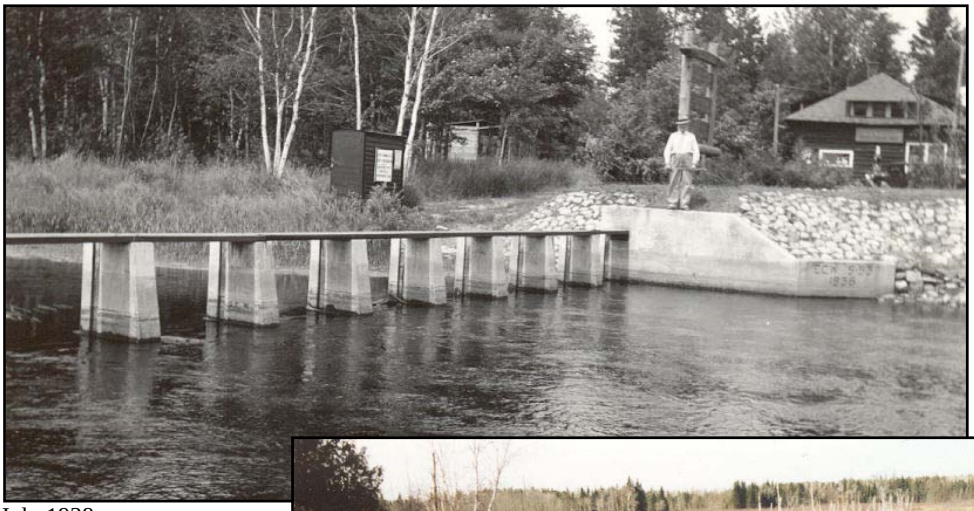
Sturgeon (69-939) / Side (69-933) Lakes

St. Louis County

Outlet Analysis



July 1938

March 2000

April 30, 2007

DNR Waters

Sturgeon (69-939) / Side (69-933) Lake
St. Louis County

Outlet Analysis

The current severe drought in northeast Minnesota is affecting the level of the Sturgeon / Side Lake chain of lakes. Low lake level conditions hinder navigation among the chain of lakes. Some local interests have proposed that stop logs be added to the outlet dam on the Sturgeon River.

The purpose of this report is to evaluate the effect of adding stop logs to the dam on low and high lake levels.

Key Information

- Authorized top of stop logs = 1370.5
- Ordinary High Water level (OHW) = 1372.7
- Highest recorded lake level = 1373.2
- Lowest recorded lake level = 1370.2
- Average of 1319 recorded lake levels = 1371.5

Note: all elevations in this report are feet above mean sea level (NGVD, 1929 adjustment).

- Watershed area = 48.5 square miles
- Combined lake area = 2,550 acres
- Watershed to lake area ratio = 12.2:1

Background

The Civilian Conservation Corps under the authority of the Emergency Conservation Works Act constructed the Sturgeon/Side Lake outlet dam in 1935/36. During its first ten years, stop logs were added and removed from the dam in an attempt to maintain desirable lake levels. Complaints regarding high and low lake levels were common during this period. In a manner similar to the approximately 300 other lake outlet dams constructed during the late 1930s, stop logs were "permanently" fixed in the Sturgeon Lake dam in July 1947 at 3.2 feet gage height = elevation 1370.5. No further manipulation of the stop logs was authorized.

Correspondence in the DNR Waters' St. Paul files indicate that there have been frequent complaints regarding high and low lake levels, in roughly equal numbers. Complaints of shoreline damage and damage to low lying structures seem to occur when the lakes are at or above their OHW. The DNR Waters dam maintenance technician has often been called upon to restore the outlet dam to the authorized stop log setting after reports that stop logs have been added or removed from the dam.

Watershed

The Sturgeon / Side Lake watershed is shown in Figure 1. The predominant land cover within the watershed is forest and water/wetlands, with a smaller amount of brushland.

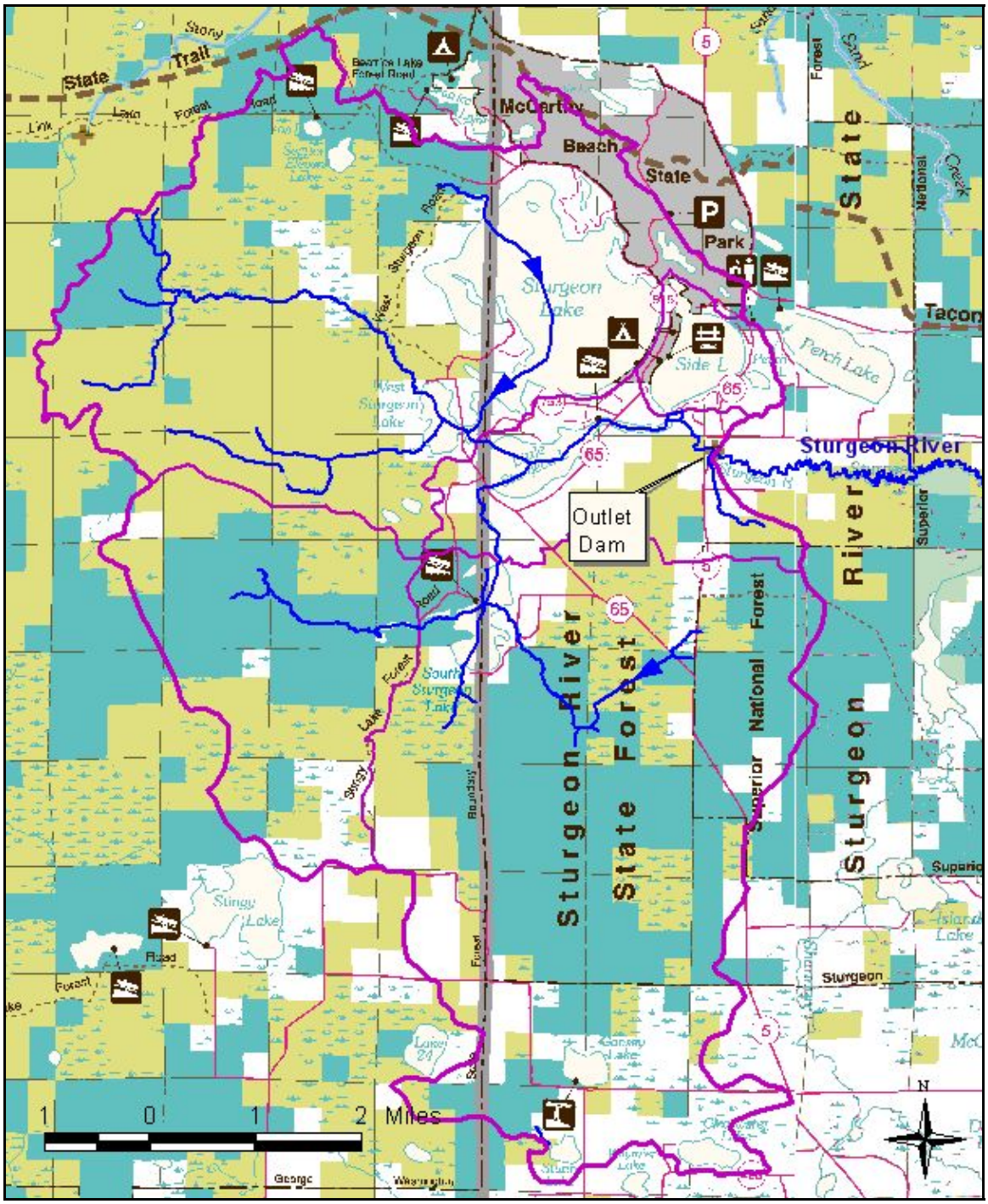


Figure 1. Watershed Map

Recorded Lake Levels

Figure 2a is a plot of all recorded lake levels for Sturgeon Lake. During the vast majority of time, lake levels have been within the 2.2-foot range between the authorized runout and the OHW. Excellent lake level data are available for the past two decades (Figure 2b). During this period, the lake has exceeded its OHW in five different years, and has fallen below the runout elevation in three different years.

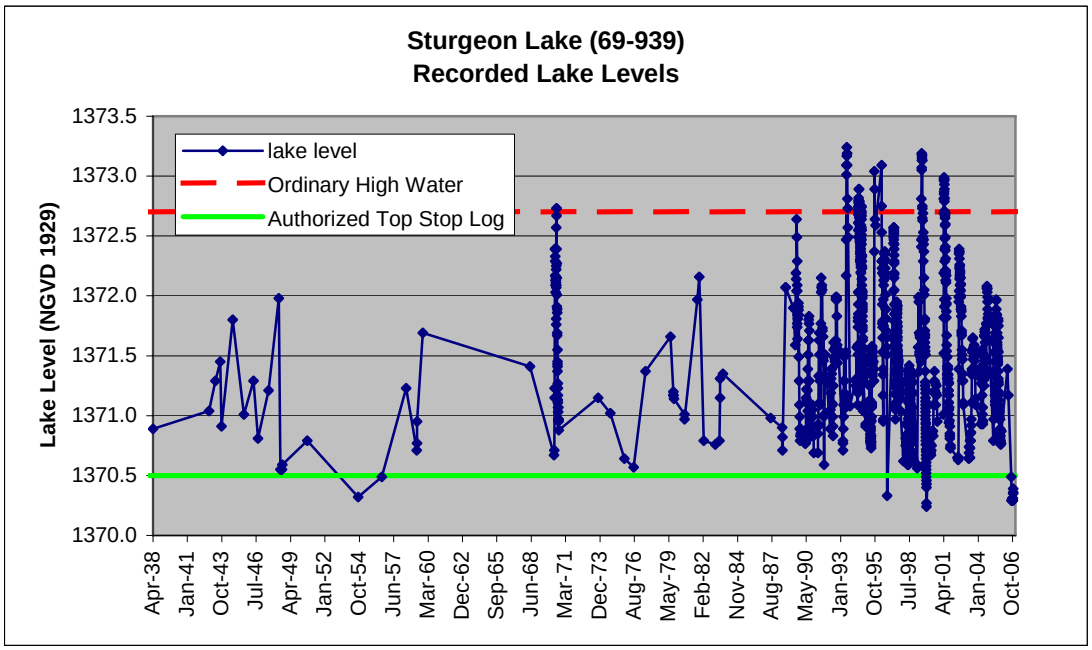


Figure 2a, All Recorded Lake Levels

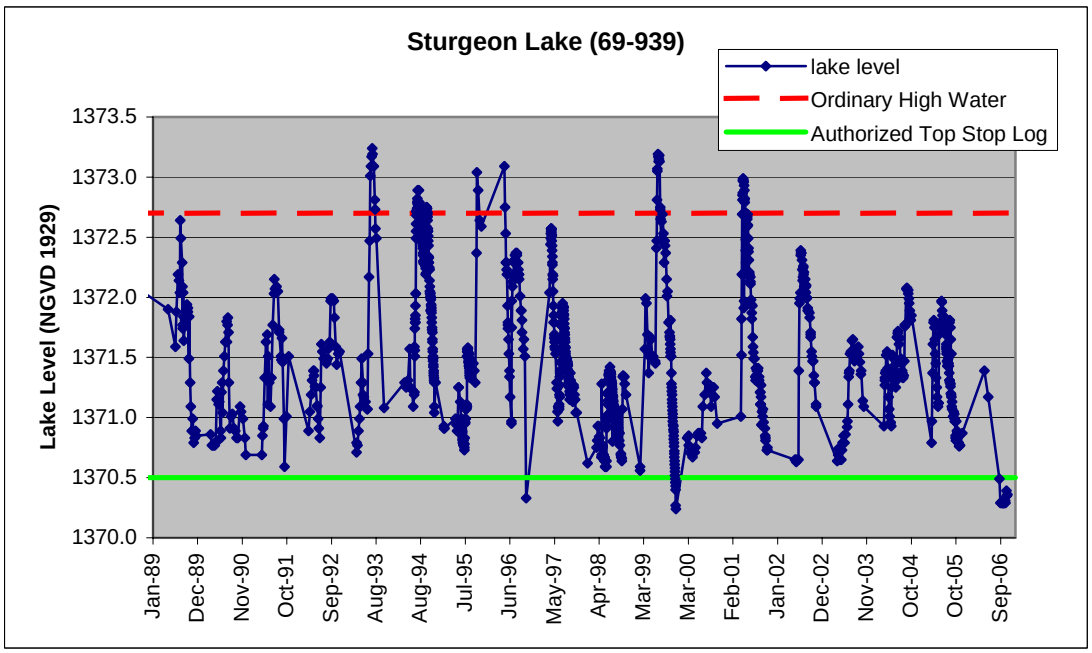


Figure 2b, Recorded lake levels, 1989 through 2006

Considering the watershed size, and watershed to lake area ratio, nothing in this lake level record is particularly noteworthy. It is expected that levels will periodically exceed the OHW during wet climatic conditions. Conversely, during dry climatic conditions, lakes throughout the state frequently fall below their respective runout elevations. Furthermore, there is nothing in the lake level record suggesting that a significant change to the outlet has occurred.

Outlet Channel

The limited flow capacity of the Sturgeon River downstream of the outlet dam has long been recognized. A distinguishing characteristic of this reach of the river is its very flat gradient. The following aerial photograph (Figure 3) vividly demonstrates the very sinuous nature of this stream – a characteristic of streams having a flat gradient, e.g., Red River of the North.

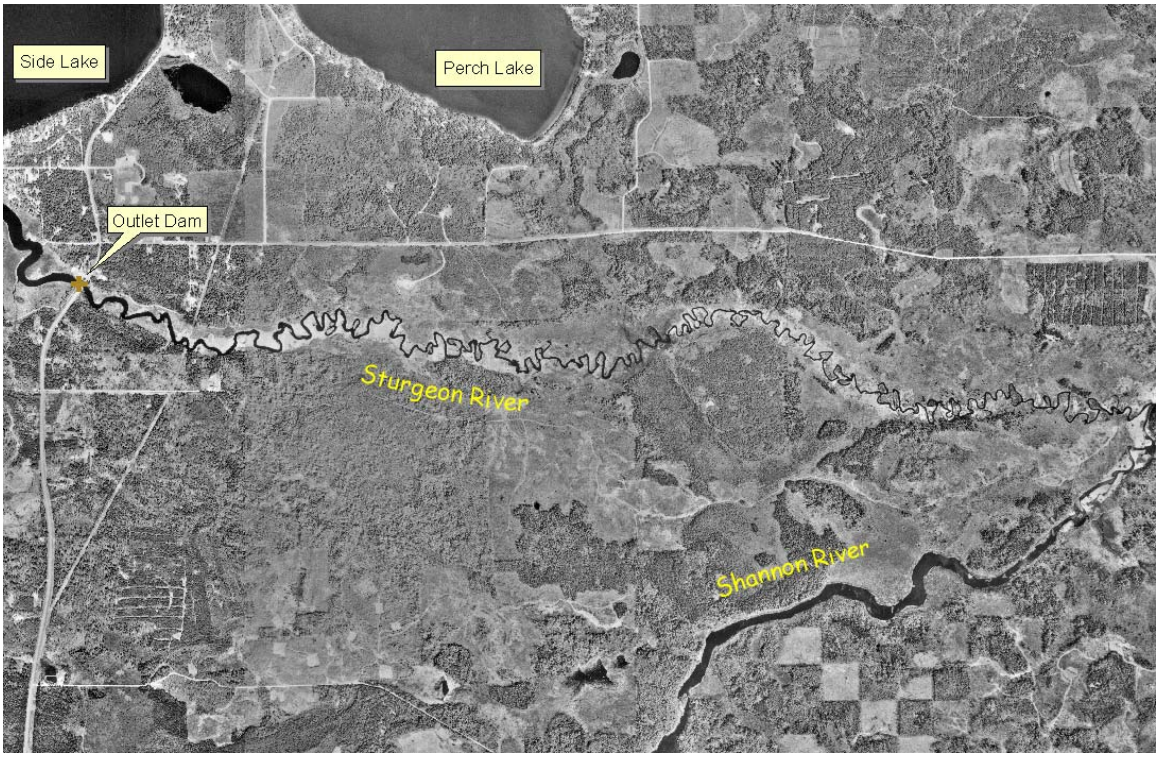


Figure 3 – Sturgeon River downstream of the outlet dam (1991/92 aerial photographs)

The correspondence file contains an occasional reference to the possibility that debris, silt or perhaps beaver dams are partially obstructing the outlet channel. DNR Waters has not surveyed the outlet channel. Close examination of the above aerial photograph as well as more recent aerial photos from 2004/05 does not reveal any obvious blockage. Nor is there a noticeable difference between the two sets of aerial photographs. Both sets of photos show a very sinuous channel, decreasing in width in the downstream direction.

Further evidence of the limited flow capacity of the outlet channel is found by comparing the recorded lake level data with stream flow data collected by the U. S. Geological Survey (USGS). For many years, the USGS maintained a stream gaging station on the Sturgeon River, just downstream of the confluence with the East Branch Sturgeon River (approximately five miles due east of Side Lake). The watershed area tributary to the gaging station is 186 square miles, compared to a total watershed area of 48.5 square miles at the Sturgeon Lake outlet dam.

Figure 4 compares the recorded USGS Sturgeon River stream flow data with recorded lake levels on Sturgeon and Long Lakes during the summer of 1993. Long Lake is located approximately seven miles southeast of Side Lake.

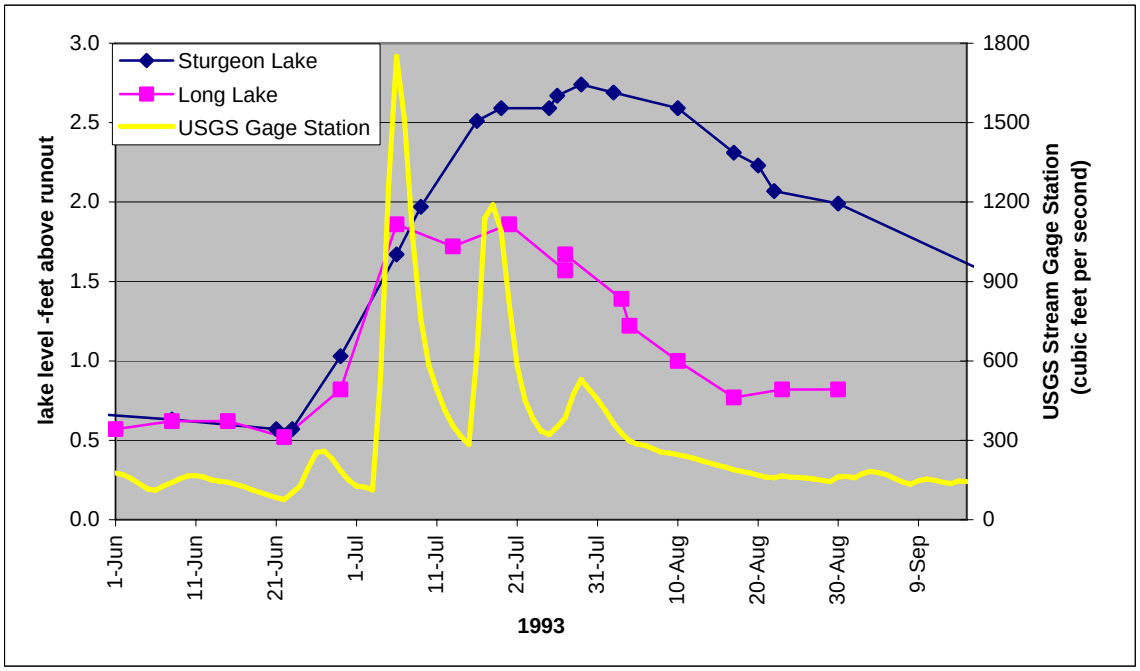


Figure 4. Comparison of stream flow and lake level data

Note that the peak recorded levels on Long Lake for runoff events in early and mid-July correspond very closely to the peak flows on the Sturgeon River. However, peak levels on Sturgeon Lake occur roughly one week following the peak stream flow. A similar pattern was found between the Sturgeon River flow data and Sturgeon Lake levels during the 2001 spring runoff event. These data suggest that even several days after the peak flow at the USGS gaging station have occurred, more runoff is entering the Sturgeon lake chain, than is flowing over the outlet dam.

The limited flow capacity of the Sturgeon River downstream of the outlet dam is a natural condition resulting from the topography of the general area.

Technical Analysis

The limited capacity of the outlet channel suggests that modifications could be made to the dam, i.e., permanently add one or more stop logs, without aggravating high lake levels.

The hydraulic analysis typically used in these types of studies would require a detailed survey of the downstream channel. Such a survey would be a major undertaking, in part due to the lack of access to this reach of the river.

Instead, the available recorded headwater and tailwater elevation data at the outlet dam were used. Figure 5 is a plot of same day headwater / tailwater measurements. These data indicate that when Sturgeon Lake is at or above elevation 1371.0 (one-half foot above the authorized stop log elevation), there typically is no difference in water levels immediately upstream and downstream of the dam. The dam exerts hydraulic "control" of outflow generally only when lake levels are at or below elevation 1371.0. A reasonably accurate estimate of outflow rates is possible using the available data for these lower (below 1371.0) lake level conditions.

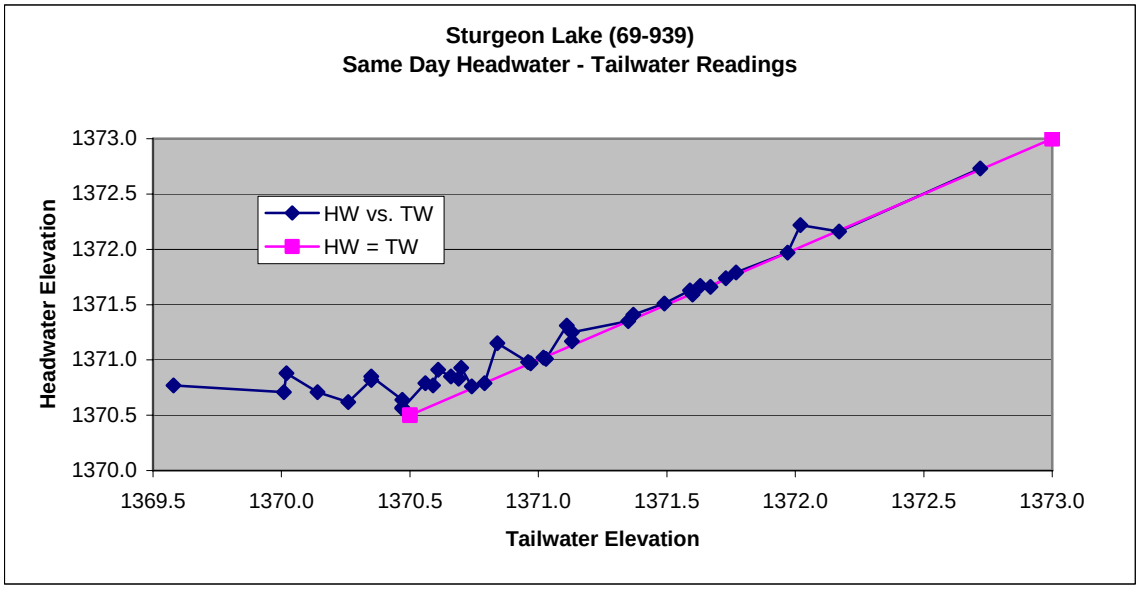


Figure 5

Outflow rates during high lake level conditions were estimated using the data shown in Figure 4. The total volume of flow measured at the USGS gage station can be accurately computed for that time period. It was then assumed that the Sturgeon Chain of Lakes watershed generated the same volume of runoff per square mile of watershed. Knowing the volume of runoff makes it possible to estimate an average outflow rate during high lake level conditions.

Having both an estimate of typical low flows and high flows at the existing outlet dam, it is then possible to analyze the effect of adding stop logs to the dam. This was

accomplished using the U.S. Army Corps of Engineers' HEC-RAS computer program (Hydrologic Engineering Center – River Analysis System).

Summary / Recommendation

Precipitation is the overwhelming factor that influences lake levels on the Sturgeon / Side Lake chain of lakes. But the results of this investigation suggest that the Sturgeon / Side Lake outlet dam could be modified to provide a limited amount of relief during low water conditions, without adversely affecting high lake levels. Due to the documented concerns regarding high lake levels, a conservative, incremental approach is strongly recommended:

- As a temporary measure, add six stop logs (each six inches high) to the Sturgeon / Side Lake outlet dam as illustrated in Figure 6. This action would raise lower lake levels by as much as two inches. High lake level conditions will not be affected.

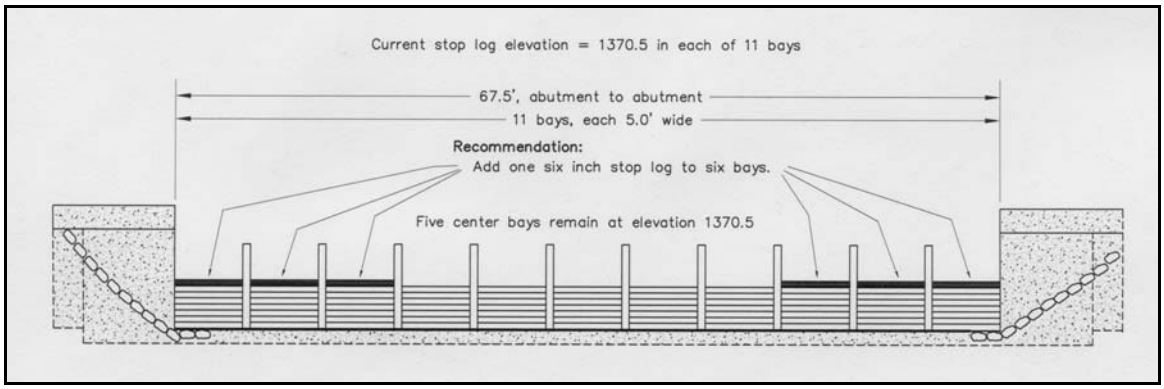


Figure 6. Proposed modification to the Sturgeon / Side Lake dam

- Continue to collect lake level readings, as well as periodic tailwater readings at the outlet dam. It is particularly important to collect tailwater data as lake levels are rising in the days following heavy rainfall or snowmelt.

- Revisit this study when sufficient additional data are collected to examine the impact of this temporary measure – say within three to five years. At that time, make a final determination as to the configuration of the dam.

- Urge local residents to resist the temptation to tamper with the dam. Meaningful results can only be obtained if the proposed stop log configuration is maintained.

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