

ICE OCCURENCE ON KANGAROO LAKE

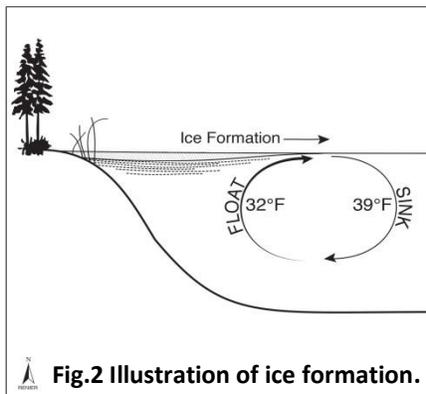
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Ice occurrence on Kangaroo Lake has been an important event to local residents for many years. Yet, there are no known past records of this event. In early years of settlement, the frozen lake provided for recreational and ice fishing activity. Commercial interest focused on cutting ice blocks to fill ice-boxes of residents during summer months. Ice from this lake was superior in that it was clearer and denser than that from Lake Michigan. Ice blocks from the lake, cut near the causeway or south end, were covered with sawdust and stored in ice sheds. It was then delivered and sold to area residents for use in ice-boxes during the summers until the mid-1940s because new electricity installations were limited during World War II.

Observers certainly noted that the fall/winter date for lake freezing differed each year. The freezing phenomenon raised questions about which local climatic conditions contributed to ice formation on a lake. These questions prompted Paul Mahlberg and the late Walter Schoof to initiate the current long-term study on dating yearly freezing (ice-on), thawing (ice-off) and ice-duration patterns for Kangaroo Lake. This report includes observations for ice-on during the 16-year period from 1999 to 2014 (Fig. 1).

Procedures. Kangaroo Lake is a rather large lake of 1,122.5 acres (without the island) with a 6,000-acre watershed. Piel Creek is a major water source for the lake, while it flows out over the dam into Heins Creek. For this study, the lake is recognized as frozen (ice-on date) on the day that both the north and south lobes of the lake become ice covered. Observations are made over a period of days to determine the day upon which ice covers the lake. The lake is checked from several vantage points, including our shore area, the causeway, O'Brien Road and the boat launch sites, to identify the day of freezing.

Not included in the freezing calculation are small areas of open water adjacent to each causeway culvert where swift flowing water, originating from Piel Creek, can delay freezing in their vicinity for a period of time. Open water also occurs in front of the dam while water flows over its crest. These unfrozen areas will occur during a year of unusually high water in the fall, but will freeze upon a decrease in the water flow-rate through the culverts.



Commentary. Ice first forms along the shoreline, where one can watch ice crystals form and progressively creep outwardly from the shallow water. Water is unique in that its greatest density occurs at 39°F / 4°C. As temperature decreases water expands, becoming least dense at 32°F / 0°C. This density difference results in rapid cycling of water near shore, where a column of water quickly cycles from its greatest density at 39° F to its least dense form at 32° F and floats to the lake surface, where it freezes. Ice once frozen can transfer heat and can become colder than 32° F. Thus, a water layer immediately under floating ice can become chilled to 32° F and freeze, thereby contributing to thickening of the ice sheet (Fig. 2).

In deeper water, the cycling water results in the cooled, densest water (39° F) at the water surface, sinking to the lake bottom to replace less dense water, which is progressively moved upward until the temperature in the uppermost less dense layer becomes 32° F, and freezes. Thus, there is a continuum of temperature differences between the ice and the 39° F temperature of water at the lake bottom in sufficiently deep lakes. Continued freezing temperatures of the air will thicken the ice on its underside. Kangaroo Lake ice can thicken to several feet, as ice fishermen can tell us, but the lake does not freeze to its bottom. Fish utilize oxygen in the water or fresh oxygen derived from new water entering the lake via Piel Creek and springs.

During the 16-year period, we observed the lake to freeze either in November or December (Table 1). The earliest date was November 22 and latest date was December 24. Thus, a spread of 33 days occurred between the earliest and latest dates for lake freezing. This point is interesting, in that if we could correlate local November and December temperatures, we may be able to detect a correlation for identifying a window of time for the freezing date for Kangaroo Lake.

Studies on lake freezing report that air temperature is the dominant variable driving the freezing process. A specific example occurred here in 2006-2007. Several weeks after the lake froze on December 4, 2006, the air temperature began to rise above freezing. This resulted in a partial opening of the lake on January 4 and an almost complete re-opening by January 6, 2007. Upon subsequent chilling of the air temperature below freezing, the lake refroze on January 12, 2007 for the remainder of the winter season.

An initial interpretation of the graph data indicates a slight cooling trend for freezing of the lake during the 16-year period (Figure 1, diagonal line). Cooler temperatures occurred for nine of the years, compared to only seven years for warmer temperatures. This trend contrasts with current broad-based studies from many lakes that show a warming trend, or later appearance of ice on lakes. Long-term studies (150 years) of south-central Wisconsin lakes, Mendota and Monona, show a trend for progressively later ice cover and shorter ice duration on the lake that indicates a trend toward atmospheric warming.

We recognize that additional years of data, perhaps ten years, are necessary before trends observed from Kangaroo Lake data can become meaningful. However, the possible significance of the current data--the slight cooling effect--may reflect the location of Kangaroo Lake adjacent to the larger Lake Michigan. Our lake may reflect a microclimate of a stable or cooling temperature pattern for Door County brought on by proximity to Lake Michigan, in contrast to lakes distant from Lake Michigan. That is, could our area, and Door County, lag other areas of the state in any trend toward global climate change? A long-term study of our lake ice, compared to inland Wisconsin lakes, could test this question and, thus, be of particular long-range interest.

TABLE 1. Freezing dates of lake.

Year	Month	Day
1999	December	10
2000	December	22
2001	December	24
2002	December	1
2003	December	3
2004	December	14
2005	November	24
2006	December	4
2007	November	26
2008	November	22
2009	December	7
2010	December	9
2011	December	27
2012	December	24
2013	November	24
2014	November	26

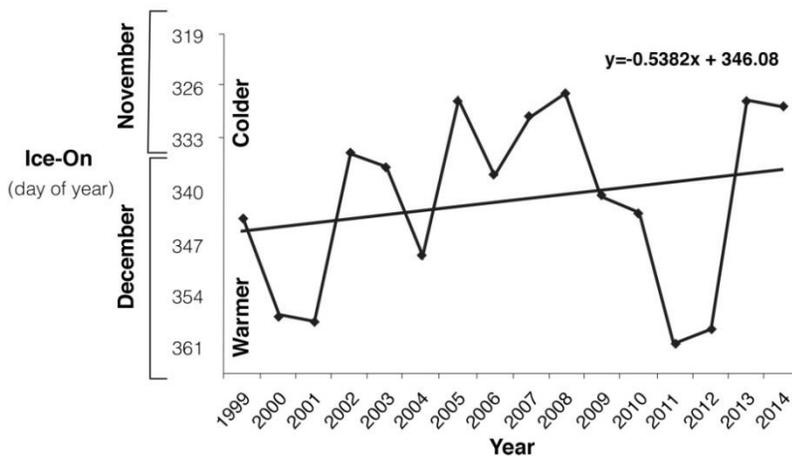


Fig. 1 Yearly Date for Freezing on Kangaroo Lake.

The greatest divergence in temperatures occurred recently, during the period December 2011 (27° F) to November 2013 (24° F). This phenomenon suggests a possible increase in temperature divergence between years in our up-coming climate period. Will this trend for fall temperatures continue here at our lake, and even escalate, in future years? This is a pertinent point to examine and evaluate in our future studies.

Our studies also include the timing of the spring ice break-up and total ice duration on the lake. These aspects will be reported in future articles. Perhaps, too, we might design a yearly competition for us to hypothesize the freezing date for ice-on. If you wish to participate in these studies contact the authors or our president.