Seasonal Summary

Great Lakes

Winter 2015-2016

By the North American Ice Service

Summary for the Great Lakes

The 2015-2016 ice season in the Great Lakes was a stark contrast to those in the previous two seasons. Whereas the 2013-2014 and 2014-2015 seasons were the winters with the 1st and 5th highest total accumulated ice coverages (TAC) respectively since 1972, the most recent winter experienced a near record low TAC of 3.99% (4th lowest on record). The Great Lakes ice season was marked by a late start and early end, with well below normal ice coverage values throughout the season, all of which contributed to the low TAC value. The first ice of the season was noted in the northern bays of Lake Superior in late November 2015, a near normal start to the season. The conclusion of the season was marked by the last ice disappearing from the same northern bays by the end of the first week of May 2016. The season in the Great Lakes typically ends with these northern bays by mid-May, indicating that the 2015-2016 season was a shorter ice season than normal.

In general, the 2015-2016 winter was marked by anomalously warm surface air temperatures. Monthly air temperature anomalies ranged from a weak positive anomaly in February 2016 of 0.5 to 2.5°C and the strongest positive temperature anomaly of 4.0 to 8.0°C in December 2015. No single month exhibiting a normal or negative temperature anomaly until the end of the season in April 2016, where anomalies were up to 3.5°C below climatological values. During the week of 8 to 14 February 2016, a minor cold outbreak over the Great Lakes did lead to a rapid increase in ice extents. This was a short-lived increase though as the lakes were covered by new and thin lake ice. This ice was destroyed subsequently as the temperatures returned to above seasonal values in late February.

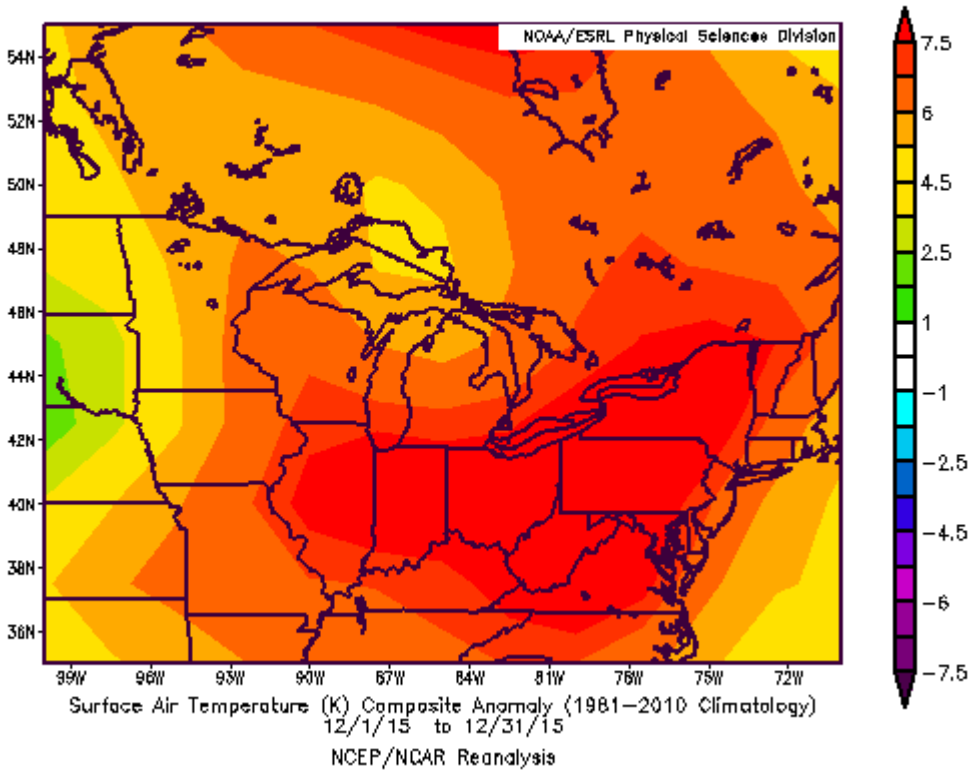

Figure 1: Surface Air Temperature Anomaly for the Great Lakes, December 2015.

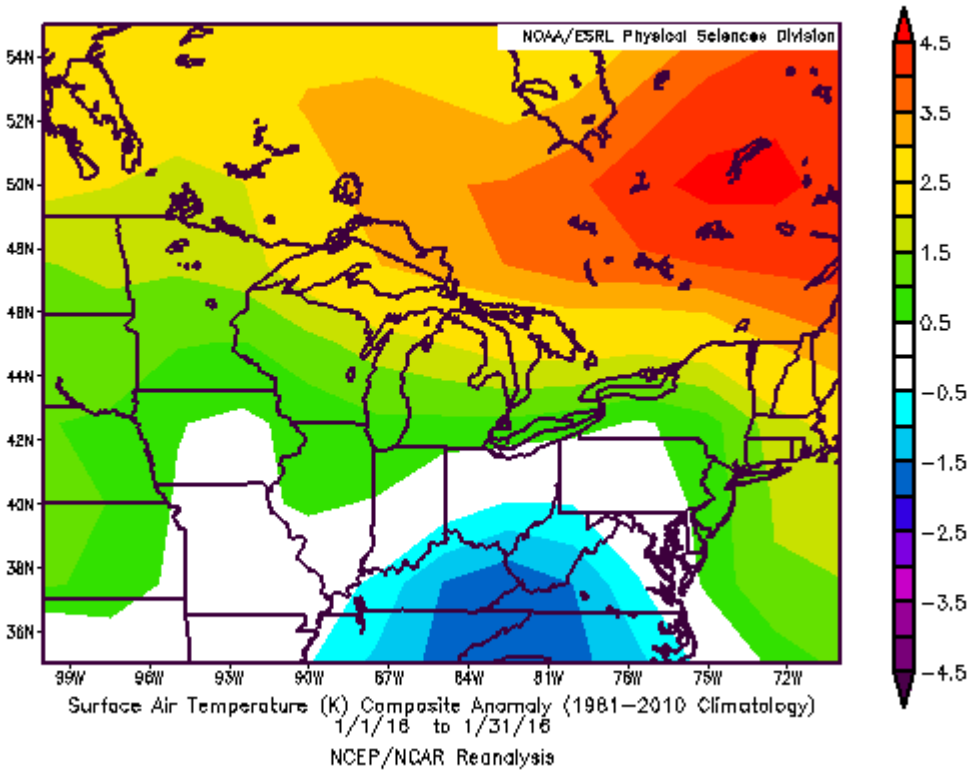

Figure 2: Surface Air Temperature Anomaly for the Great Lakes, January 2016.

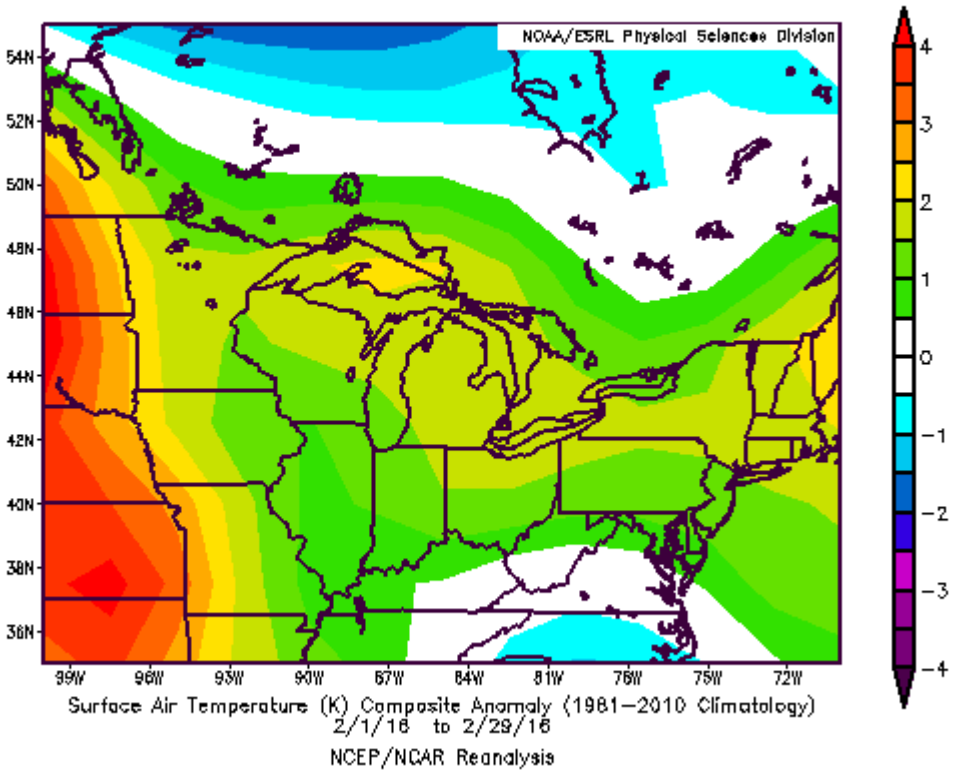

Figure 3: Surface Air Temperature Anomaly for the Great Lakes, February 2016.

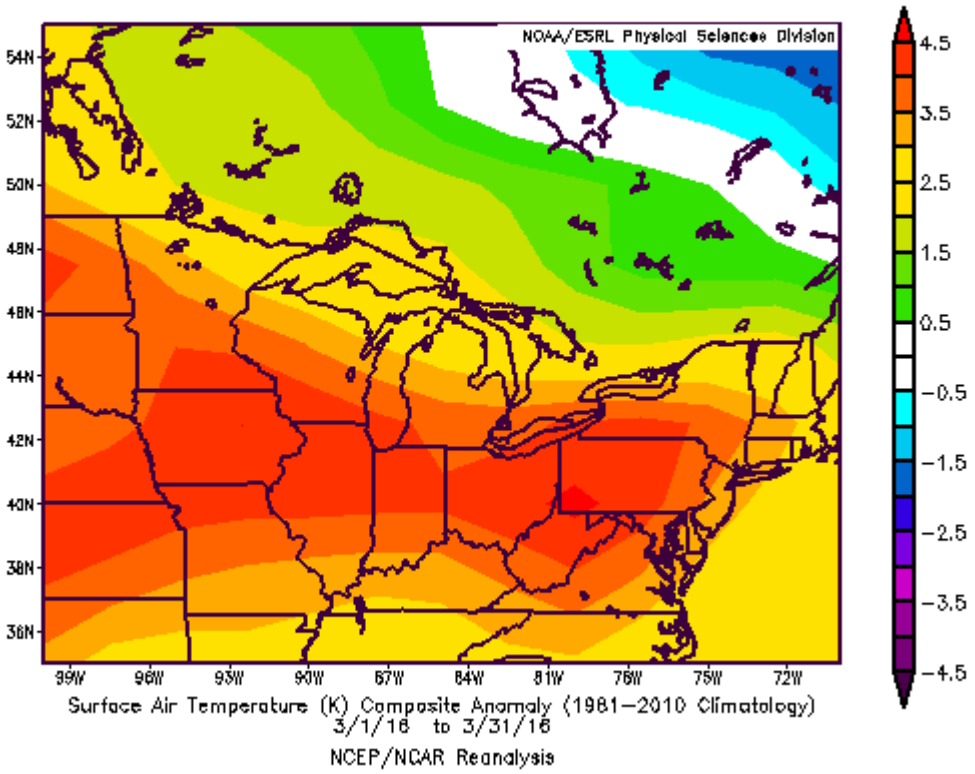

Figure 4: Surface Air Temperature Anomaly for the Great Lakes, March 2016.

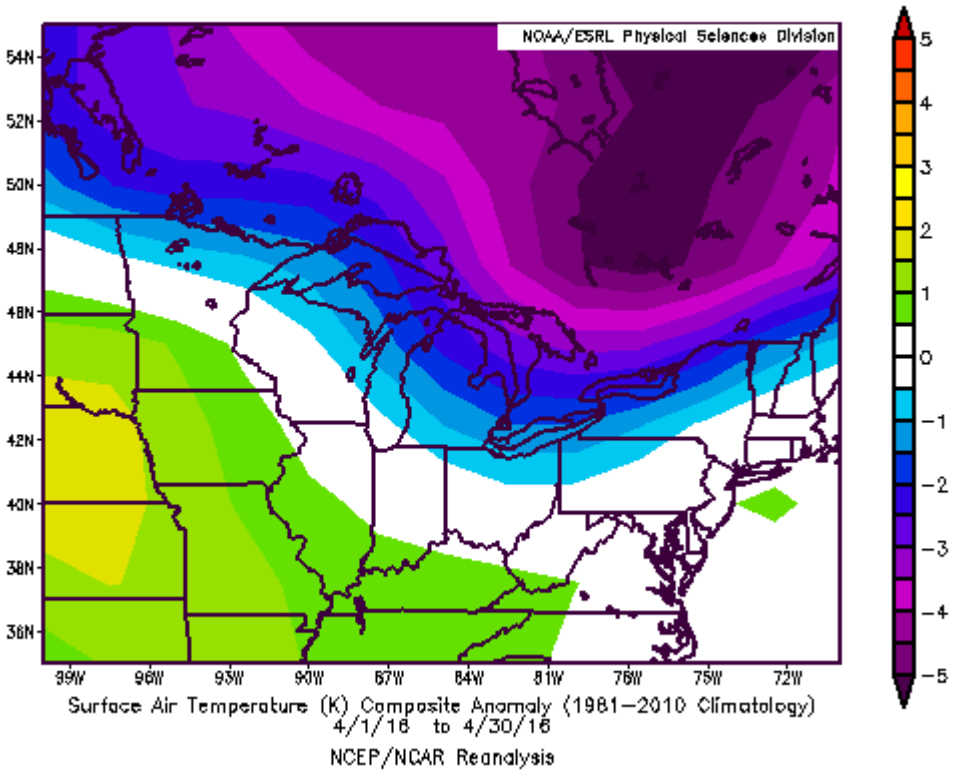

Figure 5: Surface Air Temperature Anomaly for the Great Lakes, April 2016.

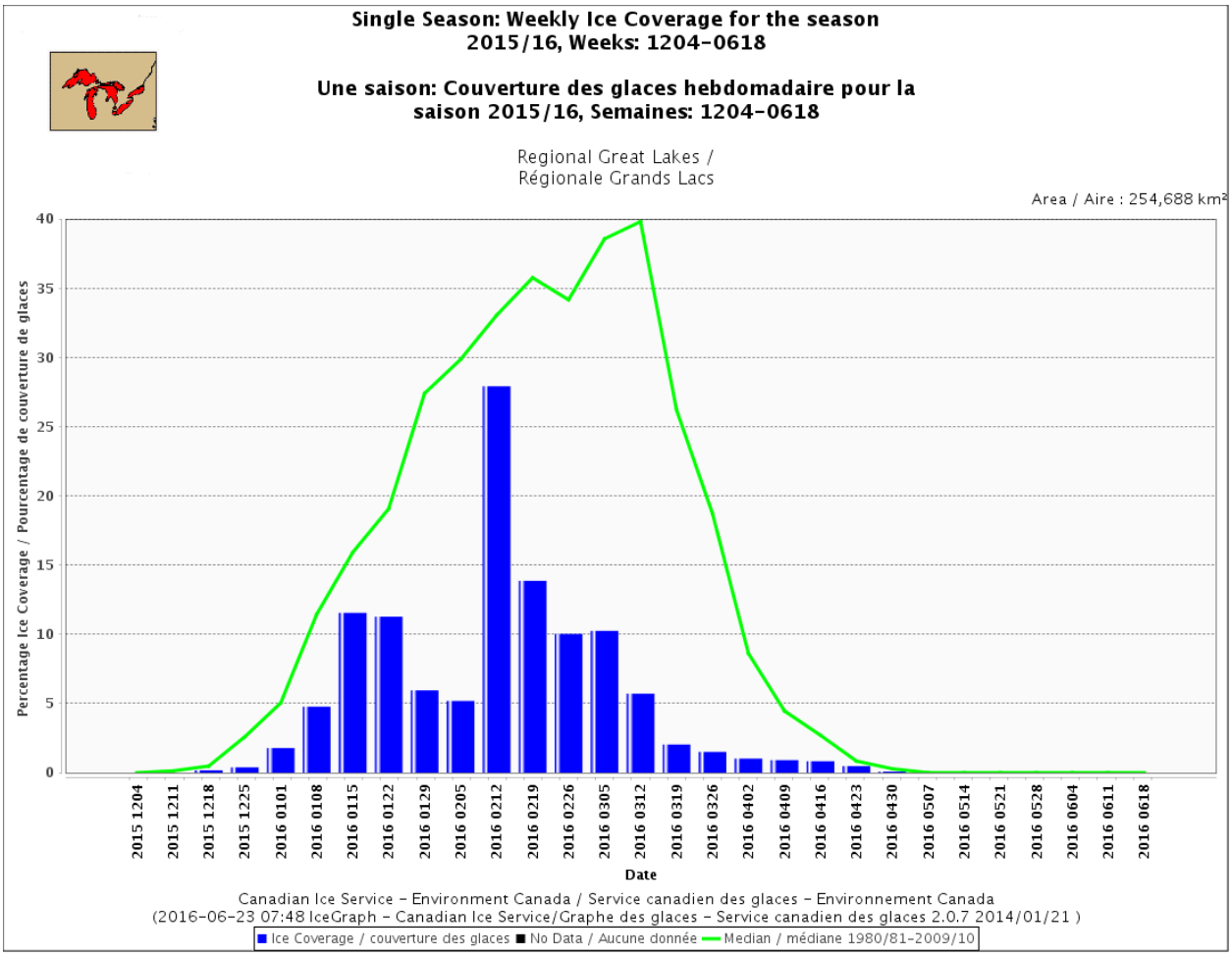

Figure 6: Weekly ice coverage for the Great Lakes, winter 2015-2016.

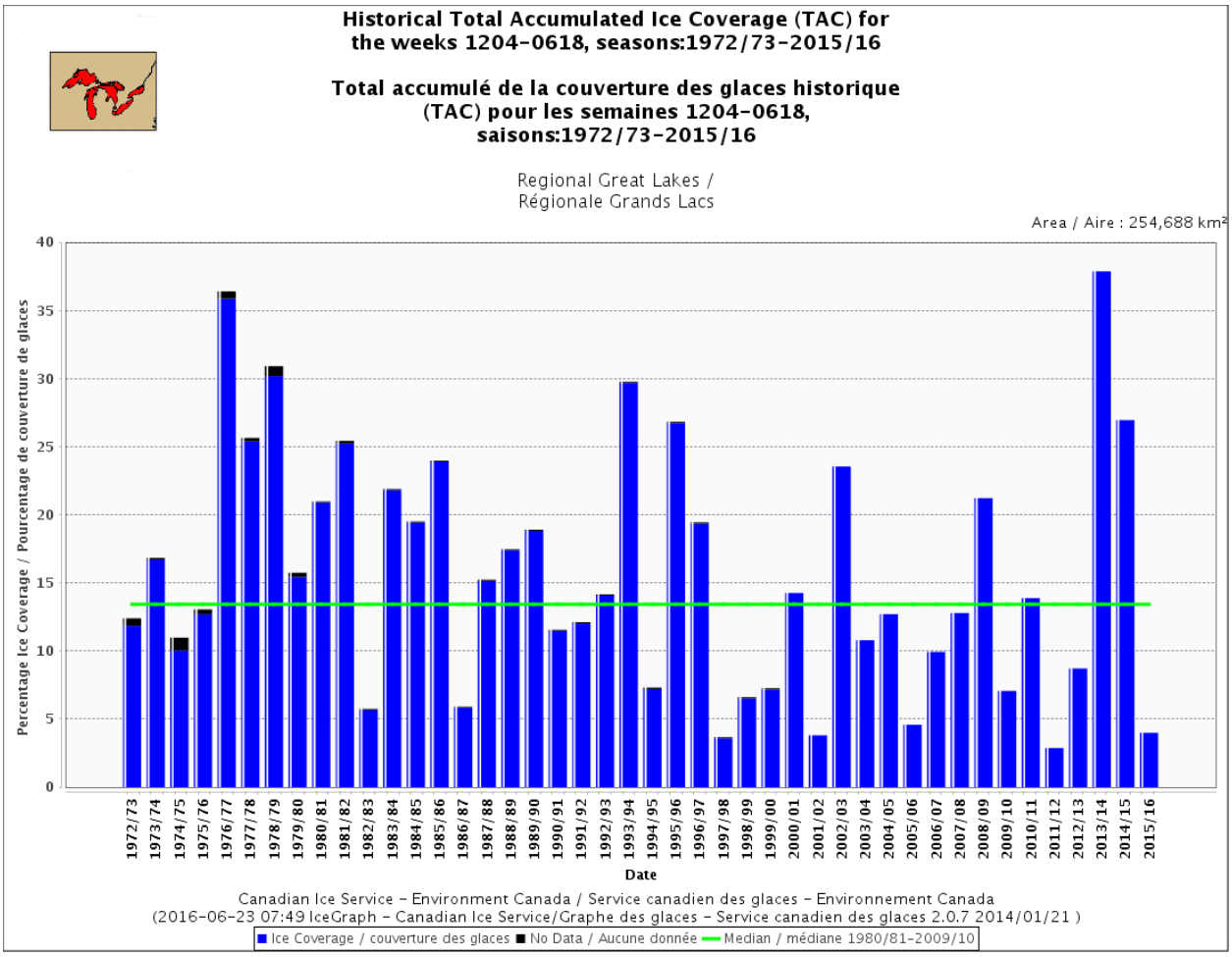

Figure 7: Historical Total Accumulated Ice Coverage on the Great Lakes, 1972-1973 to 2015-2016.

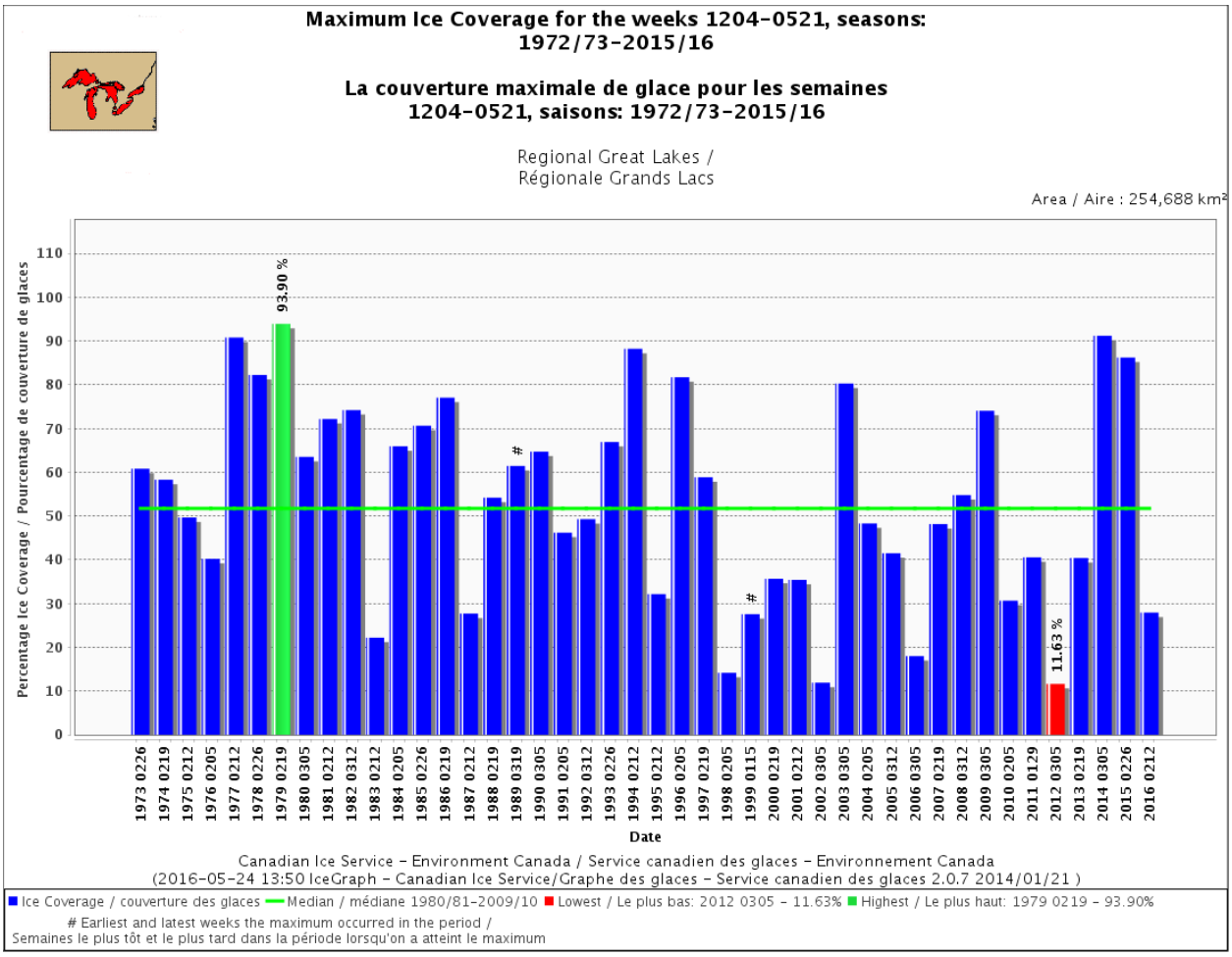

Figure 8: Maximum weekly ice coverage for the Great Lakes, 1973 to 2016.

Lake Superior

2015-2016 Season temperatures:

Ice formation began in late November in Black and Nipigon bays despite a significantly warmer than normal fall over Lake Superior. Temperature anomalies for December were up to 6.5°C above the normal. A weaker positive temperature anomaly persisted through the new year as January 2016 temperatures ranged from 2 to 3.5°C above the climatology, February 2016 experienced temperatures 1 to 2°C above normal and March 2016 was 2 to 3°C above the normal values. During April 2016 the situation was reversed as negative temperature anomalies of -0.5 to -3°C were observed.

2015-2016 Ice conditions:

New lake ice began developing in Black and Nipigon bays during the last week of November. Little change was observed in this ice extent through the first three weeks of December and only near the end of the month did the ice then expand and thicken to thin lake ice over these basins. Additional ice growth was observed in Chequamegon and Whitefish bays near the end of the month.

Ice growth slowly advanced in January, with new ice developing along the shore west of the Keweenaw Peninsula and near the Apostle Islands in the second week. Thunder Bay also experienced significant ice growth. Shortly after mid-January, ice had progressed to the thin lake ice stage in Thunder Bay and along the southern shore of the lake west of the Keweenaw Peninsula. Fast ice in Black and Nipigon bays was now reaching the medium lake ice stage of development as well. Little change in ice extent was observed over the course of the remainder. Fast ice thickened to the thick lake ice stage in Black and Nipigon bays, and to medium lake ice in Chequamegon Bay and along the western shore of Thunder Bay by the end of the month.

Ice growth remained stagnant through the first part of February and noticeable development only occurred by mid-month. New and thin lake ice covered the waters along the southern shores of Lake Superior, in Whitefish Bay, and extended from Thunder Bay southward to Isle Royale. This ice coverage was the peak achieved for Lake Superior at 19.3%, a month earlier than normal and only 50% of the median peak value. As quickly as this ice formed though, a destruction event rapidly lead to the disappearance of the ice throughout the lake in the third week of February. A thin band of medium and new ice remained along the southern shore, and from Thunder Bay and northeastward to Nipigon Bay. Whitefish Bay was covered by new lake ice with some thick lake ice but was well behind in terms of the climatological stage of development expected at this point of the year.

As March progressed the ice coverages continued to remain well below normal. At mid-month, ice destruction accelerated rapidly such that much of the mobile ice was destroyed by the third week of March. Only fast ice remained in Black and Nipigon bays, as well as in isolated sections of Thunder Bay. Consolidated ice in Chequamegon Bay broke up in the final week of March and the majority of the remaining ice cleared from Whitefish Bay.

Early April saw the clearing of the final ice from Chequamegon Bay. Fast ice breakup in Black and Nipigon Bay commenced at month end and was fully cleared by the first week of May.

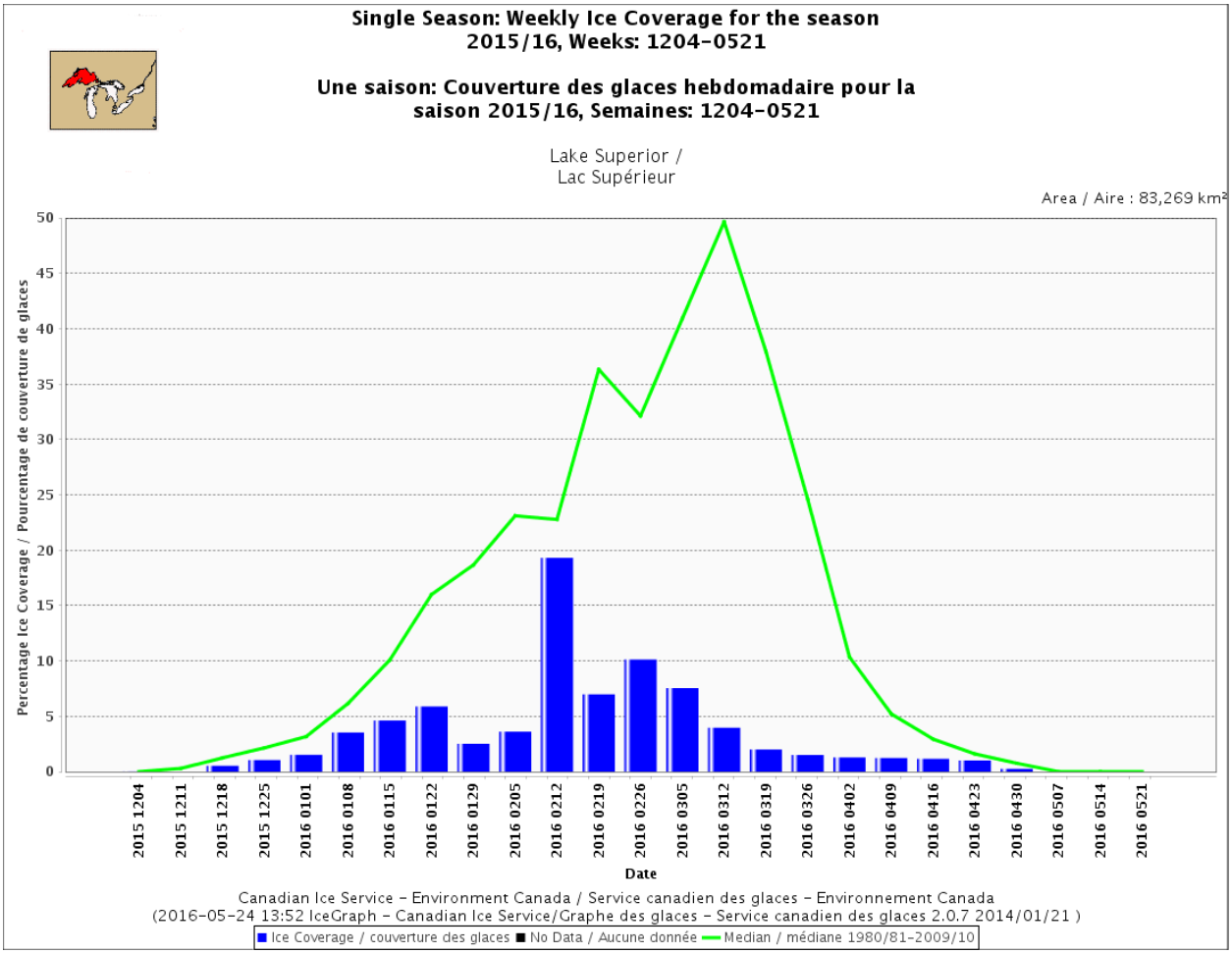

Figure 9: Weekly Ice Coverage in Lake Superior for winter 2015-16.

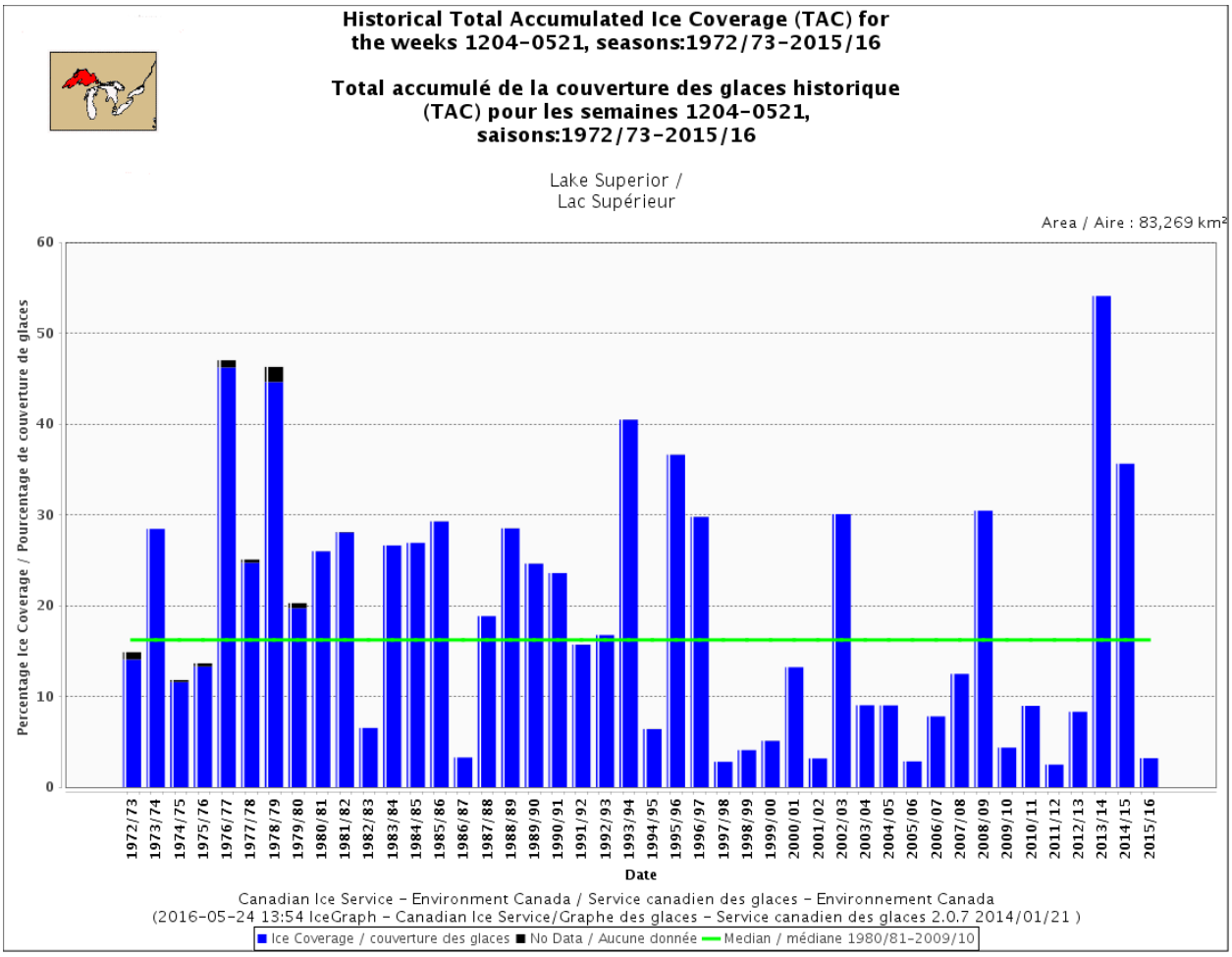

Figure 10: Historical Total Accumulated Ice Coverage in Lake Superior by season, 1972-2016.

Lake Michigan

2015-2016 Season temperatures:

Air temperature anomalies for December 2015 ranged from 8.0 to 4.5°C above the climatological normal. This pattern of anomalously warm temperatures continued for January (0.5 to 2.5°C), February (0.5 to 2°C) and March (2.5 to 4.5°C). A cooler than normal period was established in April 2016, with temperatures up to 2.5°C below normal.

2015-2016 Ice conditions:

The first ice of the season appeared in the extreme southern portion of Green Bay near the end of December, approximately two weeks later than normal. Ice in Green Bay spread over the Bays de Noc and further

over the southern section during the first week of January. Near mid-month, new ice formed along the northern shore of Lake Michigan and near the Straits of Mackinac. Fast ice in the Bays de Noc and southern Green Bay reached the thin lake ice stage and mobile ice in Green Bay was now predominantly thin lake ice. In the third week, new and thin lake ice developed along the southern and western shores of Lake Michigan as well but this ice was destroyed by the end of the month. Green Bay was nearly ice covered by the end of January with medium and thin lake ice and the fast ice reached the medium lake ice stage of development.

In early February, the thin and medium lake ice near the Straits of Mackinac began to slowly expand westward towards Beaver Island. Ice coverage reached the peak seasonal value of 17.8% on Lake Michigan near mid-February as ice again reappeared along the southern and western shores of Lake Michigan. The decline of ice after this peak was rapid, as all that remained by month end was predominantly medium lake ice over central Green Bay and an narrow extension of medium and thin lake ice from Beaver Island toward the Straits of Mackinac.

March experience some regrowth of ice and thickening of existing ice in the lake. Green Bay saw the development of thick lake ice along the western shore of the Door Peninsula and predominantly medium lake ice between Beaver Island and the Straits of Mackinac. Continued warmth in March lead to the deterioration of all the ice near the straits and over central Green Bay by mid-month, and the breakup of the fasted thick lake ice in the southern section of Green Bay. In the third week, fast ice breakup occurred in the Bays de Noc and the remaining ice in Lake Michigan was confined to these waterbodies.

By early April, the last remaining ice had cleared from Lake Michigan. This clearing was approximately two weeks earlier than normal for the lake.

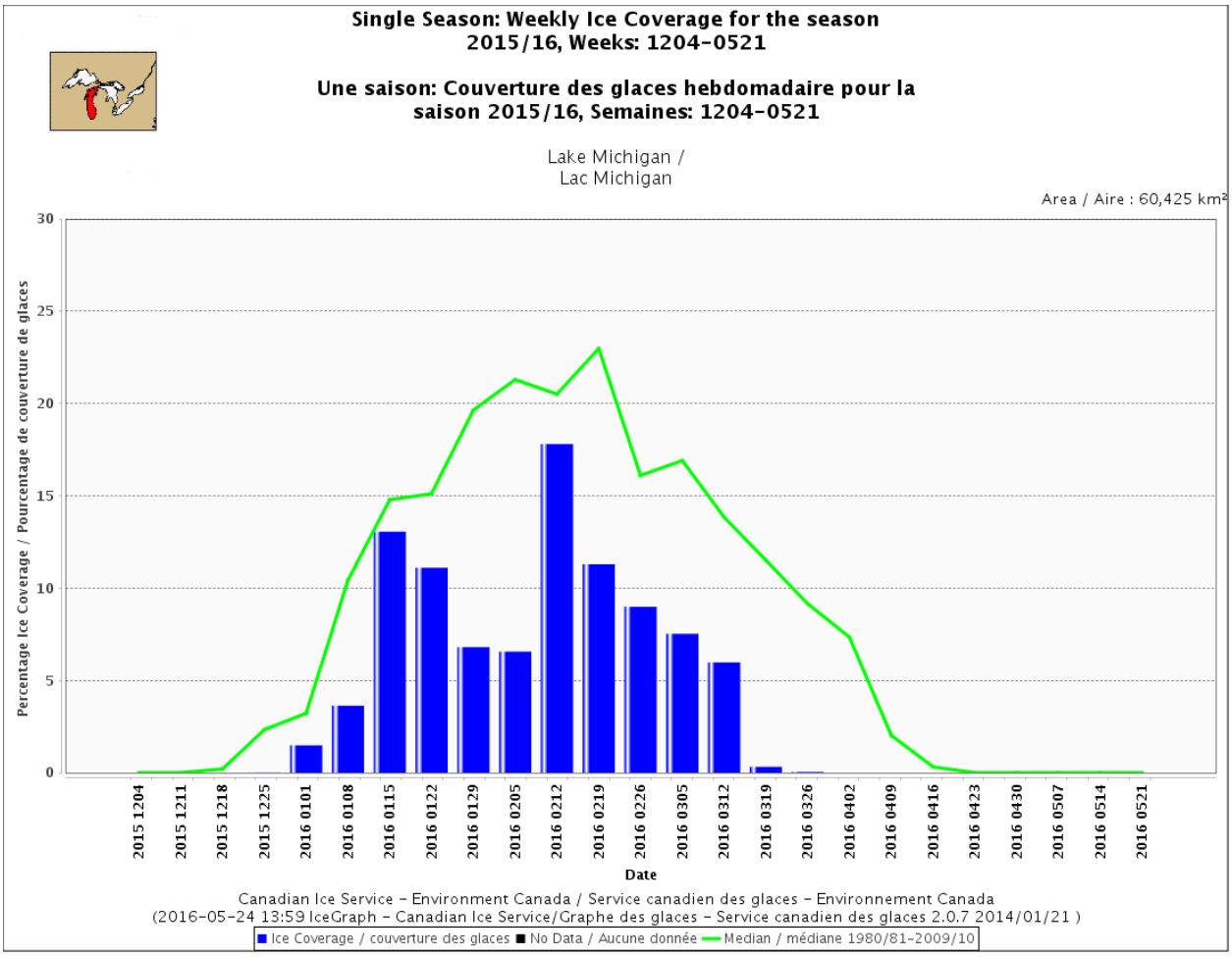

Figure 11: Weekly Ice Coverage in Lake Michigan for winter 2015-16.

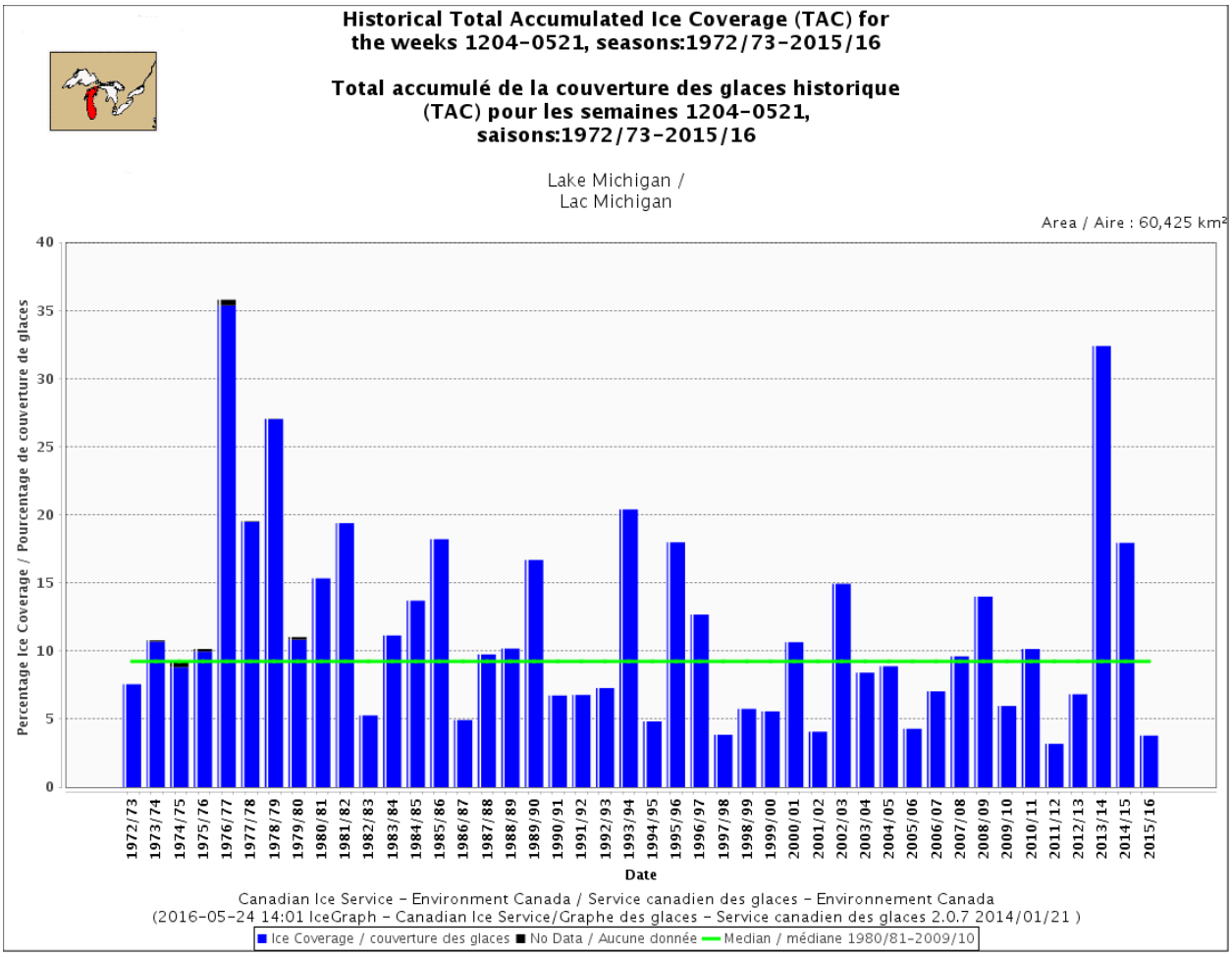

Figure 12: Historical Total Accumulated Ice Coverage in Lake Michigan by season, 1972-2016.

Lake Huron

2015-2016 Season temperatures:

A warm start to the ice season was in store for Lake Huron, with a positive surface air temperature anomaly of 5.0 to 6.0°C above normal in December 2015. This anomaly weakened through the winter, with positive values of 1.0 to 3.0°C for January and 1.0 to 2.0°C in February before intensifying in March with values from 1.0 to 3.5°C. April exhibiting a trend in the opposite direction with anomalies 2.0 to 4.0°C below climatology.

2015-2016 Ice conditions:

The St. Mary's River was the site of the first ice of the season in the Lake Huron basin by the third week of December. This constituted a delay

of roughly two weeks in the first ice formation. New ice development had spread to the north shore of the North Channel and in Saginaw Bay by the end of the month.

January saw thickening and expansion of ice in the St. Mary's River in the first week, with the predominate ice reaching the thin lake ice stage. Ice quickly covered Saginaw Bay and began to form in isolated bays and inlets along the northern and western shores of Georgian Bay. By mid-month the ice in Saginaw Bay was predominantly thin lake ice and some new ice was appearing along the eastern shore of Lake Huron near Goderich and along the shores approaching the Straits of Mackinac. In the second half of the month, the North Channel became covered with mainly thin lake ice and the fast ice was now established in the St. Mary's River at the medium lake ice stage.

At the start of February, ice has receded again across Lake Huron. The North Channel was only partially covered and concentrations had lowered significantly in Saginaw Bay. The pre-conditioned environment in the lake permitted a rapid expansion of new and thin lake ice in mid-February, as the North Channel again filled in and ice began to expand over northern Georgian Bay. Narrow bands of new and thin lake ice formed along sections of the shores all around Lake Huron as well. This expansion marked the peak ice coverage for the lake at 33.86%, very early and well below the peak median ice coverage of approximately 48% normally achieved in mid-March.

The decline that followed the February peak left medium and thin ice confined to Saginaw and Georgian bays, as well as the North Channel and near the Straits of Mackinac. Near the end of the first week, ice concentrations rebounded again to cover southern section of Lake Huron with new and thin lake ice. Ice thickened to the thick lake ice stage in the fast ice in the St. Mary's River, North Channel, Georgian Bay and Saginaw Bay. Near mid-March, fast ice began to breakup in Saginaw Bay and the mobile ice in the bay was quickly disappearing. Ice concentrations in Georgian Bay and the central North Channel also began to diminish steadily. By the end of the month fast ice breakup was advancing in Georgian Bay and the North Channel, as well as the St. Mary's River.

April's cooler temperatures slowed the deterioration of the last remaining ice. Full clearing of the ice was observed on near the end of the month, approximately normal relative to the climatology.

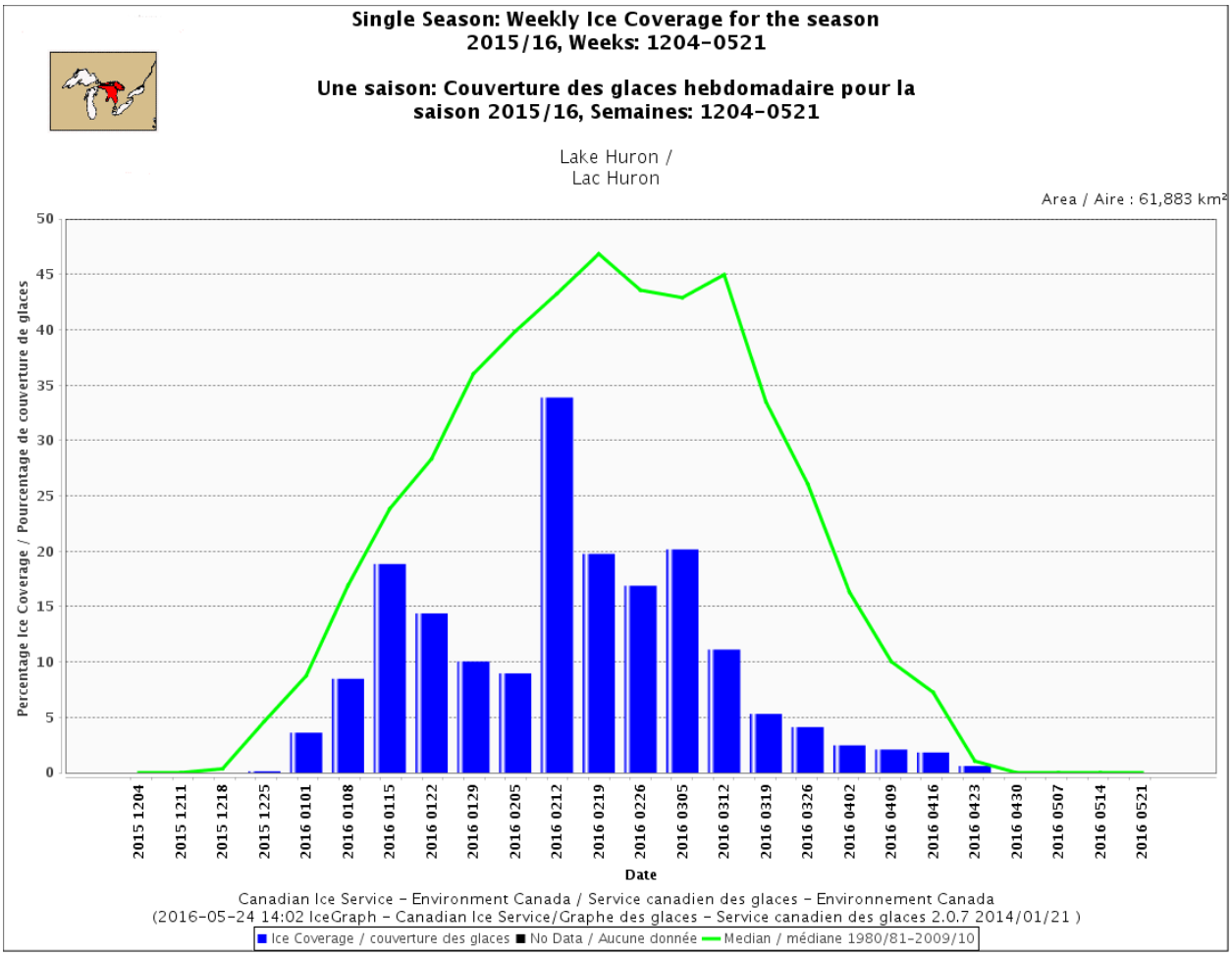

Figure 13: Weekly Ice Coverage in Lake Huron for winter 2015-16.

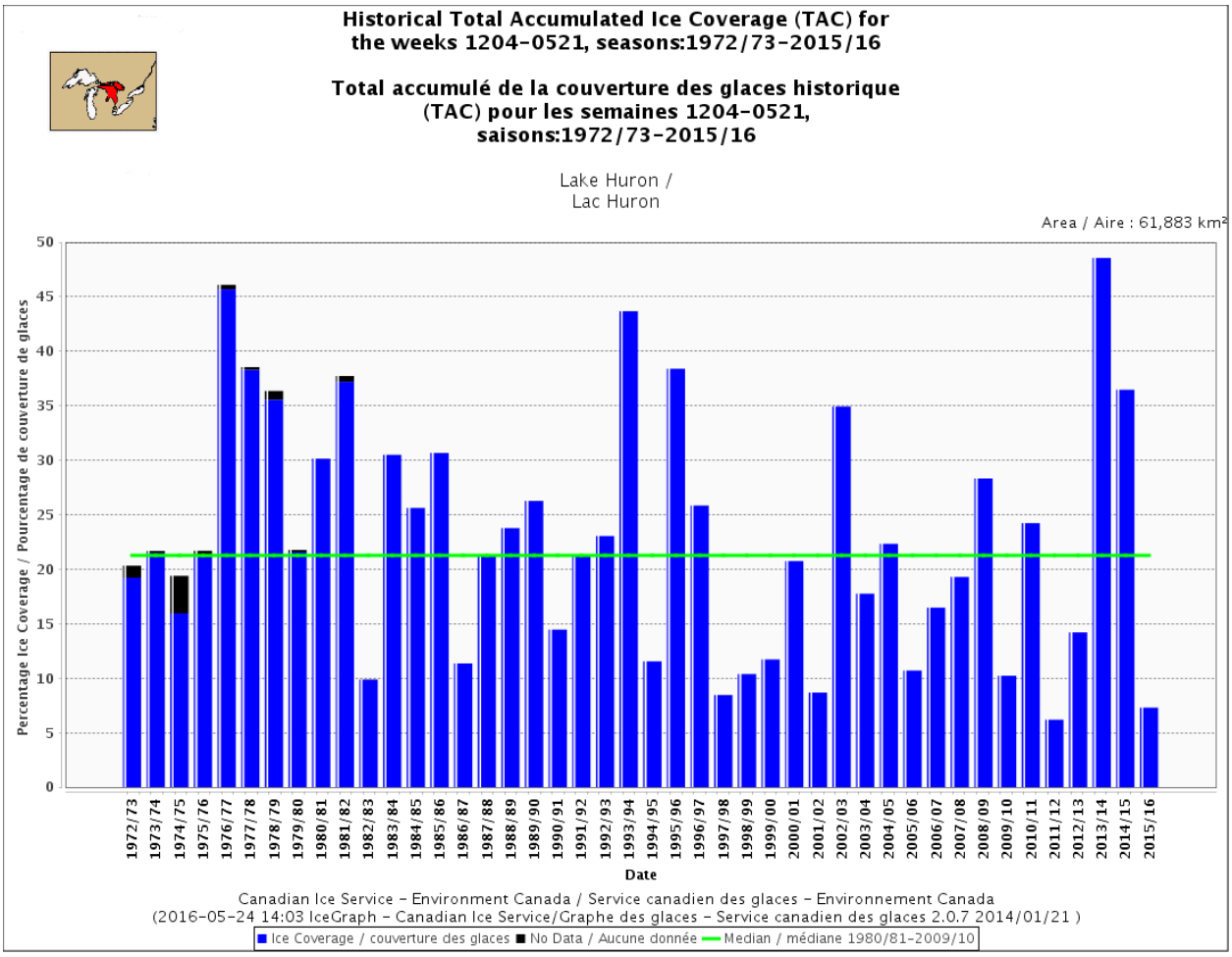

Figure 14: Historical Total Accumulated Ice Coverage in Lake Huron by season, 1972-2016.

Lake Erie

2015-2016 Season temperatures:

Lake Erie experience warmer than normal surface air temperatures beginning in December 2015 and through March 2016. Positive anomalies of 6.0 to 7.5°C in December, 0.5 to 1.5°C in January, 1.5 to 2.0°C in February and 3.5 to 4.0°C in March were recorded. April yet again exhibited a colder than normal trend, with anomalies in the range of 1.0 to 2.0 below the typical climatological surface air temperature.

2015-2016 Ice conditions:

The onset of ice formation did not take place in Lake Erie and Lake St. Clair until the first week of January, a full two weeks later than normal. By mid-month, new and thin lake ice was evident in the southern half of Lake St. Clair, the western section of the Western Basin and in Long Point Bay. Ice growth advanced steadily to cover the remainder of Lake St. Clair and the Western Basin with new and thin lake ice by the third week of January. Near the end of the month, some ice destruction took place in the Western Basin, leaving isolated areas of thin and medium lake ice. Lake St. Clair did thicken to the medium lake ice stage but experienced a reduction in the coverage.

Ice continued to diminish in early February and only with a cold outbreak did the coverage values increase by mid-month. Ice coverage approached the median peak seasonal value of 87.33%, as the mid-February assessment was registered as 74.74%. Ice spread across the western and central sections of Lake Erie as well as near Buffalo. Fast ice composed of thin and medium lake ice was established in southeastern Lake St. Clair, near Buffalo and in Sandusky Bay. A sharp decline followed this maximum with a return to warmer than normal temperatures across the region. By month end, isolated areas of ice were located near the Southeast Shoal, eastern and north Lake St. Clair and west of Long Point.

A modest redevelopment took place in the first week of March, with a return of thin and medium lake ice in Lake St. Clair and along the north shore of Lake Erie west of Long Point. But as rapidly as this ice formed, it was destroyed as quickly and by the end of the second week of March the basin was free of ice.

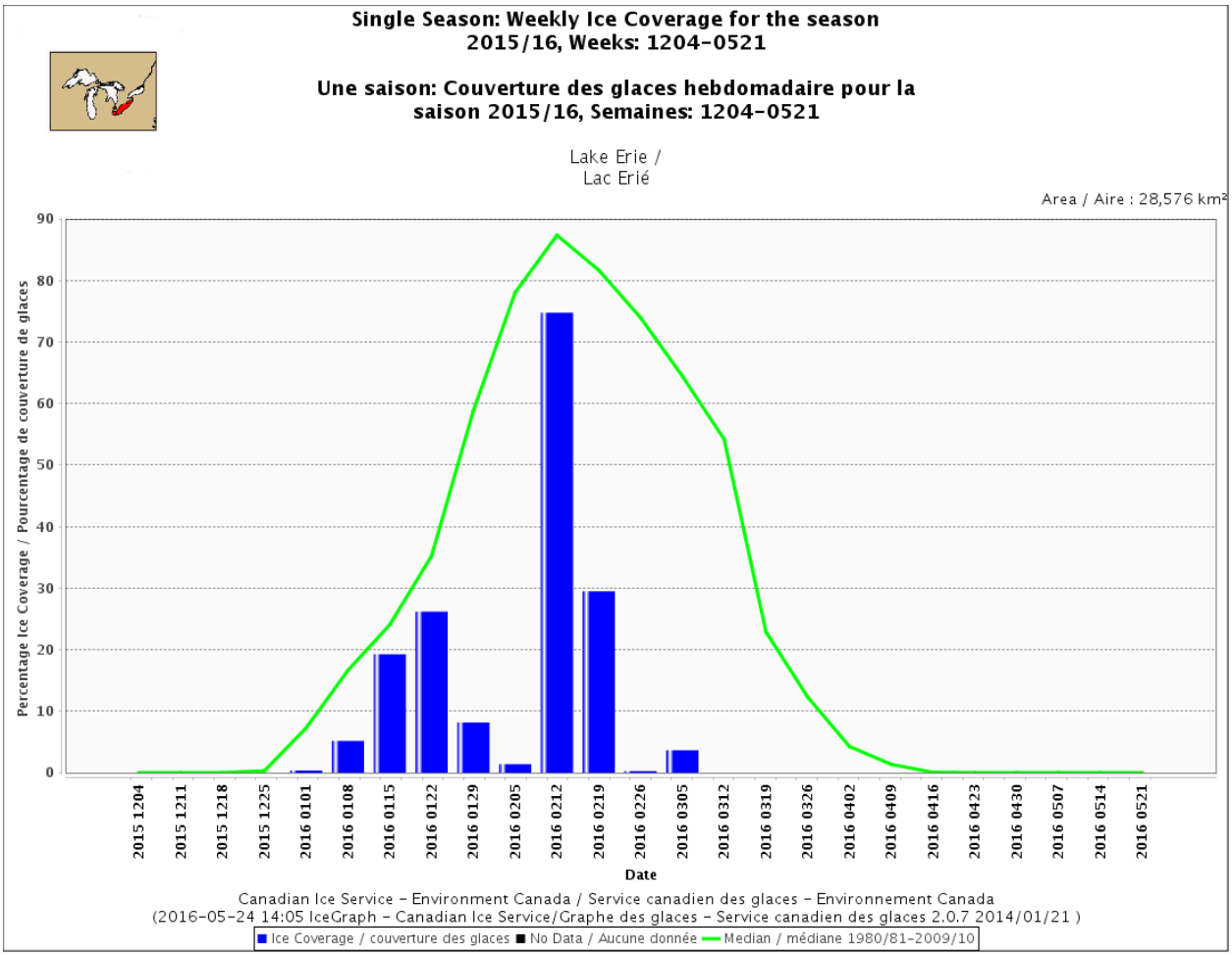

Figure 15: Weekly Ice Coverage in Lake Erie for winter 2015-16.

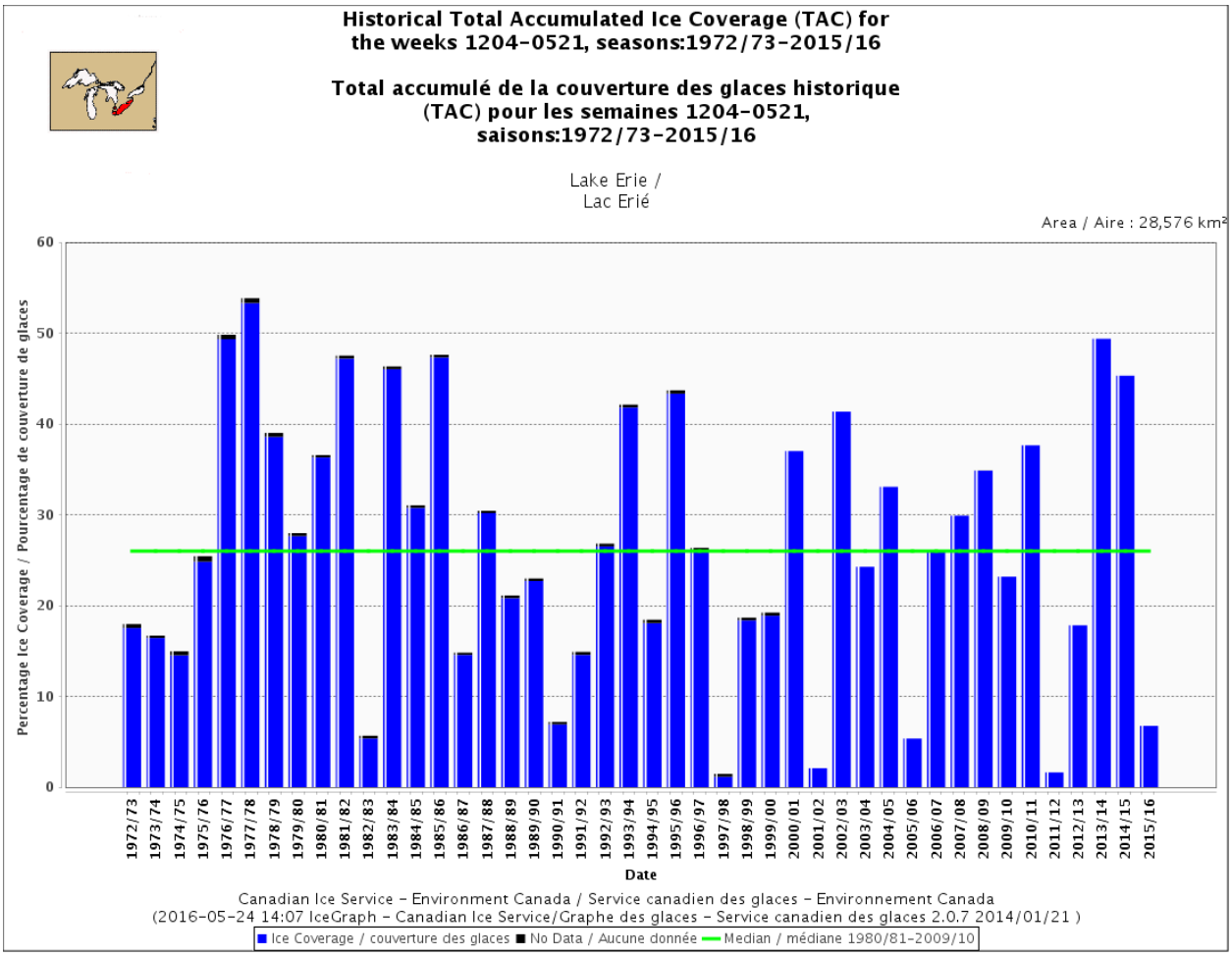

Figure 16: Historical Total Accumulated Ice Coverage in Lake Erie by season, 1972-2016.

Lake Ontario

2015-2016 Season temperatures:

Anomalously warm surface air temperatures also affected Lake Ontario from December 2015 to March 2016. Anomaly values were most extreme in December from 6.0 to 7.5°C, while January at 0.5 to 2.0°C, February at 1.0 to 2.5°C, and March at 2.5 to 3.5°C all continued the pattern of warmer than normal temperatures. A reversal in the pattern in April led to a negative surface air temperature anomaly of 1.5 to 2.5°C below the normal climate values for Lake Ontario.

2015-2016 Ice conditions:

The season began with ice forming in isolated sections of the Bay of Quinte and St. Lawrence River near the end of the month, a departure of two weeks from the normal freeze up that typically takes place by mid-month. By mid-January, the Bay of Quinte became consolidated with thin lake ice while conditions in the St. Lawrence River continued to lag behind the climate normal. The only appreciable change at the end of the month was the advance of the ice in the Bay of Quinte to the medium lake ice stage.

The colder temperatures in mid-February drove significant expansion of ice cover across the northeast section of Lake Ontario. New and thin lake ice covered the area east of Prince Edward County and into the St. Lawrence River. This event was the maximum in ice coverage in Lake Ontario at 8.81%, well below the median peak of approximately 15% for the season. As with the other lakes, this peak in ice cover was short-lived and by month end the coverage shrank dramatically. Medium fast ice remained in the Bay of Quinte and St. Lawrence River and a small section of thin and medium lake ice was isolated in the northeastern portion of the lake.

A slow regrowth period followed in early March, with ice advancing to the thin and medium lake ice stages across northeastern Lake Ontario. But by mid-month the ice deteriorated rapidly and fast ice breakup commenced in the St. Lawrence River and the Bay of Quinte. All remaining ice cleared from Lake Ontario during the fourth week of the month, thus ending the ice season for 2015-2016.

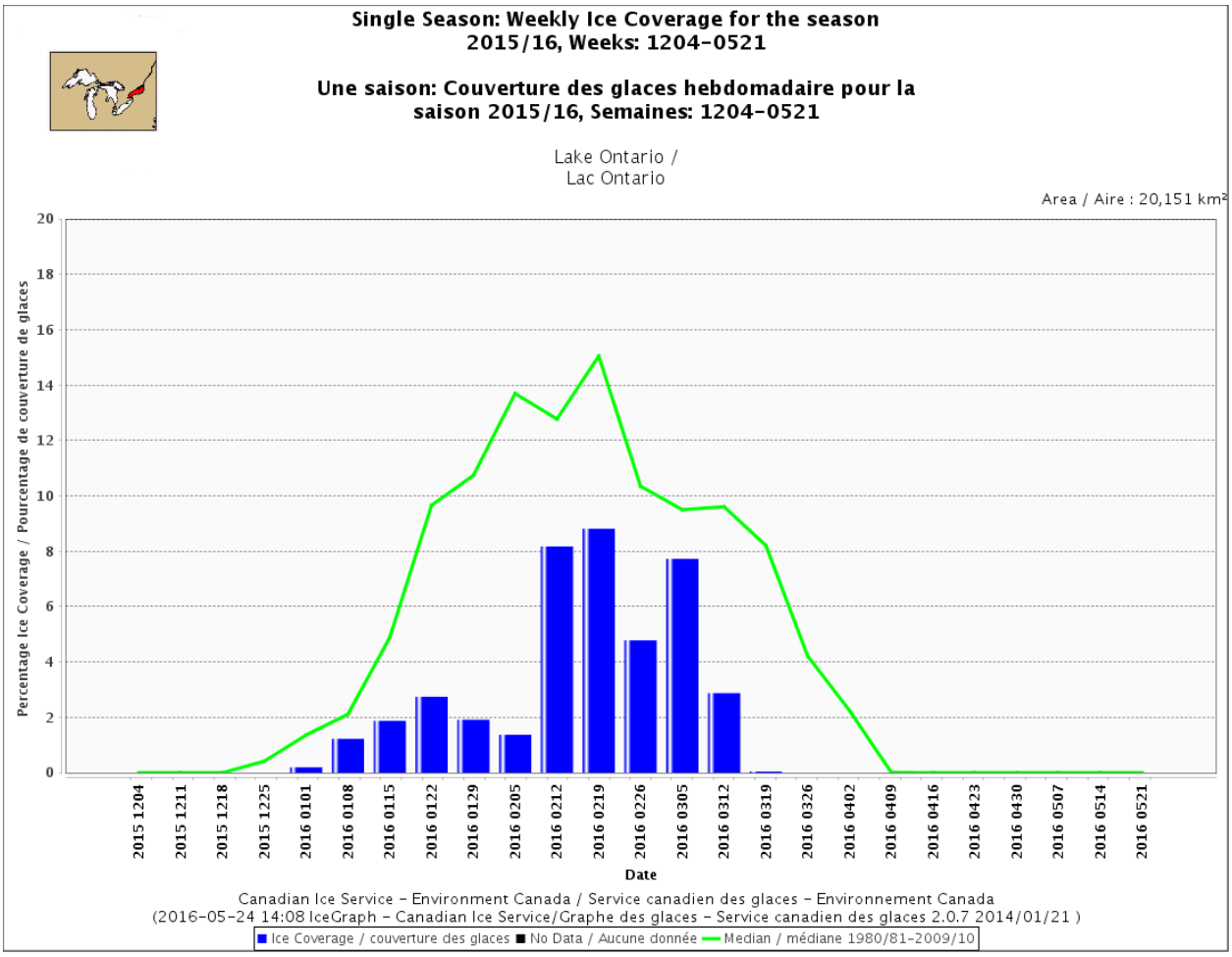

Figure 17: Weekly Ice Coverage in Lake Ontario for winter 2015-16.

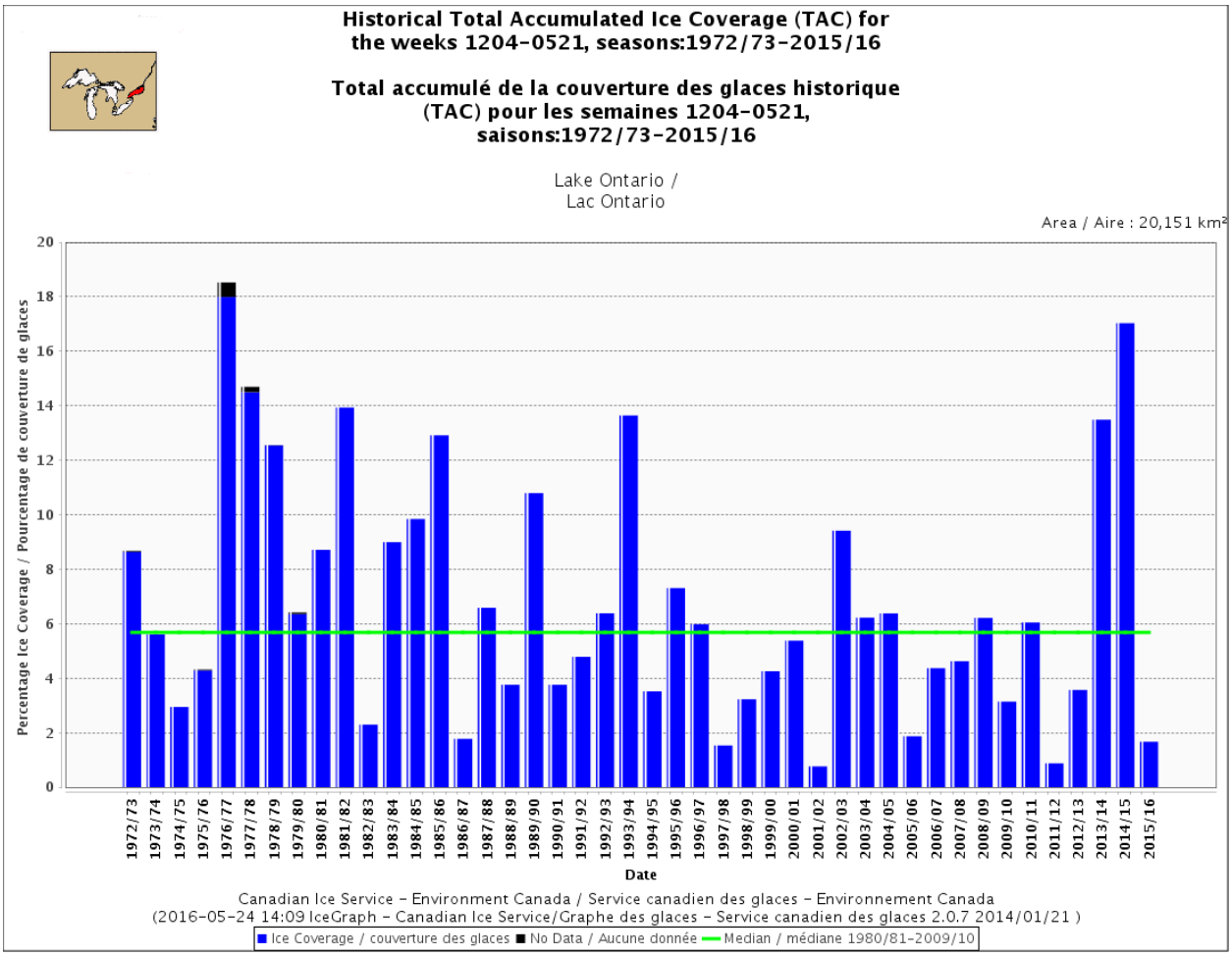

Figure 18: Historical Total Accumulated Ice Coverage in Lake Ontario by season, 1972-2016.