Water Resource Needs for Lakes and Reservoirs

Introduction and Background

The water that sustains lakes and reservoirs is dominantly surface water. The only lake with a developed water budget is Malheur Lake. The estimates of a water budget for Malheur Lake were considered by water resource studies from 1939 to the present. Recharge is dominated by the Blitzen subbasin which contributes more than twice both the Silvies and Silver Creek contributions. The information has a variety of general conclusions; surface water is the dominant source of water that supplies Malheur Lake, the Donner und Blitzen River is the dominant source of flow to reach Malheur Lake, and there is little groundwater supply that currently reaches the lake. Flow from Sodhouse Spring on the Blitzen River side of the lake discharges a relatively small amount of flow to Malheur Lake. The ongoing groundwater study by OWRD and USGS will provide a more current estimate of the water budget in the Harney basin. Current estimates of flow to Malheur Lake is some 80,000 acre-feet/year from the Blitzen and less than 20,000 acre-feet/year from the Silvies River

The primary goal of this evaluation is to provide a qualitative and to the extent possible a quantitative estimation of the water resource needs to maintain Malheur Lake. The inherent variability of the lake level makes the estimation difficult. The maintenance of Malheur Lake conditions is being explored by the Harney Basin Wetlands Initiative. Recent modeling of the lake levels of Malheur Lake (Pearson, personal communication 2019) shows strong correlation between lake levels and previous year level and discharge from the Blitzen River. The modeling of current conditions is able to effectively track historic lake level data from the late 1930's before significant groundwater development (Figure 1).

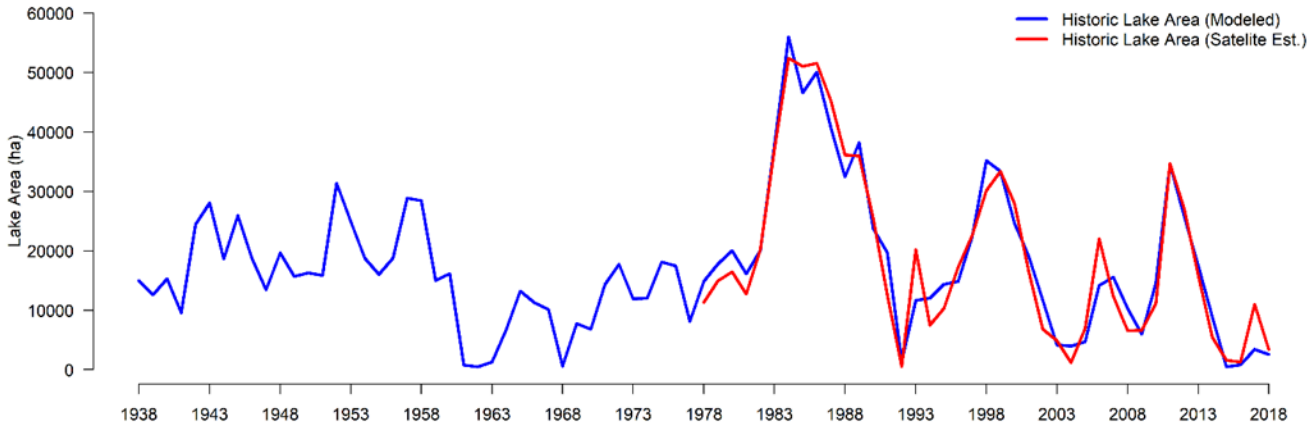

Figure 1: Measured and modeled Malheur Lake levels (from Pearson, 2019)

Modifications to the flow of surface water in the Blitzen River has reduced inflow to Malheur Lake some 60% from average flow levels (USFWS, 2013). The modifications to flow from the Silvies River has reduced inflow to Malheur Lake to occasional (2 to 3 times in a decade) contributions to Malheur Lake

levels. Similarly, groundwater irrigation expansion has had the apparent effect of reducing flow in the Double-O Spring and other springs that fed Silver Creek and Harney Lake.

Ecological Effects

The ecology of Malheur Lake has been disrupted by the introduction of invasive common carp and by reduced flows from tributary streams. Additional changes to the water quality have resulted from the loss of emergent vegetation and subsequent mobilization of sediment and algal blooms. The dynamics of the lake have apparently changed with apparent greater lake level fluctuation from year to year. The change from a clear shallow lake with abundant emergent and submergent vegetation to a turbid lake with little vegetation other than phytoplankton has changed the ability of the lake to support adfluvial redband trout and significantly reduced the nesting and feeding habitat for resident and migratory waterbirds. The Harney Basin Wetlands Initiative is evaluating and pursuing restoration approaches to address this effect. The fluctuations in surface level of the lake affects waterbird use both seasonally and interannually. Higher lake levels support dabbling and diving ducks and piscivorous birds. Lower lake levels expose flats that are used by shorebirds. While general patterns of bird use are known, there is little information on the effect of the magnitude of lake level changes on bird populations.

Cultural Significance

Malheur Lake has been of significant to Great Basin Paiute people for millennia (Elston, et al., 2014). The Burns Paiute Tribe has identified culturally significant plants, animals, and other cultural materials in their Aboriginal Territorial Protection Policy adopted as Tribal Council Resolution No. 2006-12. Malheur Lake and its shoreline is identified as a Sacred Place and Traditional Cultural Properties of the Burns Paiute Tribe by Tribal Council Resolution No. 2016-01.

Malheur Lake is also of significance as one of the early National Wildlife Refuges, created by executive order of President Theodore Roosevelt in 1908, which at the time was a shallow marsh dominated by emergent beds of tule and bulrush.

Current Water Supply

Maintenance of Malheur Lake levels will continue to depend on direct precipitation and runoff from the Steens Mountains. Malheur Lake currently is supplied by flow from the Blitzen River of 224 cfs. of average annual flow before diversions. Diversions reduce flows to some 25 cfs. Fluctuating lake levels will continue to reflect annual precipitation. Since there is little apparent influence from groundwater on Malheur Lake levels, the declining groundwater levels are likely not significantly affecting Malheur Lake. Spring flow into Harney Lake and the Double-O unit of the Malheur Wildlife Refuge has been reduced apparently due to groundwater use for irrigation. The groundwater pumping in the Weaver Springs area has moved the lowest point of groundwater from beneath Harney Lake to the area of greatest pumping according to the most recent groundwater study.

Water rights for reservoir storage from surface and groundwater totals approximately 42,835 acre feet. The majority of the storage occurs in the Silver Creek basin and the majority of all pond storage is for livestock. The total storage is approximately 10% of the volume of water used for irrigation.

The current recharge deficit of 90,000 to 150,000 acre feet/year means that any additional recharge will help to offset the deficit. Recharge through playas has been evaluated in the Great Plains (Gurdak and Roe, 2009; Gurdak and Roe, 2010). The information from the Great Plains indicates that playa recharge is potentially significant. Research on playas in the Harney Basin (Clausnitzer, 2000) also has indications that playas are not evaporation basins since they do not typically form saline crusts and have rather dilute solutions of ions. He summarizes the playa water by:" Surface water in the vernal pool is neither strongly alkaline nor saline; there has apparently not been appreciable long-term accumulation of salts as is observed in other hydrologically closed water bodies in arid and semiarid climates."

Restoration of playas and conservation of playa habitats could help with the recharge deficit. The greatest effort necessary to reduce the deficit is to reduce discharge for agricultural irrigation.

Future Water Supply

As climate changes with increasing precipitation as rain and reduced snowfall, the effect on Malheur Lake is difficult to determine. A possible outcome of changing patterns of precipitation could be a difference in timing of lake levels, with earlier filling from the Blitzen River and subsequently more rapid drawdown during late spring and summer.

Limiting the expansion of groundwater pumping from the south side of Malheur Lake could protect the subsurface flows to Double-O Spring, Sodhouse Spring and other sub surface flows to the Lake. The recent groundwater study (Garcia et al., 2022) states: "*The large variability in discharge at Sodhouse Spring could indicate it lies a short distance from its recharge source, is largely influenced by water-table fluctuations caused by variable stage in the nearby Donner und Blitzen River, responds to multi-year precipitation patterns, and (or) discharges from a highly-transmissive portion of the groundwater system (Gingerich and others, 2022). Stable isotope measurements reported by Gingerich and others (2022) indicate that the source of water supplying Sodhouse Spring is likely recharged from the Donner und Blitzen River.*"

As with all water resources in the Harney Valley, future water resource supplies that maintain Malheur Lake and other lakes and reservoirs will be stressed. Reduced groundwater use will have only a minimal effect on the lakes but management of surface water could affect Malheur Lake and other lakes and reservoirs.

Data Needs and Critical Unknowns

- Hydrology of the Lakes: There is only estimated information on historic contributions of surface water to the lakes. Contributions to Malheur Lake have been estimated but changes to Silver Creek and subsequent contributions to Harney Lake are poorly understood. The effect of changes of the groundwater low point from beneath Harney Lake to the area of Weaver Springs are also poorly known. General effects of groundwater level decline on all the lakes is not well known.
- Ecology of the Lakes: As information on the ecology of Malheur Lake is improved through the Harney Basin Wetlands Initiative, the effects of changing surface and groundwater hydrology can be better evaluated. There is limited information on the invertebrates of the Lakes and the

relationship between habitats of the lake edge and macroinvertebrate communities. There remains uncertainty about the lack of emergent vegetation reestablishment in Malheur Lake.

- Monitoring and Evaluation: Development of a hydrodynamic model to help forecast Malheur Lake levels and turbidity would assist in management. Development of information on sediment supplies to the Lake would help in further assessing turbidity in the Lake. Systematic monitoring of emergent vegetation will help in identifying the conditions that enhance establishment and expansion of emergent vegetation. Connecting avian use data with lake condition information (seasonal size, turbidity, drawdown rate, etc.) could provide management information for the Refuge.

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