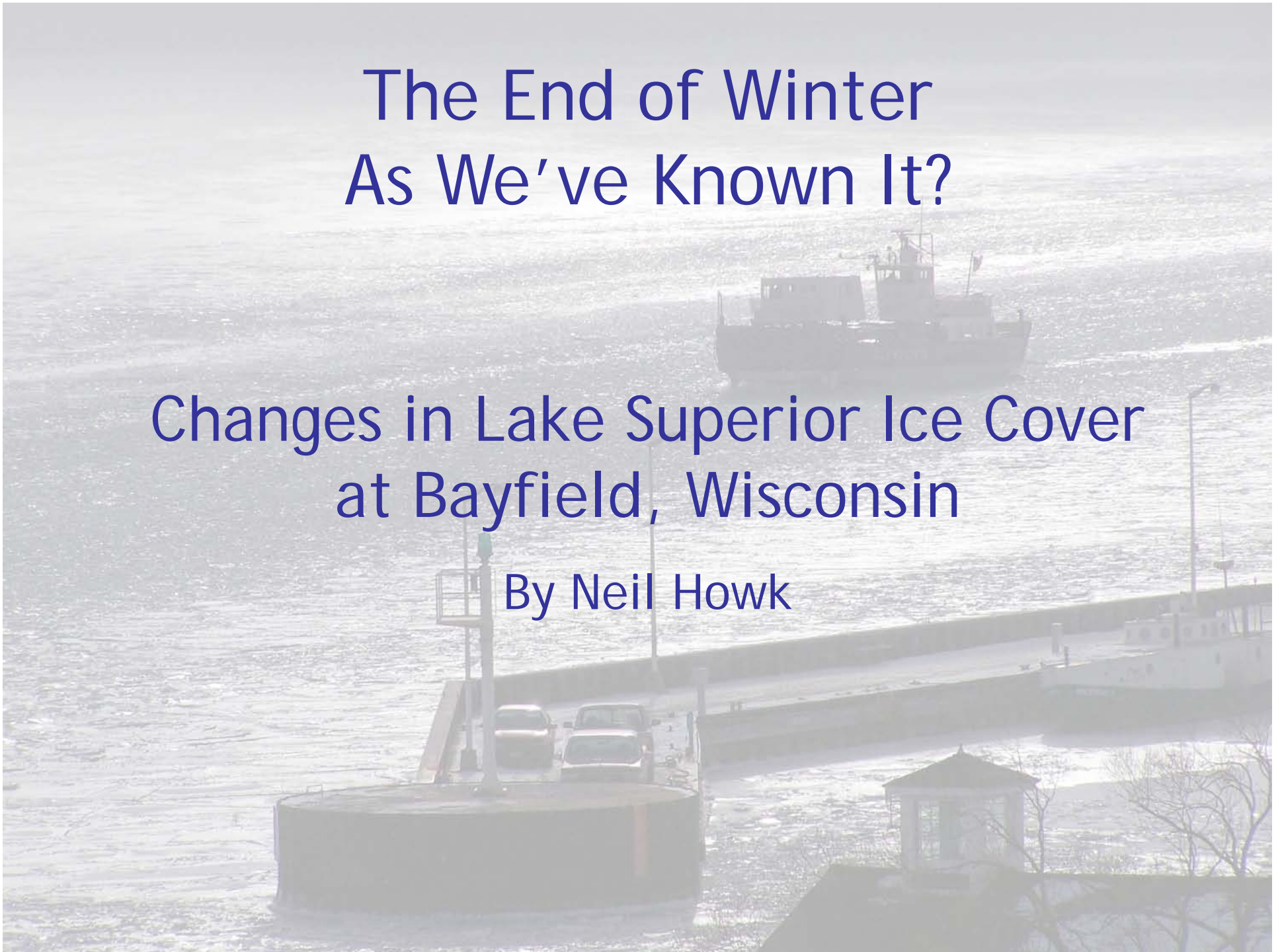


The End of Winter As We've Known It?

Changes in Lake Superior Ice Cover at Bayfield, Wisconsin

By Neil Howk



Winter in Bayfield means Ice



Earliest Ice Record Alexander Henry - 1765



Earliest Ice Record - 1765

Freeze-up:
December 15, 1765

Breakup:
April 20, 1766

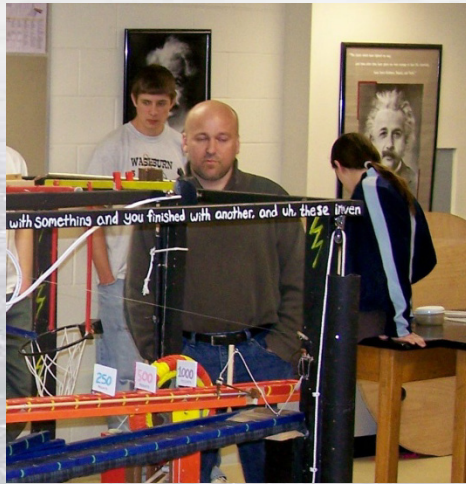
Ice Season:
126 Days



What's Happening to the Ice?



The Start of a Science Project



- Bayfield Science teacher Rick Erickson



- Junior Science and Humanities Symposium
- Intel International Science and Engineering Fair


Selecting a Topic

- Neil suggests investigating evidence of climate change close to home.

Climate Change

Great Lakes Area
National Park Service
U.S. Department of the Interior

Dying birch trees, minimal snowpack, and ice-free lakes are just some...
Impacts of Midwest Warming




The Science is In

Recent reports by the U.S. Global Change Research Program, the National Academy of Sciences, and the United Nations Intergovernmental Panel on Climate Change, give a clear indication of a warming world and related changes in our global climate system. The climate is changing, and there is little scientific doubt that most of the temperature increases since the mid 20th century are due to greenhouse gases produced by human activities. Taking action now will diminish the risks associated with climate change, and reduce the likelihood of catastrophic and far more expensive consequences.

A Changing Climate	Change has it seen from a powerful force of nature. National parks help us understand how much change influences our lives by illustrating how interconnected we are with our environment.	Climate warming is occurring in most regions across the globe and is largest at high latitudes in the Northern Hemisphere.
	In the last ten years, the Earth's surface temperatures have risen an average 1.5°F (0.8°C). More than 20% of this change has occurred since 1996, with seven of the last twelve years ranking among the twelve warmest years on record.	James Hansen, NOAA's chief climate scientist has said "We are getting close to a tipping point, and the degree of temperature rise is unpredictable. The changes will be accelerated, but something to which we can probably adapt. However, if we stay on a business as usual path for another decade, the impacts will be dire."
Temperature and Precipitation	The Northern Midwest, including the Great Lakes region, has warmed by about 4°F (2°C) in the 20th century.	Changes occur when the lake reaches a uniform temperature and the water completely mixes from top to bottom.
	Data for Lake Michigan, Huron and Superior show that summer water temperatures are increasing. Lake Superior's summer surface water temperatures have increased by 4°F (2.2°C) since 1970.	Based on climate model predictions, summer temperatures in the Great Lakes region are projected to rise by at least 5°F (3°C), and as much as 9°F (5°C) by 2050. Projected temperature changes vary depending on the model and scenario, however all projections indicate warming for the region.
	The timing of Lake Superior's summer season is now two weeks earlier than expected in 1970.	Extreme weather events such as heat waves, droughts, hurricanes, and floods/droughts will also become more frequent.
		Ice is forming later and melting earlier on lakes and streams in the Great Lakes region. Two-thirds of the winter between 1970 and 2000 in the Midwest had temperatures above the long-term average. Winters are getting shorter in the Great Lakes region. The last spring freeze is coming earlier and the first autumn frost is coming later. Snow cover in the northern hemisphere has declined about 5% since 1960.
		The combination of reduced winter ice, warmer lake temperatures, and greater evaporation leads scientists to believe that the level of Lake Superior will fall seven inches by 2050. A warmer lake could mean increased algae growth and significant changes in species composition.

Ice is forming later and melting earlier on lakes and streams in the Great Lakes region. This contributes to greater evaporation and falling lake levels in the Great Lakes.



Presenting Results

- National Junior Science and Humanities Symposium.
- Intel International Science and Engineering Fair

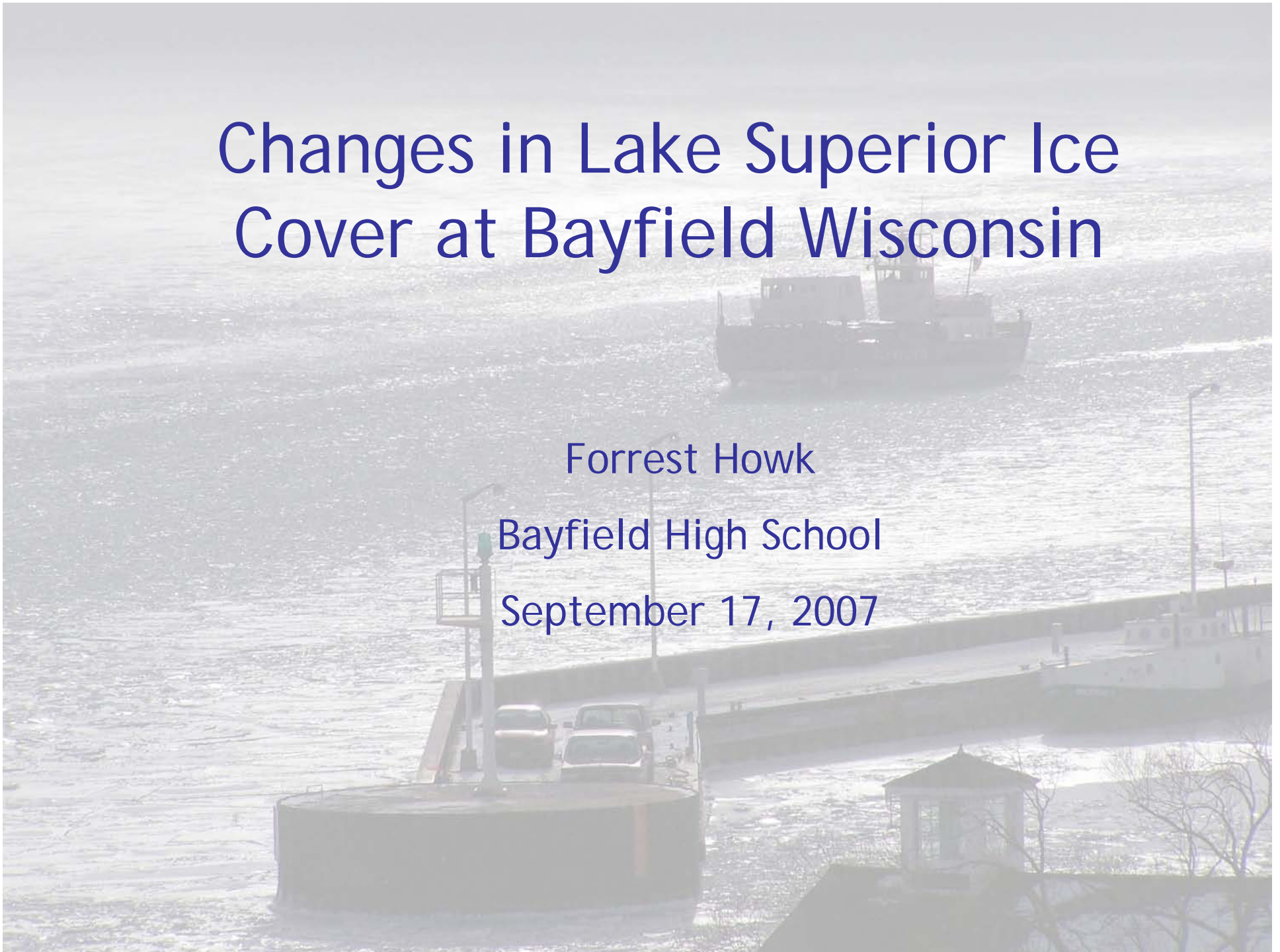


Changes in Lake Superior Ice Cover at Bayfield Wisconsin

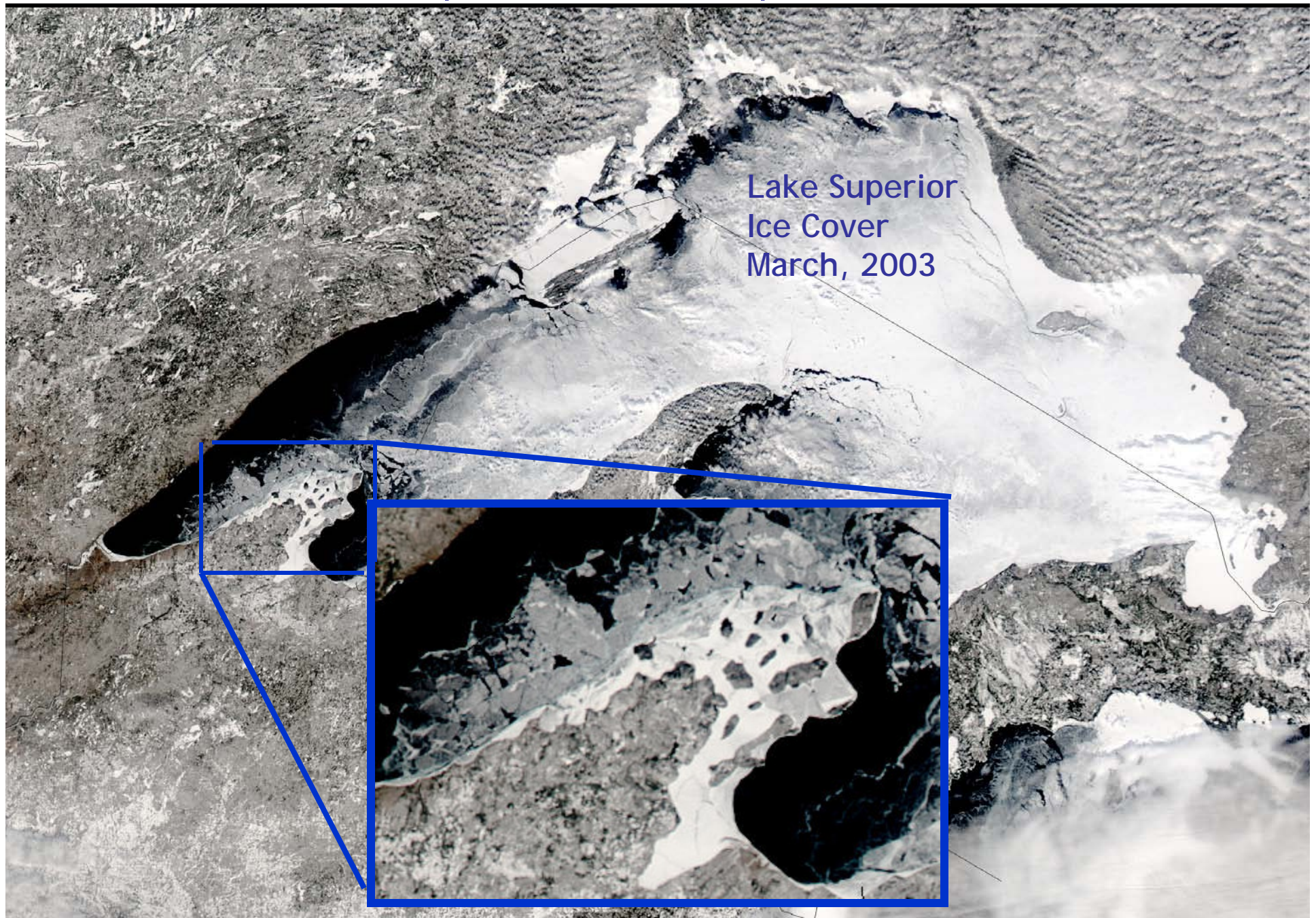
Forrest Howk

Bayfield High School

September 17, 2007



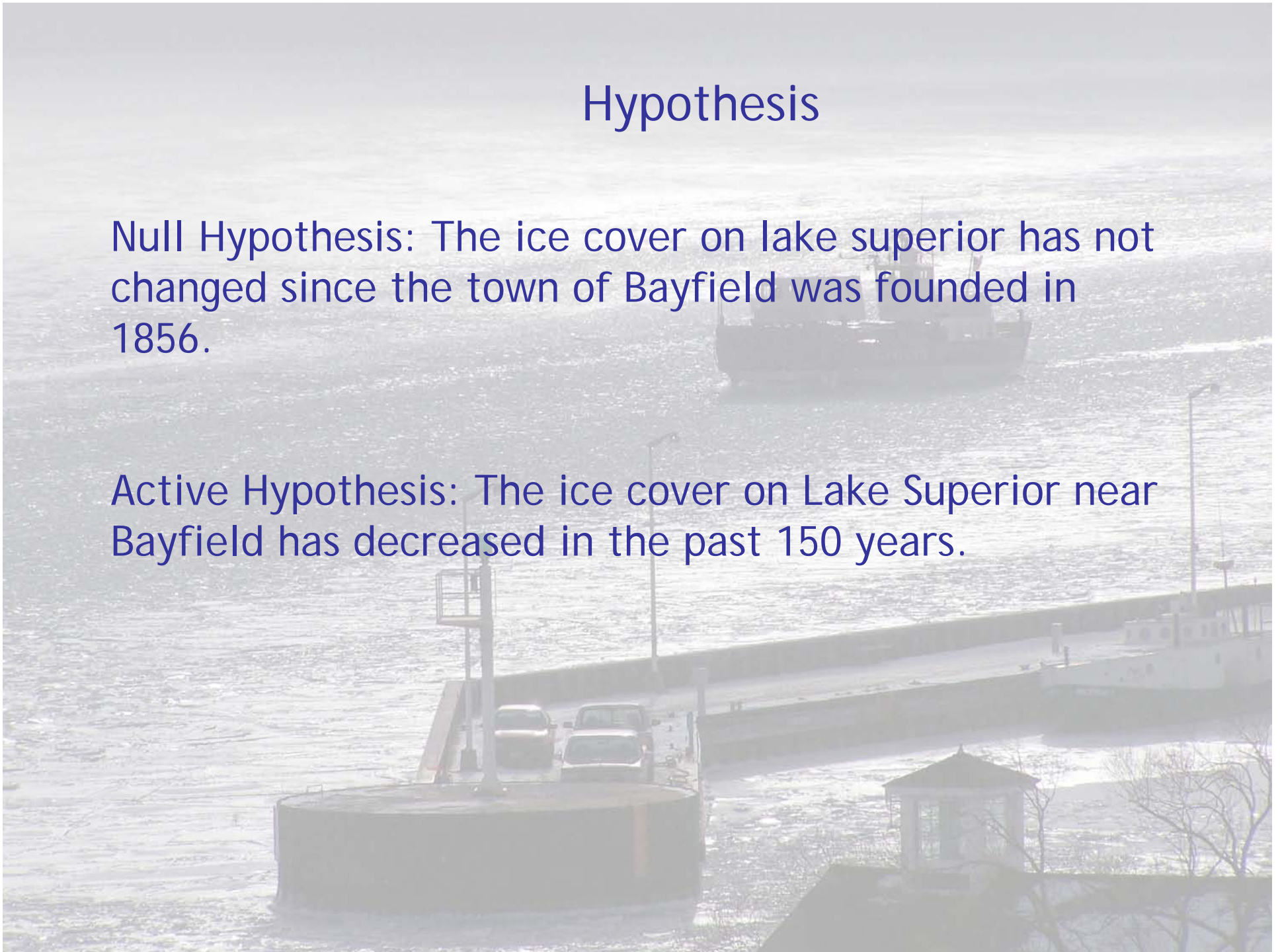
Lake Superior and the Apostle Islands



Hypothesis

Null Hypothesis: The ice cover on lake superior has not changed since the town of Bayfield was founded in 1856.

Active Hypothesis: The ice cover on Lake Superior near Bayfield has decreased in the past 150 years.



Forrest, FYI Good Luck. Robin T Russell

Madeline Island Ferry Line

Operating Season	Spring Break-up	Winter Freeze-up	Ice Road
1970	4/9/1970	1/8/1971	
1971	4/13/1971	1/7/1972	
1972	4/24/1972	12/15/1972	
1973	3/26/1973	1/1/1974	
1974	4/17/1974	1/18/1975	
1975	4/1/1975	1/9/1976	
1976	3/25/1976	12/10/1976	
1977	3/30/1977	1/7/1978	
1978	4/6/1978	1/1/1979	
1979	4/19/1979	1/24/1980	
1980	4/5/1980	1/1/1981	
1981	3/31/1981	1/9/1982	
1982	4/14/1982	1/25/1983	
1983	3/4/1983	12/23/1983	
1984	4/9/1984	1/11/1985	1/16/1985
1985	3/28/1985	12/20/1985	1/4/1986
1986	4/2/1986	1/25/1987	2/6/1987
1987	3/9/1987	1/9/1988	2/1/1988
1988	4/6/1988	1/7/1989	2/6/1989
1989	4/17/1989	12/20/1989	12/28/1989
1990	4/2/1990	1/3/1991	1/14/1991
1991	4/2/1991	1/18/1992	1/27/1992
1992	3/30/1992	1/10/1993	2/12/1993
1993	4/1/1993	1/5/1994	1/24/1994
1994	4/10/1994	1/27/1995	2/12/1995
1995	3/23/1995	1/8/1996	1/25/1996
1996	4/25/1996	1/7/1997	1/20/1997
1997	4/7/1997	NEVER SHUT DOWN!	N/A
1998	CONTINUOUS...	1/11/1999	2/1/1999
1999	3/24/1999	1/20/2000	1/31/2000
2000	3/4/2000	2/10/2001	
2001	4/8/2001	3/11/2002	
2002	3/18/02	1/19/2003	
2003	4/9/2003	1/19/2004	
2004	3/26/04	1/13/05	1/31/05 (1st of 4 diff reads)
2005	4/1/05	2/27/06	NONE
2006	3/10/06		
2007			
2008			
2009			



Gazette
the Town

Procedure

1. My first source of data was from the Madeline Island Ferry Line.

2. The Ferry Line then directed me to the Island Gazette for data dating to 1964.

3. Data from 1857-1964 was collected by looking back through issues of the Bayfield County Press.



Bayfield County
Press

Wisconsin's
Top Newspaper

1938.

Established 1870

Section
Tax Roll

the city of
ly improved
cent of the

"Faithful" Makes the First Boat Crossing of Season

It's Getting to Be That Time of Year ... Wonder When?

Opening of Navigation Was
in the Olden Days, as Now,
a Matter of Major Importance.

By ELEANOR KNIGHT

This month Bayfield will be 99
years old. Also, in this month of
March the ice may or may not go
out of the bay. Chances are that
it will not, for, as the following

It's Getting to Be That Time of Year ... Wonder When?

Opening of Navigation Was
in the Olden Days, as Now,
a Matter of Major Importance.

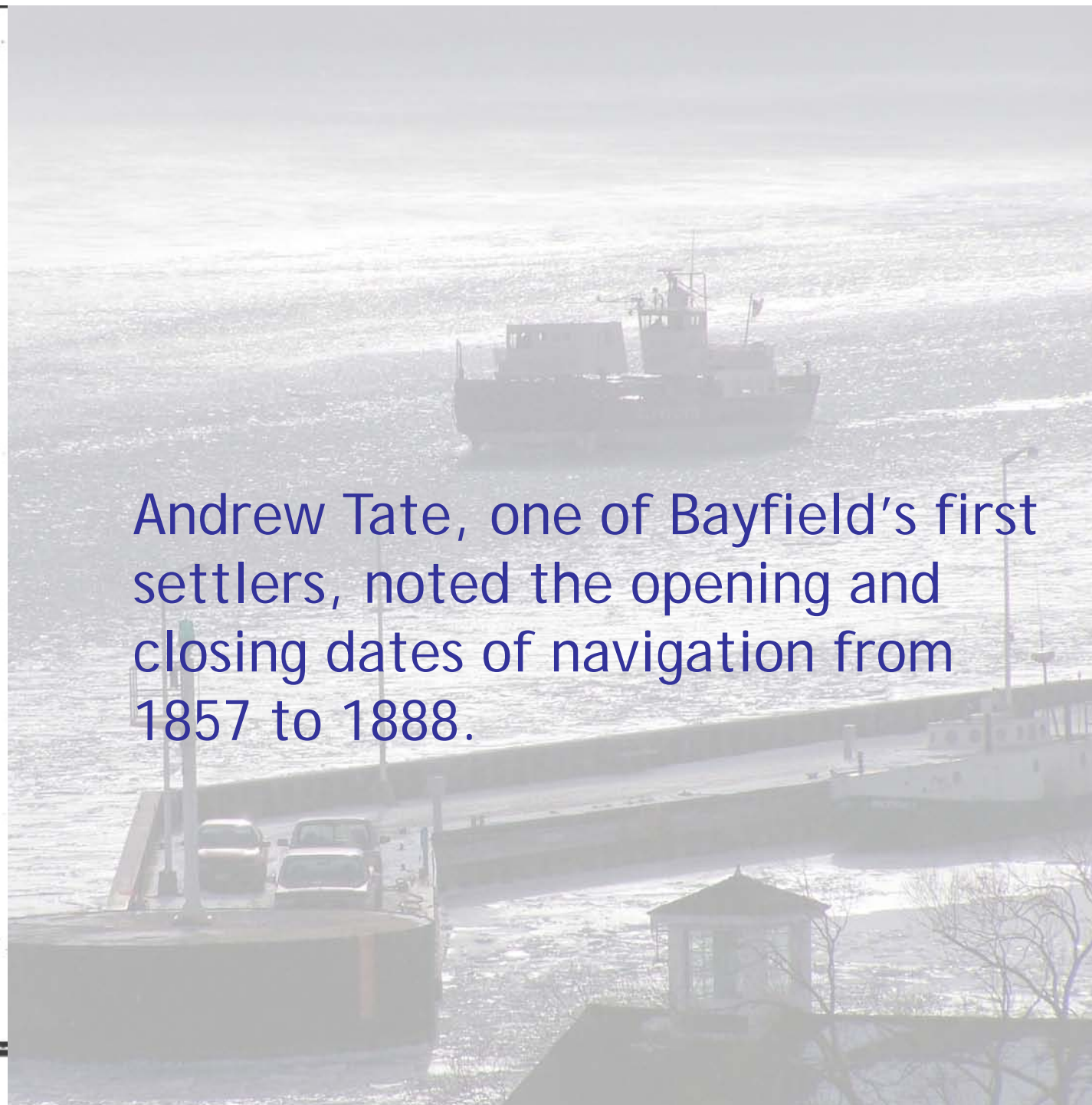
By ELEANOR KNIGHT

This month Bayfield will be 99 years old. Also, in this month of March the ice may or may not go out of the bay. Chances are that it will not, for, as the following record shows, it went out in March only twice in 31 years. For the benefit of those who like to guess at the departure date of the ice this table is reprinted. It first appeared in The Press in 1888 with the statement: "The Press is indebted to Andrew Tate, one of Bayfield's first settlers, for this chart showing the opening and closing dates of navigation since 1857.

Open	Closed
May 20, 1857	Jan. 6, 1858
March 20, 1858	Dec. 24, 1858
April 10, 1859	Dec. 26, 1859
April 15, 1860	Dec. 17, 1860
April 17, 1861	Dec. 22, 1861
April 19, 1862	Dec. 31, 1862
April 10, 1863	Dec. 20, 1863
April 13, 1864	Dec. 22, 1864
April 22, 1865	Dec. 23, 1865
April 17, 1866	Dec. 23, 1866
April 20, 1867	Dec. 23, 1867
April 23, 1868	Dec. 24, 1868
April 19, 1869	Dec. 25, 1869
April 25, 1870	Dec. 27, 1870
April 3, 1871	Dec. 13, 1871
April 26, 1872	Dec. 10, 1872
May 5, 1873	Dec. 6, 1873
May 4, 1874	Dec. 26, 1874
May 13, 1875	Dec. 17, 1875
May 7, 1876	Dec. 15, 1876
April 17, 1877	Jan. 28, 1878
March 3, 1878	Dec. 25, 1878
April 21, 1879	Dec. 17, 1879
April 24, 1880	Dec. 1, 1880
Mar. 2, 1881	Jan. 4, 1882
April 10, 1882	Dec. 26, 1882
April 25, 1883	Dec. 19, 1883
April 27, 1884	Dec. 19, 1884
April 27, 1885	Jan. 8, 1886
April 24, 1886	Dec. 16, 1886

(See 'E.K.' page 3, column 2)

Andrew Tate, one of Bayfield's first settlers, noted the opening and closing dates of navigation from 1857 to 1888.



Why was Ice Data Noteworthy?

July 3, 1934
**Druggist, Lawyer,
District Attorney,
Town Official, etc.**

Andrew Tate Was, It Seems,
One of the Community's
Most Versatile Individuals.

By ELEANOR KNIGHT

Andrew Tate was Bayfield's pioneer druggist. He built and lived in the house now owned by Mrs. E. R. Mitchell, and his drug store was close by — right where the Odd Fellows building now stands. To say merely that Andrew Tate was a druggist is doing him an injustice, because for many years he was lawyer, doctor and general adviser to the whole village.

He came to Bayfield in 1857 and, like most of our pioneer men, undertook many civic jobs and did them well. Through his efforts the first school was organized. For many years his services as legal and medical adviser were in demand and were given to all, usually without price. He was county judge, district attorney, county treasurer, member of the town board, president of the water company, and held other minor offices, all with honor to himself and profit to the community.

One of his jobs in 1859 was Deputy Collector for the Port of Bayfield. He kept the record of boat arrivals and departures, and when the Steamer "Lady Elgin" which left Bayfield on September

In 1859, Andrew Tate kept records of boat arrivals and departures as deputy director for the port.



Why was Ice Data Noteworthy?

Open water was important for shipping.

ERN WISCONSIN.

TERMS: \$2.00 A Year.

JANUARY 16, 1891.

No. 13

E. A. Inglis has been spending a few days at home this week. He returned to St. Paul Tuesday. He is engaged in the machine shops of the C. St. P. & O. Ry.

Sheriff Halloran has appointed John McMillen, of Mason, as his deputy. Mr. McMillen's many friends all unite in pronouncing it a good appointment.

Presiding Elder and Mrs. Bushnell were at Rice Lake last week, the Elder taking a prominent part in the installation exercises of the Masonic lodge at that place.

FOR SALE—A new set of double harness; A new bob tote sleigh; A Fish Bros. wagon. All new and in first-class condition. Enquire at the office of the county clerk, Bayfield Wis. 43-11

The 'Young Peoples' Companion, published at Minneapolis contains a fine cut in its last issue, showing a birds eye view of Bayfield and in the fore ground the old church at La Pointe.

T. W. Higginson and C. O. Greenlaw have taken the contract to run the new mill. They are both gentlemen of experience in mill work and will undoubtedly make money for themselves as well as for owners of the mill.

Miss Josie Miller, of Tomah, formerly a teacher in the primary department of the Bayfield public schools has been secured to teach the department formerly in charge of Miss Prudhomme. Miss Miller comes highly recommended as a teacher of ability and experience.—*Washburn News.*

A thin coating of ice covered the harbor between Madeline Island and Bayfield on Thursday morning, Jan. 8th, open water having prevailed up to that time. This makes open navigation at this port 37 days longer than at any other point on Lake Superior so far reported. That Bayfield possesses the best natural harbor on the "Great Unsalted" is again demonstrated.

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company wish that all his ventures in the future may be as successful as his farewell ball.

Steamboat Excursion.

Probably no other town in the northwest celebrated New Year's day, as did Bayfield, by a steamboat excursion. Capt. Pike placed his lighter at the disposal of the people and Capt. Murphy with his tug May Corgan furnished the motive power. The afternoon was as bright and balmy as a September day, and the result was between two and three hundred people participated in an event that will long be remembered. The boats left the Dalrymple dock about three o'clock, returning at sun set, thus giving all an opportunity to obtain a fine view of the eclipse. Mrs. Pike secured two very fine views of the party.

A very complete filling for even

Why was Ice Data Noteworthy?

Access to mail/danger for La Pointe residents.

BAYFIELD, WISCONSIN FRIDAY APRIL 16, 1915--8 PAGES

tion Picture Serial Story ne" Starting in This Issue

every week. See the pictures at the Princess Theatre every Thursday evening, c

Three Men Meet Tragic Death In Icy Waters

In what is undoubtedly the most tragic accidents occurring on Chequamegon Bay in many years was the drowning Monday afternoon of three well known Madeline Island residents, Charles Russell, Chauncey Wright and Nels Teigen. The sudden deaths and miraculous escape from a like fate by the two survivors of the accident, Capt. Angus and W. S. Johnson, cast a gloom upon the city and their home village LaPointe, which is indeed diffi-

shore, which we finally succeeded in doing and attempts were made to rescue us. This however, was not accomplished until about half past six o'clock when Matt Tiegen and Miles Peterson reached us. In the meantime we had great difficulty in maintaining our seats the ice and cold water chilling us to the bone. We had not been in this position long when Charlie was stricken dead by heart failure, undoubtedly aggravated

having been attracted by signal fire built on the island beach and by the sounding of a fog siren. Latest reports are that Johnson has about fully recovered.

All three of the drowned men leave families, Mr. Wright his wife, mother and sister, Mr. Tiegen his wife and two sons and Mr. Russell his wife and six sons. To each and all of these the greatest sympathy the Press and the entire community extended.

A pathetic feature of the tragedy lies in the fact that Mrs. Russell has but recently undergone a serious operation in an Ashland hospital and is now convalescent. The mere fa-

Why was Ice Data Noteworthy?

Fishing, supplies, emergencies.

April 11, 1957

HEADLINE OF THE WEEK

CG Cutter Woodrush Called to Open Channel Between the Bayfield and La Pointe Docks



**Gar-How II Proved Inadequate
for Job of Cutting Ice Bridge
from La Pointe to Mainland.**

The ice bridge between Madeline Island and the Bayfield mainland has been cut and navigation was opened this afternoon about 3:00 o'clock, with the Nithevo arriving at 3:48 and Gar-How II some 10 minutes later.

But it was not as simple as it sounds. Gar-How II attempted on Sunday afternoon to cut the ice planking but gave up after several hours of work, reaching a point off O'Brien's landing. Another assault was made Monday, the boat reaching a point about half way to Bayfield.

Continued cold weather, well below freezing each night, made of impractical further efforts by the ferry boats.

accommodation of visitors.

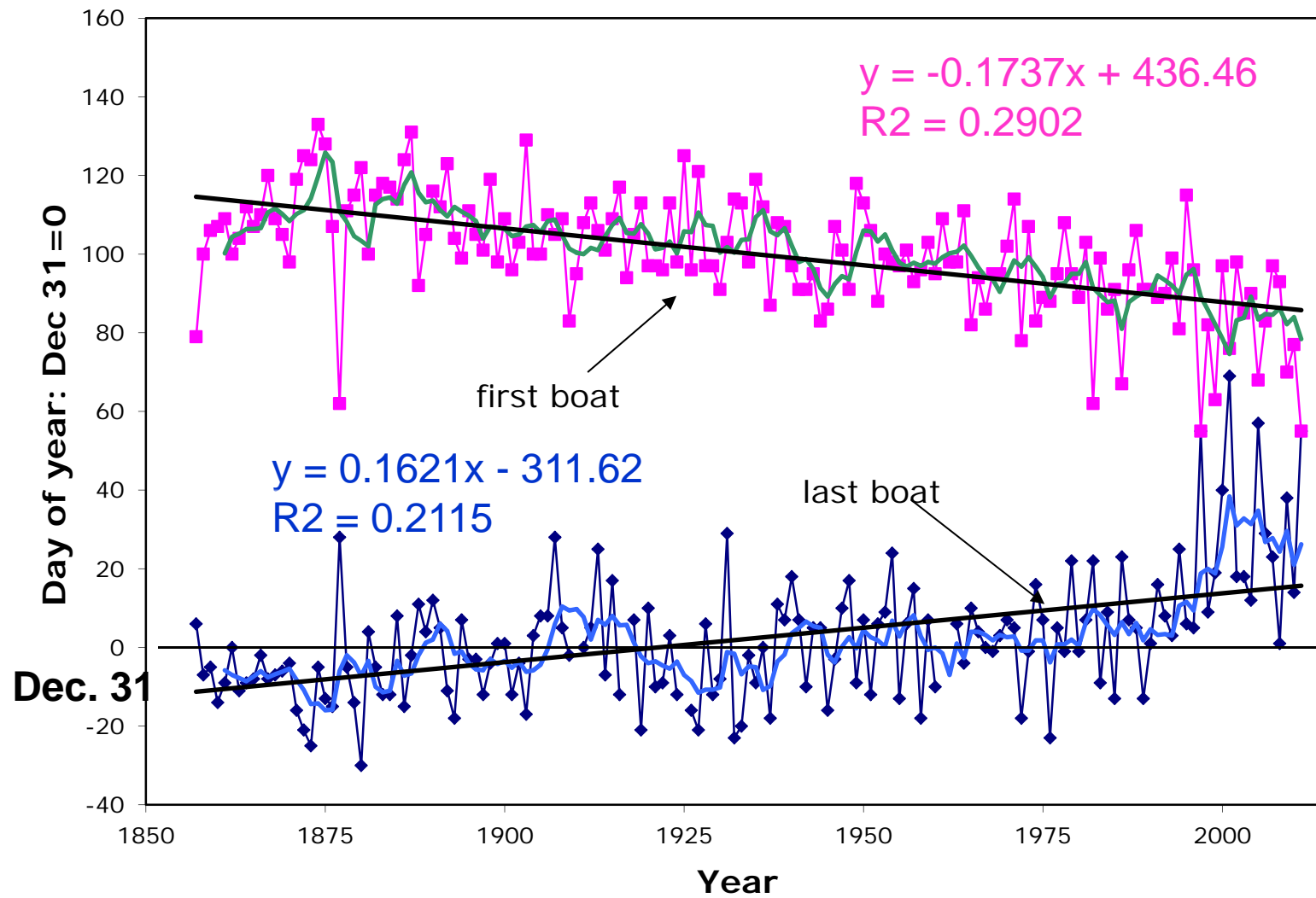
Page 2 says: "The channels of entrance into the bay are wide and deep, making it one of the

plowed land, fences, farms would grow under their hands, with half the labor now given to pro-

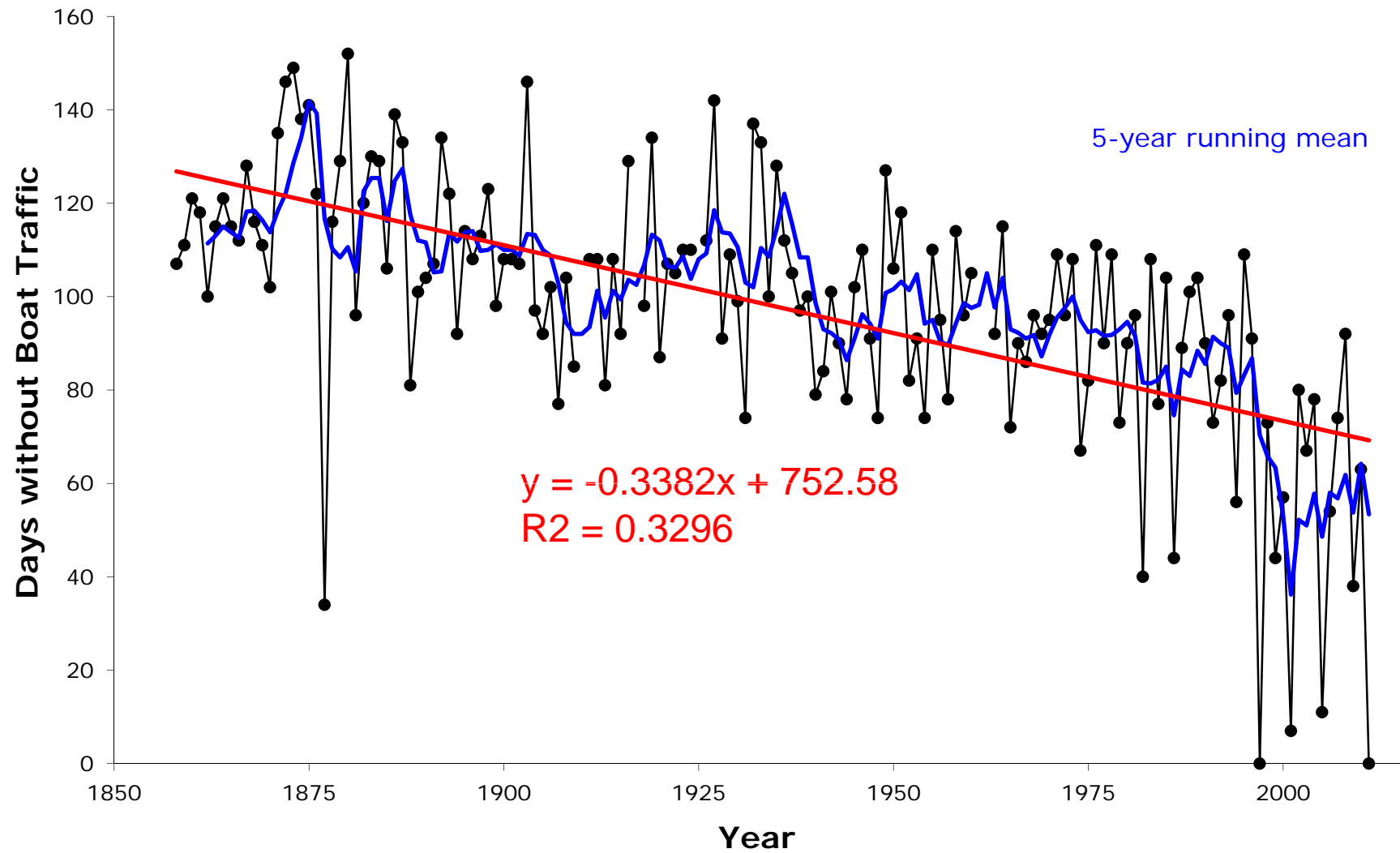
Opening and Closing Dates of Navigation in Bayfield Harbor

start year	last boat	first boat	duration	lastboat	firstboat
1857	6-Jan-58	20-Mar-58	73	6	79
1858	24-Dec-58	10-Apr-59	107	-7	100
1859	26-Dec-59	15-Apr-60	111	-5	106
1860	17-Dec-60	17-Apr-61	121	-14	107
1861	22-Dec-61	19-Apr-62	118	-9	109
1862	31-Dec-62	10-Apr-63	100	0	100
1863	20-Dec-63	13-Apr-64	115	-11	104
1864	22-Dec-64	22-Apr-65	121	-9	112
1865	23-Dec-65	17-Apr-66	115	-8	107
1866	29-Dec-66	20-Apr-67	112	-2	110
1867	23-Dec-67	29-Apr-68	128	-8	120
1868	24-Dec-68	19-Apr-69	116	-7	109
1869	25-Dec-69	15-Apr-70	111	-6	105
1870	27-Dec-70	8-Apr-71	102	-4	98

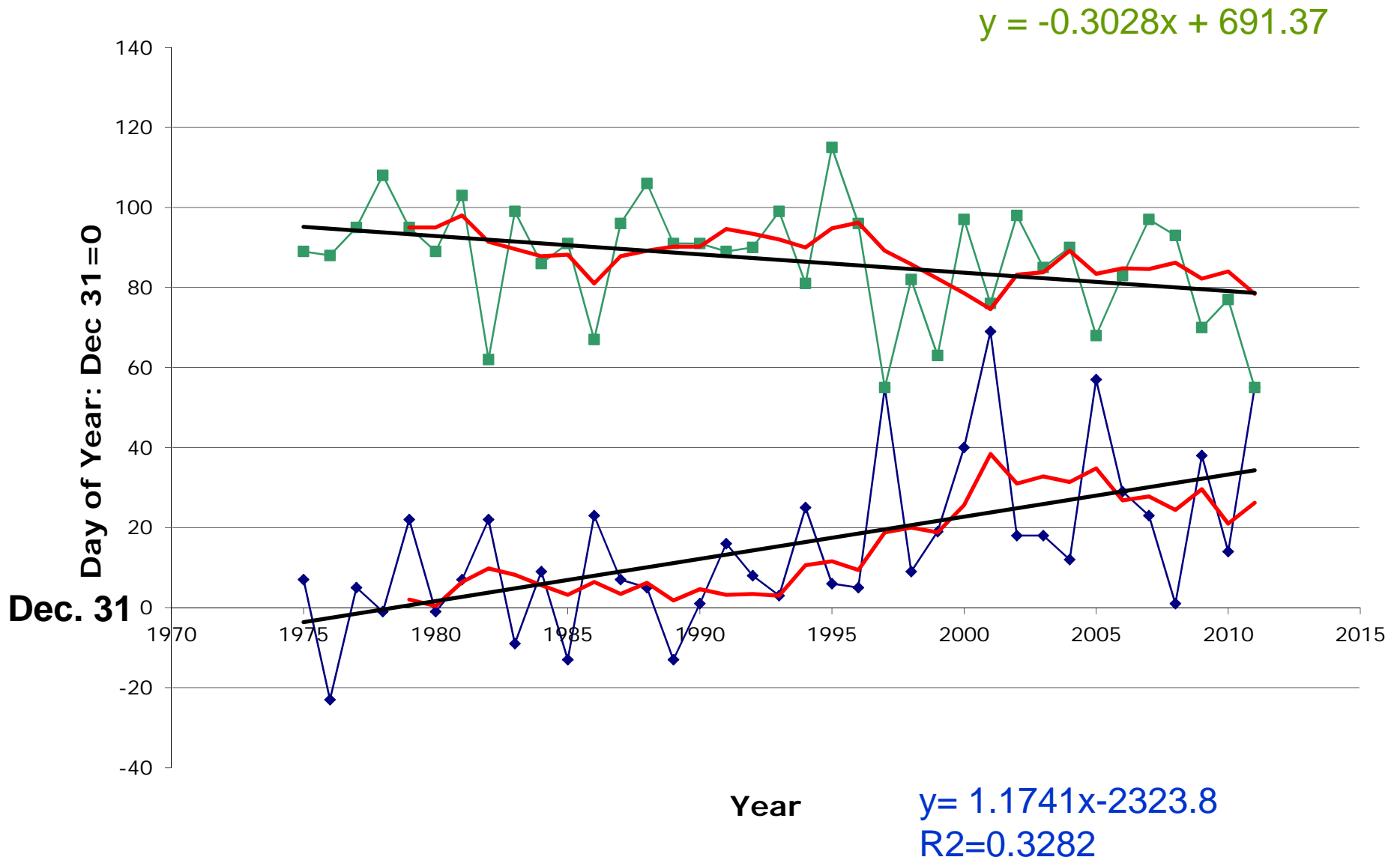
Opening and Closing Dates of Navigation for Bayfield Harbor



Duration of Closed Navigation for Bayfield Harbor

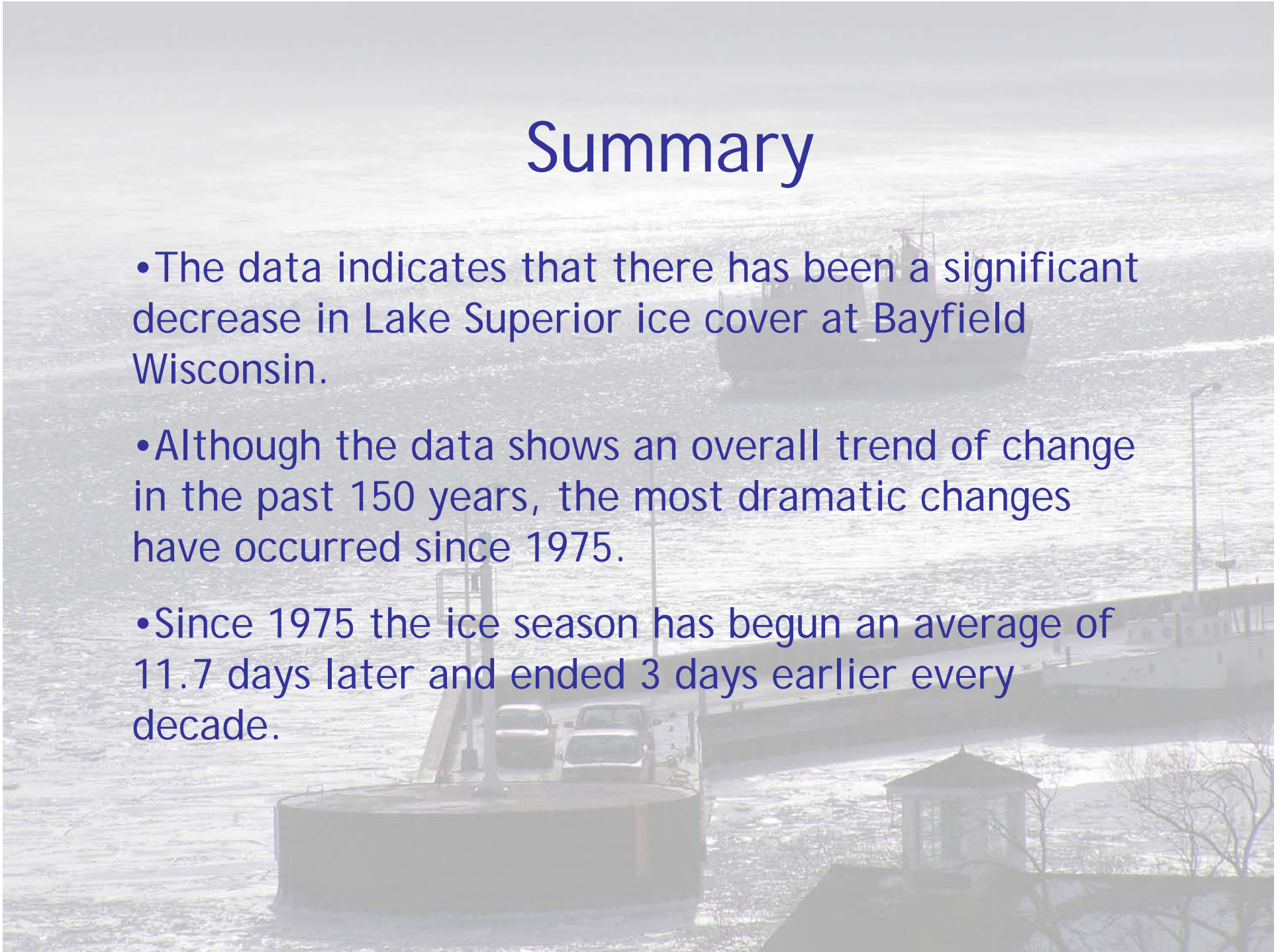


Opening and Closing of Navigation of Bayfield Harbor since 1975

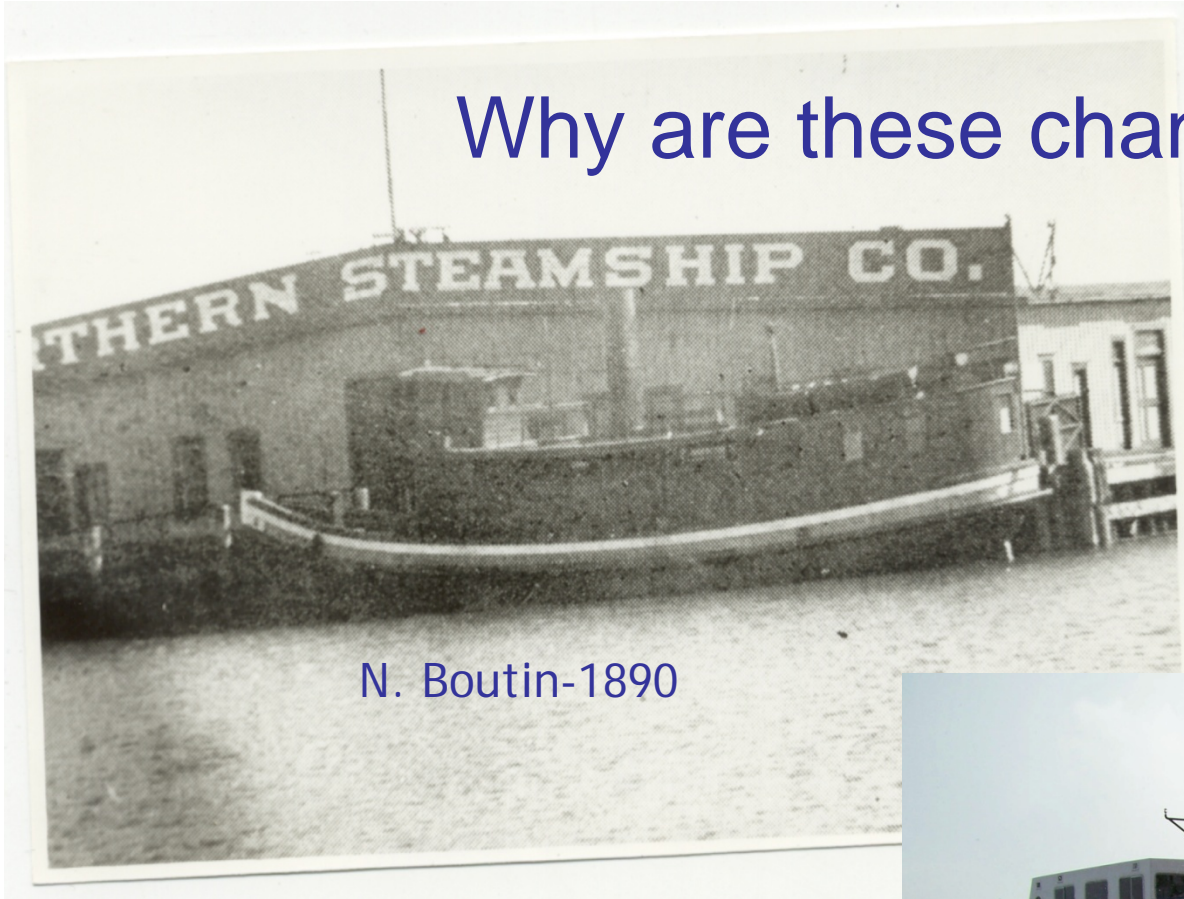


Summary

- The data indicates that there has been a significant decrease in Lake Superior ice cover at Bayfield Wisconsin.
- Although the data shows an overall trend of change in the past 150 years, the most dramatic changes have occurred since 1975.
- Since 1975 the ice season has begun an average of 11.7 days later and ended 3 days earlier every decade.



Why are these changes happening?



N. Boutin-1890

- Technological advances in the local vessel's design and materials might account for some of the change in the length of the ice season.



Island Queen

2007

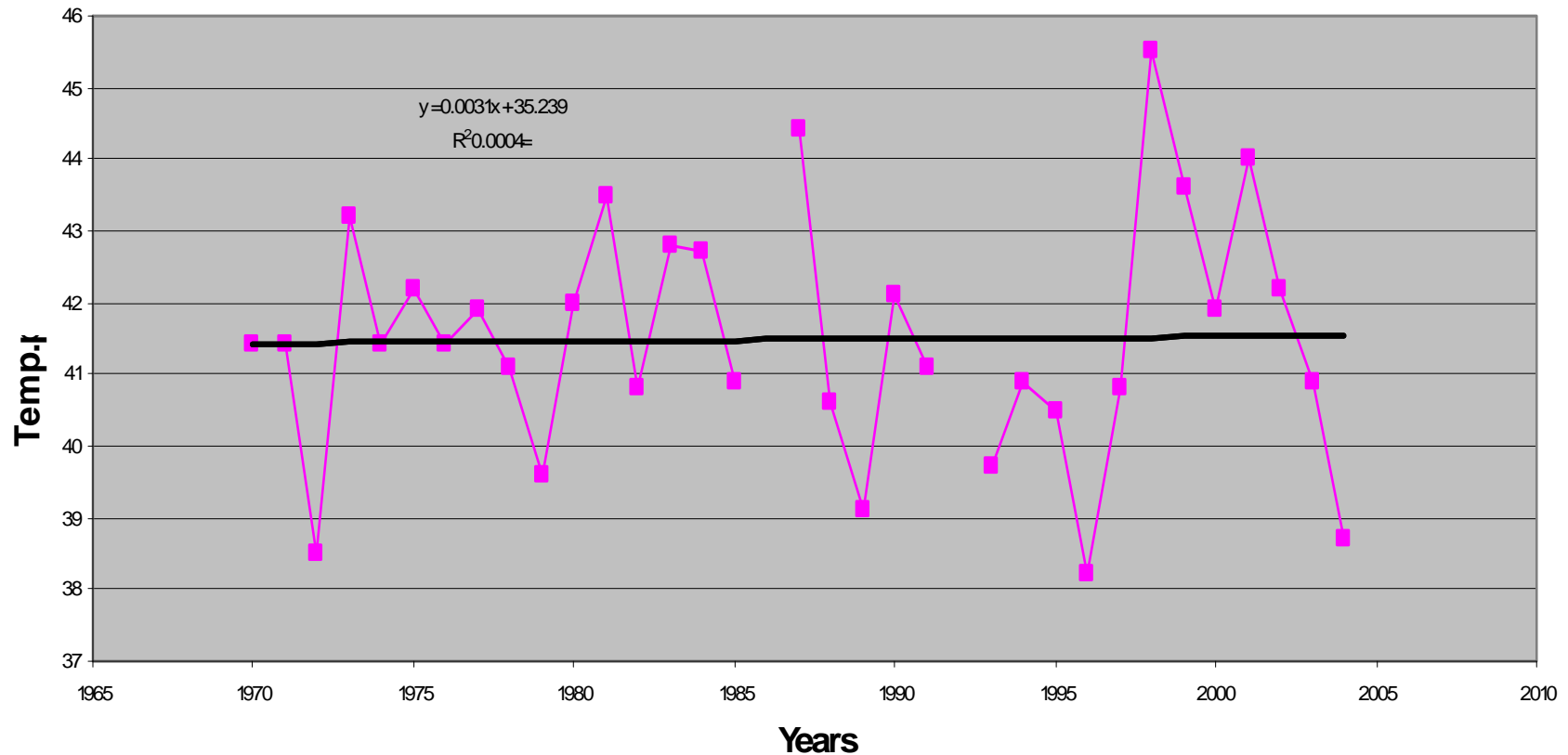
Global Climate Change?

The most likely reason for a lack of ice is the rise in local air and water temperatures.



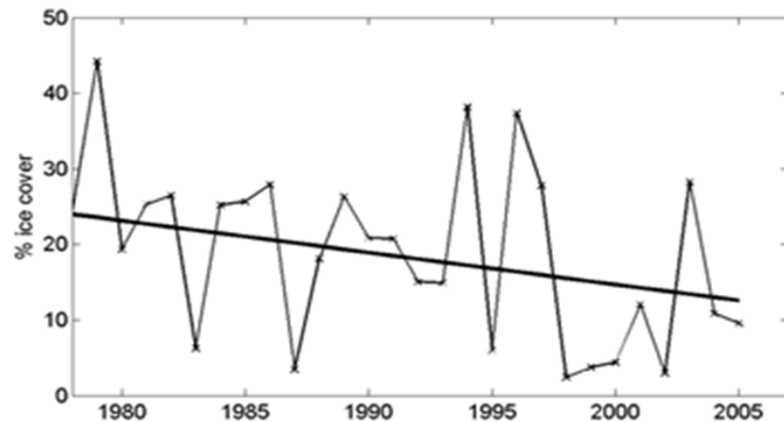
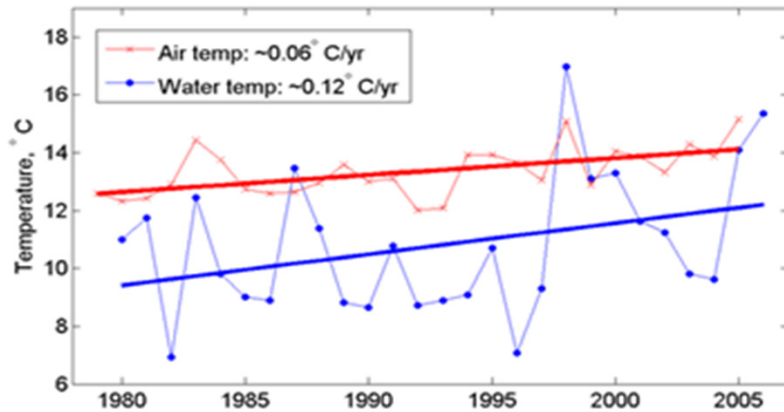
Bayfield Air Temperatures ... Fairly Steady?

Bayfield Annual Mean Air Temperature from 1970 -2004



Data from Midwest Regional Climate Center

Lake Superior is Warming



- Water temperatures are rising at twice the rate of air temperatures since 1980
- This correlates with decreasing ice cover over the same period
- Research is by Jay Austin and Steve Colman of the Univ. of Minnesota Large Lakes Observatory (Duluth)

From <http://www.d.umn.edu/~jaustin/ICE.html>
(Austin and Colman, 2007)

Lake Superior's Decreasing Ice Cover



March, 2009

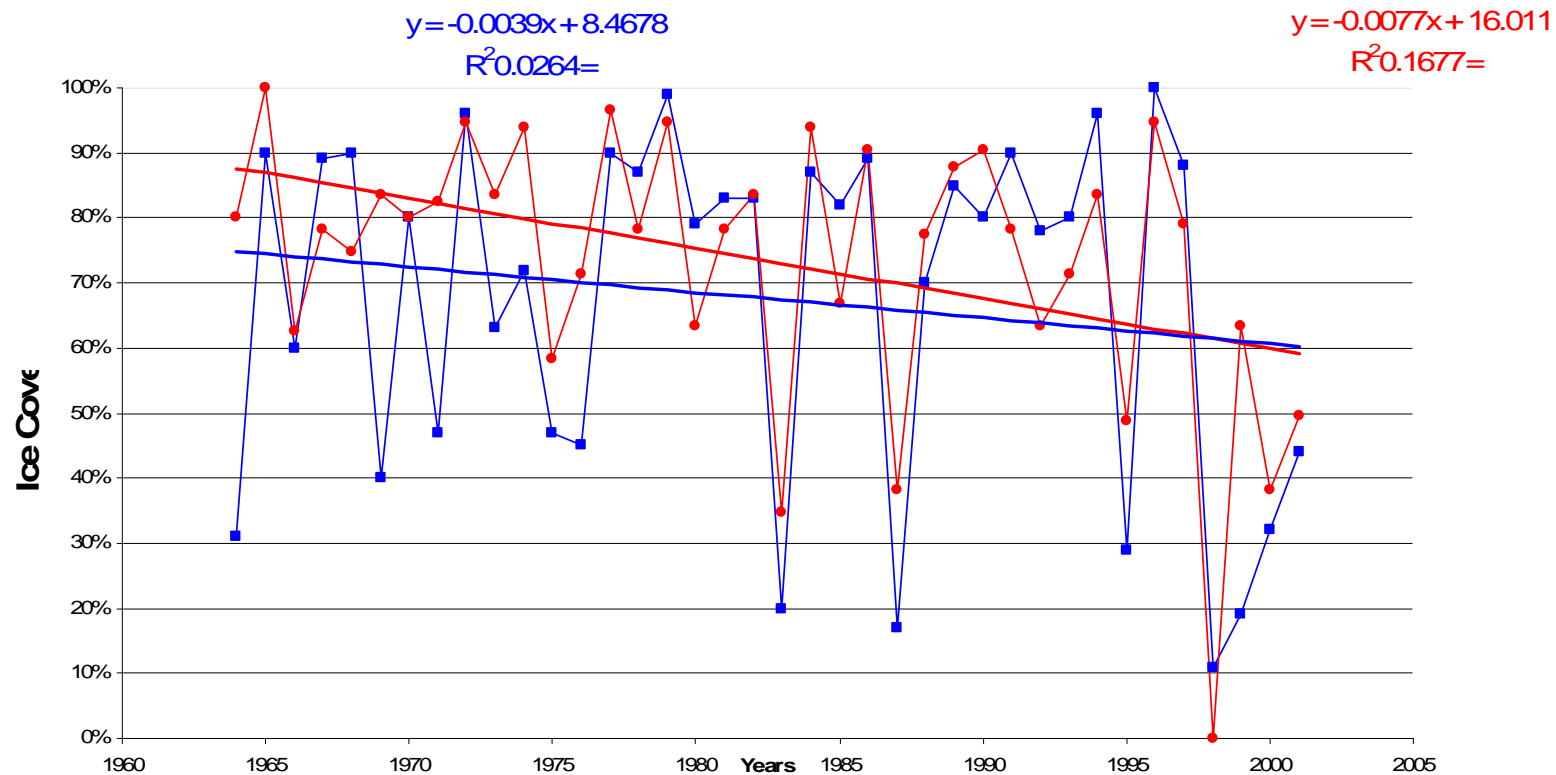


March, 2010

Historical satellite data were used to measure ice cover in the Great Lakes from 1973 to 2010. There was a significant downward trend in ice coverage for all of the lakes. The total loss for overall Great Lakes ice coverage is 71%, while Lake Superior showed a 79% decrease in ice cover from 1973 to 2010.

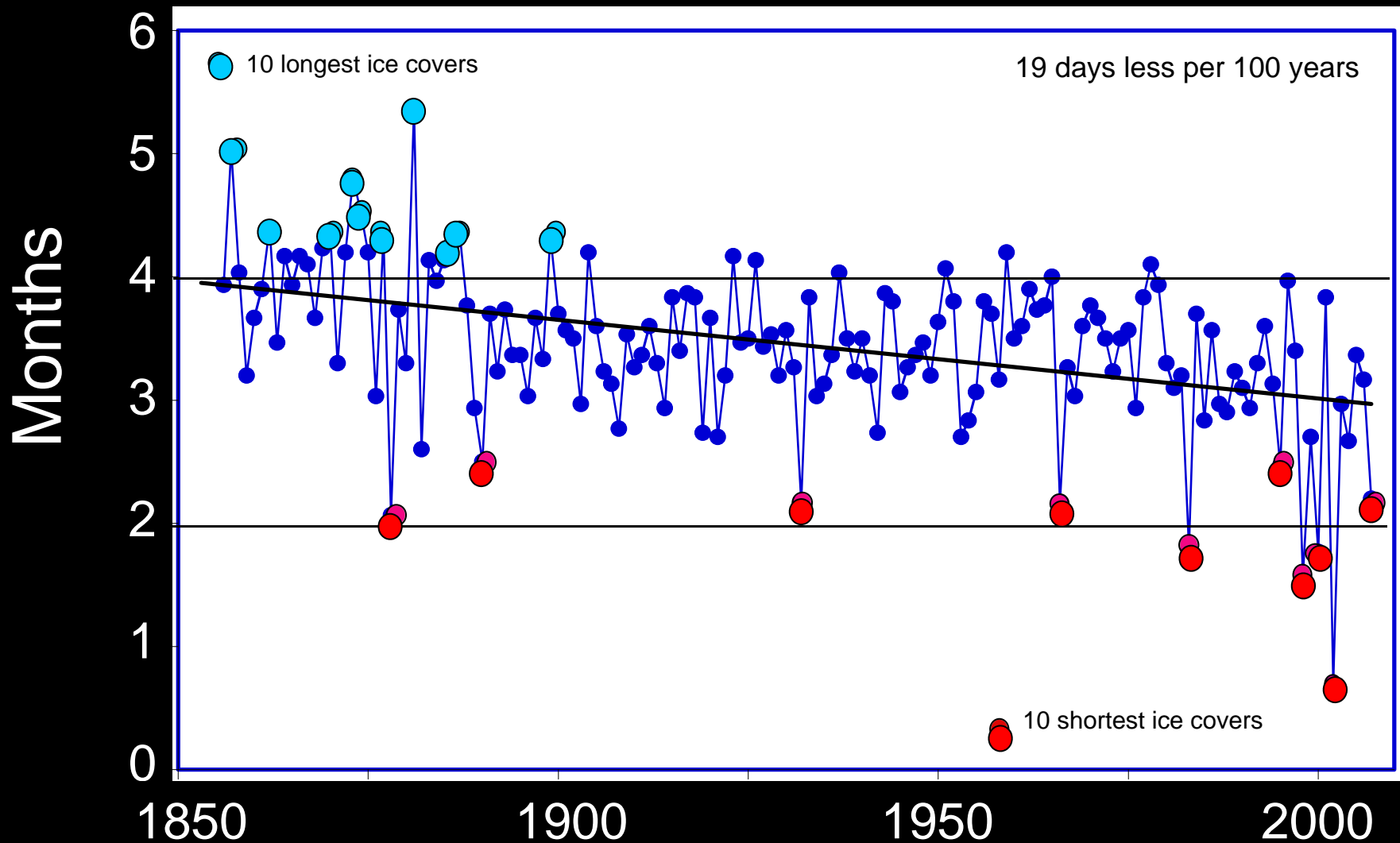
- (Wang et. al., 15 Feb., 2012, Journal of Climate)

AMIC vs. Bayfield



AMIC - Annual Maximum Ice Cover on Lake Superior
(Data from Assel, Cronk, & Norton, 2003)
Bayfield - % of Ice Season with Ice Cover

Ice Duration on Lake Mendota



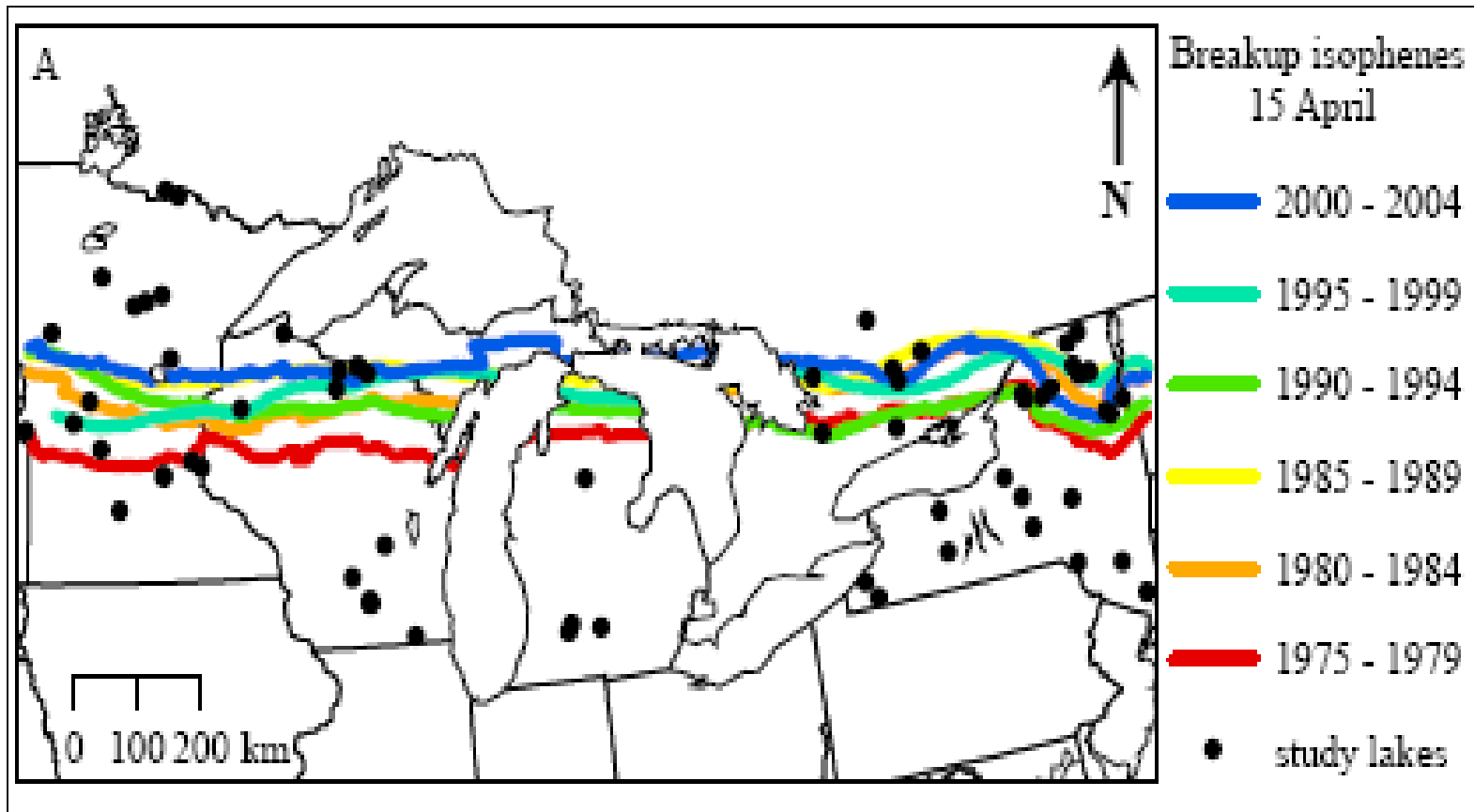
Changes around the Northern Hemisphere

(36-37 of the 39 time series
are in the direction
of warming)



Source: IPCC 3rd Assessment 2001 Modified from Magnuson et al. 2000

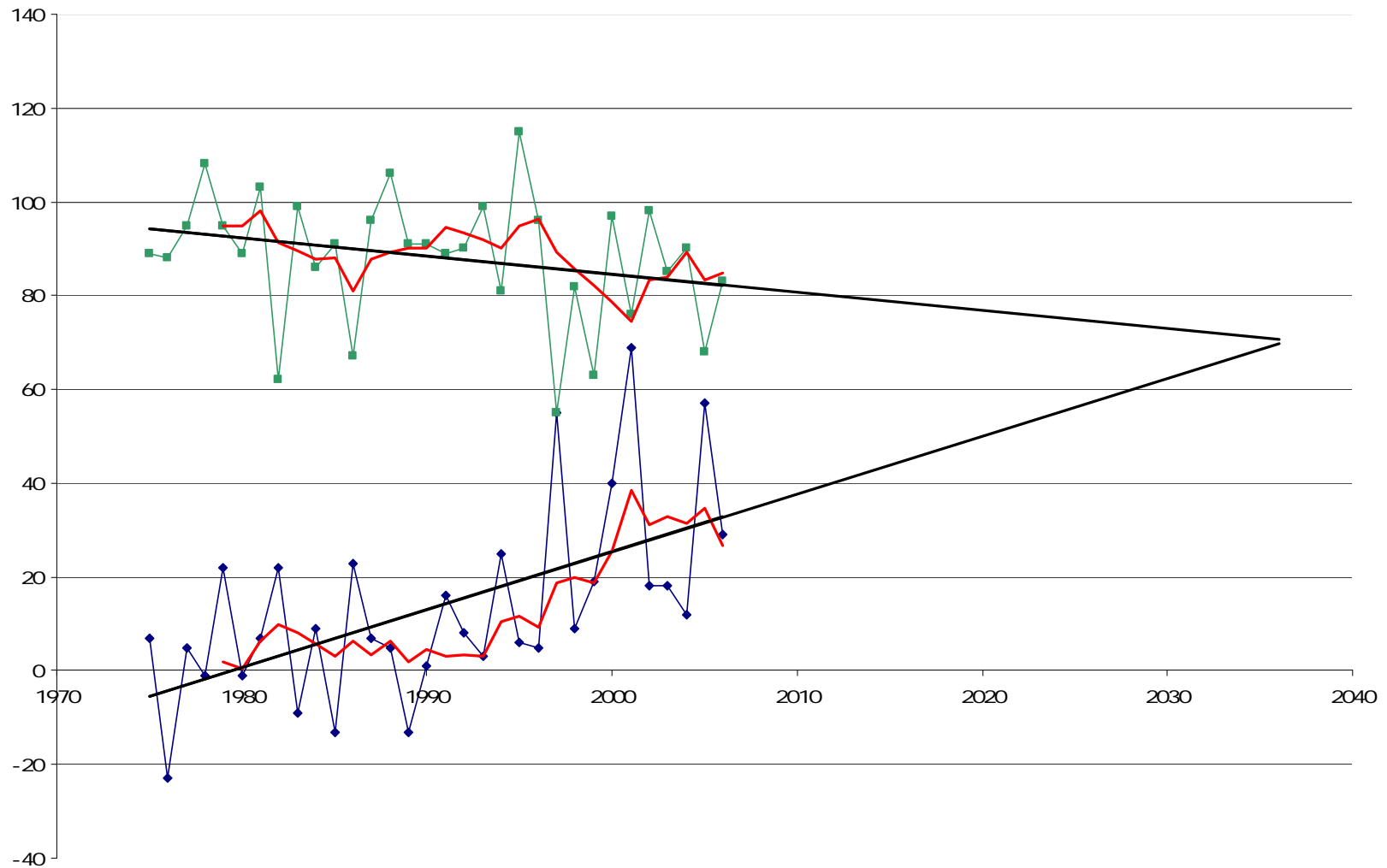
The April 15 Ice Out Line is Moving North



Jenson, Benson, Magnuson et al. In press

If the 30 year trend continues...

Opening and Closing of Navigation of Bayfield Harbor since 1975



What will winter in Bayfield mean?

- Less ice road?
- More wind sled?
- Longer navigation season?



What will winter in Bayfield mean?

1765 - 126 days of ice

2006 - 54 days of ice



2036 - 0 days ?



The End of Winter As We've Known It ?

