Lake Levels

Introduction

The Lake Hydrology Program exists to support the DNR Waters director and staff by collecting and providing data on lake levels and other lake characteristics that are needed to effectively carry out DNR Waters' statutory responsibilities and management programs.

A key component of the Lake Hydrology Program is the development and maintenance of the Lake Level Minnesota Monitoring Program (LLMP). The LLMP primarily uses both temporary (movable) and permanent lake gages as indicators for measuring and determining the water surface level of certain lakes. DNR Waters currently oversees a network of over 1000 lake gages. The program relies on over 700 citizen volunteers and local government partners who record lake levels on a regular basis and submit the data to DNR Waters. Approximately 25% of the monitoring sites are managed currently under oral cooperative agreements with governmental units. In addition, DNR Waters purchased three continuous water level gaging systems in 2005 – 2006 for installation on high-profile lakes.

Data Uses

Water level data are used by DNR field staff as rationale for decision making in the public waters permit program and appropriations permit program. The records are used as supporting data for establishing ordinary high water levels and historical high water elevations, which are also the foundation for setbacks within the land use management programs.


photo by Sandy Fecht

The data are used by local zoning officials for platting, locating structure sites, and for establishing low floor elevations for new construction. Watershed managers and planners use historical lake level data while preparing local water management plans and modeling lake water quality characteristics. Fisheries staff use data as one variable in studying impacts on habitat. Other researchers use the data for climate change studies. Water level data are used for decisions by lakeshore owners on dock location/timing, vegetative shoreline protection, and understanding the natural fluctuations of a lake.

Lake level data support many DNR Waters hydrologic and hydraulic analyses. A consistent record of lake levels provides a long-term indication and understanding of the hydrology of the lake, watershed, and the relation between surface water and ground water. Long-term records show normal fluctuations, as well as the extreme highs and lows. Data are used to calibrate hydrologic models, especially applications for flood levels and lake outlets. The information is crucial to surface water and ground water interaction studies for appropriations decisions.

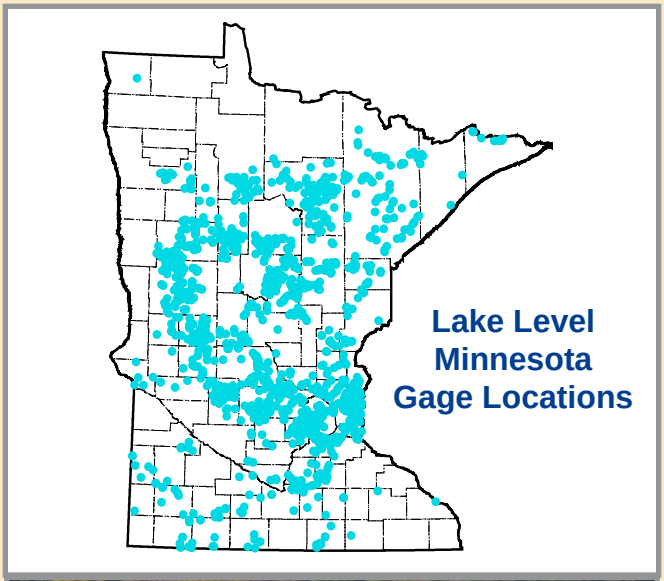



photo by Skip Wright

Information Management

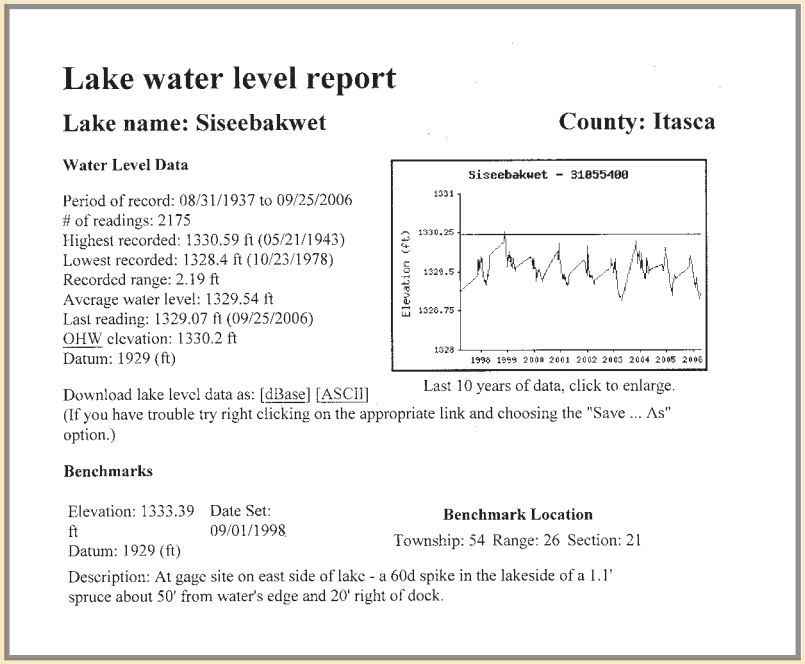
All lake level readings received are entered into Lakes-DB©, a database program for storing and retrieving a variety of information on Minnesota's lake basins.

The Lake Finder web site is the best means for the public to access available data on more than 4,500 Minnesota lakes and rivers relating to lake water levels, fisheries information, lake area and maximum depth, depth maps, water quality and clarity, air photos, and topographic maps. After searching by county, lake name, or identification number for a particular lake, a click on the word "*go*" below *"lake water/levels ruler"* displays the Lake Water Level Report page. This report contains information, including:

- reported historical and current lake levels
- period of record and number of readings
- highest recorded lake level
- highest known lake level
- lowest recorded lake level
- recorded range
- average water level of reported readings
- ordinary high water level [also shown as the red line on the 10-year graph]
- datum
- benchmarks
- most recent 10-year graph [X-axis Year tick mark references mid-year]

About 1,300 of the lakes have a historical record of more than 100 water level readings. In addition to the summary information, a Lake Finder user can retrieve and view all the reported lake elevations for a specific lake via the download of lake level data as dBase or ASCII from the center of the Lake Water Level report page.

Clicking on ASCII is the most common method used to view the water surface elevations and the date of the readings. The chronological water surface elevation data can then be viewed, saved, or highlighted and copied into a computer software spreadsheet for sorting and graphing. The levels of a chosen lake can be compared by the user to other historical drought or wet years or other lakes.



Lake water level report

Lake name: Siseebakwet **County: Itasca**

Water Level Data

Period of record: 08/31/1937 to 09/25/2006
# of readings: 2175
Highest recorded: 1330.59 ft (05/21/1943)
Lowest recorded: 1328.4 ft (10/23/1978)
Recorded range: 2.19 ft
Average water level: 1329.54 ft
Last reading: 1329.07 ft (09/25/2006)
OHW elevation: 1330.2 ft
Datum: 1929 (ft)

Last 10 years of data, click to enlarge.

Download lake level data as: [dBase] [ASCII]
(If you have trouble try right clicking on the appropriate link and choosing the "Save ... As" option.)

Benchmarks

Elevation: 1333.39 ft
Datum: 1929 (ft)
Date Set: 09/01/1998

Benchmark Location

Township: 54 Range: 26 Section: 21

Description: At gage site on east side of lake - a 60d spike in the lakeside of a 1.1' spruce about 50' from water's edge and 20' right of dock.

Lake Levels

The primary factor that affects water level changes is the quantity and distribution of precipitation. Other factors that contribute to water level changes are soil moisture conditions, runoff, evapotranspiration, outlet conditions, beaver dams, human-made dams, ground water movement, and watershed characteristics and size.

The water levels of all lakes fluctuate depending on their unique water budget — some more than others. A water budget is the sum of "incoming" resources minus "outgoing" resources. It is an estimation of the water resources available to "spend" or "save" and must take into account all available ground and surface water. Water enters the lake as precipitation, surface-water inflow, and ground-water inflow. Water leaves the lake as evaporation, surface-water outflow, and ground-water outflow.

In a prolonged dry cycle, runoff and rain may be absorbed first by the soil and not contribute to lake levels. Knowing, understanding, and accepting the history of water level fluctuations can help lake users deal with expectations and problems associated with the changing levels.

Drought

Our volunteer readers' remarks definitely told the story of the dry spell and drought of 2005 – 2006 (Figure 1 hydrographs).

"I have been on the lake for 40 years, and lived in the area for 56 years, and the months of September-November are the lowest I have ever seen the lake."

"Most of this summer I've had about 8-10 feet of beach that I never had before in 20 years."

"I have never seen our lake as low as this in 30 years."

"The lowest anyone has ever seen it!"

"Lowest level in 13-14 years."

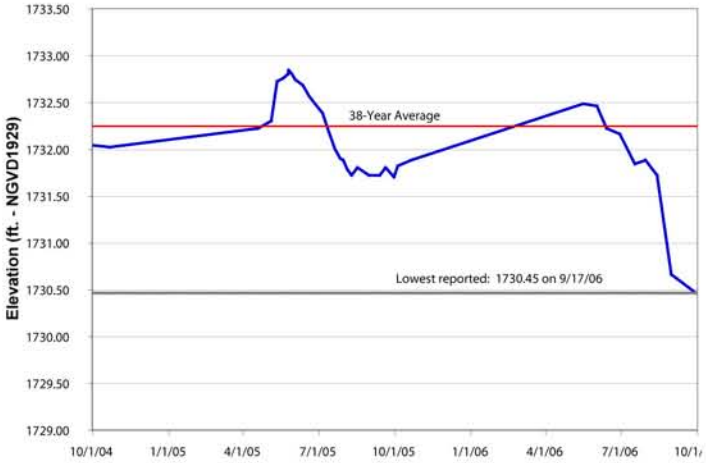
"SEND RAIN NOW!!!!!"

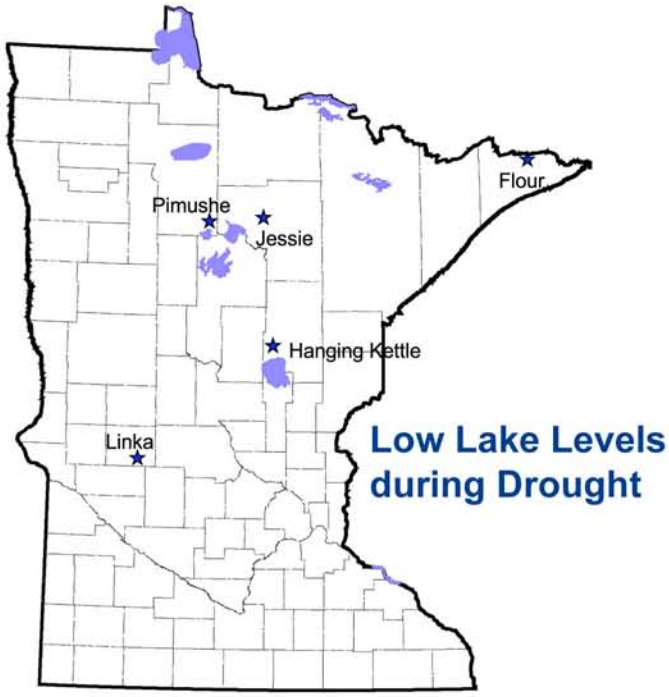
July 2005 rainfall totals ranked among the lowest on record for some central and northern locales. The Arrowhead region remained extremely dry in August 2005, and the dry conditions persisted into September 2005 in northeastern and north-central Minnesota. In response to the lack of precipitation, many lakes receded to low water levels. A large number of lakes in Itasca County were at their all-time recorded low water levels.

Figure 1

Pimushe Lake (04-0032), Beltrami County

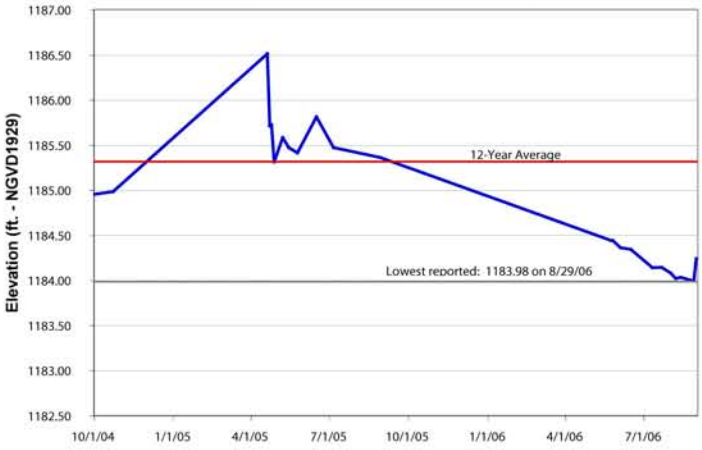
Flour Lake (16-0147), Cook County



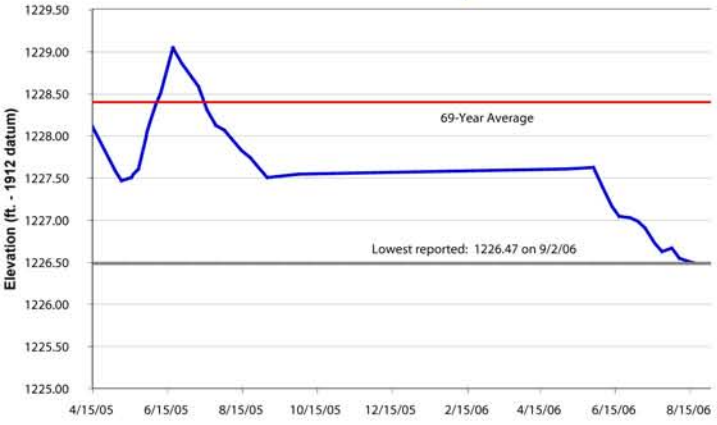


Jessie Lake (31-0786), Itasca County

Linka Lake (61-0037), Pope County



Hanging Kettle Lake (01-0170), Aitkin County



Although most lake levels in these dry areas recovered somewhat by spring 2006, the relief of landowners was short-lived. Very dry and hot weather from mid-May to September intensified conditions into a drought that was entrenched across northern and central Minnesota. Lake levels continued to drop steadily and significantly over the summer. Over 100 gaged lakes in our network experienced their lowest reported water levels in summer 2006, including a long list from Beltrami, Itasca, St. Louis, Aitkin, Todd, Stearns, and Pope counties. A number of gages had to be reset one to three times over the summer in deeper locations in order to capture any water level readings.


photo by Sandy Fecht

Lake Level Responses

In contrast to the drought, other areas' significant rainfalls were reflected in lake level increases during the 2005-2006 Water Year (Figure 2 hydrographs). Frequent and abundant rainfalls across the state in spring 2005 were exemplified by the fact that many lakes in Otter Tail County reported their highest water levels. Severe thunderstorms and large amounts of rainfall in late August 2005 raised water levels and kept them high throughout late summer in Kandiyohi County. A large portion of east-central counties received up to seven inches of rain in one day in October 2005. This rare occasion overtopped lake gages and spiked lake levels to a number of highest reported levels in the metropolitan area, as well as Chisago, Stearns and Sherburne counties.

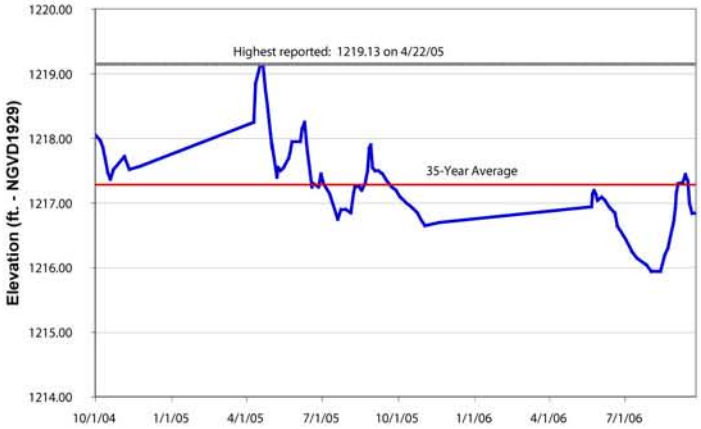
Wet weather in spring 2006 caused over a dozen Otter Tail County lakes to rise and experience their highest reported water levels. After May, only a few lakes reached their highest lake level as the drought intensified. August 2006 rainfall events resulted in lake level responses in spots; unfortunately, the rains did not fall on those areas in the midst of the drought.


photo by Kate Le Mieur

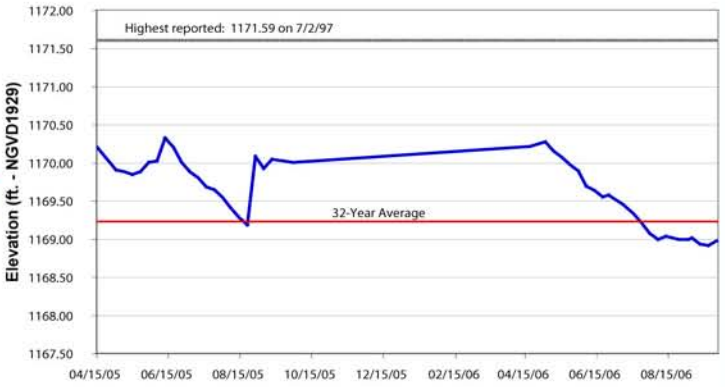

photo by Kate Le Mieur

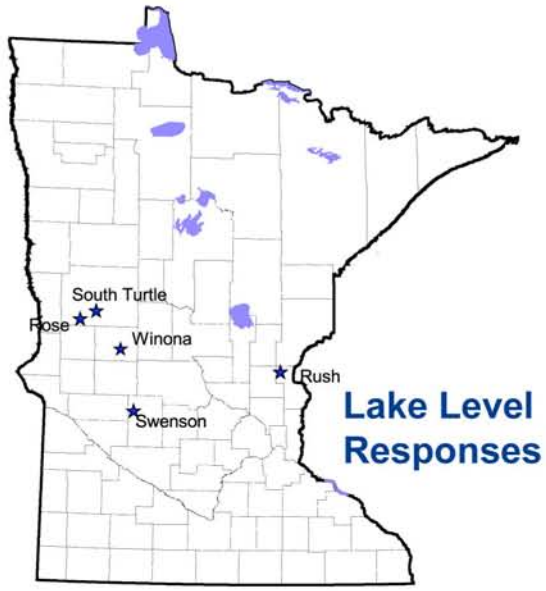
Figure 2

Rose Lake (56-0620), Otter Tail County
Spring 2005

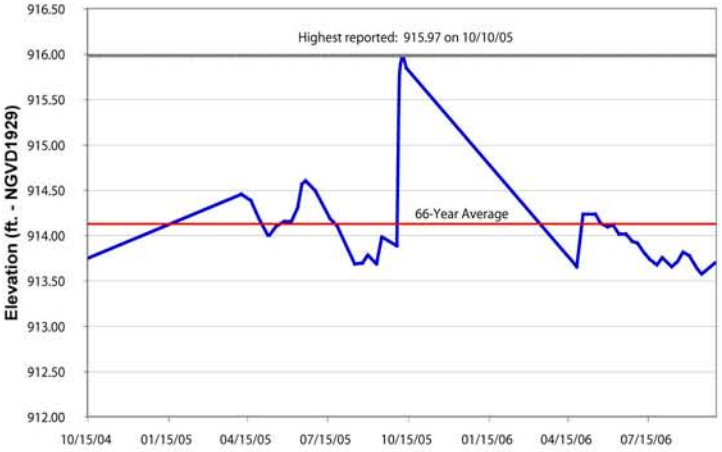


Swenson Lake (34-0321), Kandiyohi County... Late Summer 2005



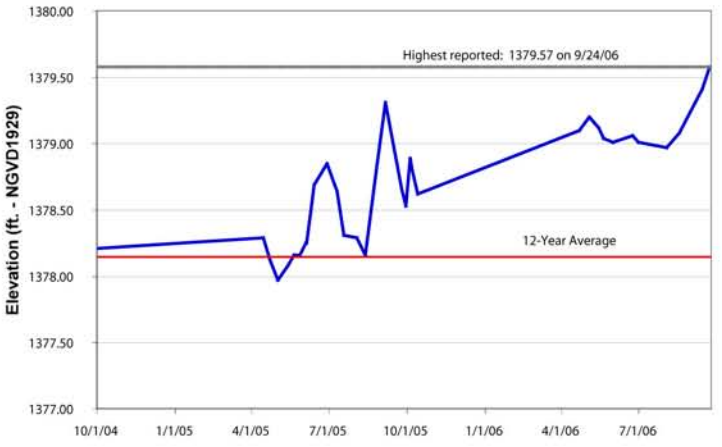


Rush Lake (13-0069), Chisago County
October 2005



South Turtle Lake (56-0377), Otter Tail County
Late Spring 2006

Winona Lake (21-0081), Douglas County
Late Summer 2006



Ten-Year Trends

Information has been collected and reported over a period of more than 10 years for many of the lakes that are currently monitored. A 10-year average may be used as a point of reference when comparing water year data to a shorter or longer time period, or a 10-year climate cycle. It may be useful in discerning trends for an individual basin.

A selection of lakes is shown in Figures 3 and 4. Nine out of 10 of these lakes indicated responses to the dry climate. Any lake level recoveries during the spring were not retained, as the lakes from the northern half and many of the lakes in the central part ended Water Year 2006 below average. Three of the five northern lakes reported their lowest levels of the last 10 years, as well as White Bear Lake from the metro area.

Landlocked Basins

A landlocked lake has no regularly-functioning surface outlet channel, and usually a small watershed. These types of lakes typically experience large, long-term water level fluctuations. The importance of ground water contributions to a landlocked lake can make the lake a good indicator of local ground water levels and movement. Examples of landlocked basins are shown in Figure 5. These lakes also reflect responses to the dry conditions of 2005 and 2006.

Annual Lake Level Fluctuation

Minnesota lakes typically fluctuate one to two vertical feet in a given year, but historical fluctuations have been recorded in excess of 10 feet. Assessing the annual fluctuation can be done by looking at the changes from one Water Year to the next. Another primary evaluation tool is the "starting point," (i.e., the elevation of the lake in spring), and how that compares to the end of the open water season and how that year compares to the "starting point," "end point," and pattern of other years. The lake levels and their patterns can then be evaluated in the context of historical climate data.

The statewide average fluctuation for Water Year 2005 was 1.07 feet, but increased to 1.29 feet for the statewide average during Water Year 2006. Average fluctuations for the past 10 Water Years are shown in the figure below. Link here to tables which display fluctuations, spring and fall elevations, ranges, reported highest and lowest lake levels and their dates, and averages for selected lakes grouped by county.

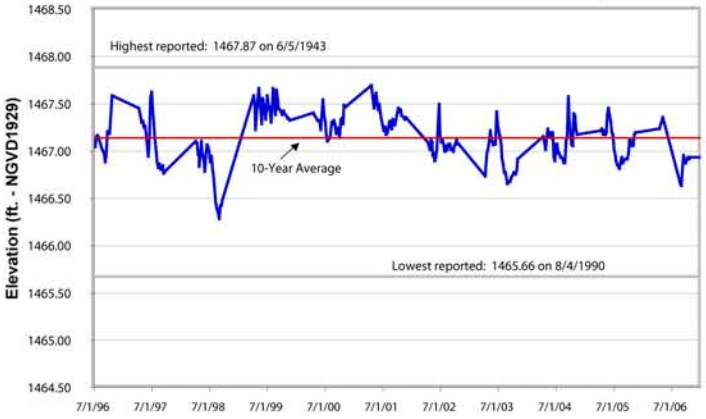
Additional summary information, 10-year trend graphs, and a comprehensive list of all reported lake levels for an individual lake may be found on the DNR Lake Finder web site.

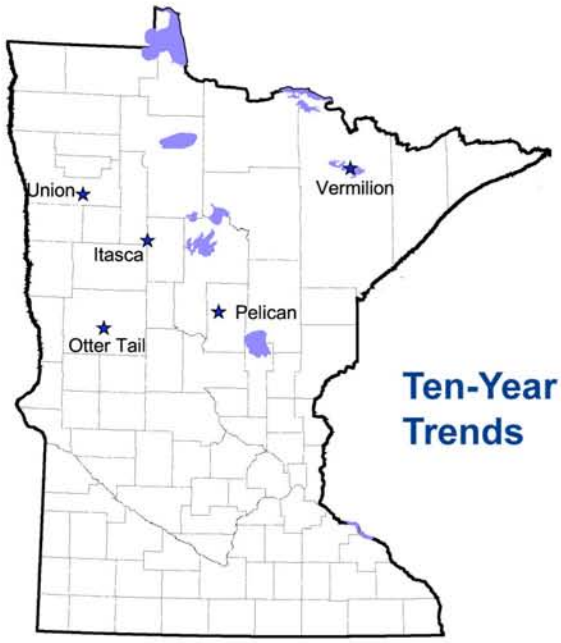
Water Year	Average Fluctuation Statewide (ft.)
1997	1.55
1998	1.04
1999	1.24
2000	1.05
2001	1.97
2002	1.33
2003	1.42
2004	1.24
2005	1.07
2006	1.29

Figure 3

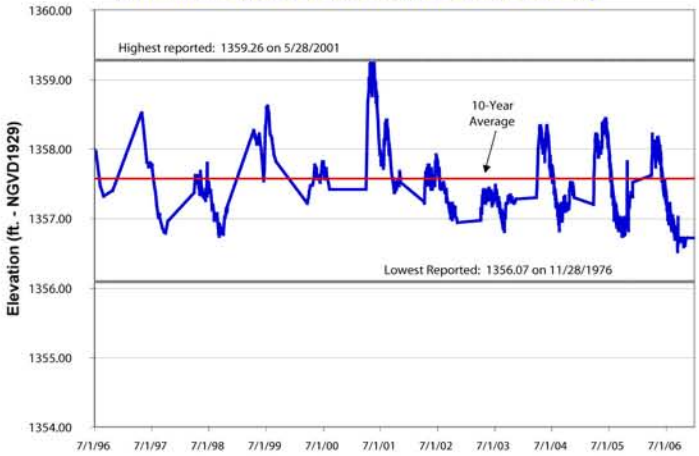
Union Lake (60-0217), Polk County

Lake Itasca (15-0016), Clearwater County

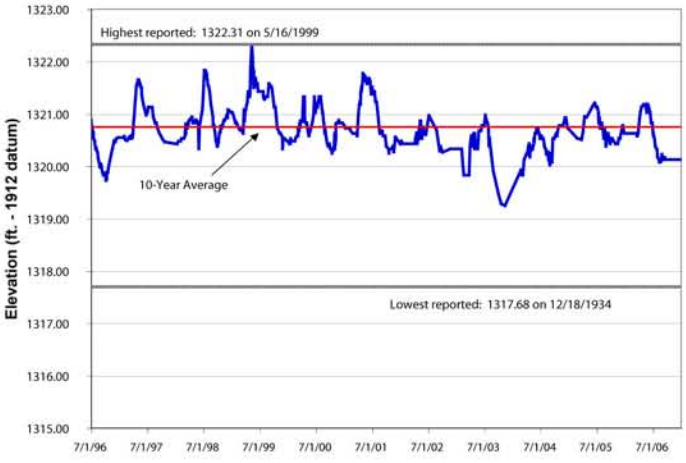




Vermilion Lake (69-0378), St. Louis County



Otter Tail Lake (56-0242), Otter Tail County



Pelican Lake (18-0308), Crow Wing County

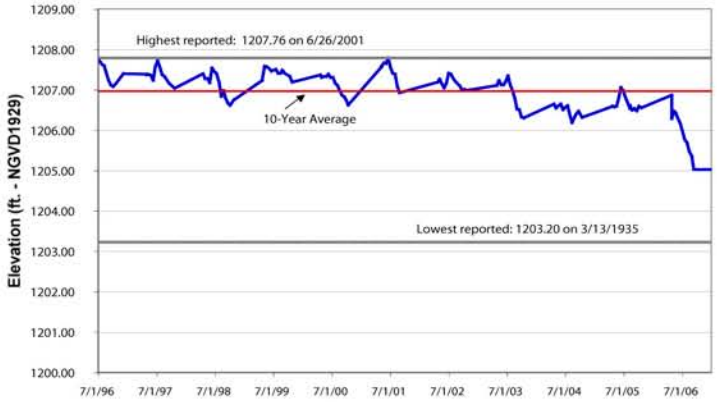
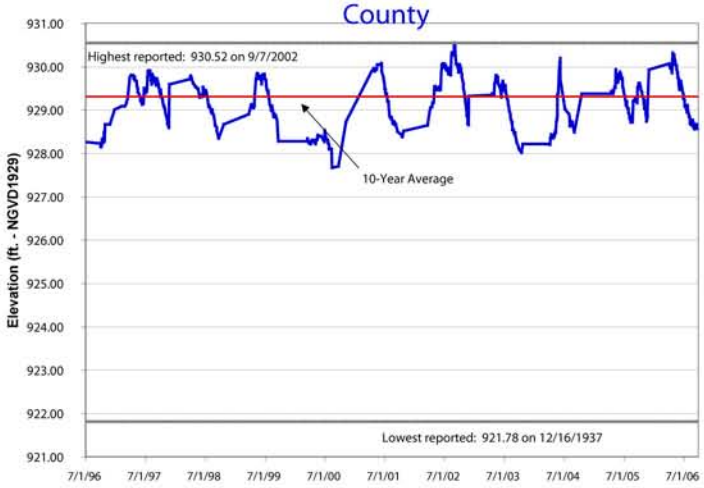
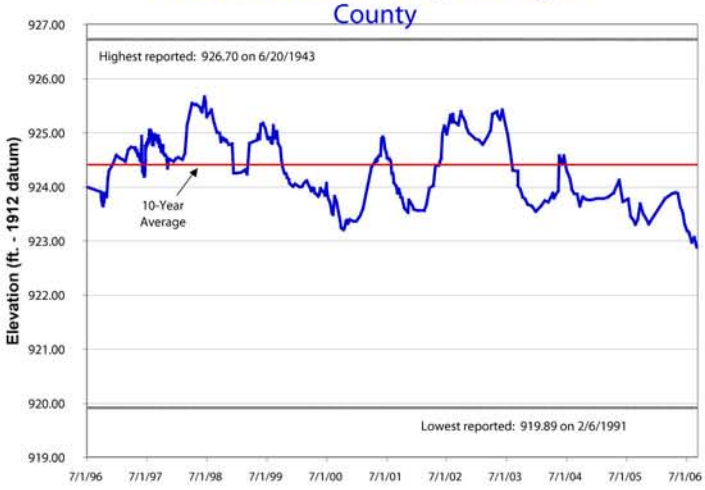


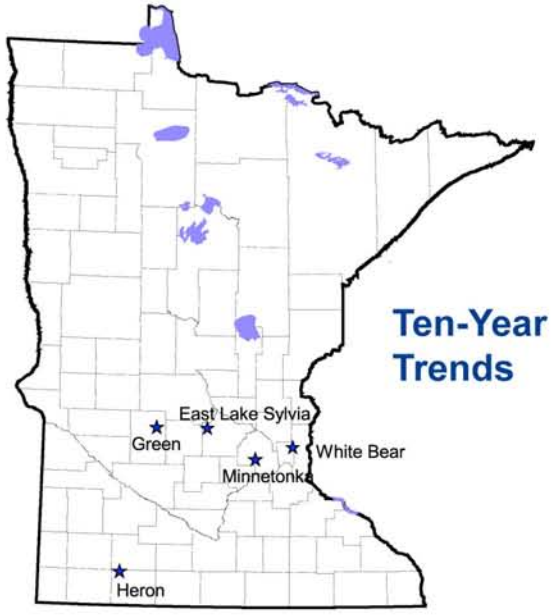
Figure 4

Lake Minnetonka (27-0133), Hennepin County

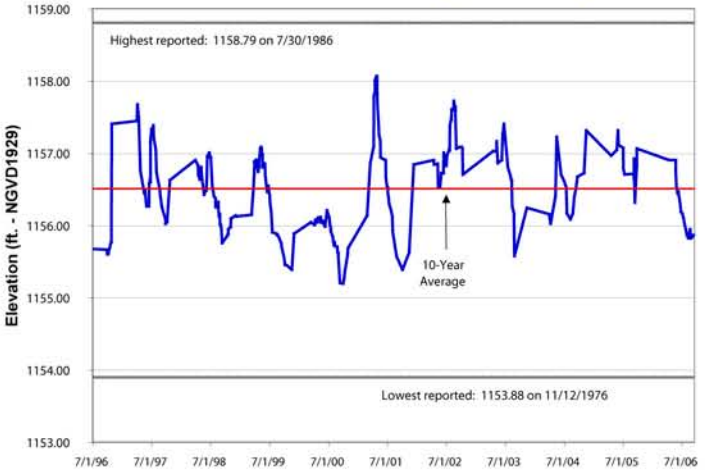


White Bear Lake (82-0167), Washington County

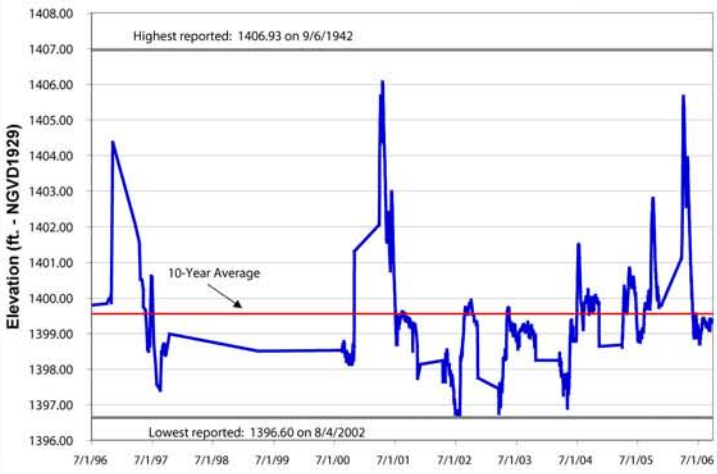




Green Lake (34-0079), Kandiyohi County



Heron Lake (32-0057-01), Jackson County



East Lake Sylvia (86-0289), Wright County

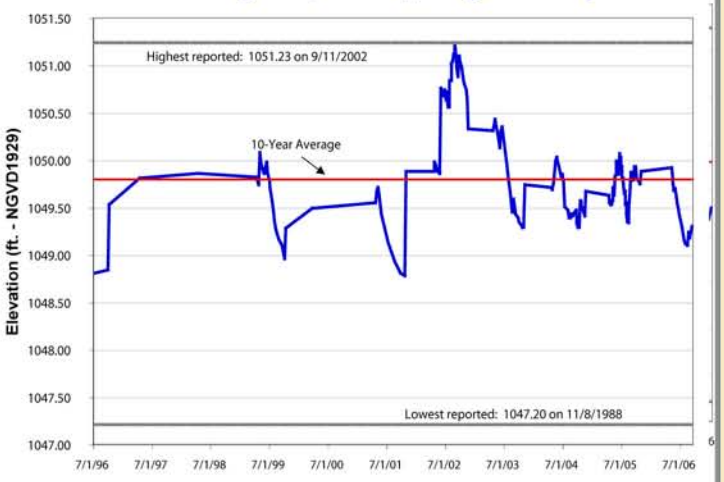
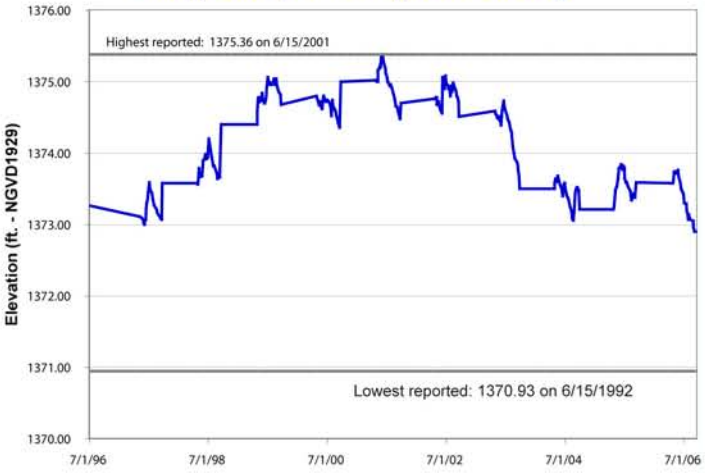
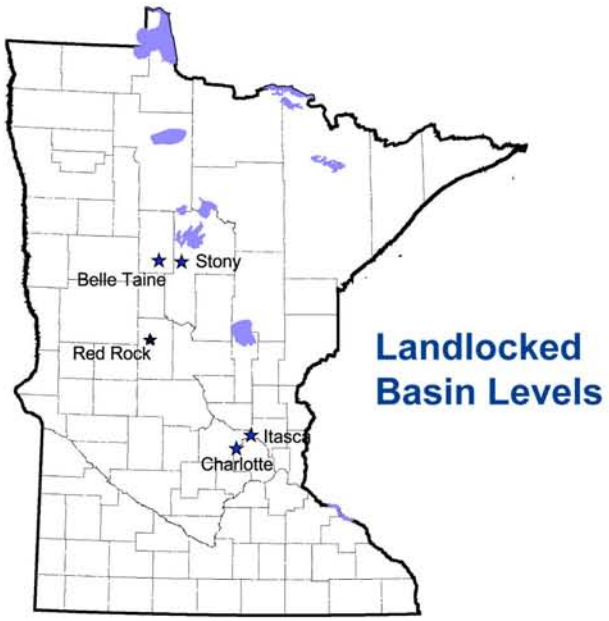


Figure 5

Belle Taine Lake (29-0146), Hubbard County

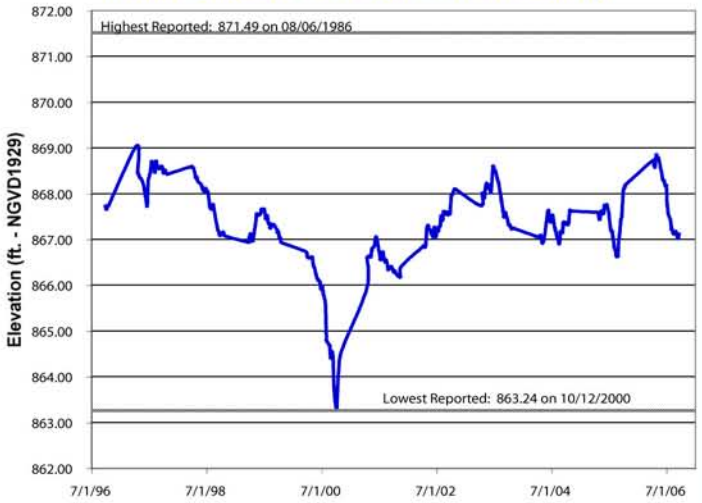
Stony Lake (11-0371), Cass County



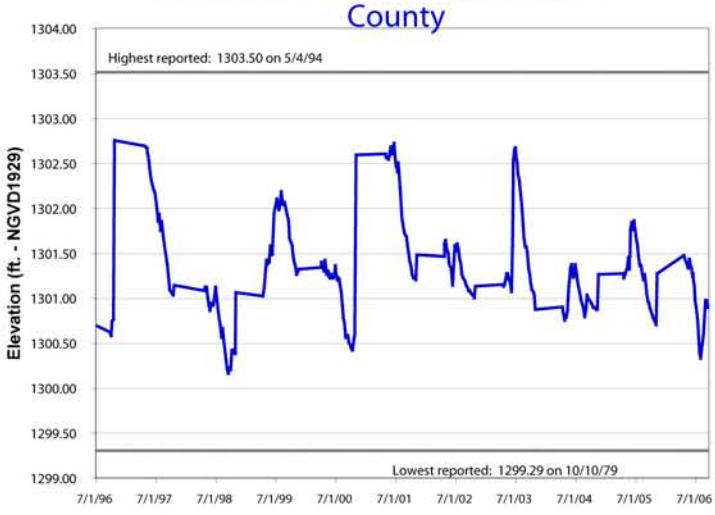


Landlocked Basin Levels

Itasca Lake (02-0110), Anoka County



Red Rock Lake (21-0291), Douglas County



Charlotte Lake (86-0011), Wright County