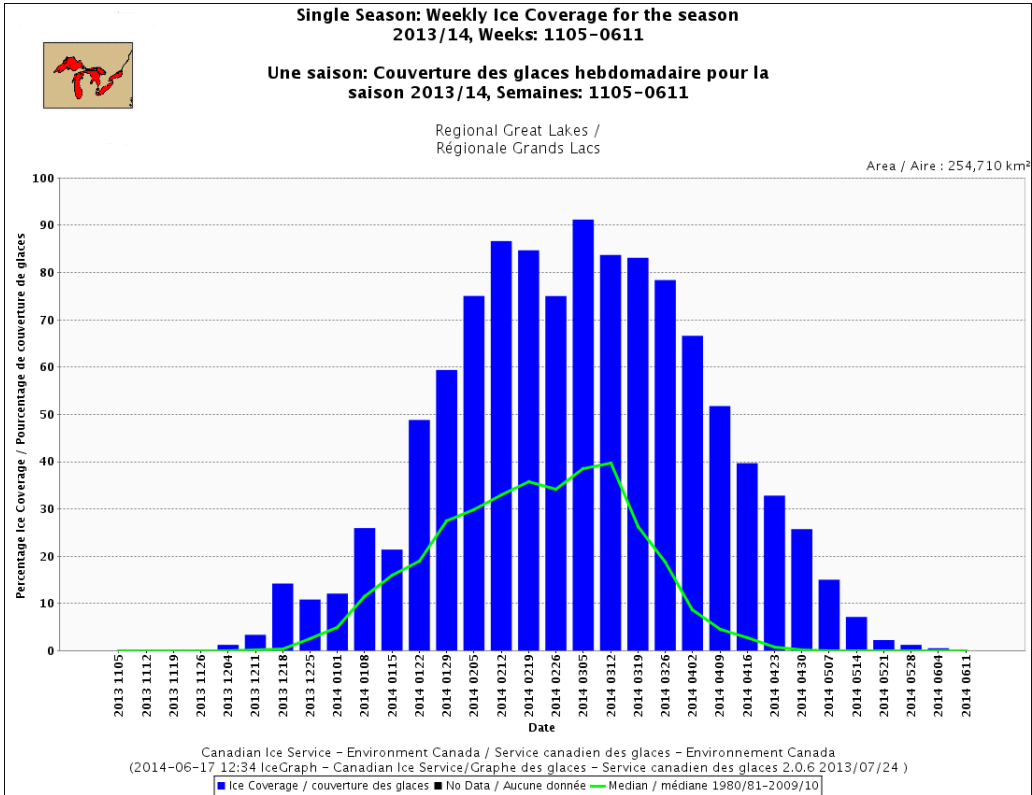


Figure 4: Weekly Ice Coverage, Great Lakes, November 2013 to June 11 2014

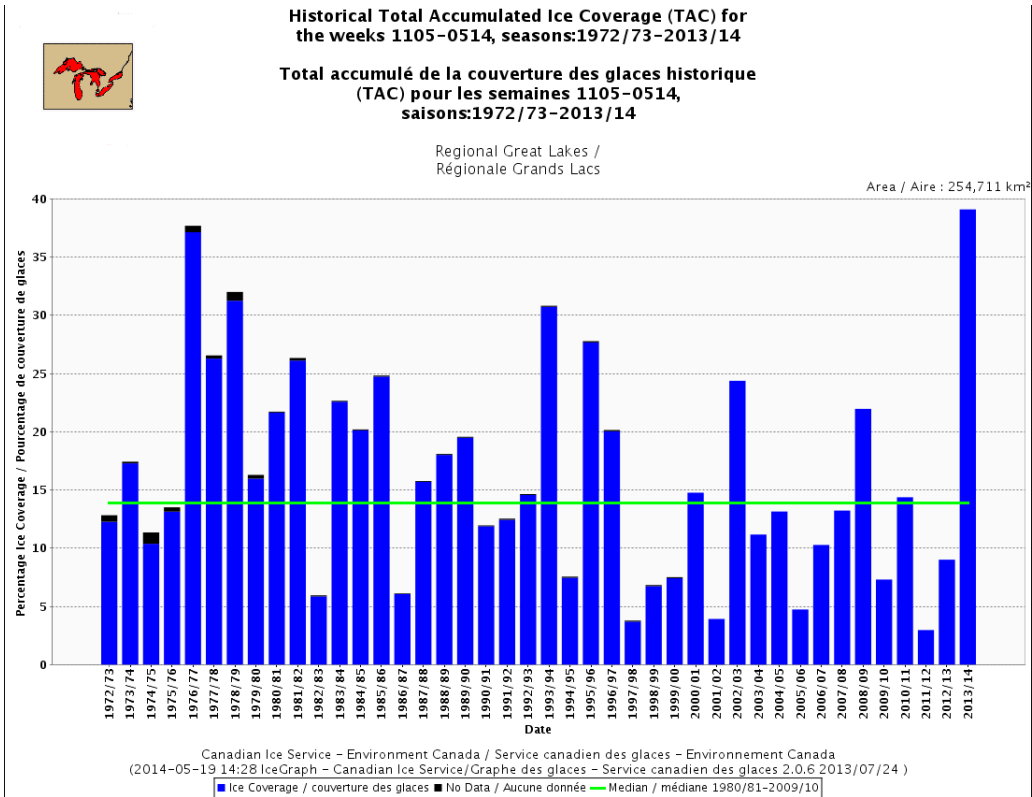


Figure 5: Historical Total Accumulated Ice Coverage, Great Lakes, November to mid-May 2014: Highest since 1973

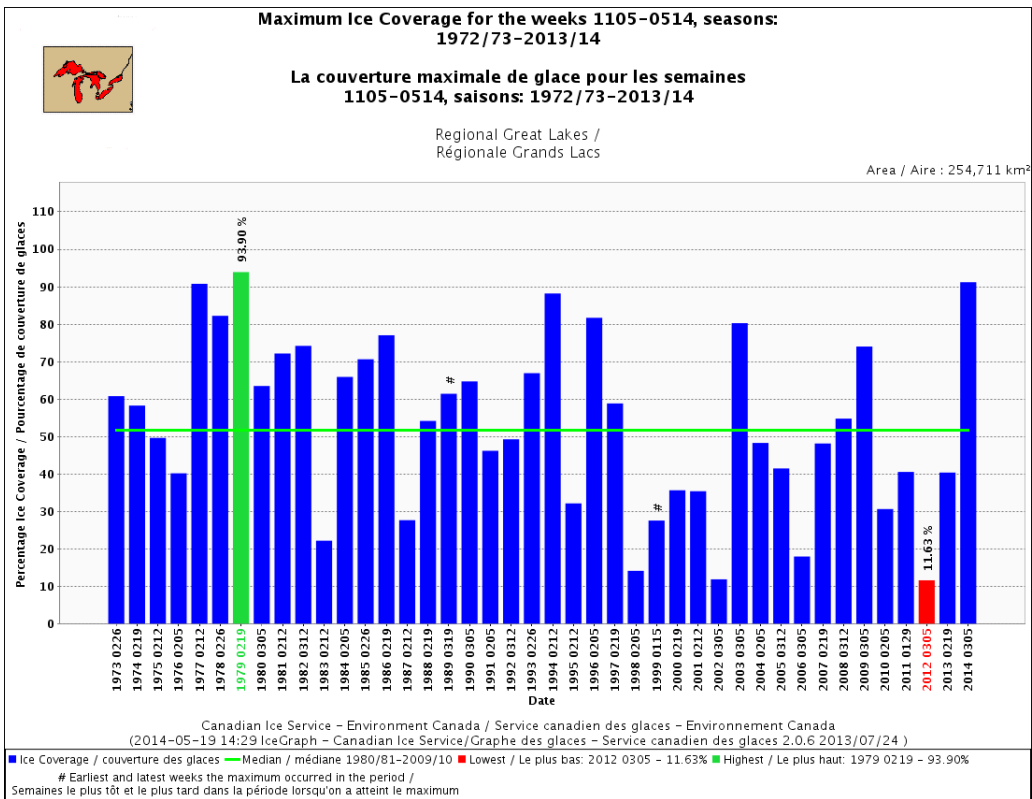


Figure 6: Maximum ice coverage was 91.2% in the first week of March - Second highest since 1973

Lake Superior

2013-2014 Season temperatures: November to mid-May.

The season started near normal with ice forming in Black Bay in the last week of November. From then on it was generally cold with temperatures averaging from about 3°C to 3.5°C below normal. The Historical Total Accumulated Ice Coverage for the season, an average of the weekly ice coverages from November 5 to May 14, reached a new record high (Fig. 8).

November - December ice conditions:

Some new lake ice developed in Black Bay in the last week of November. In early December, ice was present in Black Bay and Nipigon Bay and a small portion of the south shore of the lake. By mid-December ice development was 3 weeks faster than normal. Nipigon Bay, Black Bay and Chequamegon Bay were consolidated with thin to medium lake ice and Thunder Bay was ice covered. Ice was present in Whitefish Bay and along the southern shores of the lake. At the end of December, ice in Nipigon and Black Bays reached the thick lake ice stage.

January ice conditions:

In early January, fast medium lake ice covered most of Thunder Bay and medium lake ice consolidated around the Apostle Islands. Ice formation accelerated in the second half of the month. Whitefish Bay became covered with medium lake ice and ice was present along most of the lake shore. The entire western portion of the lake, west of the Keweenaw Peninsula, was becoming ice covered. At the end of month, fast ice reached the thick lake ice stage in Thunder Bay, in Chequamegon Bay and around the Apostle Islands. Ice cover on Lake Superior was already above the normal peak, usually reached around March 12.

February ice conditions:

Whitefish Bay became consolidated with thick lake ice in early February. More fast ice than we normally see in most years was present along the southern and eastern shores of the lake. A small open water area persisted in the eastern portion of the lake but otherwise Lake Superior was ice covered. Before the end of the first week, the lake became over 90% ice covered, mostly with thin and medium lake ice although some thick lake ice was present in the pack. Thick lake ice was predominant in a few areas, mostly along northwest facing shores and fast ice edges. By mid-month, thick lake ice was predominant in the center

portion of the lake and over most of eastern Lake Superior at the end of the month. Ice cover would remain over 90% until early April.

March ice conditions:

The maximum ice coverage was reached around March 5 at 97.4%, the second highest coverage since our records began in 1973. Before the end of the first week, most of the fast ice around the lake, including the eastern shore from Whitefish Bay to Michipicoten Bay where a rarely seen area of fast ice had developed, reached the very thick lake ice stage. By mid-month, thick lake ice was predominant on a large portion of the lake. On March 19, ice cover was at a new record for the third week of March, and a new record was established from then onward to May 14 in every week but one.

April - May ice conditions:

Ice coverage on the lake fell under 90% at the end of the first week of April. It had been over 90% for 8 weeks. By mid-April a wide open water area had developed along the northwestern shore of the lake. Near the end of April, ice cover on Lake Superior was still above the normal March peak. In the first week of May, break-up occurred around the Apostle Islands, in Chequamegon Bay and in Whitefish Bay and the fast ice in Thunder Bay started breaking up. By mid-May, Black and Nipigon Bay were breaking up and some fast ice remained in Thunder Bay. Large areas of rotting very thick lake ice were still present in the eastern portion of the lake and elsewhere along the southern shore. Clearing in Whitefish Bay and Thunder Bay occurred in the third week of May. Black and Nipigon Bays cleared near the end of the third week. The ice finally melted near Duluth and the Apostle Islands at the end of May.

June ice conditions:

Some ice persisted near the south shore east of the Apostle Islands and east of the Keweenaw Peninsula into the first week of June. The last piece of ice finally melted near the end of the first week.

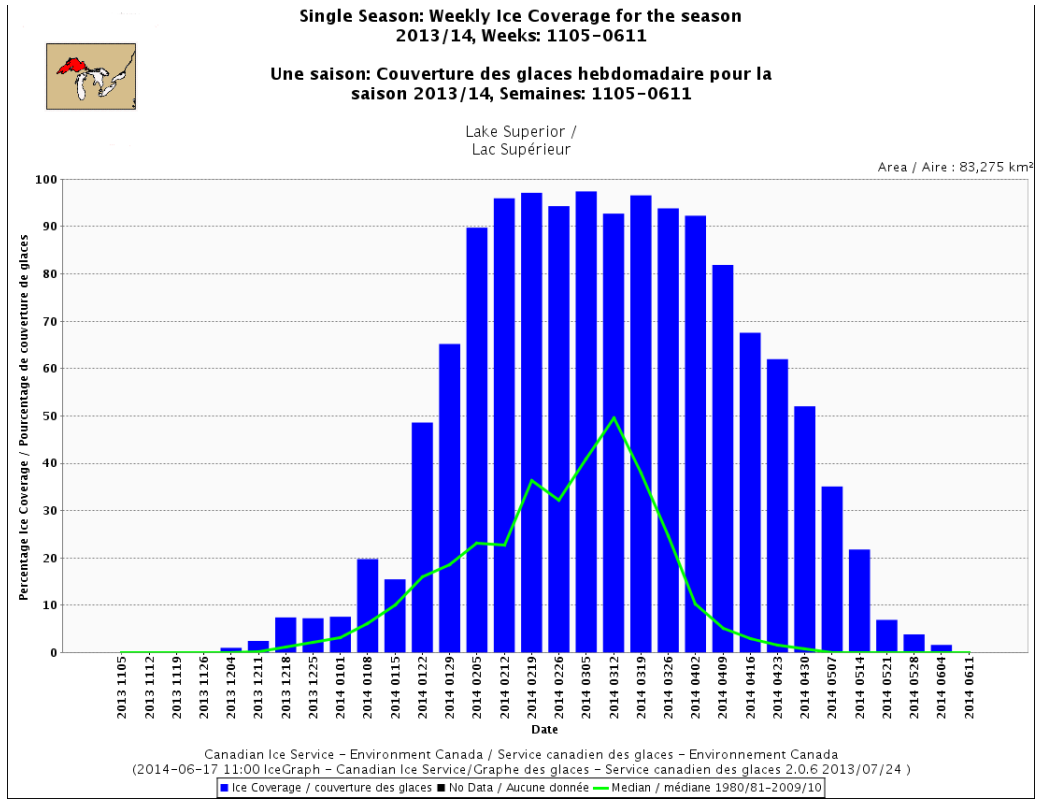


Figure 7: Weekly Ice Coverage, Lake Superior, November 2013 to June 11 2014

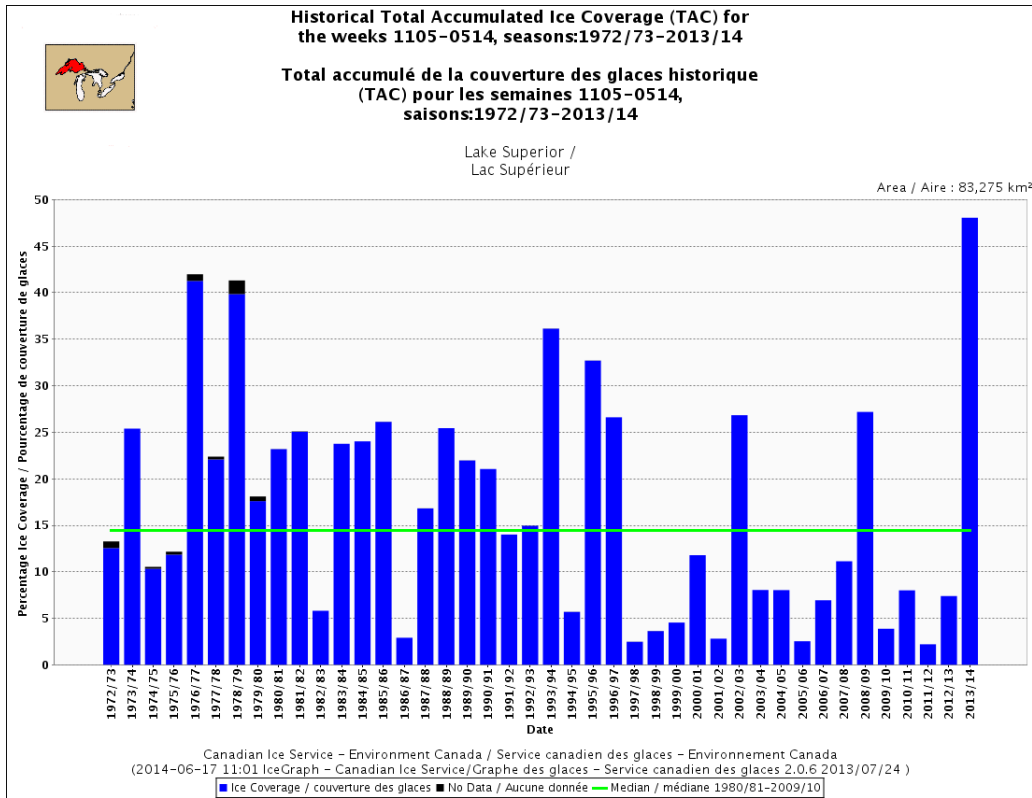


Figure 8: Historical Total Accumulated Ice Coverage, Lake Superior, November to mid-May 2014: Highest since 1973

Lake Michigan

2013-2014 Season temperatures: November to mid-May.

Cold weather prevailed, as air temperatures averaged 2.5°C to 3.25°C below normal. Ice formation started early and clearing occurred late compared to normal. The Historical Total Accumulated Ice Coverage for the season, an average of the weekly ice coverages from November 5 to May 14, was the second highest on record (Fig. 10).

November – December ice conditions:

Ice started forming in the Bays de Noc at the end of November, 2 weeks faster than normal. In early December new and thin lake ice had developed in the southern third of Green Bay and ice was present along the northern shores of the lake early in the second week of December.

Near mid-December, Green Bay was ice covered. The Bays de Noc and a portion of the southern third of Green Bay were consolidated with thin and medium lake ice. New and thin lake ice was present from the north shore of the lake to Beaver Island and in the Straits of Mackinac. Narrow areas of new lake ice developed along portions of the southern and western shores of the lake after mid-month.

At the end of December, most of the southern two thirds of Green Bay were consolidated with medium lake ice and fast medium lake ice was present along the north shore of the lake and along the southern shore of the Straits of Mackinac. 9 to 10 tenths of medium lake ice extended from Beaver Island to the north shore of the lake.

January ice conditions:

Fast ice in the Bays de Noc and the southern two thirds of Green Bay reached the thick lake ice stage in the first week. At that time, the rest of Green Bay was covered with medium lake ice. A large area of new and thin lake ice developed along the western and southeastern shores of the lake and ice cover on Lake Michigan was above the normal peak for the season. Most of that ice was destroyed by a storm in the second week re-setting ice coverage back to normal.

After mid-month, most of Green Bay became consolidated with thick lake ice and new, thin and medium lake ice developed along all the shores of the lake except in Grand Traverse Bay where only new lake ice was briefly present.

At the end of the third week of January the ice cover on the lake was again above the normal peak of season which occurs around February 19, and would remain above the normal seasonal peak until the second week of April.

The Straits of Mackinac and Little Traverse Bay consolidated with medium and thick lake ice in the last week of the month. At the end of January medium and thick lake ice was present along most of the eastern shore of the lake and thin and medium lake ice was present along the western shore. There was thin and medium lake ice in Grand Traverse Bay.

February ice conditions:

All of Green Bay was consolidated with thick lake ice in early February and all of Green Bay would remain covered with fast ice until mid-April, a rare occurrence. Also in early February, the portion of the lake north of Frankfort, including Grand Traverse Bay, was completely covered with new, thin and medium lake ice. New, thin and medium lake ice extended up to 30 nautical miles off the western shore of the lake and medium and thick lake ice extended up to 20 nautical miles off its eastern shore. Even more ice developed in the second week and only the deepest portion of Lake Michigan remained open water. Around mid-month Grand Traverse Bay became covered with fast ice, also a rare occurrence. Ice coverage on Lake Michigan decreased after mid-month, but remained well above the normal seasonal peak.

March ice conditions:

More ice developed in early March and the maximum ice coverage for the season was reached in the first week at 87.9%. It was the third highest maximum ice coverage on Lake Michigan in our records, based on weekly charts dating back to 1973. The highest ice coverage was registered in the second week of February 1977 at 93%. At the end of the first week, the fast ice in Green Bay and in the Straits of Mackinac reached the very thick lake ice stage. Ice destruction occurred in the last week and the south-western portion of the lake was open water at the end of the month. Ice coverage on Lake Michigan remained above the normal seasonal peak.

April ice conditions:

Ice coverage on the lake decreased below the normal seasonal peak in the second week of April. Near mid-month, only a small area of rotting thick lake ice was left in the southern portion of the lake and break-up occurred in Grand

Traverse Bay and in Green Bay. Break-up of the fast ice in the Straits of Mackinac started in the third week. The last piece of ice in southern portion of Lake Michigan melted in the last week.

May ice conditions:

Clearing in northern Lake Michigan, including Green Bay, the Bays de Noc, Grand Traverse Bay and the Straits of Mackinac occurred in the second week of May.

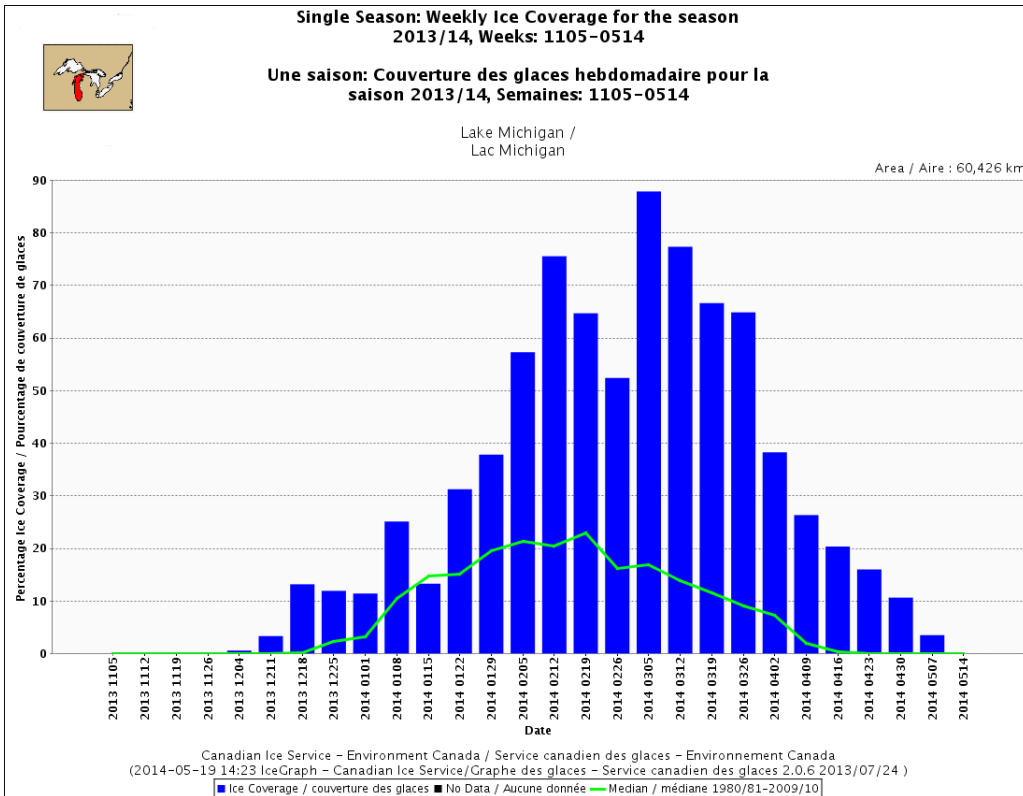


Figure 9: Weekly Ice Coverage, Lake Michigan, November 2013 to May 14 2014

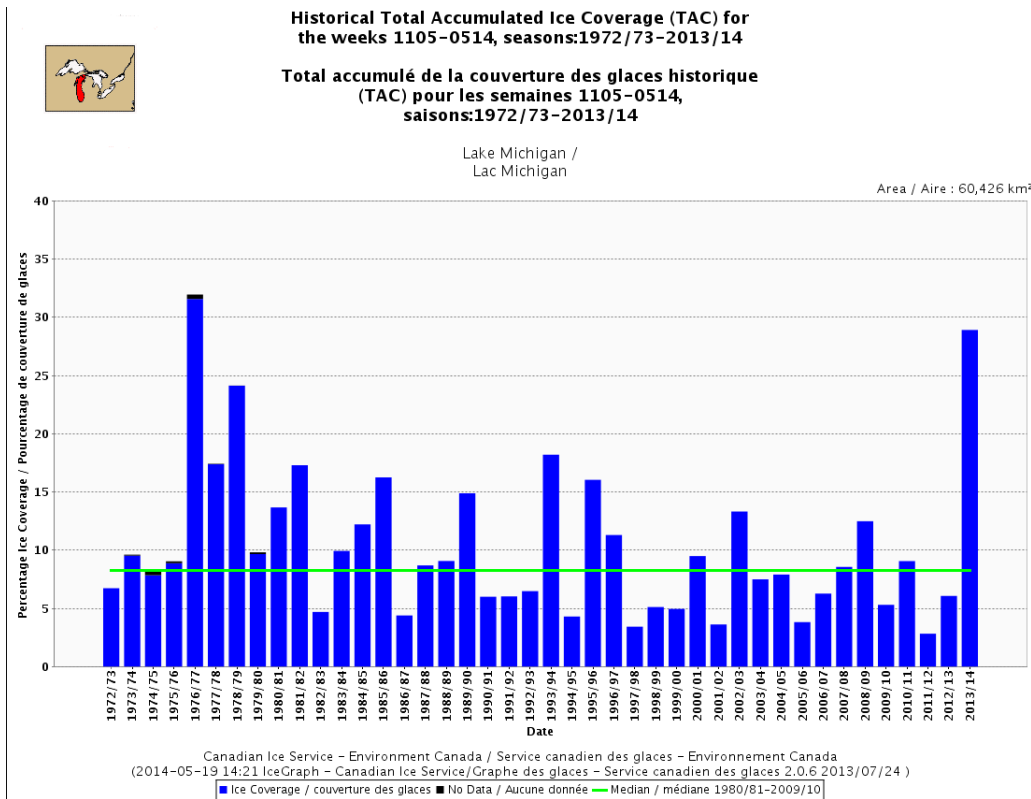


Figure 10: Historical Total Accumulated Ice Coverage, Lake Michigan, November to mid-May 2014: Second highest since 1973

Lake Huron

2013-2014 Season temperatures: November to mid-May.

The season was cold as temperatures were about 2.5°C to 3.0°C degrees below normal. Ice started forming in the last week of November, about two weeks faster than normal. The Historical Total Accumulated Ice Coverage for the season, from November 5 to May 14, reached a new record high (Fig. 12).

November - December ice conditions:

New lake ice started developing in the North Channel, St. Mary's River and Saginaw Bay in the last week of November. In early December new lake ice was developing along the eastern shore of Georgian Bay and along the western shore of the Bruce Peninsula. Around mid-December, new and thin lake ice was present along most of the lake shore. Fast thin lake ice had developed along the eastern and northern shores of Georgian Bay and along the shores of the North Channel and of Saginaw Bay. The rest of the North Channel and Saginaw Bay were covered with new and thin lake ice. St. Mary's River was consolidated with

thin and medium lake ice. Saginaw Bay became consolidated with medium lake ice near the end of the third week of December.

January ice conditions:

The North Channel became consolidated with medium and thick lake ice in the first week of January. Ice developed rapidly after mid-month and ice coverage at the end of the third week was above the normal seasonal peak, usually reached around February 19. Ice coverage on Lake Huron would remain above the normal seasonal peak until the second week of April. At the end of January, about 70% of the lake was ice covered. There was an area of open water in the northeastern portion of the lake, the deepest portion, and in southwestern Georgian Bay. Fast ice in the North Channel, in Saginaw Bay and in Georgian Bay reached the thick lake ice stage.

February ice conditions:

Areas of thick lake ice developed in the southern portion of the lake in the first week of February. In the second week, Lake Huron became over 95% ice covered and thick lake ice became predominant along the south-eastern shore. Around mid-month, an area of predominantly thick lake ice had developed in eastern Georgian Bay and an ice bridge formed between Manitoulin Island and the Bruce Peninsula, a rare event. Ice coverage decreased briefly in the last week and an open water area appeared in the northern portion of the lake and in Georgian Bay but the ice cover was still well above the normal seasonal peak.

March ice conditions:

More ice developed by the first week of March and ice coverage reached its peak for the season at 97.86%, practically tying the previous high of 97.88% reached at the end of February 1994. A large area of very thick lake ice in the eastern portion of the lake and in Georgian Bay also developed in the first week of the month. At that time, the fast ice in Georgian Bay, the North Channel and St. Mary's River had reached the very thick lake ice stage. Clearing started in late March as wide open water areas were appearing and the ice bridge between Manitoulin Island and the Bruce Peninsula was fracturing, but ice cover on the lake was still above the normal seasonal peak.

April - May ice conditions:

Break-up in Saginaw Bay occurred in the second week of April. At that time, ice coverage on the lake decreased below its normal seasonal peak for the first time since the third week of January. Clearing in Saginaw Bay occurred in the third week of April. Break-up in the North Channel and in St. Mary's River started in late April- early May. St. Mary's River, the North Channel and Georgian Bay cleared in the second week of May. A small area of ice west of the Bruce

Peninsula finally melted near mid-May. This was the last piece of ice to melt on Lake Huron this season.

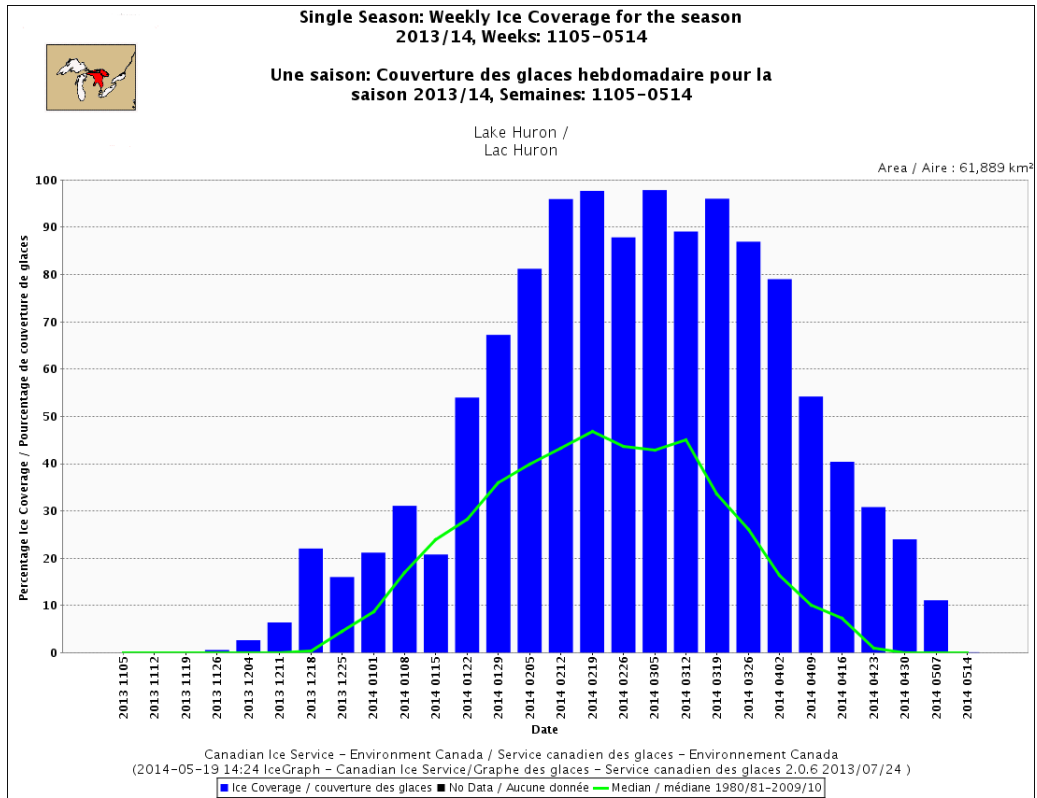


Figure 11: Weekly Ice Coverage, Lake Huron, November 2013 to May 14 2014

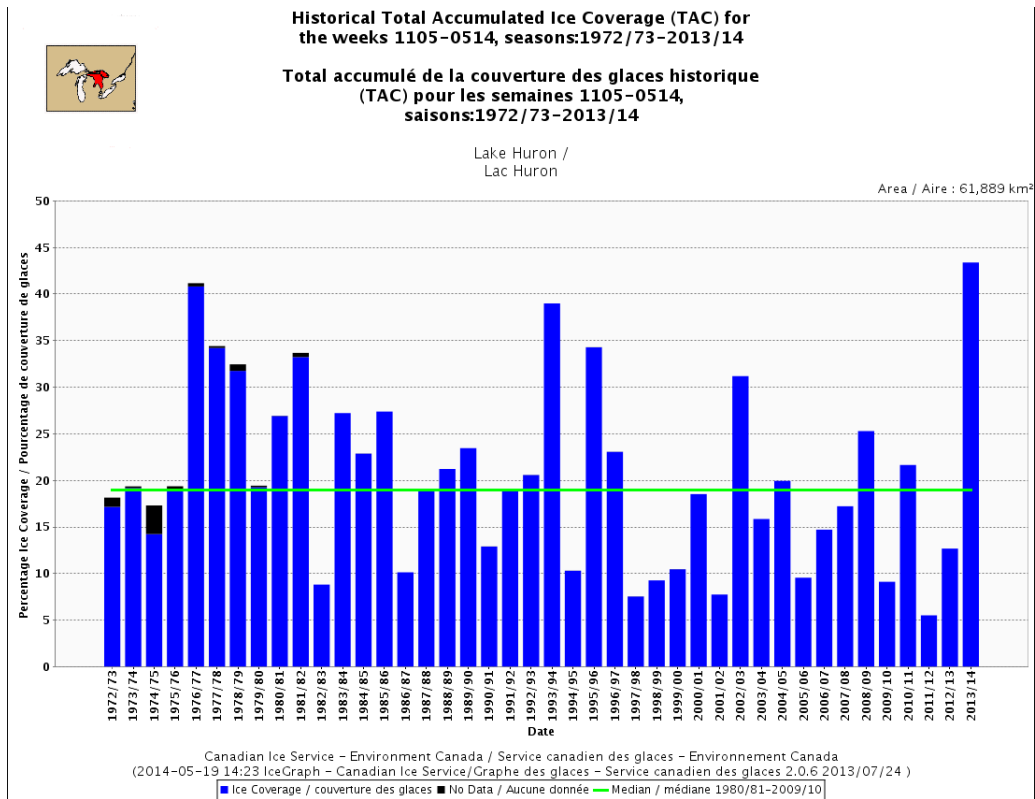


Figure 12: Historical Total Accumulated Ice Coverage, Lake Huron, November to mid-May 2014: Highest since 1973

Lake Erie

2013-2014 Season temperatures: November to mid-May

The season was cold as air temperatures were about 2.0°C degrees below normal. Ice started forming in the last week of November, two to three weeks faster than normal. The Historical Total Accumulated Ice Coverage for the season, from November 5 to May 14, was the second highest on record (Fig. 14).

November - December ice conditions:

New lake ice started forming along the eastern shore of Lake St. Clair in the last week of November. Early in the second week of December, new lake ice was present in Lake St. Clair, along the western shore of the Western Basin, in Sandusky Bay and Long Point Bay. Near mid-December, Lake St. Clair and the Western Basin were covered with new and thin lake ice and Sandusky Bay and Long Point Bay were consolidated with thin lake ice. Elsewhere, a narrow band of new lake ice was present along the north shore of the lake. Ice development was more than two weeks faster than normal. Ice destruction brought the ice coverage closer to normal at the end of December.

January - February – March ice conditions:

Rapid ice growth resumed in January and at the end of the month Lake Erie was over 90% ice covered. Lake St. Clair and the Western Basin were consolidated with medium and thick lake ice. Elsewhere at the end of January, medium and thick lake ice predominated in the eastern portion of the lake and thin and medium lake ice in the western portion. There was consolidated medium and thick lake ice within about 15 nautical miles of Buffalo. In the second week of February, thick lake ice became predominant over most of Lake Erie. In the last week of February, with the help of wind induced compression, very thick lake ice became predominant in the eastern half. Lake Erie was generally over 90% ice covered from the end of January until mid-March. Clearing started at the end of March; it normally starts in late February. Ice coverage remained well above normal during break-up.

April - May ice conditions:

The Western Basin cleared in the first week of April; Lake St. Clair in the second week. In mid-April, the western half of Lake Erie was open water but ice lingered in the eastern half of the lake. Break-up of the fast ice near Buffalo occurred in the third week of April. The last piece of ice melted in the second week of May.

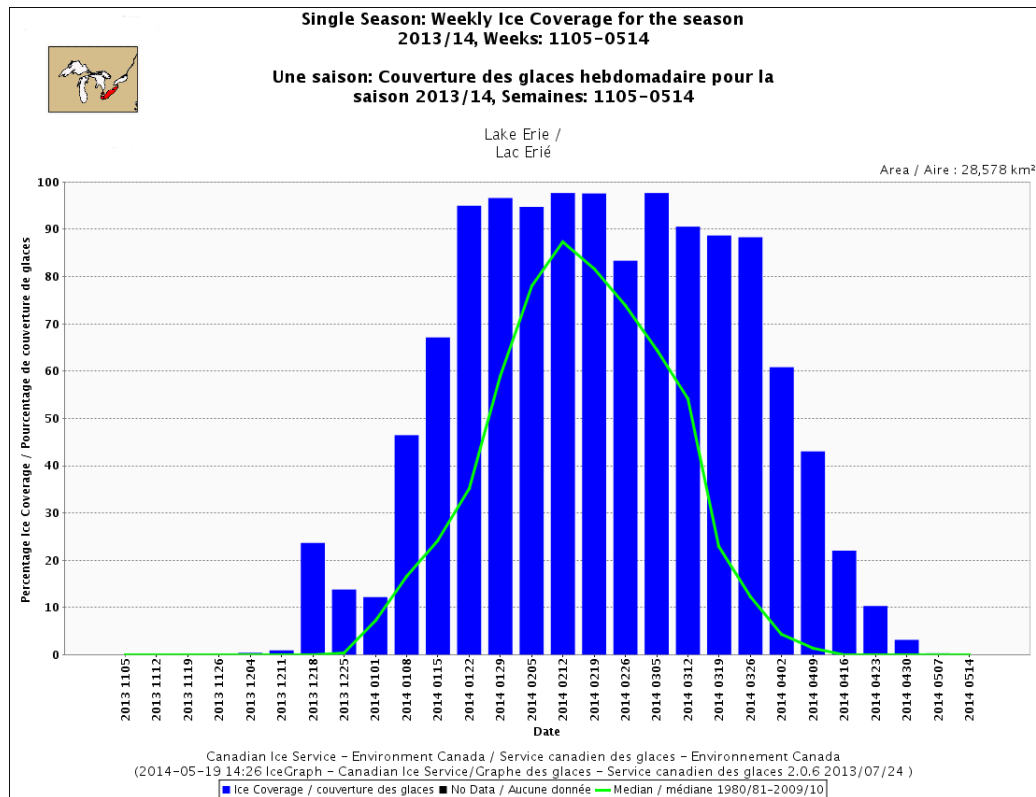


Figure 13: Weekly Ice Coverage, Lake Erie, November 2013 to May 14 2014

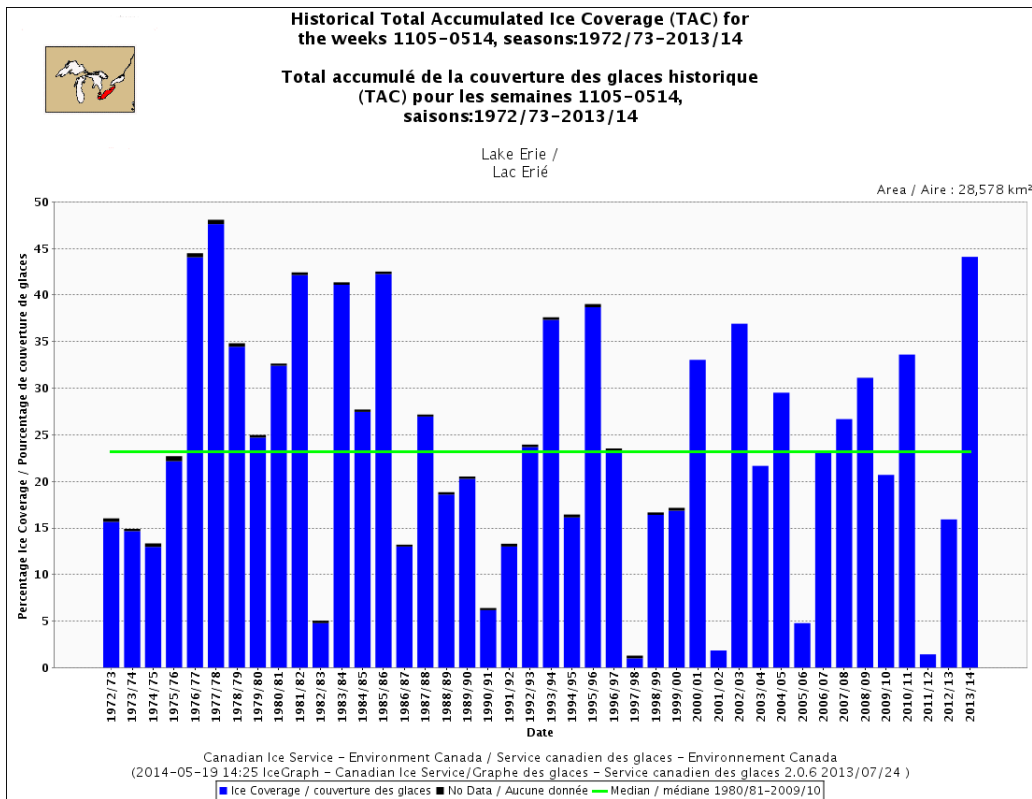


Figure 14: Historical Total Accumulated Ice Coverage, Lake Erie, November to mid-May 2014: Second highest since 1973

Lake Ontario

2013-2014 Season temperatures: November to mid-May

Cold weather prevailed and temperatures from early November to mid-May averaged about 2.0°C below normal.

November - December - January ice conditions:

New lake ice started forming in the Bay of Quinte in the last week of November, two to three weeks earlier than normal. New ice started developing in the St. Lawrence River east of Kingston early in the second week of December. Near mid-December, narrow bands of new and thin lake ice developed along the shores of Lake Ontario while the Bay of Quinte became consolidated with thin lake ice. Ice coverage was far above normal. Ice destruction in the third week of December brought the ice cover closer to normal. Ice growth accelerated at the

end of January, and consolidated medium lake ice developed in the northeast end of the lake. Fast ice in the Bay of Quinte reached the thick lake ice stage.

February – March - April ice conditions:

From the end of January to the end of April, ice coverage on Lake Ontario was generally above normal. It was well above normal around mid-February but most of the pack ice was new and thin lake ice which was easily destroyed by stormy weather in the last week of the month, re-setting the ice coverage to near normal. Rapid ice growth resumed at the end of February and ice coverage in early March was again well above normal. Maximum ice coverage occurred in the first week of March, when it reached about 46%. The normal is 15% in the third week of February. At that time, a large area of consolidated thick lake ice was present in north-eastern Lake Ontario and wide areas of new and thin lake ice were present off the fast ice and along the southern shore. By mid-March, the fast ice had reached the very thick lake ice stage and some thick lake ice was present in the pack off the fast ice. By the end of March, ice cover had decreased to 14.8%, still far above the normal of 4.2%. Break-up of the fast ice occurred in the first week of April and clearing occurred in the last week of April, three weeks later than normal.

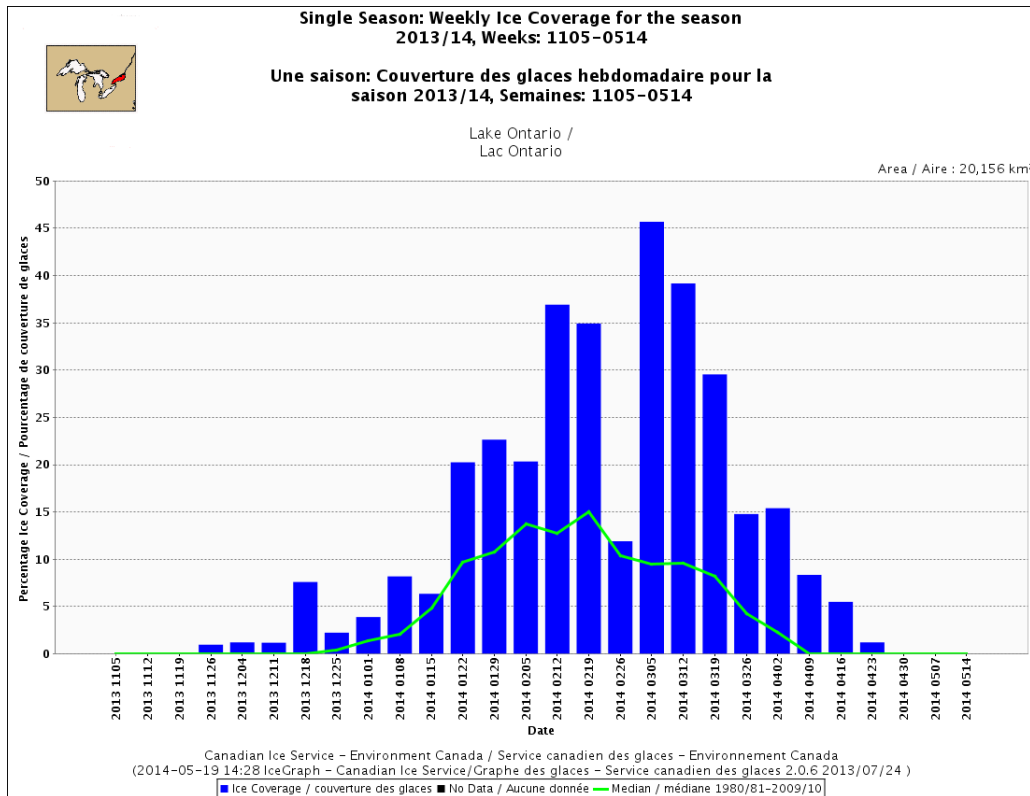


Figure 15: Weekly Ice Coverage, Lake Ontario, November 2013 to May 14 2014

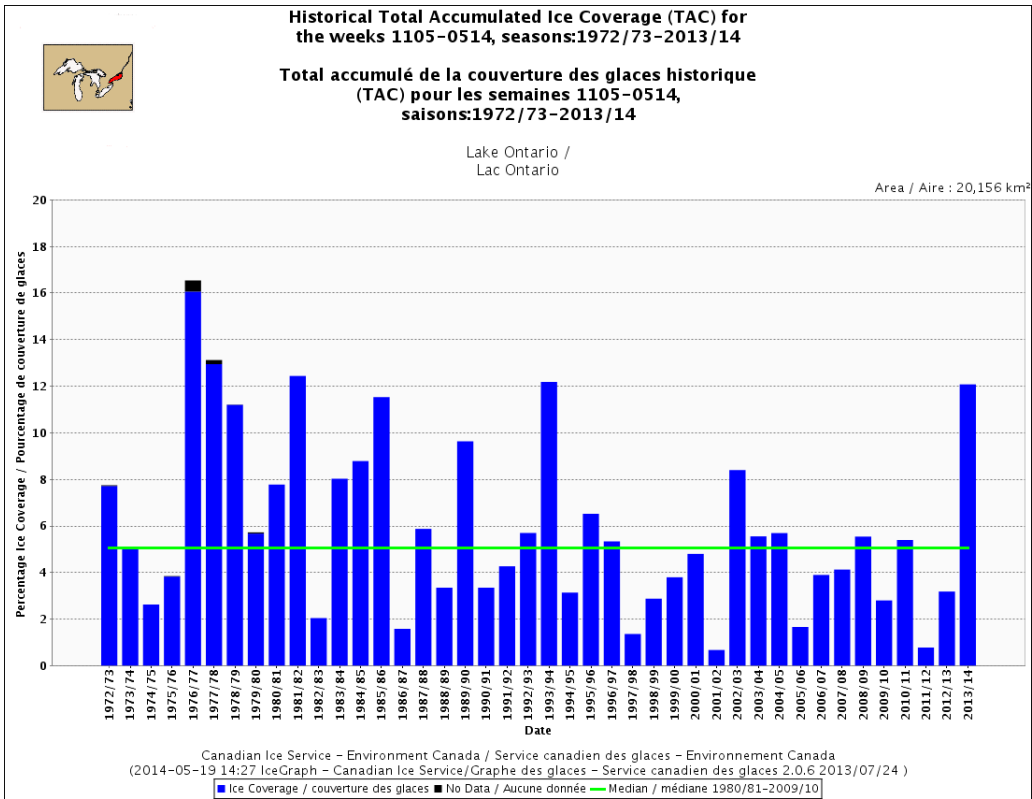


Figure 16: Historical Total Accumulated Ice Coverage, Lake Ontario, November to mid-May 2014

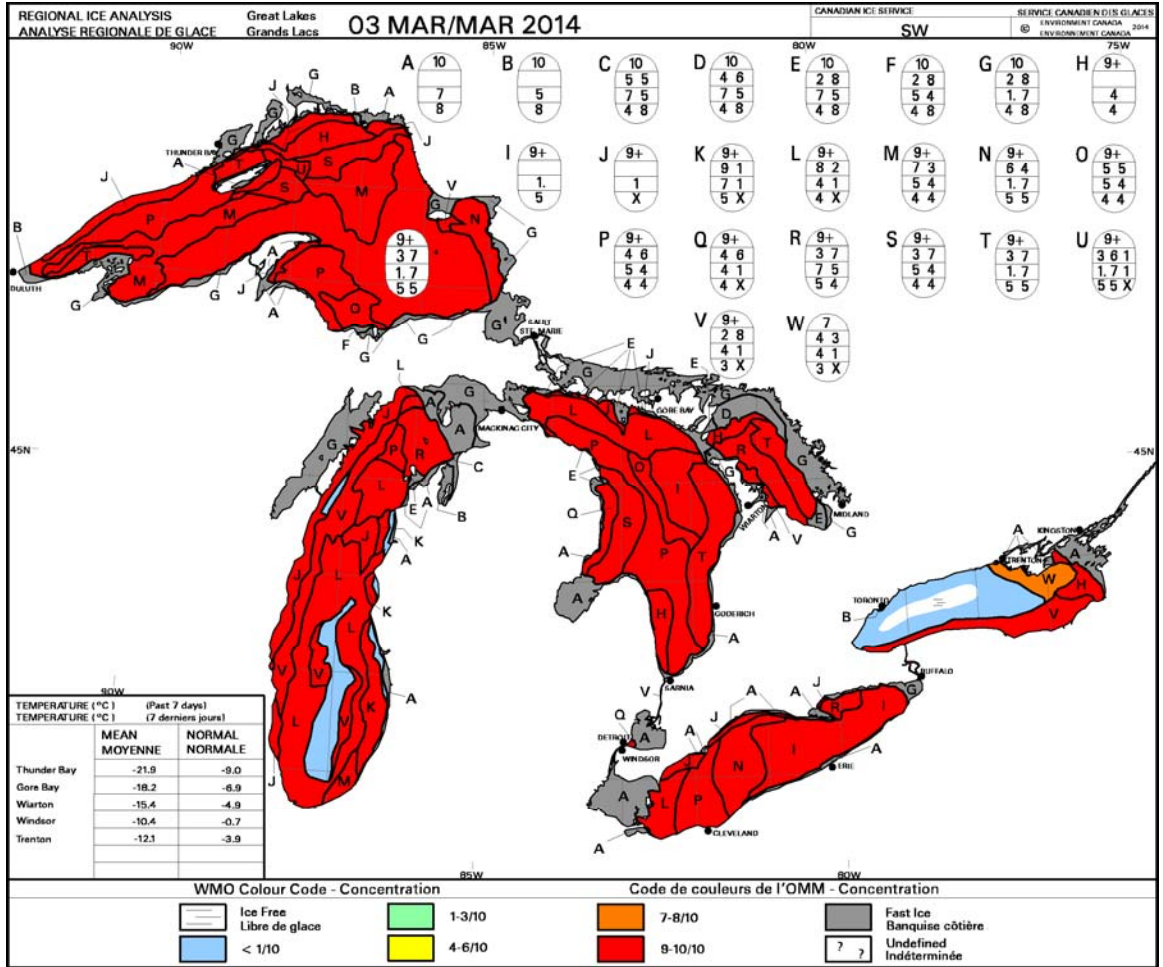


Figure 17: Maximum Great Lakes ice coverage 2014