December 2023

BIG STAR LAKE
PRECIPITATION ANALYSIS

PREPARED FOR:
BIG STAR LAKE ASSOCIATION
BALDWIN, MI

progressive ae

INTRODUCTION

In October of 2023, the Big Star Lake Association hired Progressive AE to conduct an analysis of climatological data to assess the potential impacts on current water levels. This report provides a summary of those data and conclusions.

LAKE CHARACTERISTICS

Big Star Lake is located in Lake Township, Lake County, MI (T17N,R14W) and has a surface area of approximately 902 acres. The surrounding watershed is approximately 1,302 acres (Figure 1). The drainage area into Big Star Lake is relatively small for its total surface area when compared to other lakes in Michigan. Since there are no inlets draining to Big Star Lake, all of its water is supplied by precipitation and groundwater inputs.

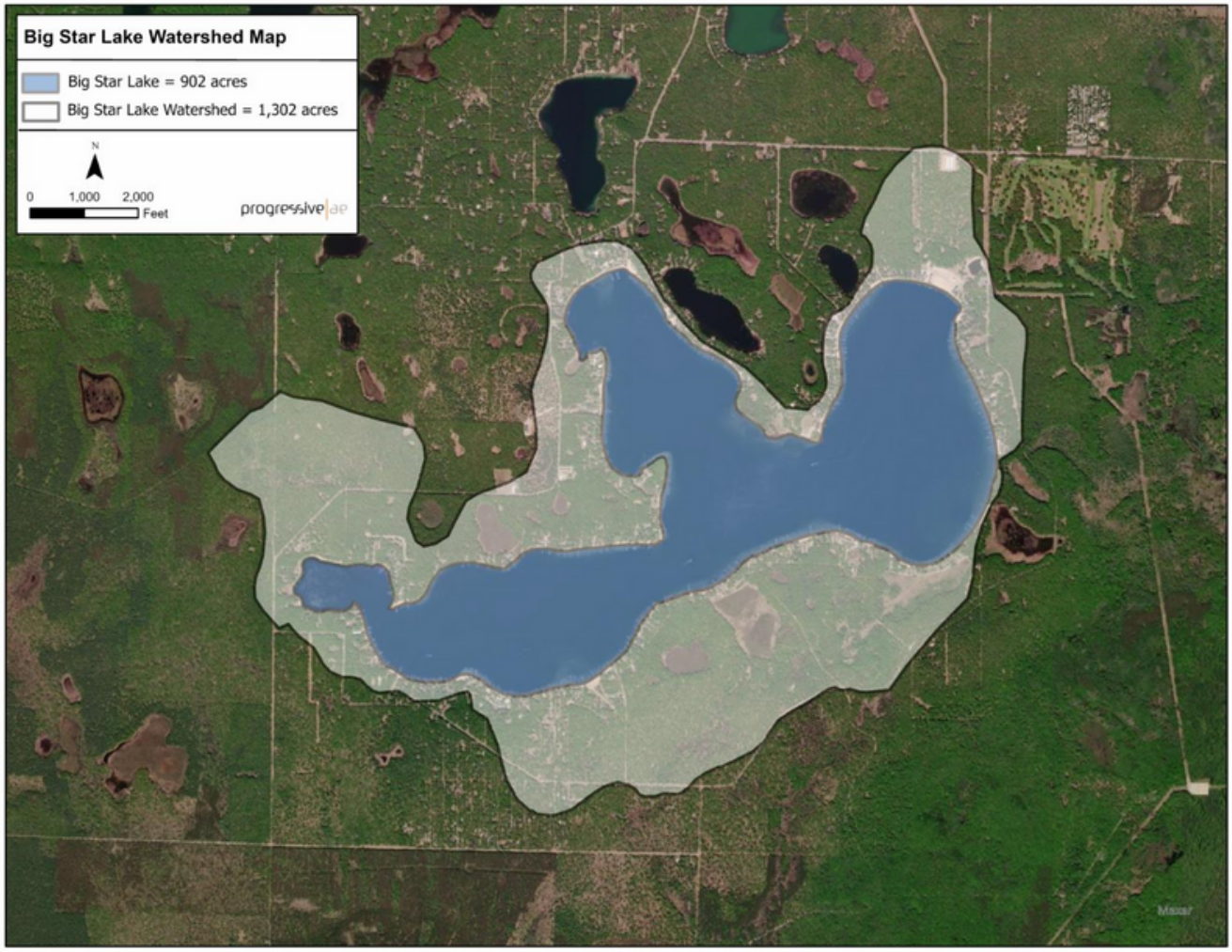

Figure 1. Big Star Lake Watershed Map

Big Star Lake is located within the Bayport Limestone and Michigan Geological Formation (Figure 2). This formation is not a principal water bearing formation, therefore, significant water sourcing from seeps and springs are unlikely on Big Star Lake.

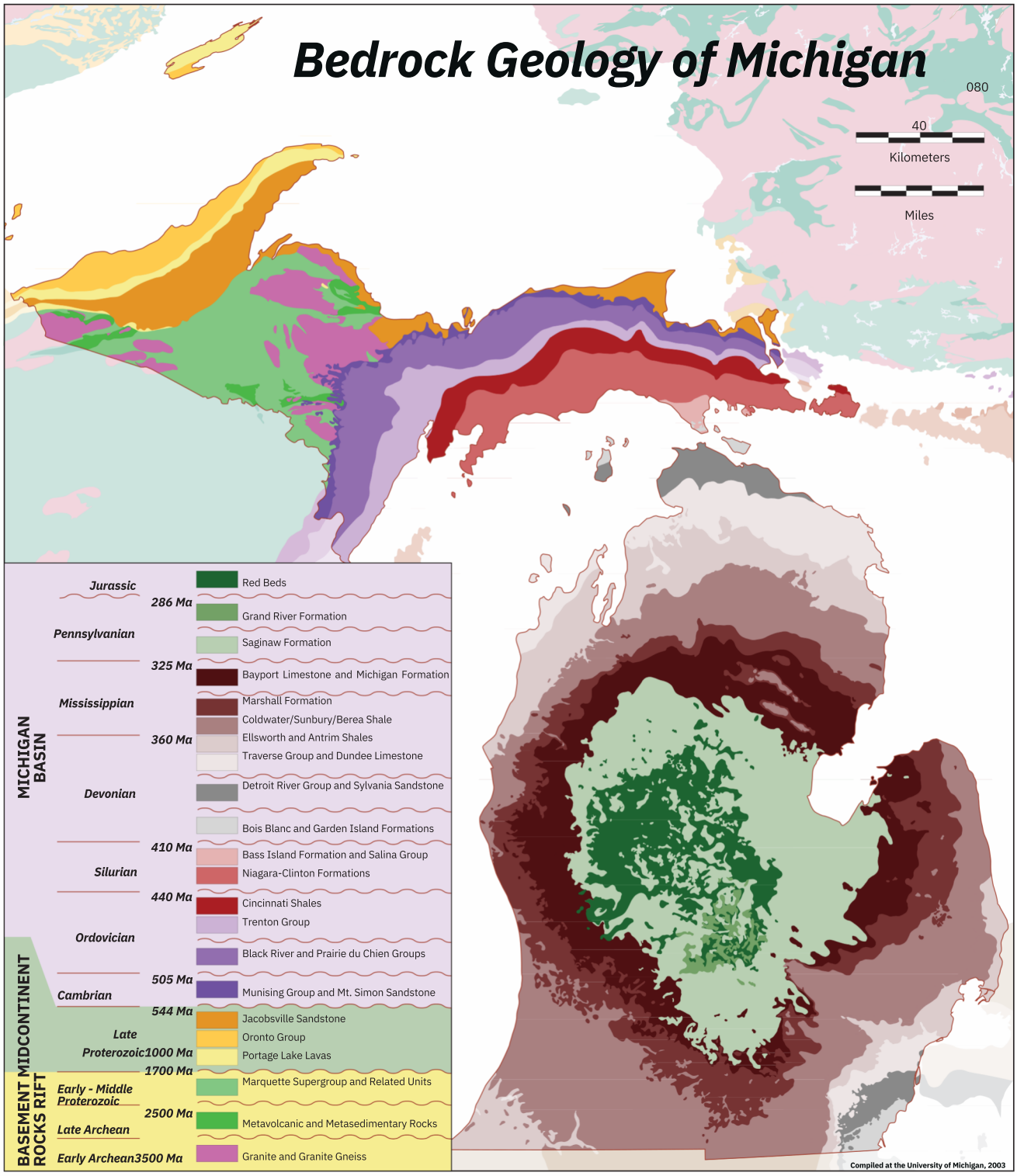

Figure 2. Bedrock Geology of Michigan. ***University of Michigan, 2003***

CLIMATOLOGICAL DATA

Two weather stations were used to evaluate the regional climate around Big Star Lake. The first station is located in Mason County, just east of Ludington. The second station is located in Mecosta County, southeast of Big Rapids (Figure 3). These weather stations were chosen based on their proximity to Big Star Lake and the size of the datasets they offered relative to other sources. Precipitation and reference potential evapotranspiration (RPET) are used in this analysis to gauge the potential gain or loss of surface water over the past several years compared to historical averages. RPET is the amount of potential evaporation that occurs on an open source of water (such as a lake). RPET is calculated at the weather stations using the Penman equation, this formula uses daily radiation, vapor pressure, air temperature, humidity, and windspeed to estimate the potential evapotranspiration from available water in a given area. It is not possible to calculate the actual amount of evapotranspiration on Big Star Lake without having surface water temperature data. However, RPET can be used to provide a meaningful basis for a year-over-year comparative analysis to determine if climate/ weather is a likely contributing factor to the recent observed low water levels. Precipitation and RPET collected by the weather stations were measured in inches.

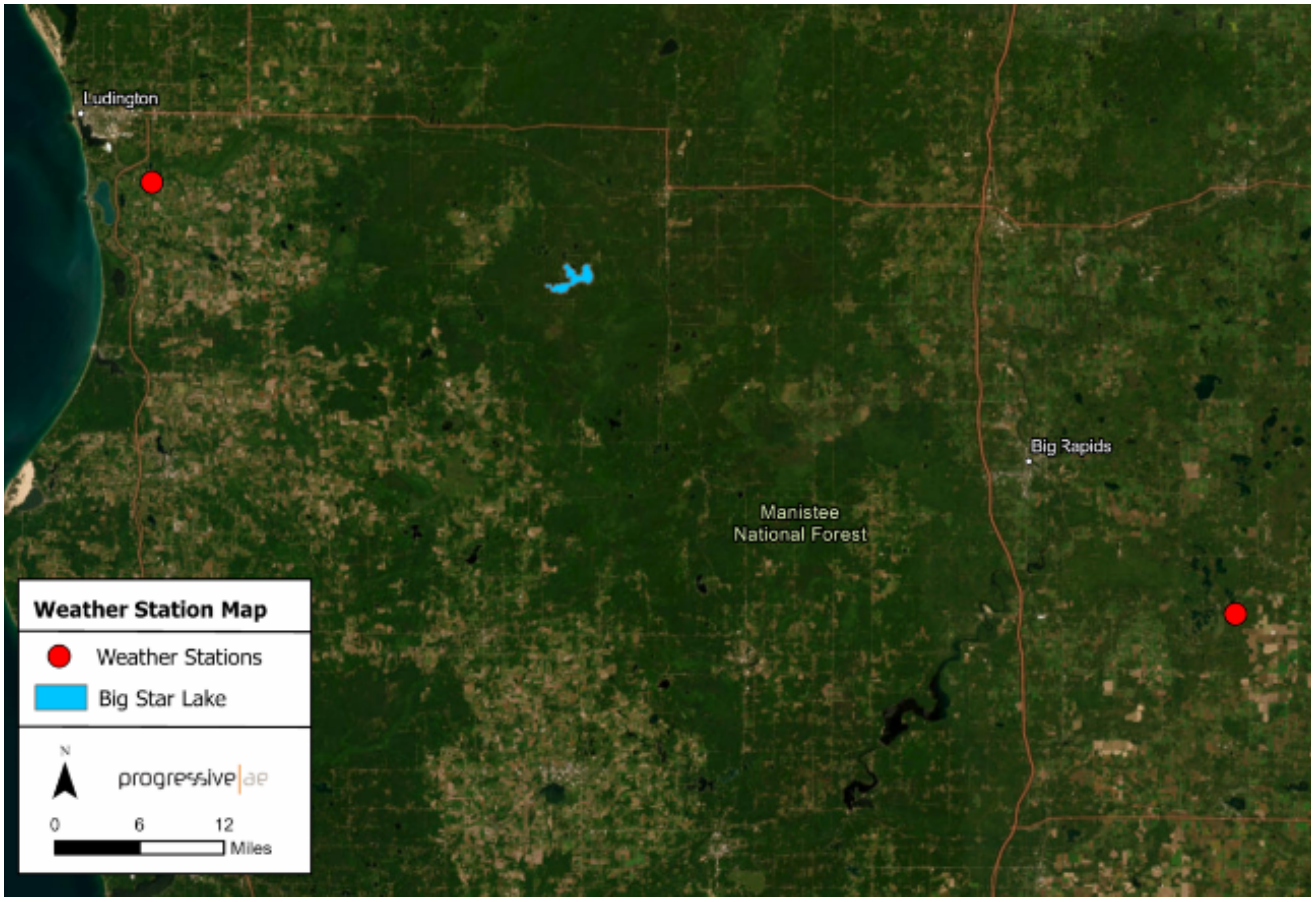

Figure 3. MSU Weather Station Location Map

RESULTS

In 2023, precipitation in the Ludington region was at an all time low since 2003. The Mecosta weather station recorded a relatively low annual accumulation of precipitation in 2023 compared to previous years. Since 2019, both the Ludington and Mecosta regions have had a significant decline in annual rainfall (Figure 4).

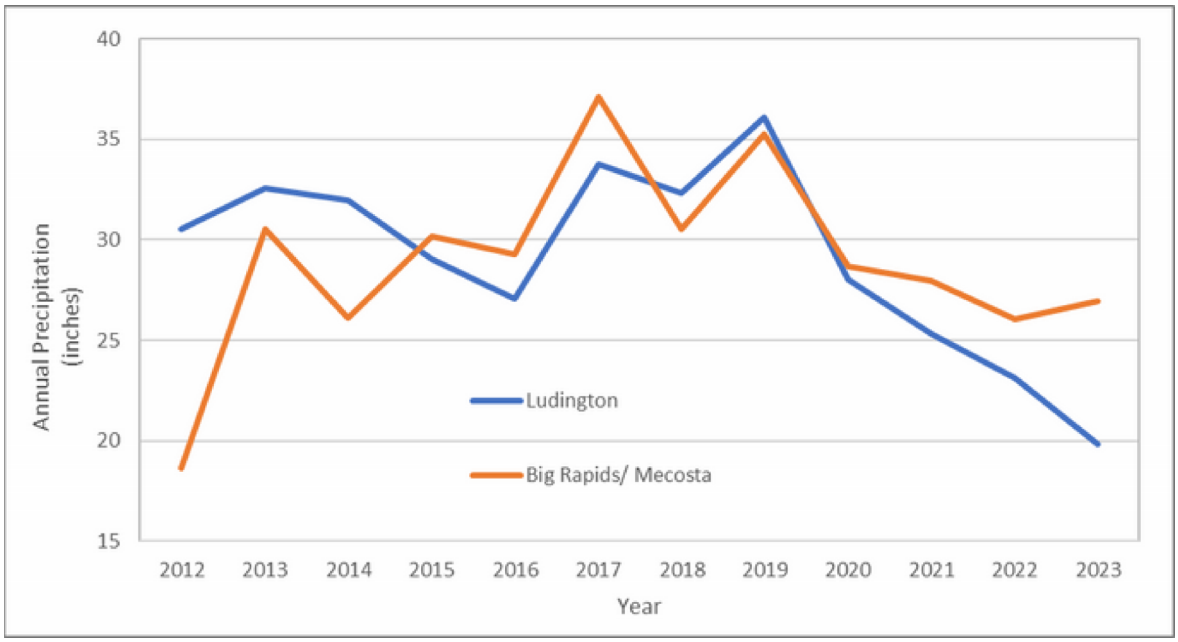

Figure 4. Annual Precipitation at Ludington and Mecosta Weather Stations

The RPET at both stations has increased since 2013, with the greatest potential for evapotranspiration occurring in 2020 (Figure 5).

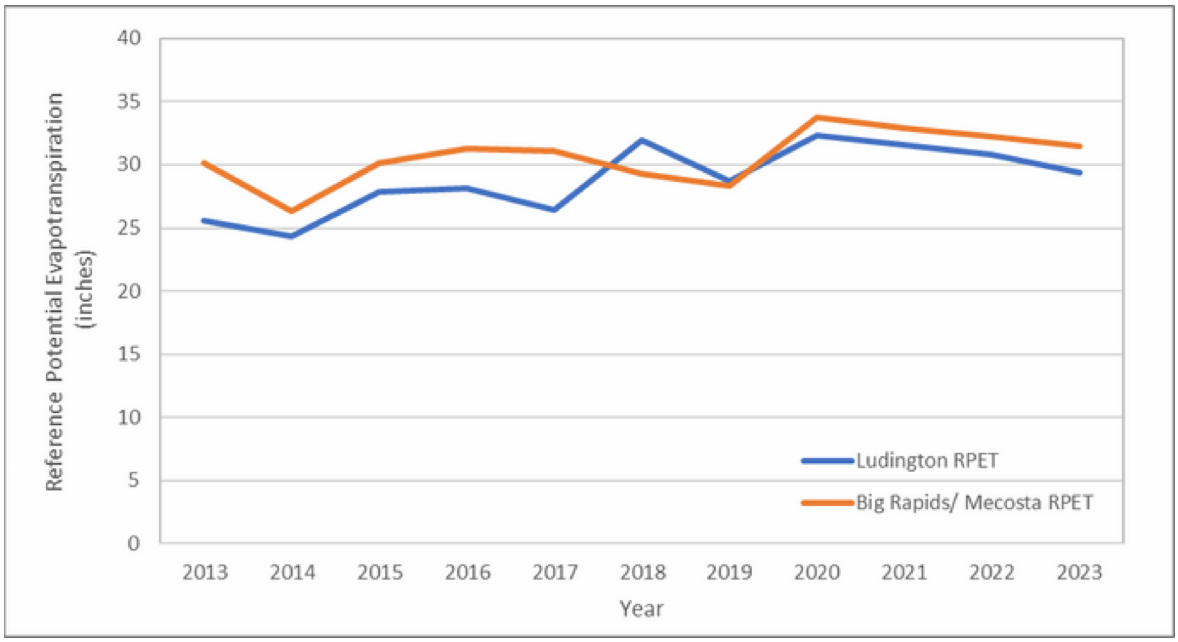

Figure 5. Annual RPET at Ludington and Mecosta Weather Stations

The overall net gain or loss of surface water was estimated by taking the annual precipitation and subtracting the annual RPET. Since 2019, both locations had a significant loss of potential surface water. The Ludington station recorded its greatest potential losses in 2022 and 2023. The Mecosta station had its greatest potential loss in 2022 (Figure 6).

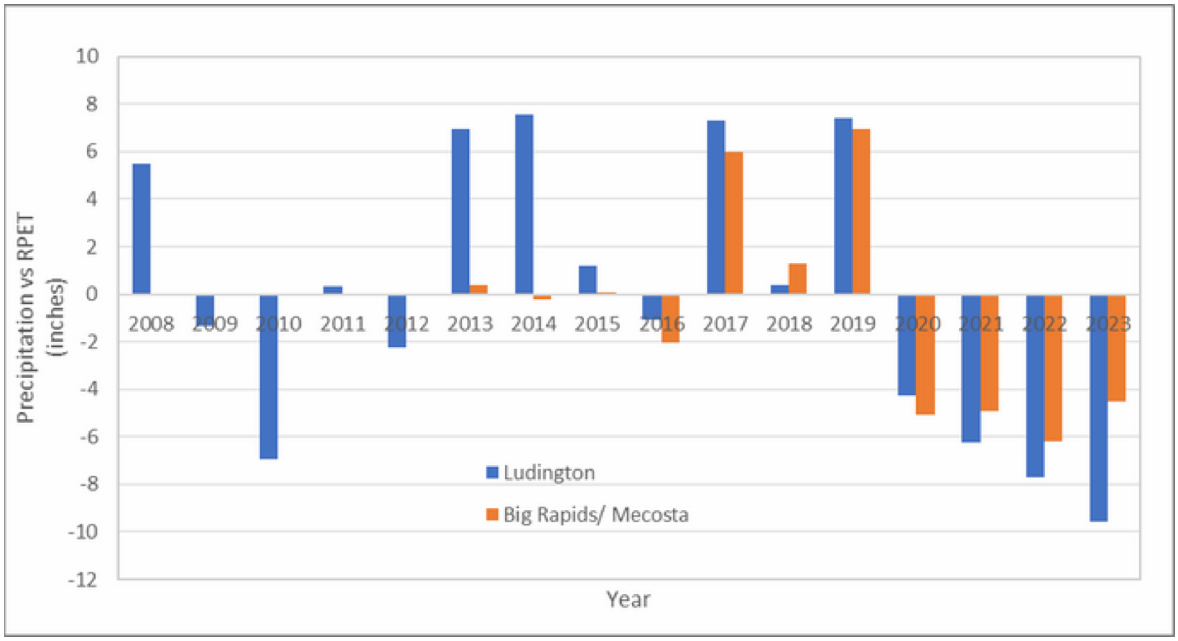

Figure 6. Estimated Gain/Loss of Water at Ludington and Mecosta Weather Stations

DISCUSSION

Big Star Lake's water level has been a growing concern among residents. The lake has no major inlets and its watershed is relatively small for its surface area. Based on these factors, the water level has the potential to fluctuate if abnormal weather conditions persist. In the 2017 status of the fishery report published by the Michigan Department of Natural Resources (MDNR), it is noted that Big Star Lake's water level can fluctuate several feet during unusually dry or wet conditions (MDNR 2017).

There is no significant difference between the datasets collected by each weather station, therefore, these weather stations can be used to generalize the climate within the region where Big Star Lake is located. Since 2019, the annual precipitation has declined significantly and the reference potential evapotranspiration within the region has increased. It is also worth noting that annual ice formation has an impact on the evaporation potential. While there are no records available indicating dates of ice formation or departure on Big Star Lake, in years where there is little to no ice formation, greater evaporation/ water loss should be anticipated. Using the estimated net loss of surface water, the region has had approximately 24 inches of surface water loss since 2019.

Based upon the data provided by the MSU weather stations, the overall cumulative surface water within the region has had a significant loss since 2019. Using precipitation and RPET data, it can be assumed that unusual weather conditions have persisted over the past several years. These conditions likely contribute to the low water level on Big Star Lake. However, since surface water temperature and precipitation data were not collected at Big Star Lake, only a generalized conclusion of the current water level can be made. Although we have not studied the lake level control structure at the east end of the lake directly, our review of the climatological data for the region leads us to conclude weather is the single largest contributor to the low water levels. It is apparent from observations on other nearby lakes including Bassford Lake and Lake Cecile, that these climatological conditions are affecting the levels of these lakes as well.

REFERENCES

Big Star Lake, Michigan. United States Geological Survey Topographical Quadrangle Map (1:24,000). 1987.

Michigan Automated Weather Network (MAWN). *Weather Station at Ludington, MI*. https://legacy.enviroweather.msu.edu/weather.php?stn=ldt. Accessed: December 12, 2023.

Michigan Automated Weather Network (MAWN). Weather Station at Mecosta, MI. https://legacy.enviroweather.msu.edu/weather.php?stn=mct. Accessed: December 12, 2023.

Michigan Department of Natural Resources. 2017. *Status of the Fishery Resource Report, Big Star Lake, Lake County, Pere Marquette River Watershed; Last surveyed summer 2015*. https://www.michigan.gov/dnr/managing-resources/fisheries/status-of-the-fishery-resource-reports Accessed: December 12, 2023.

University of Michigan College of Literature, Science, and the Arts. 2003. *Bedrock Geology of Michigan*. https://lsa.umich.edu/earth/community-engagement/downloadable-resources/bedrock geology-of-michigan.html. Accessed: December 12, 2023.