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Can the Causeway in the Great Salt Lake be Used to Manage Salinity

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Can the causeway in the Great Salt Lake be used to manage salinity?

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Southern Pacific's railroad causeway, converted to solid fill in 1959, divided the Great Salt Lake into Gunnison Bay to the north and Gilbert Bay to the south and changed the lake's water and salt balance. Gilbert Bay has a higher surface elevation and a lower salinity (typically 8-17%) because it receives nearly all of the fresh stream flow from the Bear, Weber, and Jordan/Provo watersheds. Bear River Bay is considered part of the south arm because the two are connected by an opening in the causeway. With little fresh water, but plenty of evaporation, Gunnison Bay is often completely saturated with salt (~27%). Some water and salt flows through the causeway at breaches and culverts as well as through the fill of the causeway, but this interflow is not enough to equalize salinity or the surface elevation between the north and south arms of the Great Salt Lake.

There is an inverse relationship with lake elevation and salinity, so that as elevation rises in wetter years, salinity decreases (Figure 2). The salt threshold for Great Salt Lake brine shrimp is not well documented, but probably ranges between about 8 – 20%. Even less is known about the salinity threshold for brine flies, but the two species occupy similar habitats in the Great Salt Lake, and thus may have similar salt tolerances.

Figure 1. Railroad causeway with Gunnison Bay on left and Gilbert Bay on right, photo courtesy of Wayne Wurtsbaugh.

We wondered how much the railroad causeway alters natural conditions and what the salinity of the lake would be like had the causeway not been built. To calculate the salinity of the "whole" Great Salt Lake, we used lake elevations to estimate water volume and a measured salt content of 4.9 billion metric tons, until pumping to the west desert in the mid-1980s reduced it to 4.5 billion tons. Without the causeway, we estimate that the "whole" Great Salt Lake salinity would have exceeded the tolerance of brine shrimp in 73% of the years between 1960-2011 (Figure 2B). The fresher Farmington and Bear River Bays would likely have supported brine shrimp during those years, but nevertheless, "whole" lake production would likely have been lower than what actually occurred in Gilbert Bay with the causeway. During those drier years with the causeway, Gilbert Bay had acceptable salinities and supported brine shrimp, brine flies, and the bird community dependent on these prey species. In the very wet years of the mid-1980s, Gilbert Bay became too fresh to support large populations of brine shrimp. Then Gunnison Bay, which at that time was less saline from heavy precipitation, supported brine flies and shrimp (as well as brine shrimp cyst harvesters).

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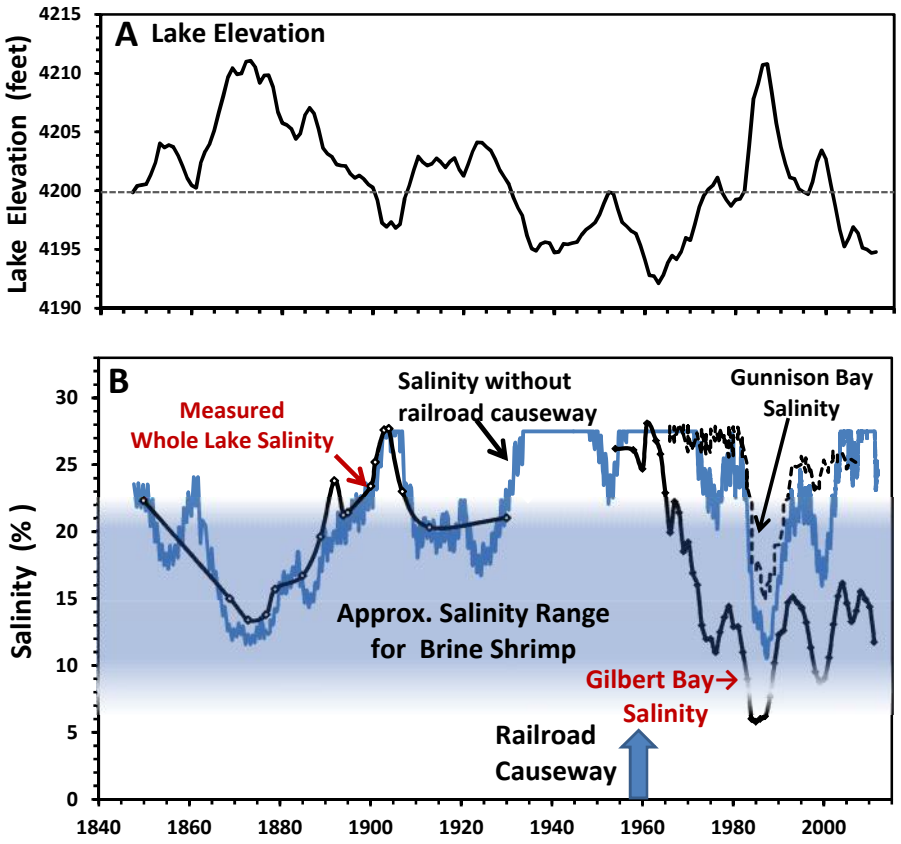

Figure 2. (A) Gilbert Bay elevation. (B) measured Gilbert Bay surface salinities (solid black line from http:// ut.water.usgs.gov/greatsaltlake), estimated "whole" Great Salt Lake salinity (thick blue line), and Gunnison Bay salinities (dashed line).

This illustrates that the causeway provides some benefit by increasing the range of salinity levels throughout the lake during any given year. While the causeway in the Great Salt Lake has certainly altered natural conditions, it has also increased the resiliency of life in the Great Salt Lake by raising the chances that tolerable salinity levels will exist somewhere despite hydrologic variability. But there are tradeoffs. Mineral extraction companies in the south are hurt by a divided and lake, whereas those in north benefit by having saturated brine to utilize. In years when "whole" lake salinity would have been within an acceptable range to support life, the divided lake had a much smaller area for brine shrimp and brine fly production. Another negative is that the causeway causes a deep brine layer to form under about half of Gilbert Bay where brine shrimp and brine flies cannot survive, and where toxic methyl mercury is produced.

If the railroad causeway separating Gilbert and Gunnison Bays were updated with a control structure to manage the flow of water and salt, the causeway might be a management tool to maintain salinity, aquatic life, and industry. Salt lakes worldwide are vulnerable to changes in salinity from hydrologic variability as well as human alteration from water regulation, land use, and climate change. A well-managed causeway could provide some resiliency from these changes.

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