Climate Trends at Voyageurs National Park

- We monitor weather and climate using existing weather stations in or near Network parks. Summaries presented here represent precipitation and temperature data collected by weather stations in International Falls and Littlefork, MN.
- Data are collated on the website www.ClimateAnalyzer.org and were summarized here through an agreement with the website's creator.

Comparing Recent Years to a 30-Year Reference Period

Typically, when a weather report states that a particular month was warmer or cooler than "average," it is making a comparison to a set of averages calculated over an agreed upon time period. These average are known as "climatological normals" and are updated every 10 years by the National Oceanic and Atmospheric Administration (NOAA). They are not simple averages or totals, but instead have been corrected for missing values and other irregularities.

The most recent normals available for International Falls were calculated for the period 1971–2000 (Figure 1). They reveal that more than half (56%) of a year's total precipitation typically falls between June and September (about 24 inches annually; Figure 1a), and that July, the hottest month, has average daily maximum temperatures (Tmax) of 79 degrees Fahrenheit (°F) and average daily minimum temperatures (Tmin) of 54 °F (Figure 1a).

During the first six months of 2012, temperatures at the Littlefork, MN, automated station (Figure 1b, red lines) were generally above temperatures recorded during 2003–2011 (the period of record) at that station (Figure 1b, gray lines). Average Tmax during July at Littlefork (the hottest month) was 84 °F and Tmin was 59 °F. In contrast, during the second half of 2012, temperatures at Littlefork were generally cooler than in past years. Tmax

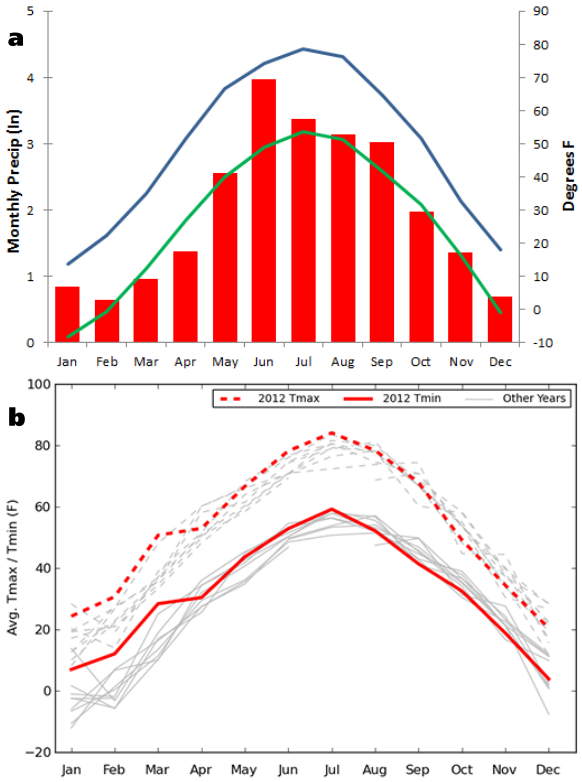

Figure 1. (**a**) Official temperature and precipitation averages at International Falls, MN, 1971–2000. Red bars = precipitation. Blue Line = Tmax, Green Line = Tmin. (**b**) Average temperatures during 2012 (red lines) at Littlefork, MN, automated station compared to 2003–2011 (gray lines).

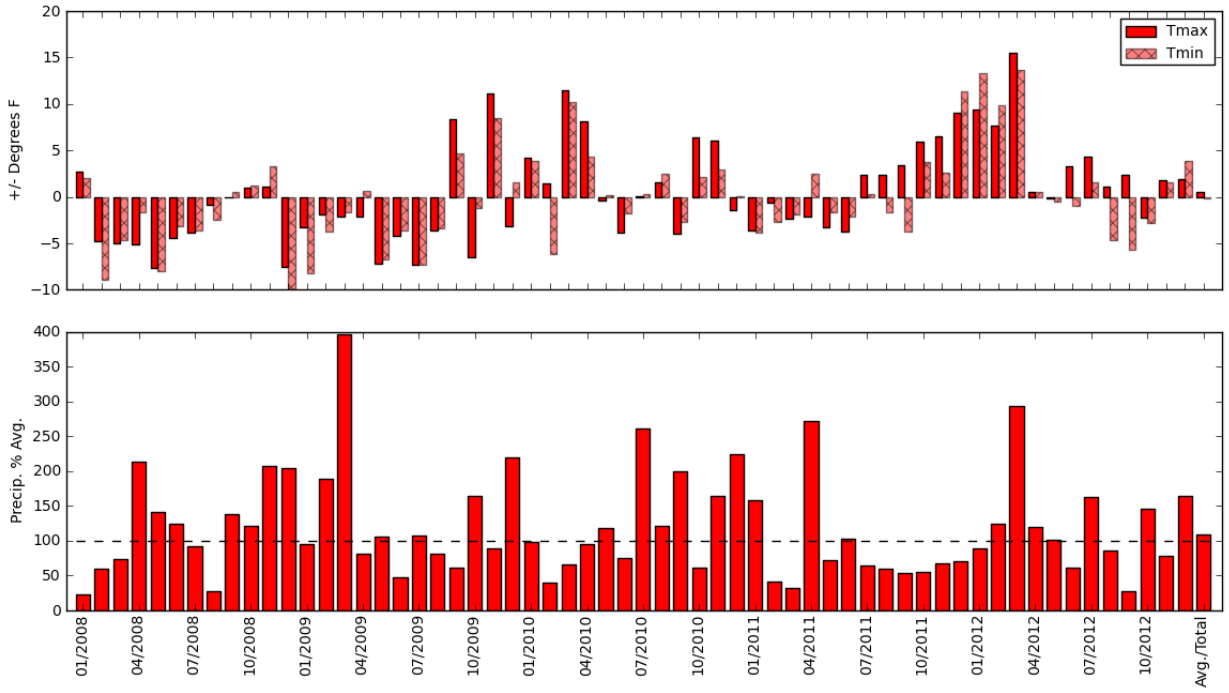

Figure 2. Monthly departures of 2008-2012 temperature and precipitation from the 30-year baseline averages, as recorded the International Falls, MN, weather station. The right-most column shows the overall departures for the five-year period.

during December, the coldest month, was 20 °F and Tmin was 4 °F.

Using these 30-year averages as a baseline for comparison, we see that the average temperature during the last four years (2008–2012) was very near to the baseline (less than 1 degree above); the average amount of precipitation was also just slightly above the baseline (110%) (Figure 2). If we narrow the analysis period down to the five months of September 2011 – March 2012, we see the climate in that period was warmer and wetter compared to the baseline. Average temperatures were consistently higher, with Tmax during March 2012 more than 15 degrees above the baseline. March 2012 also had nearly 300% average precipitation (Figure 2). In other words, Spring was starting earlier.

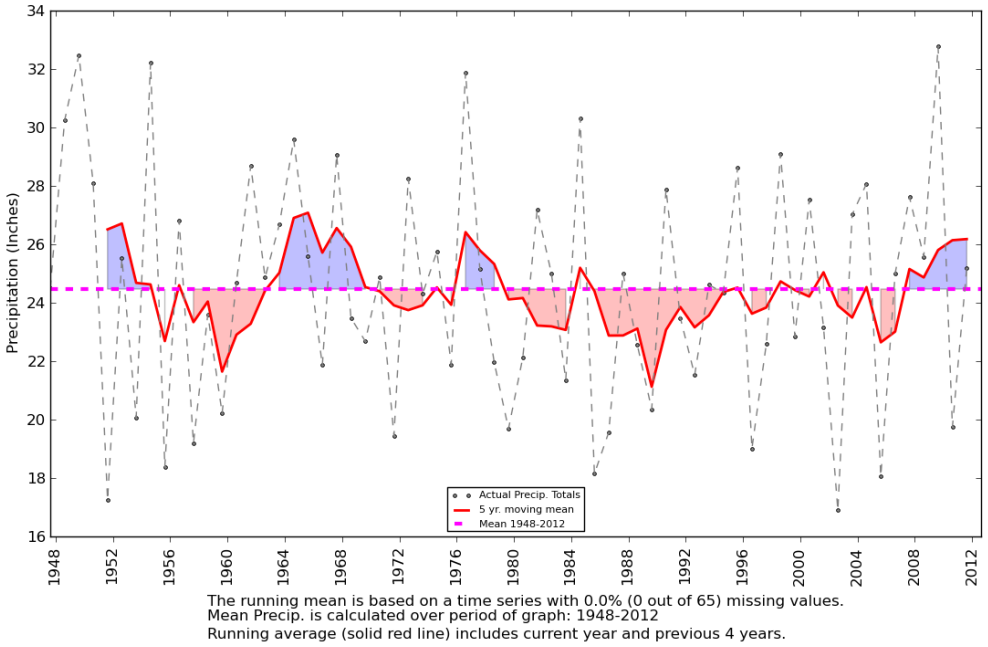

Figure 3. Annual precipitation as measured at the International Falls, MN, weather station, 1948–2012.

Longer-term Perspective

Precipitation in the 2008–2012 period was nearly average relative to the 30-year baseline. But what happens if we look further back? If we stretch the baseline to 65 years (1948-2012), the 2008-2012 period proved to be wetter than the annual average precipitation from 1948-2012 (blue shaded areas in Figure 3). Interestingly, there was a long period of generally below average annual precipitation beginning in the early 1980s and lasting up until 2008 (red-shaded areas in Figure 3). What does this mean, this shift from 25 relatively dry years to five relatively wet years?

Something else revealed by the longer baseline is the dryer than normal summers (data not shown). Average summer precipitation (June–August) between 2008 and 2012 was generally below the 65-year average.

There is no clear pattern in the long-term temperature data. The 5-year running mean (2008-2012) for Tmax fluctuated between roughly 48 and 50 °F, while the 5-year running mean for Tmin fluctuated between roughly 25 and 27 °F. Both of these are within the range of running means calculated for many earlier years.

Integrating Temperature and Precipitation—The Keetch-Byram Drought Index

The Keetch-Byram Drought Index (KBDI) is an estimate of how much water would be required to replenish the soil to full field capacity (the amount that it can hold without running off). It is expressed in hundredths-of-an-inch, so a KBDI of 800 indicates an estimated soil water deficit of 8 inches. Because it is an index of soil moisture, the KBDI is often used to predict the ability of fires to spread once they have started.

When calculated on a daily basis for the last five years (2008-2012), the KBDI shows that soils near International Falls had high water content (i.e., low moisture deficit)—levels that were generally wetter than the previous 64 years (gray lines in Figure 4). The deficit was generally <1.5 inches (KBDI<150) during 2009, 2010, and 2012; there was a moisture deficit of nearly 2.5 inches (KBDI of 250) during September of 2008 and 2011.

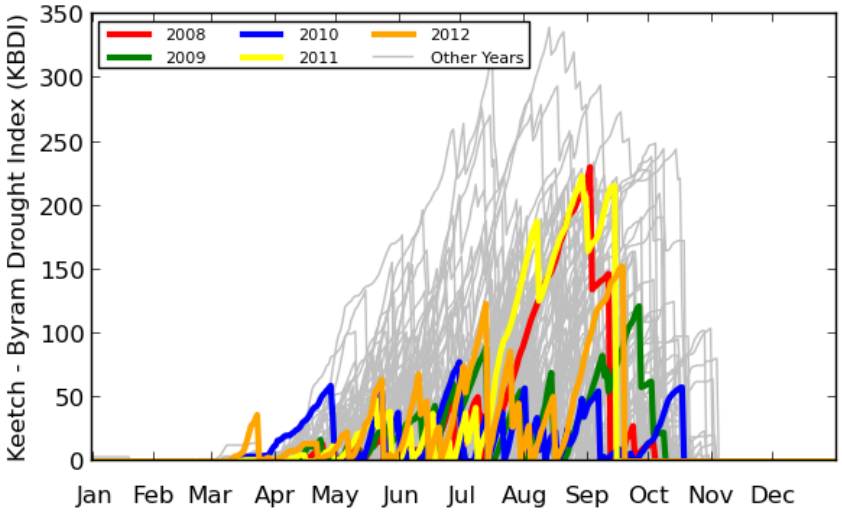

Figure 4. The Keetch-Byram Drought Index (KBDI) recorded at International Falls, MN, 1948–2012.