## Shell Lake's Ice 1905 - 2022



Sunrising Over Shell Lake on December 19, 2022, minus 6 F, Photo Courtesy of Jim Ahasay

Ice Activity	Day(s) of Year	Date(s) of Year
Average Freeze Day	336	12/02
Earliest Freeze Day	308	11/04/1950
Latest Freeze Day	356	12/22/1998
Average Thaw Day	110	4/20
Earliest Thaw Day	84	3/24/2012
Latest Thaw Day	132	05/11/1928
Average Freeze Duration Days	139	12/2 - 4/20
Shortest Freeze Duration Days	99	12/16/2011 - 3/24/2012
Longest Freeze Duration Days	178	11/04/1950 - 5/01/1951

Figure 4: Summary of Shell Lake Ice Freeze and Thaw Dates 2000 - 2022			
Ice Activity	Day(s) of Year	Date(s) of Year	
Average Freeze Day	340	12/06	
Earliest Freeze Day	327	11/23/2022	
Latest Freeze Day	354	12/20/2015	
Average Thaw Day	108	4/18	
Earliest Thaw Day	84	3/24/2012	
Latest Thaw Day	131	5/11/2013	
Average Freeze Duration Days	132	12/6 - 4/18	
Shortest Freeze Duration Days	99	- 12/16/2011 3/24/2012	
Longest Freeze Duration Days	157	- 11/28/2013 5/4/2014	

Shell Lake's Ice Freeze and Thaw Dates 1905 - 2022 Compared to 2000 - 2022

### Preface

Before and during the early 20th century monitoring and recording the dates of when Shell Lake freezes for the winter and thaws in the spring was likely of more interest than it is today. Back then the date of ice breakup meant logs could soon be collected into booms and driven in the open water to Shell Lake's enormous lumber mill for processing after being dumped into the bay by the Crescent Springs's narrow gauge railroad. The date of ice freeze meant new jobs from a burgeoning ice industry involving cutting, hauling and shipping of ice for local use and export to distant cities by the nearby Chicago, St. Paul, Minneapolis & Omaha Railroad.

Stephen S. Hoar, a local businessman and an agent for the Pabst Brewing company is reported to be the first to cut Shell Lake's ice for commercial purposes. In 1915 William Jacobs took over Hoar's ice railroad contracts. It is reported that Jacobs's ice crew worked around the clock. At times loading thirty cars or more every 24 hours and they shipped 1,800 carloads or 72,000 tons of ice from Shell Lake during the warm winter of 1918 - 1919. The railroad even furnished Jacobs's ice business with a locomotive switch engine to spot cars for loading and sequencing. Representatives from different railroads frequented the ice operation to ensure their requisition of Shell Lake's clear, clean and tasteless ice. The ice crews pushed their operations into the warmer days of spring that at times caused their saws to drop through the melting ice. (Stouffer and Washburn County Historical Society 1961. P. 5: Washburn County Historical Scrapbook Committee et al. 1977, P.21; Kohlin 2022)

Today the lake's freeze up and thaw dates are not only monitored for their influence on winter sports i.e. ice fishing, snowmobiling, cross country skiing, ice boating, skating, ice hiking etc. but are also being recorded and examined with data from other North American lakes as an indicator of climate change. The narrative and figures that follow analyze these records and the findings made from Shell Lake's historically valuable ice records.



Figure 1: William Jacobs's ice house on Shell Lake in 1908. His ice business shipped 1,800 rail cars of ice during the warm winter of 1918 - 1919.

### **117 Years of Ice Records**

The Washburn County Clerk's office has been keeping records of Shell Lake's ice freeze and thaw dates since 1905 and the National Snow and Ice Center has ice thaw dates for the years 1892, 1893 and 1894. Figure 2 on the following page reports the ice freeze, thaw and freeze duration dates for the 117 year period starting on November 30, 1905 through November 23, 2022. However ice freeze dates were not recorded for 1968, 1969, 1970 and 1979. Thus the period of freeze duration was not calculated for these four years. The following are the results of separately analyzing the freeze dates, thaw dates, and the paired freeze to thaw duration periods beginning in 1905.

1905 - 2022 Freeze Dates The average day of the year the lake freezes is day 336 which is December 2nd or December 1st during a leap year. The earliest day of the year the lake froze was day 308 on November 4, 1950. The Latest day of the year the lake froze was day 356 on December 22, 1998. The day of the year the lake most frequently freezes is day 336, the same as the average. The lake froze on this day eight times: 1934, 1949, 1954, 1957, 1960, 1983, 2001 and 2019. All these days were on December 2nd with the exception of the 1960 leap year when the freeze occurred on December 1st, See Figure 2. A summary of the Lake's Historical freeze dates are summarized in Figure 3. A scatter chart is shown in Figure 6, with a calculated trendline showing how the lake is gradually freezing later in the year.

Freeze Date	Thaw Date	Days Frozen	Freeze Date	Thaw Date	Days Frozen	Freeze Date	Thaw Date	Days Frozen
11/30/1905	4/20/1906	141	11/25/1945	4/3/1946	129	12/4/1984	4/20/1985	137
12/3/1906	5/5/1907	153	11/25/1946	4/29/1947	155	11/25/1985	4/13/1986	139
12/1/1907	4/17/1908	138	11/26/1947	4/18/1948	144	11/29/1986	4/10/1987	132
12/5/1908	5/11/1909	157	12/7/1948	4/17/1949	131	12/17/1987	4/14/1988	119
12/7/1909	3/27/1910	110	12/2/1949	5/9/1950	158	12/7/1988	4/25/1989	139
11/28/1910	4/18/1911	141	11/4/1950	5/1/1951	178	11/23/1989	4/19/1990	147
11/16/1911	4/15/1912	151	11/18/1951	<b>4/26/195</b> 2	160	12/11/1990	4/17/1991	127
12/8/1912	4/23/1913	136	11/19/1952	4/16/1953	148	11/26/1991	<b>4/28/199</b> 2	154
12/18/1913	4/25/1914	128	12/10/1953	4/20/1954	131	12/6/1992	4/24/1993	139
12/18/1914	4/21/1915	124	12/2/1954	4/17/1955	136	11/28/1993	4/18/1994	141
12/18/1915	4/21/1916	125	11/19/1955	4/24/1956	157	12/6/1994	4/27/1995	142
11/25/1916	5/5/1917	161	12/8/1956	4/24/1957	137	11/22/1995	5/4/1996	164
12/4/1917	4/22/1918	139	12/2/1957	4/16/1958	135	11/24/1996	4/24/1997	151
12/6/1918	4/19/1919	134	11/30/1958	4/23/1959	144	11/24/1997	4/6/1998	133
11/26/1919	4/25/1920	151	11/18/1959	<b>4/18/196</b> 0	152	12/22/1998	4/13/1999	112
12/17/1920	4/6/1921	110	12/1/1960	4/21/1961	141	12/17/1999	4/27/2000	132
12/6/1921	4/28/1922	143	12/8/1961	4/19/1962	132	12/2/2000	4/21/2001	140
12/6/1922	5/2/1923	147	12/10/1962	4/16/1963	127	12/2/2001	4/18/2002	137
12/5/1923	4/26/1924	143	12/11/1963	4/22/1964	133	12/3/2002	4/20/2003	138
11/29/1924	4/12/1925	134	11/29/1964	5/6/1965	158	12/1/2003	4/19/2004	140
11/24/1925	4/24/1926	151	12/3/1965	4/24/1966	142	12/14/2004	4/14/2005	121
11/21/1926	4/14/1927	144	12/1/1966	4/15/1967	135	12/4/2005	4/12/2006	129
12/1/1927	5/11/1928	162	11/28/1967	4/8/1968	132	12/5/2006	4/16/2007	132
12/5/1928	4/7/1929	123	NA	4/20/1969	NA	11/30/2007	5/2/2008	154
11/24/1929	4/12/1930	139	NA	4/22/1970	NA	12/7/2008	4/15/2009	129
11/28/1930	4/11/1931	134	NA	4/20/1971	NA	12/12/2009	4/2/2010	111
12/7/1931	4/22/1932	137	12/1/1971	4/30/1972	151	12/3/2010	4/20/2011	138
11/16/1932	4/23/1933	158	12/2/1972	4/13/1973	132	12/16/2011	3/24/2012	99
11/5/1933	4/25/1934	171	12/10/1973	4/26/1974	137	12/11/2012	5/11/2013	151
12/2/1934	4/22/1935	141	12/3/1974	4/29/1975	147	11/28/2013	5/4/2014	157
11/22/1935	5/1/1936	161	12/1/1975	4/14/1976	135	11/24/2014	4/7/2015	134
11/25/1936	4/26/1937	152	11/26/1976	4/13/1977	138	12/20/2015	<b>4/1/201</b> 6	103
11/22/1937	4/11/1938	140	11/24/1977	4/14/1978	141	12/12/2016	4/1/2017	110
11/23/1938	4/25/1939	153	11/22/1978	4/24/1979	153	12/10/2017	5/6/2018	147
12/14/1939	4/30/1940	138	NA	<b>4/22/198</b> 0	NA	11/29/2018	4/25/2019	147
11/28/1940	4/14/1941	137	12/3/1980	4/11/1981	129	12/2/2019	4/18/2020	138
12/10/1941	4/17/1942	128	12/11/1981	4/25/1982	135	12/18/2020	4/3/2021	106
11/28/1942	4/24/1943	147	12/8/1982	4/28/1983	141	12/5/2021	4/29/2022	145
11/20/1943	4/25/1944	157	12/2/1983	4/18/1984	138	11/23/2022	NA	NA

Figure 2, Shell Lake Ice Freeze, Thaw and Freeze Duration Dates 1905 - 2022

Dates in bold type are leap years. *[Washburn County Clerk 1905 - 2022;* National Snow & Ice Data Center and Lake Ice Analysis Group (LIAG) 2022, LIAG also had these late 1800 thaw dates for Shell Lake as well: 4/221892, 5/10/1893 and 4/19/1894 these dates are included in Figure 6 only]

1905 - 2022 Thaw Dates The average day of the year the lake thaws is day 110 which is April 20th or April 19th during a leap year. The earliest day of the year the lake thawed was day 84 which was March 24th, 2012, a leap year that would have been March 25th during a regular year. The latest day of the year the lake thawed was day 132 on May 11th, 1928, a leap year that would have been May 12 during a regular year. The day of the year the lake most frequently thaws is day 110 the same as the average. The lake thawed on this day eight times: 1906, 1954, 1969, 1971, 1985, 2003, 2004 and 2011. All these days were on April 20th with the exception of the 2004 leap year when the thaw occurred on April 19th, see Figure 2. A summary of the lake's thaw dates are shown in Figure 3 . A scatter chart illustrating these ice thaw dates is shown in Figure 6 with a calculated trendline showing how the lake is gradually thawing later in the year.

1905 - 2022 Freeze Duration Dates The average number of days the lake is frozen is 139 days. The greatest number of days the lake was frozen was 178, this occurred during the period of November

Figure 3: Summary of Shell Lake Ice Freeze and Thaw Dates 1905 - 2022				
Ice Activity	Day(s) of Year	Date(s) of Year		
Average Freeze Day	336	12/02		
Earliest Freeze Day	308	11/04/1950		
Latest Freeze Day	356	12/22/1998		
Average Thaw Day	110	4/20		
Earliest Thaw Day	84	3/24/2012		
Latest Thaw Day	132	05/11/1928		
Average Freeze Duration Days	139	12/2 - 4/20		
Shortest Freeze Duration Days	99	12/16/2011 - 3/24/2012		
Longest Freeze Duration Days	178	- 11/04/1950 5/01/1951		

4th 1950 to May 1st 1951. The least number of days the lake was frozen was 99 from freeze up on December 16th 2011 until the ice thaw on March 24th 2012. The most frequent period for the lake being frozen was 141 days this occurred seven times: | Nov. 30, 1905 - Apr. 20, 1906 | Nov. 28,1910 - Apr. 18 1911 | Dec. 2 1934 - Apr. 22 1935 | Dec. 1, 1960 - Apr. 21 1961 | Nov. 24 1977 - Apr. 14 1978 | Dec. 8, 1982 - Apr. 28 1983 | and Nov. 28 1993 - Apr. 18 1994| see Figure 2. A summary of the historical freeze duration periods are shown in Figure 3. All the historical data on ice freeze periods are presented on a scatter chart in Figure 7 with a calculated trendline showing how the number of lake freeze duration days are decreasing as time goes on.

### 21st Century Freeze and Thaw Dates

For purposes of concentrating on current ice freeze and thaw trends, more recent data for the period of 2000 - 2022 only are presented in Figures 4 and 5 and compared with 1905 - 2022 freeze and thaw data below.

Figure 4: Summary of Shell Lake Ice Freeze and Thaw Dates 2000 - 2022				
Ice Activity	Day(s) of Year	Date(s) of Year		
Average Freeze Day	340	12/06		
Earliest Freeze Day	327	11/23/2022		
Latest Freeze Day	354	12/20/2015		
Average Thaw Day	108	4/18		
Earliest Thaw Day	84	3/24/2012		
Latest Thaw Day	131	5/11/2013		
Average Freeze Duration Days	132	12/6 - 4/18		
Shortest Freeze Duration Days	99	12/16/2011 - 3/24/2012		
Longest Freeze Duration Days	157	- 11/28/2013 5/4/2014		

2000 - 2022 Freeze Dates From 2000 to 2022 the average freeze is day 340 or December 6th, see Figure 4. This is four days later than day 336, the December 2nd average freeze date, encompassing all years from 1905 to 2022 shown in Figure 3. The earliest freeze date was on day 327 or November 23, 2022, 19 days later than the November 4, 1950 early freeze date during the 1905 - 2022 period. The latest freeze occurred on day 354, or December 20 2015, two days earlier than the latest freeze date of December 22, 1998 or day 356 during the period from 1905-to 2022, see Figures 4 and 5.

<u>2000 - 2022 Thaw Dates</u> From 2000 to 2022 the average thaw day is day 108 or April 18th, see Figure 4. This is two days earlier than day 110, or April 20th covering all thaw dates from 1905 through 2022 shown in Figure 3. The earliest thaw date was day 84 or March 24, 2012. The latest thaw date was day 131 on May 11 2013, one day earlier than day 132 that occurred on May 11, 1928, a leap year during 1905 - 2022 period, see Figures 4 and 5.

2000 - 2022 Freeze Duration Dates From 2000 to 2022 the average freeze duration period was 132 days with the average freeze duration dates running from December 6th to April 18th, see Figure 4. This is seven days less than the 139 freeze duration days covering all years from 1905 through 2022 shown in Figure 3. The shortest 21st Century freeze duration period was 99 days from December 16, 2011 to March 24, 2012, the same as the entire period from 1905 - 2022. The longest freeze duration period was 157 days from November 28th 2013 to May 4th 2014, see Figure 4. This was 21 days shorter than the 178 day average frozen duration period from 1905 to 2022, See Figures 3, 4, 5.

Figure 5: All Shell Lake Ice Freeze and Thaw Data 2000 - 2022				
Freeze Date	Freeze Day of Year	Thaw Date	Thaw Day of Year	Freeze Duration Days
12/17/1999	351	4/27/2000	118	132
12/2/2000	337	4/21/2001	111	140
12/2/2001	336	4/18/2002	108	137
12/3/2002	337	4/20/2003	110	138
12/1/2003	335	4/19/2004	110	140
12/14/2004	349	4/14/2005	104	121
12/4/2005	338	4/12/2006	102	129
12/5/2006	339	4/16/2007	106	132
11/30/2007	334	5/2/2008	123	154
12/7/2008	342	4/15/2009	105	129
12/12/2009	346	4/2/2010	92	111
12/3/2010	337	4/20/2011	110	138
12/16/2011	350	3/24/2012	84	99
12/11/2012	346	5/11/2013	131	151
11/28/2013	332	5/4/2014	124	157
11/24/2014	328	4/7/2015	97	134
12/20/2015	354	4/1/2016	92	103
12/12/2016	347	4/1/2017	91	110
12/10/2017	344	5/6/2018	126	147
11/29/2018	333	4/25/2019	115	147
12/2/2019	336	4/18/2020	109	138
12/18/2020	353	4/3/2021	93	106
12/5/2021	335	4/29/2022	119	145
11/23/2022	327	NA	NA	NA
Average of the above				
12/06	340	4/18	108.0	132

т





Years



### Annual Number of Days Lake Frozen and Trendline

Figure 7: Number of Days Shell Lake Frozen, 1905 - 2022

Dates Lake Frozen, 1905 - 2022

#### Less Icing on the Lake

It is apparent from analyzing the historical ice freeze, thaw and freeze duration dates that the number of days Shell Lake remains frozen is gradually decreasing. The freeze up days are mostly moving later into December and thaw days are mostly moving earlier into April. This trend and its impacts are examined in conjunction with other North American lakes by the U.S. Environmental Protection Agency and other organizations.

### U.S. Environmental Protection Agency's Climate Change Indicator Report

The longevity and consistent recording of Shell Lake's ice freeze and thaw dates by Washburn County Clerks since 1905 resulted in this data being requested for inclusion in a report titled: *"Climate Change Indicators in the United States: Lake Ice".* The U.S. Environmental Protection Agency used data from 14 lakes that had the longest and most complete ice records. What follows is a summary of the findings of this report covering these lakes in the states of Minnesota, Wisconsin, New York and Maine.

The formation and breakup of ice cover on lakes is influenced primarily by air temperature, cloud cover, and wind; making ice formation and breakup dates good indicators of climate change. Longer periods of ice freeze signifies a cooling climate and shorter periods suggest a warming climate. A declining freeze duration period on lakes leads to increased evaporation, lower water levels, higher sunlight penetration and higher water temperatures. These changes can affect the availability of suitable habitats for established

aquatic and terrestrial plants and animals. Shorter ice duration periods also influence a community in regards to lifestyle opportunities for resident and tourist participation in winter sports such as ice fishing, snowmobiling, cross country skiing, ice boating, skating, ice hiking etc.

North American Lakes Freeze Dates The graph in Figure 8 below shows the dates of first freeze for nine U.S. lakes including Shell Lake. The four lakes in the state of Maine and Lake Osakis only had records for ice thaw, so they are not included in Figure 8. The dates reported are available from 1850 to 2019 depending on the lake, with the data being smoothed using a nine year average. These Lakes are generally freezing later than they did in the past. Freeze dates have moved later at a rate of about half a day to one-and-a-half days per decade. The dots on the graph in Figure 8 follow the freeze date trendline for Shell Lake. (United States Environmental Protection Agency and Washburn County Clerk and Other Organizations Updated April 2021)



Figure 8: Date of First Freeze for Shell Lake and 8 Other Lakes 1850 - 2019 Source: https://www.epa.gov/climate-indicators/climate-change-indicators-lake-ice

North American Lakes Thaw Dates The graph in Figure 9 below shows the dates of ice thawing and breakup for 14 U.S. lakes including Shell Lake. The dates reported are available from 1840 to 2019 depending on the lake, with the data being smoothed using a nine year average. Thaw dates for most lakes indicate a trend toward earlier ice break up in the spring. Thaw dates in the spring are decreasing by up to 24 days in the past 114 years. All the lakes but two were determined to be thawing earlier in the year. The dots on the graph in Figure 9 follow the thaw date trendline for Shell Lake. (United States Environmental Protection Agency and Washburn County Clerk and Other Organizations Updated April 2021)





Source: https://www.epa.gov/climate-indicators/climate-change-indicators-lake-ice

NorthAmerican Lakes Thaw Date Change | The map shown in Figure 10 below reports the change in ice-off or ice thawing and breakup dates, for 14 U.S. lakes including Shell Lake for the period from 1905 to 2019. *Twelve of the 14 lakes had earlier thaw dates including Shell Lake at -6 days.* Larger circles indicate larger changes. (United States Environmental Protection Agency, Washburn County Clerk and Other Organizations. Updated April 2021)

The changes in lake freeze and thaw dates described here are consistent with other studies. For example, long-term ice data from lakes and rivers throughout the Northern Hemisphere reveal that since the mid-1800s, freeze dates have occurred later and thaw dates have occurred earlier, both shifting at an average rate of 0.8 days to one day per decade. (*Benson et al. 2012, P. 299-323*)



Figure 10: Shell Lake and Other U.S. Lakes Ice Thaw Date Change 1905 - 2019

Source: https://www.epa.gov/climate-indicators/climate-change-indicators-lake-ice

# The Environmental Protection Agency's Lake Ice Freeze and Thaw Indicator Sources

Data used for Ice Freeze and thaw dates for the 14 lakes are all based on visual observations. While the procedures for making observations of lake ice are consistent over time, visual observations by individuals are open to some interpretation and can differ from one individual to the next. In addition, historical observations for lakes have typically been made from a particular spot on the shore, which might not be representative of lakes as a whole or comparable to satellite-based observations. Considerations for defining the thaw date are specific to each lake. Data through 2004 for most lakes were obtained from the Global Lake and River Ice Phenology Database, which is maintained by the National Snow and Ice Data Center. Historical and more recent sources were obtained from state, local, and other organizations that collected or compiled the observations. These data are at: https://nsidc.org/data/lake\_river\_ice. (National Snow & Ice Data Center and Lake Ice Analysis Group (LIAG) 2022)

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