FLATHEAD LAKE BIO STATION
UNIVERSITY OF MONTANA

FLBS Breakdown of 2023 Flathead Lake Level Data

The following information was presented by Dr Jim Elser, FLBS Director & Member of the US National Academy of Sciences, in his State of the Lake talk at FLBS on 4 August 2023.

- It is important to recognize that Flathead Lake and the rivers that feed it are part of the Columbia River drainage, a vast network of free as well as regulated rivers and lakes. This network of dams and other regulatory structures is governed by a complex system of statutory, regulatory, and contractual arrangements involving federal, state, tribal, and private entities. Short-term changes in operations by individual components of this system are very challenging to implement.

- Given that lower water levels of -3 feet are within the normal annual range of lake level fluctuation and represent only 0.8% of the lake's maximum depth and 2% of its average depth, **we do not anticipate major ecological impacts** in the main body of the lake. Our ongoing 45+-year monitoring record will allow a more comprehensive assessment once data are in hand.

- 2023 was a **low snow year**. Across the upper Flathead drainage, water stored in snow during winter 2022-2023 was only 80% of the long-term median, as exemplified by data from Flattop Mountain (Figure 1). (source: https://www.nrcs.usda.gov/resources/data-and-reports/snow-and-climate-monitoring-predefined-reports-and-maps)

- Spring **snowmelt was exceptionally rapid** in 2023 due to warm temperatures and rain in May. While typically snowmelt persists through June and into July, snowmelt was effectively zero by the start of June. (Figure 1)

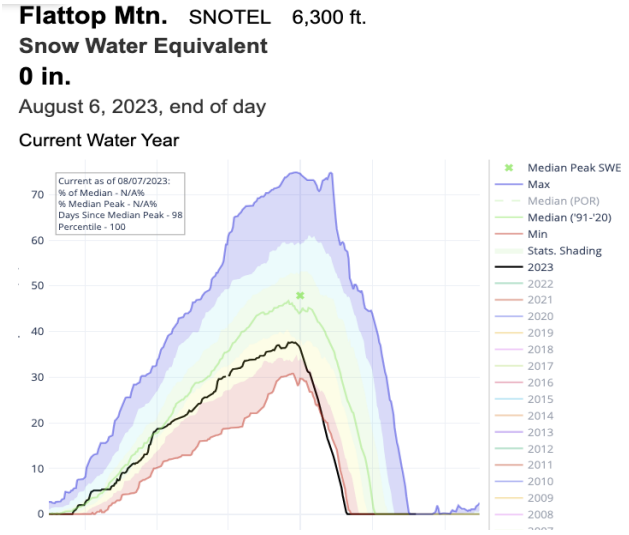


Figure 1. Snow water equivalent (amount of water held in snowpack) for the Flattop Mountain SNOTEL site (west side of Glacier NP) in 2023 (black line) relative to median (green line) and record low (red) and high (blue) values.

- The rapid snow melt appears as a sharp increase in the river discharge data (Figure 2A) and in lake level (Figure 2B) in May and the lake reached near-full pool during the beginning of June. However, river discharge declined precipitously (Figure 2A) as snow melt ceased (Figure 1). Sources: https://waterdata.usgs.gov/ https://flathead.uslakes.info/Level/

- Comparing total annual discharge of the mainstem Flathead River (at Kalispell) from 1 January to 6 August 2023 to median discharge (1969-2023) during those same months, discharge in 2023 was **61% of the median**. We calculate that the volume of river inflow "missing" from 1 January - 6 August 2023 (relative to the median) would have been sufficient to raise the level of Flathead Lake by one foot at least **seventeen times**.

Figure 2A. Discharge of the Flathead River at Kalispell in 2023 (dark blue and yellow data; yellow indicates provisional data) relative to the 1969-2023 median (dotted line).

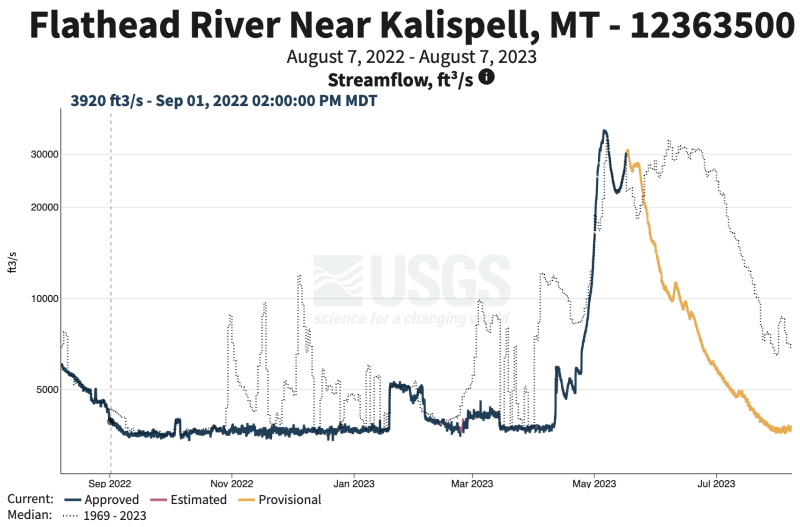
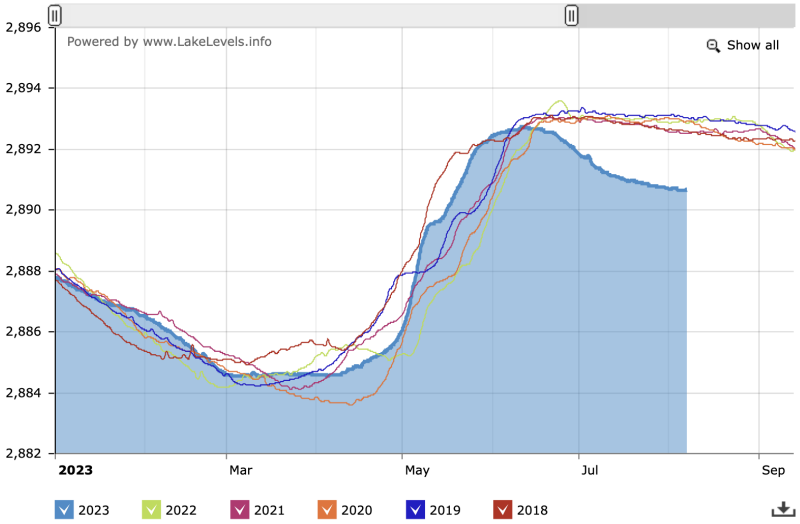
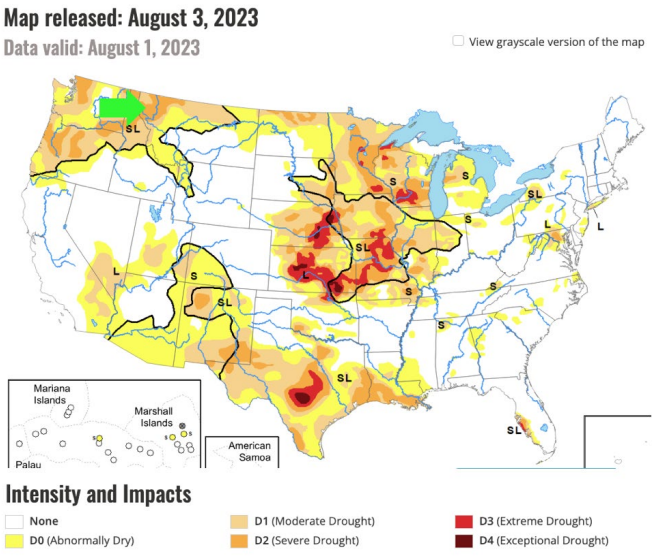


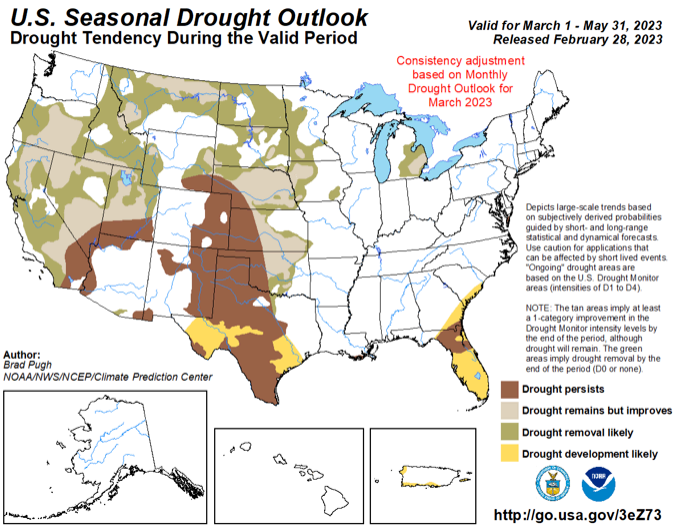
Figure 2B. Level of Flathead Lake (feet above sea level) in 2023 (blue shaded line) relative to other years (2018-2022).





- The low flow conditions we are seeing are consistent with the **severe drought** northwestern Montana has been experiencing in recent years (Figure 3). Indeed, the region remains in severe drought. (source: https://droughtmonitor.unl.edu/)

Figure 3. Map of areas in the USA experiencing various levels of drought (as of August 3 2023). The location of Flathead Lake is given by the green arrow.



- Contributing to the challenges faced by regional water managers, NOAA medium-range forecasts made in late February 2023 predicted (inaccurately) that our region would come out of drought during March - May (Figure 4). While this forecast was adjusted in subsequent releases, this initial forecast may have influenced winter and spring decision-making in the basin. (https://www.cpc.ncep.noaa.gov/products/Drought/)

Figure 4. Map of possible future drought conditions in the USA for projections made on 28 February 2023. Note that northwestern Montana was predicted to be relieved from drought (green color) during March-May 2023.

- This year's low snow conditions are part of **a longer-term and likely ongoing decline in snowpack** in western Montana (Figure 5). Thus, we can anticipate recurrence of these conditions in coming years. Source: EPA 430-F-16-028

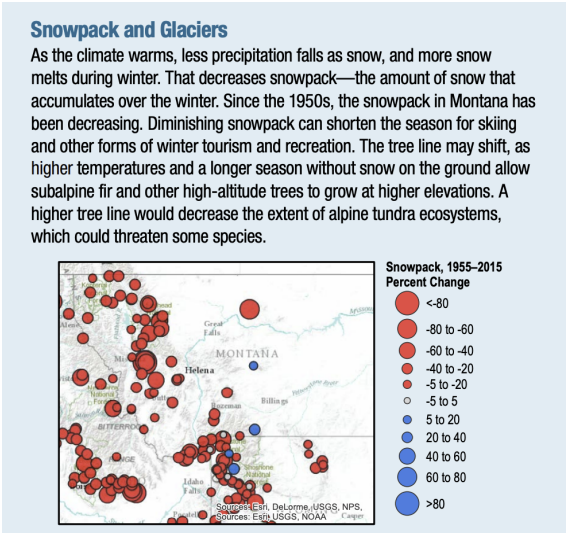


Figure 5. Trends in April snowpack in Montana.

Addendum: Further analysis (all data from USGS)

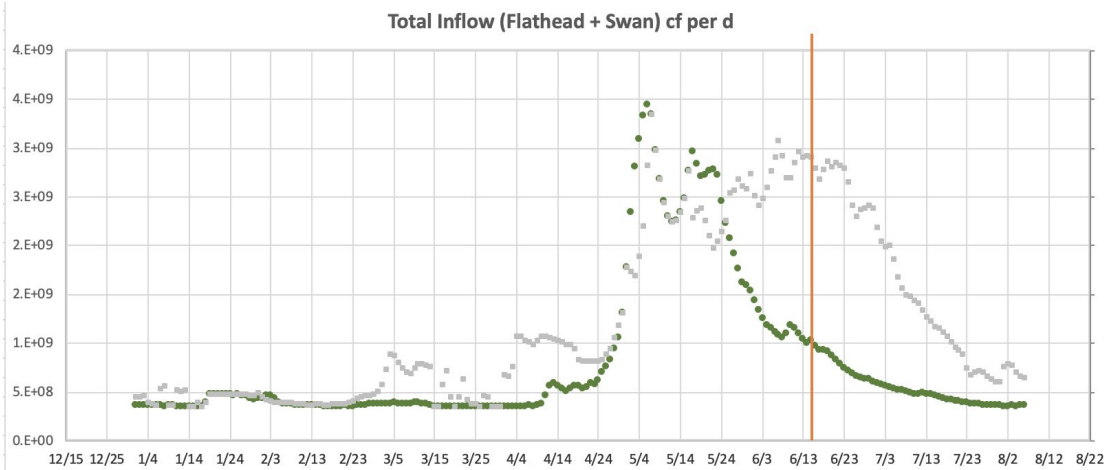


Figure 6: Total river inflow (Flathead River (at Kalispell) + Swan River; cubic feet per day) to the lake for 1 January - 8 August 2023 (green dots). (Previous analysis (Figure 1) included only the Flathead River.) The grey dots indicate the median discharge. The vertical red line indicates 13 June, the date when the lake reached its highest level (2892.71 ft, within 0.29 ft of full pool of 2893 ft).

- In January-August 2023 (Figure 6), total inflow was **63% of median**. During April - June 12, the period when the lake is normally filling, inflows were **78% of median** (similar to the relative snowpack observed). The lake was filled on schedule. However, for the period 13 June - 6 August, inflows were only **34% of median**.

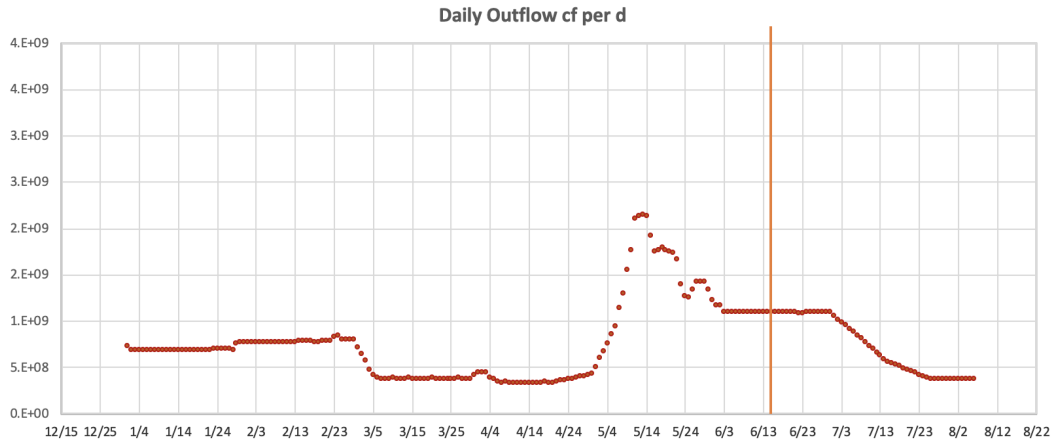


Figure 7. Total flows (cubic feet per day) in Flathead River at Polson for 1 January - 8 August 2023. These data reflect discharges from the dam. The vertical red line indicates the date when the lake reached its highest level.

- Soon after inflows began to rise (Figure 6), discharge also began to rise, peaking on 10 May (Figure 7). Discharges then declined until **reaching a minimum on 3 June, 10 d before lake level began to decline**. This minimum reflects the seasonal minimum discharge mandated by the SKQ operating license. In late June, discharge was ramped down to a second minimum that was reached at the end of July. This down-ramping rate is also specified by the SKQ operating license. Overall, median lake discharge during 1 January - 8 August 2023 was 68% of median with a similar reduction for the 1 April -12 June period when the lake was filled. From 13 June - 6 August 2023, lake discharge was 54% of the median, reflecting the impact of the sustained minimum discharges and downramping that occurred.

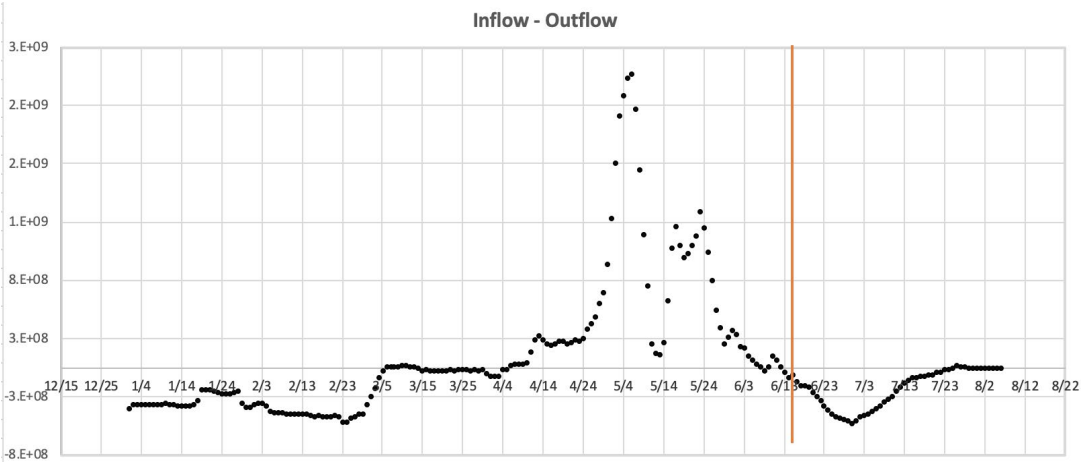


Figure 8. Net flows (Total inflows - dam discharge, cubic feet per day) for Flathead Lake for 1 January - 8 August 2023. The vertical red line indicates the date when the lake reached its highest level.

- Positive water balance (inflows greater than outflows) to the lake **increased sharply at the end of April** (Figure 8) as the snow pack began its extremely rapid melt. Thus, **the lake filled rapidly during the month of May**, allowing (near) full pool to be reached on 13 June (Figure 9). However, by early June inflows had dropped precipitously (Figure 6) and were less than the mandated minimum discharge from the dam that began on 3 June (Figure 7). Thus, **water balance went negative on 13 June** (Figure 8) and lake level began to decline (Figure 9). Note that **once river inflow rates had declined to levels below the mandated minimum discharge rate at the dam, SKQ dam operators had no capacity to maintain lake level**. SKQ dam operators could conceivably have held more water in the lake during May (although their ability to do so is constrained by flood avoidance strictures). This would have filled the lake earlier (risking shoreline erosion due to spring storms and raising flood risk) but **would not have avoided lake level decline after 13 June once river inflows had declined to levels below the mandated minimum discharge rate.**

- When down-ramping of dam discharge began in late June, the negative water balance began to moderate (Figure 8) and the rate of lake level decline (Figure 9) slowed. By the end of July, inflows and discharge came into approximate balance and lake level stabilized at its diminished level.

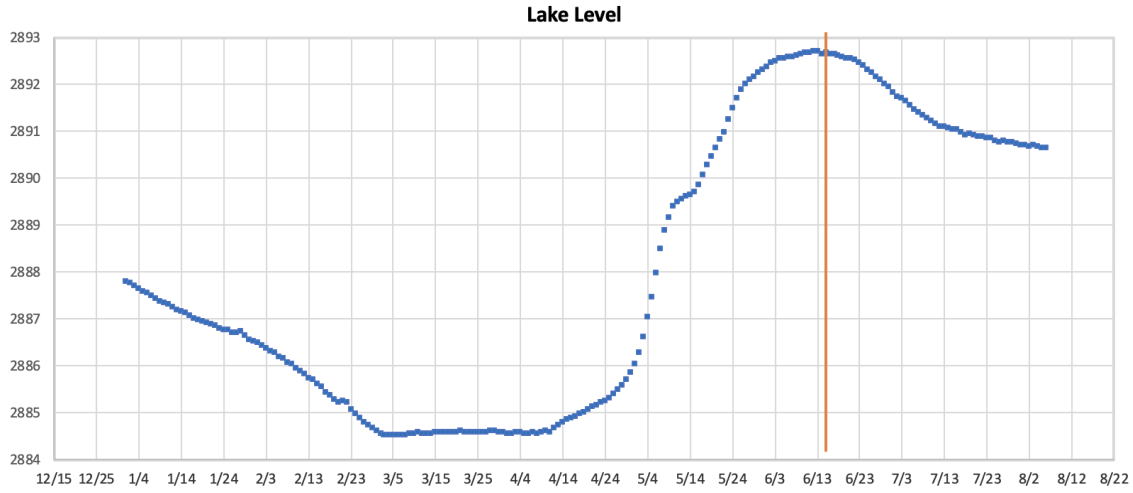


Figure 9. Level of Flathead Lake (feet above sea level) in 2023. The vertical red line indicates the date when the lake reached its highest level.

In light of these challenging limnological, hydrological, and climatic conditions, FLBS recommends that water managers, political leaders, and community members engage in constructive dialogue about adjustments in operations, infrastructure, expectations, and attitudes to cope with the possibility that the difficult situation we are experiencing in 2023 might recur in coming years.