
Photo credit: Kelly Hannah

GREAT SALT LAKE DATA AND INSIGHTS SUMMARY

A synthesized resource document for the 2025 General Legislative Session

January 17, 2025
Version 1.0

In 2024, Great Salt Lake continued to rise from the record-low elevation reached in 2022, aided by two years of above-average precipitation and the adaptive management berm. Economic activity, public health, and the lake's ecosystems continue to be adversely impacted by low water levels. This summary synthesizes essential data and insights so decision-makers have the information they need to improve water management, increase water deliveries to the lake, mitigate adverse impacts, and recover the lake to a healthy range.

UtahState University | The University of Utah | Utah DNR | UDAF | Utah Department of Environmental Quality | Great Salt Lake

Special thanks to Kelly Hannah for allowing the use of his Great Salt Lake photography.

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Glossary

Water Depletion vs. Diversion – Water diversion involves redirecting water from streams or rivers for beneficial uses, such as irrigation or municipal supply. While some diverted water eventually returns to the system as return flows, water that is consumed and does not re-enter the system is considered depleted.

GSL – Great Salt Lake

Municipal and Industrial (M&I) – Includes water use and depletion for commercial, industrial, institutional, and residential purposes.

Natural Flow – The amount of streamflow that would occur if there were no human depletions. It is estimated by adding calculations of depletions to measured streamflow.

Runoff Efficiency – The ratio of the annual runoff amount to annual precipitation amount in a given basin. Higher temperatures and consecutive dry years reduce runoff efficiency by depleting groundwater storage.

Thousand Acre-feet (KAF) – An acre-foot is the amount of water it takes to fill one acre of land one foot deep, typically expressed in this report as thousand acre-feet (KAF) and occasionally referred to by million acre-feet (MAF).

Water year – A 12-month period that begins on October 1st of one calendar year and ends on September 30th of the following year. The period covering October 1, 2022 to September 30, 2023 is the 2023 water year.

Great Salt Lake Strike Team

The Great Salt Lake Strike Team includes researchers from Utah State University and the University of Utah working together with state leads from the Utah Departments of Natural Resources, Agriculture and Food, Environmental Quality, and experts from other entities. Together, these entities join in a model partnership to provide timely, relevant, and high-quality data and research that help decision-makers make informed decisions about Great Salt Lake.

The Strike Team fulfills a two-fold purpose: 1) Serve as the primary point of contact to tap into the expertise of Utah's research universities, and 2) Provide urgent research support and synthesis that will enhance and strengthen Utah's strategies to improve watershed management and increase water levels in Great Salt Lake.

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January 2025

Dear friends,

Great Salt Lake continues to demand urgent action. Low lake elevations created by rising air temperatures and water depletions put at risk the economic and quality of life benefits Utahns receive from the lake, while posing a threat to human and ecological health. Gov. Spencer Cox and the Utah Legislature realize the risks and embrace a data-driven, multi-year strategy to stabilize and raise Great Salt Lake elevation levels and manage salinity levels.

The Great Salt Lake Strike Team supports state leaders by collecting and synthesizing foundational data about the lake. Team members include university researchers from the state's two research universities, state agency experts, and policy specialists. This first-of-its-kind, multidisciplinary, multi-university, and multi-agency collaboration ensures state leaders, non-profit entities, and the public at large benefit from best available information about the lake. It's a unique Utah approach to a hemispheric challenge.

Progress in 2023 and 2024 was hard earned. State leaders funded water infrastructure projects, changed state water law, tightened regulations on mineral extraction, restricted overhead sprinklers and irrigation on government properties, actively managed the berm, and more. In the words of Great Salt Lake Commissioner Brian Steed, "State leaders and the public understand and are acting to conserve, dedicate, and deliver water to the lake."

Restoring a healthy lake is going to take continued work over many years. The data, policies, strategies, and investments formulated over the past few years lay a foundation for long-term success.

We acknowledge—and celebrate—that many other entities join with us to address the lake's decline. We partner closely with the Great Salt Lake Commissioner's Office to analyze policy scenarios and emergent needs and provide relevant and impartial data and analysis.

We appreciate the support of Gov. Spencer Cox and his Cabinet, Senate President Stuart Adams, Speaker Mike Schultz, the Utah Legislature, Presidents Elizabeth Cantwell and Taylor Randall, and other colleagues and partners who support data-informed solutions for the lake. We affirm that actions to ensure a healthy Great Salt Lake are both necessary and possible.

Sincerely, The Great Salt Lake Strike Team

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Executive Summary

The Great Salt Lake Strike Team – a collaboration of technical experts from Utah's research universities and state agencies – analyzes and synthesizes essential data about the lake so decision-makers can make informed decisions.

The Strike Team offers 12 major insights from this analysis.

ECONOMIC, HEALTH, AND ECOLOGICAL

1 **Economic benefits** – Great Salt Lake benefits the Utah economy through industrial activity, aquaculture, and recreation. Low water levels put these benefits at risk.

2 **Health risks from dust** – Dust plumes from over 800 square miles of exposed lakebed pose a health and property value risk to Utahns and can increase snowmelt rates in nearby mountains.

3 **Ecological contributions** – Great Salt Lake wetlands provide vital habitat for as many as 12 million migratory birds. The lake's health requires Utah's environmental stewardship and will be a focal point in the lead up to the 2034 Winter Olympic and Paralympic Games.

HYDROLOGIC

4 **Lake elevation and the 2024 water year** – Above-average precipitation led to another modest rise in lake levels after reaching historic lows in 2022. The water year ended with the south arm elevation staying effectively the same, while the north arm achieved a rise of 2.8 feet. Both arms still remain well below healthy levels.

5 **Reservoir storage** – Reservoir storage levels in the Great Salt Lake Basin reached a high of 91.6% in July 2024, before declining to 73.4% in October 2024, which is significantly higher than average.

6 **Salinity** – After peaking in 2022 and causing adverse effects to brine shrimp health, salinity declined in 2023 and 2024, staying mostly within the healthy range.

7 **Precipitation, air temperature, groundwater storage, and headwater streamflow** – Increasing annual average air temperature and declining groundwater storage have resulted in declining headwater streamflow to reservoirs and rivers that supply water for all uses in northern Utah.

8 **Human water use (depletions)** – Human consumptive water use (depletions) increased over the 19th and 20th centuries but has remained relatively stable over the last 40 years. Current depletions are at levels too high to restore a healthy Great Salt Lake.

9 **Trends in air temperature, precipitation, and evaporation** – Climate models project that future increases in precipitation will be overshadowed by rising air temperatures and evaporation.

10 **Conservation planning** – Three future hypothetical lake elevation scenarios are considered, from very low to very high water conservation levels. The baseline (no additional conservation) scenario shows persistent lake level declines. The scenario with 250 KAF/yr of additional streamflow shows a reversal of the long-term downward trend of the lake, resulting in rising lake levels. The scenario with 770 KAF/yr of additional water results in lake levels in the "healthy" category for 45% of the potential future simulations. None of these scenarios represent specific policy recommendations.

WATER RIGHTS AND CHANGE APPLICATIONS

11 **Water rights** – To date, 288,000 acre-feet of water have been approved for beneficial use for the lake and its managed wetlands. While these changes do not mean this water is delivered to the lake nor do they necessarily represent new water that will go to the lake in the future, it does demonstrate that water rights holders engaged in the process to change water rights for the benefit of Great Salt Lake.

MINERAL EXTRACTION

12 **Mineral extraction** – Compass Minerals, Morton Salt, North Shore Limited Partnership, and Earth's Elements agreed to voluntarily reduce water diversions depending upon the level of Great Salt Lake.

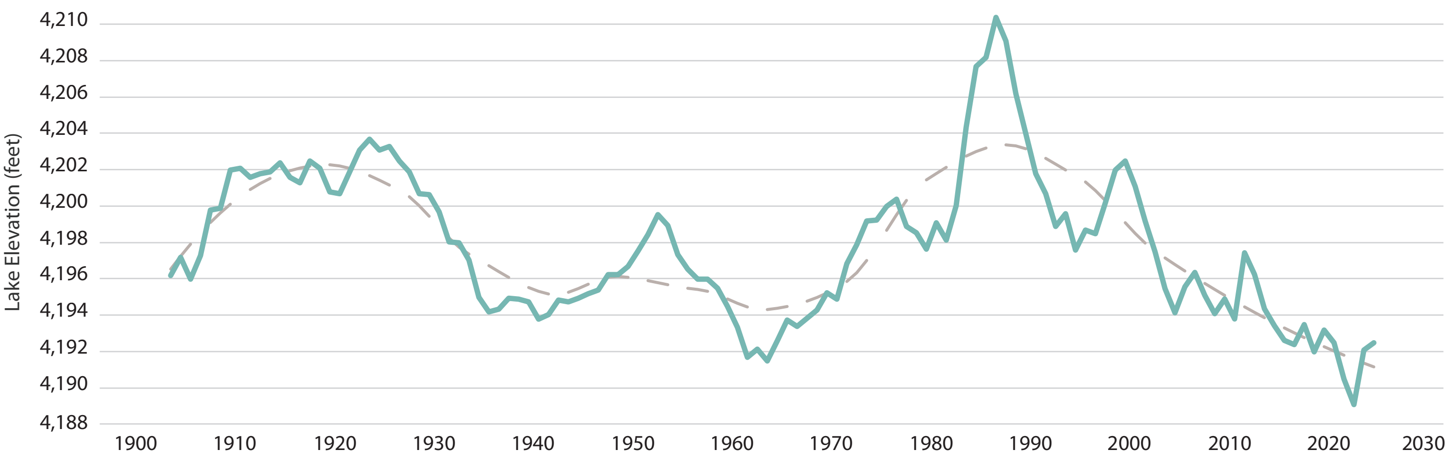
GREAT SALT LAKE:

Five Lessons Learned in 2024

The Great Salt Lake Strike Team engaged in thousands of hours of work over the past year to synthesize existing research, prepare new analyses, evaluate alternatives, and consult with the Office of the Great Salt Lake Commissioner. We learned five broadly applicable lessons in 2024:

- **More tools in the toolbox**
  The development of data, resources, policy, and organizational structure over the past two years better position Utah to address Great Salt Lake challenges. The foundation is in place for enduring success.
- **Details matter**
  To positively impact lake levels, policies and programs need to address all aspects of conservation, dedication, and delivery of saved water. Being attentive to details requires dedication and resources.
- **Cost of doing nothing**
  All indications demonstrate that delivering more water to the lake is a far more cost-effective solution than managing the impacts of a perpetually low-level lake. We can invest the time and financial resources now, or pay a lot more later.
- **Long game**
  Addressing Great Salt Lake's low elevation levels is not a short-term emergency response exercise, but rather requires long-term intentional management. The state of Utah must lock in for a strategic and multi-decade response.
- **Leadership…pass it on**
  Today's leaders must pass on what they've learned about managing the lake to each new generation of decision makers. New leaders must be careful to reject the time-honored tradition of supplanting the priorities of previous leaders with their own short-term thinking. Success requires a long-term leadership commitment to the lake.

Water-year-end Elevation of Great Salt Lake South Arm, 1903-2024



Note: Solid line shows actual lake levels. Dashed line shows the smoothed trend line.
Source: US Geological Survey Historical Elevation at Saltair Boat Harbor

Major Milestones: 2024

Ecosystem conditions

- **Lake elevation** – Increased inflows during 2024 were spread across both arms of the lake, resulting in a stable elevation for the south arm and larger gains for the north arm (2.8-foot rise). Both arms still remain well below healthy levels
- **Ecosystem recoveries**
  - Brine shrimp populations increased, with egg numbers up 50% from last year.
  - American white pelicans returned to nesting sites on Gunnison Island and were newly found nesting at Hat Island this year after completely abandoning their nests on Gunnison Island last year.
  - The Intermountain West migratory shorebird survey is the first comprehensive census for birds in 30 years.
- **Invasive species** – Additional efforts were implemented to help mitigate water-intensive phragmites, with removal of 15,600 acres by the Division of Forestry, Fire and State Lands (FFSL), plus many more by other entities. Additionally, the Utah Legislature provided funding to FFSL and the Division of Wildlife Resources to increase the number of staff working on eradicating phragmites.

Additional funding

- The U.S. Bureau of Reclamation directed **$50 million** toward Great Salt Lake preservation projects.
- Utah awarded **$5.4 million** to four projects, supporting 6,000 acres of Great Salt Lake wetlands through state and non-governmental efforts.
- Utah allocated **$22 million** for Great Salt Lake water infrastructure projects through the HB3 budget bill.
- The federal government provided **$3 million** for stream gauges and buoys at the Great Salt Lake to monitor water and ecosystem conditions.
- The Legislature allocated **$15 million** to the Great Salt Lake Commissioner's Office, including funding to lease Ogden water for delivery to the lake via Willard Spur.
- Utah SB270 allocates **$1.5 million** for a Utah Lake study to explore improving water flow to the Great Salt Lake by 2025.

Water donations and releases

- Jordan Valley Water Conservancy, Welby Jacob Water Users, and the Church of Jesus Christ of Latter-day Saints released approximately **10,000 acre-feet** from Utah Lake to the Great Salt Lake via the Jordan River in September.
- Compass Minerals agreed to forgo **200,000 acre-feet** of future water use, and Morton Salt agreed to forgo **54,000 acre-feet** of future water use. Both companies also agreed to cease all usage if the lake drops to 2022 levels.
- In 2024, water conservancy districts released stored water during the winter, including approximately **700,000 acre-feet** of water that was released through the Jordan and Weber systems.

Policy and programs

- The federal **Great Salt Lake Stewardship Act** expands the Central Utah Completion Act, unlocking unused funds for water conservation and lake replenishment.
- The federal government designated 2.7 million acres as the **"Great Salt Lake Sentinel Landscape,"** recognizing its importance for national defense and conservation.
- **Utah HB453** tightens regulations on Great Salt Lake mineral extraction, establishes a water distribution management plan, and dedicates mineral revenue to lake conservation.
- **Utah SB18** allows agricultural water users to lease or sell saved water value through measures approved by the state engineer.
- **Utah HB11** restricts overhead sprinklers in new government construction and limits overhead spray irrigation within the Great Salt Lake Basin.
- **Utah SB211** establishes the Water District Water Development Council to forecast generational water needs and manage Utah water projects strategically.

Studies and strategies

- **Plans**
  - The Great Salt Lake Commissioner released the **Great Salt Lake Strategic Plan** in January 2024.
  - The Utah Division of Water Resources and Bureau of Reclamation finalized the **Great Salt Lake Basin Work Plan**, outlining its integrated water strategy.
  - The Great Salt Lake Watershed Trust unveiled a **five-year plan** aiming to deliver 100,000 acre-feet annually to the lake by 2028.
  - The Great Salt Lake Commissioner's Office outlined eight **priorities for dust management**, focusing on hotspot research, mitigation testing, and improving lake water levels.
  - The Division of Water Resources released a **water pricing study**, suggesting clarification on economic vs. conservation priorities for determining costs.
  - Utah will study engineered structure alternatives for **managing the Union Pacific causeway berm**, crucial for Great Salt Lake salinity and ecosystem health.
- **Research**
  - Utah State University and Utah Division of Water Rights release **Measurement and Infrastructure Gap Analysis in Utah's Great Salt Lake Basin**.
  - University of Utah researchers found **Great Salt Lake's exposed playa** sediments are potentially more harmful to air quality than other Wasatch Front dust sources.
  - The Utah Geological Survey launched the **Utah Groundwater Data Hub**, offering public access to groundwater data with interactive maps and visualization tools. Senate Bill 2 funded efforts to summarize Utah aquifer knowledge.
  - A Utah State University study found the shrinking Great Salt Lake exacerbates drought, reducing precipitation along the Wasatch Front by up to 50% if the lake were to be completely dry.
- **Other actions**
  - A conservation group petitioned the U.S. Fish and Wildlife Service to list Wilson's phalarope as threatened under the Endangered Species Act.
  - Utah HB249 prohibits granting legal personhood to water bodies, despite conservation groups' arguments that it could enhance protections for the Great Salt Lake.

Data and Insights Summary

The Great Salt Lake Strike Team continues to monitor lake elevation, reservoir storage, salinity, streamflow, and human water use. Enhanced modeling efforts also chart the course for returning the lake back to healthy elevations.

Great Salt Lake Elevation, Reservoir Storage and Salinity

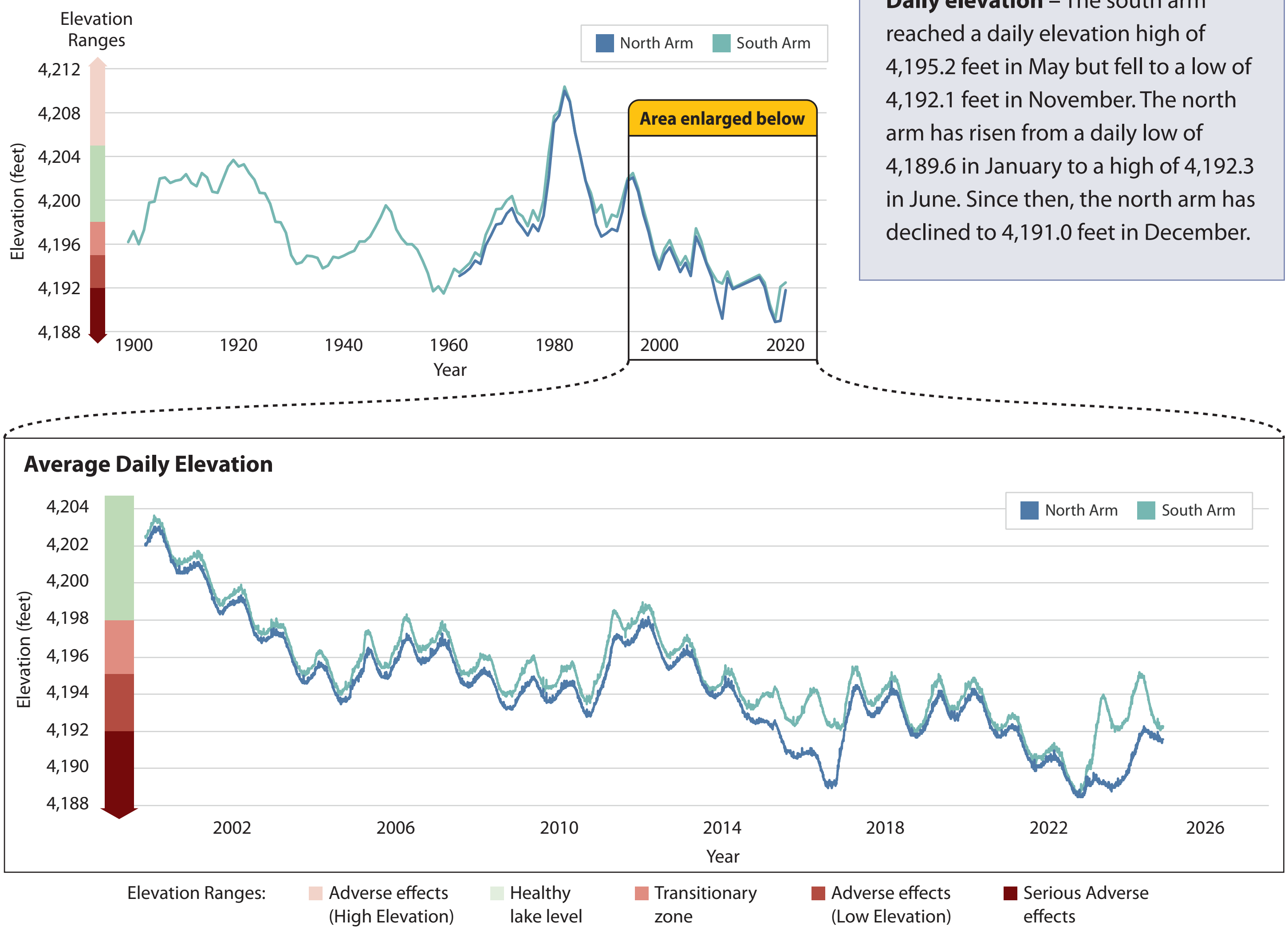
Aided by above-average precipitation in 2023 and 2024, the elevation of Great Salt Lake continues to rise after reaching historic lows in 2022. However, the elevation of the north and south arms remains critically low, still within the range of "adverse effects." Reservoir storage remains above average, and salinity has declined since reaching concerning levels in 2023.

Insights

Water-year-end elevation – The 2024 water year ended with a small gain for the south arm (0.4-foot rise) and larger gains for the north arm (2.8-foot rise).

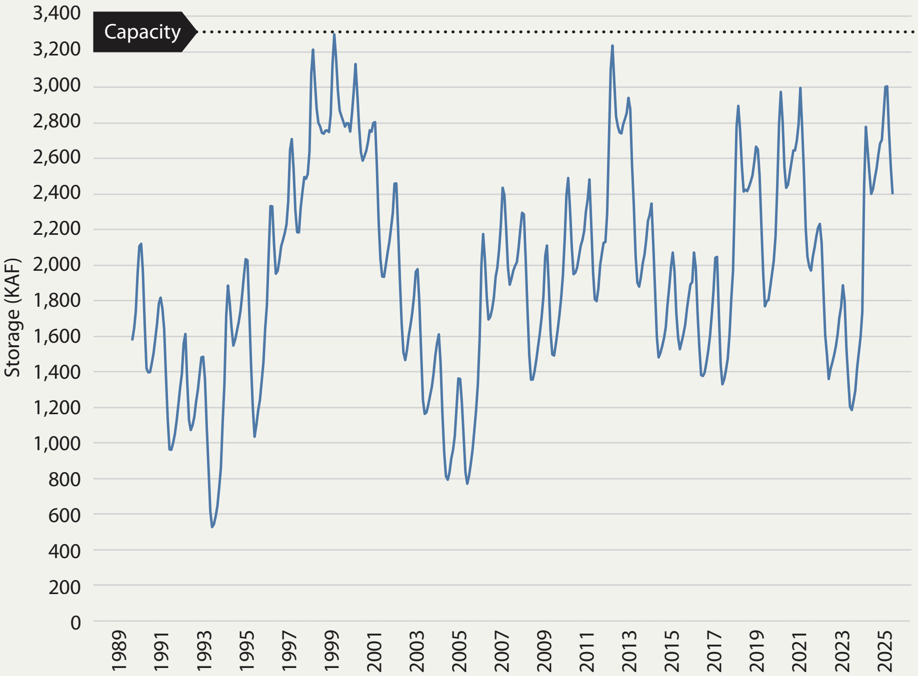
Daily elevation – The south arm reached a daily elevation high of 4,195.2 feet in May but fell to a low of 4,192.1 feet in November. The north arm has risen from a daily low of 4,189.6 in January to a high of 4,192.3 in June. Since then, the north arm has declined to 4,191.0 feet in December.

Figure 1: Elevation of Great Salt Lake North and South Arms, 1903-2024
Water-year-end Elevation



Note: From 1903-1959, daily elevation was collected once a month. In 1960, the elevation was collected twice monthly. Starting in 1990, the data were collected daily. Recently, data are collected multiple times a day but averaged for a single daily average value.
Source: US Geological Survey Historical Elevation at Saltair Boat Harbor and Saline, UT.

Figure 2: Reservoir Storage in the Great Salt Lake Basin, 20 Largest Reservoirs, 1989-2024



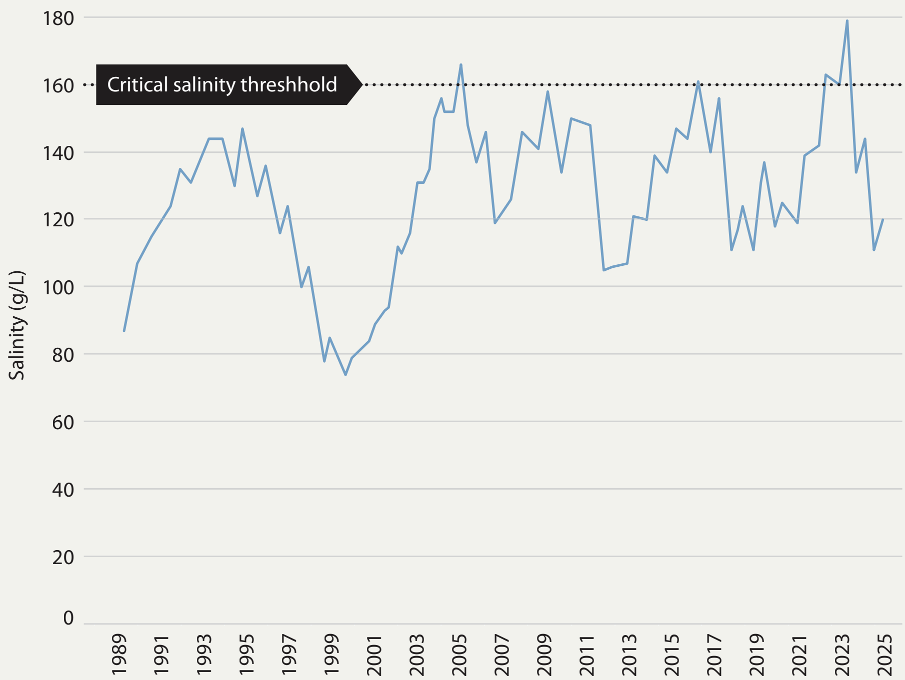
Sources: US Department of Agriculture, National Water and Climate Center. (2024). Air & Water Database Report Generator; US Bureau of Reclamation (2024). Reservoir Data Site Map; Bear River Commission. (2024). Teacup Diagram of Reservoirs; Utah Division of Water Resources. (2024). Reservoir Levels.

Insights

Reservoir storage gains – In November 2022, reservoir storage reached its lowest level since 2005, at 36.3% of capacity. In 2024, reservoir storage reached a high of 91.6% of capacity in July before declining to 73.4% in October.

Great Salt Lake Basin reservoirs – The Great Salt Lake Basin contains hundreds of reservoirs. However, the 20 largest reported here account for approximately 92% of storage capacity. These reservoirs are constructed to store water for agricultural, municipal, and industrial use. Bear and Utah Lakes are naturally occurring water bodies that are managed like reservoirs and are included in these reservoir storage totals.

Figure 3: Salinity of Great Salt Lake South Arm, 1989-2024



Source: Utah Geological Survey. (2024). EOS Salinity at site AS2, 10-foot depth.

Insights

Healthy south arm salinity – Maintaining the ecological integrity of Great Salt Lake requires salinity to be below 160 grams per liter. Declining freshwater inputs and greater evaporation from higher air temperatures result in higher salinity. Management of salinity has been focused on the south arm.

Salinity returns to healthy levels – South arm salinity peaked in 2022, with adverse effects to brine shrimp and brine fly health. Since then, salinity has declined, staying mostly within the healthy range.

Impact of the berm separating the north and south arms

Great Salt Lake separated into two arms – In 1959, a rock-filled causeway was completed that separated Great Salt Lake into two separate bodies of water – the north and south arms. Two culverts along the causeway allowed water to flow between the two arms until 2012, when they were filled in.

Major tributaries flow into the south arm – The Great Salt Lake's major tributaries (Bear River, Jordan River, and Weber River) all flow into the south arm of Great Salt Lake. As a result of the causeway and freshwater inflows to the south arm, the south arm is less saline and is typically higher in surface elevation.

Focus on the south arm – Official state policy is to manage Great Salt Lake, including both arms, as a single lake. Great Salt Lake managers focus primarily on the salinity and elevation of the south arm of the lake for several reasons. First, the ecological integrity of the lake resides in the south arm. Brine shrimp and brine flies are abundant in the south arm, while the north arm is typically too saline to support brine shrimp and brine fly populations. Second, the major dust hotspots of concern occur in the south arm, particularly in Farmington and Bear River Bays.

Creating an adaptive management berm – In 2016, a breach in the causeway was created to restore flow between the two arms of the lake. The elevation of the berm in the breach can be used as an adaptive management tool, controlling the flows between the north and south. In 2022, the berm was raised four feet to prevent north-arm brines from flowing to the south. While this was very effective, drought persisted, and the berm was raised another four feet in 2023 to restrict flows in both directions, effectively acting as a dam. Due to the above-average snowpack, the south arm overtopped the berm and flowed to the north, eventually eroding the berm by nearly five feet in the center. Lake managers intentionally left this open to export salt to the north arm, stabilize lake levels, and reduce overall salt mass in the south arm. In 2024, the Utah Legislature provided the Division of Forestry, Fire, and State Lands with funding to begin the design of an engineered structure that will allow the state to more effectively and adaptively manage salinity and water between both arms of the lake.

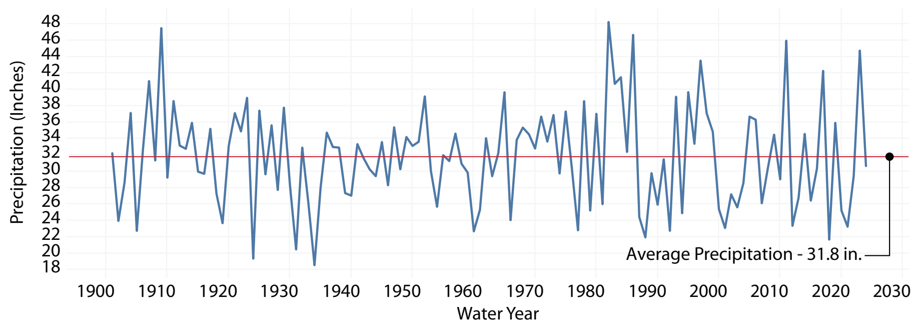
Precipitation, Air Temperature, Ground Water Storage, and Headwater Streamflow

Approximately 95% of the water available for all uses in the Great Salt Lake watershed originates as streamflow and groundwater in the mountains of northern Utah. Understanding how these sources respond to climate is key to predicting and managing downstream water supply.

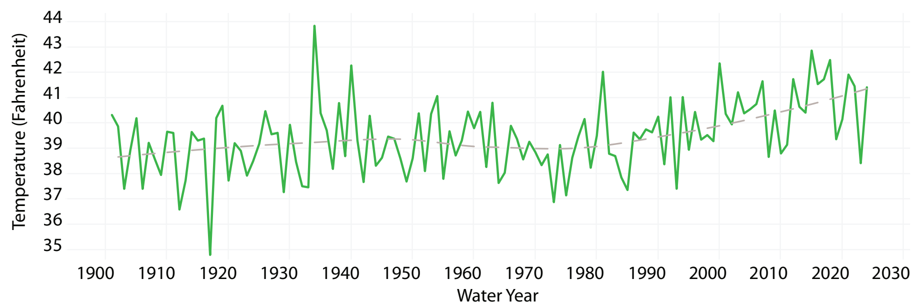
In northern Utah, precipitation shows no long-term trend, but air temperature has increased. Warmer temperatures and consecutive dry years reduce groundwater storage and runoff efficiency (or the fraction of precipitation that becomes streamflow), reducing water availability for all uses.

Figure 4: Historical Precipitation, Temperature, Groundwater Storage, and Headwater Streamflow in Great Salt Lake Headwaters

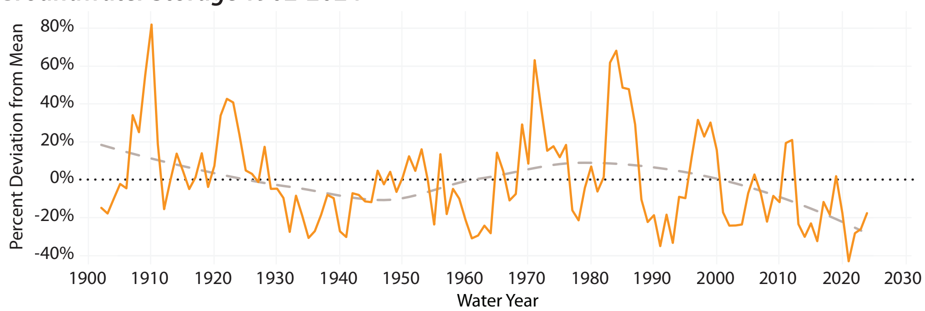
Precipitation, 1901-2023



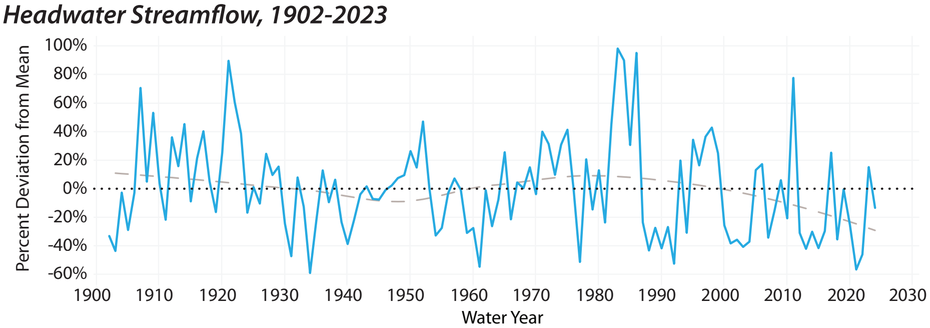
Air Temperature 1905-2024



Groundwater Storage 1902-2024



Headwater Streamflow, 1902-2023



Source: Brooks, P, Wolf M., and Olds, B. (2024). Department of Geology and Geophysics, University of Utah.

Insights

Precipitation - There has been no change in mean annual precipitation in the mountains of northern Utah. Since 2000, precipitation has been below average in 17 out of 25 years. In this period, three of the highest precipitation years on record have also occurred (2011, 2017, and 2023).

Air Temperature - The annual average air temperature in the mountains of northern Utah has increased by approximately 2 degrees Fahrenheit since 1983. Between 1901 and 1999, the average annual temperature was 39.1 degrees. Since 2000, only four years have been at or below this temperature.

Groundwater storage - Higher temperatures and consecutive dry years interact to reduce groundwater storage, which decreases runoff efficiency and streamflow in subsequent years. Groundwater storage in the headwaters has declined since the 1980s, reaching the lowest level in 2021. Since then, groundwater storage has steadily increased, but remains 18% below the mean in 2024.

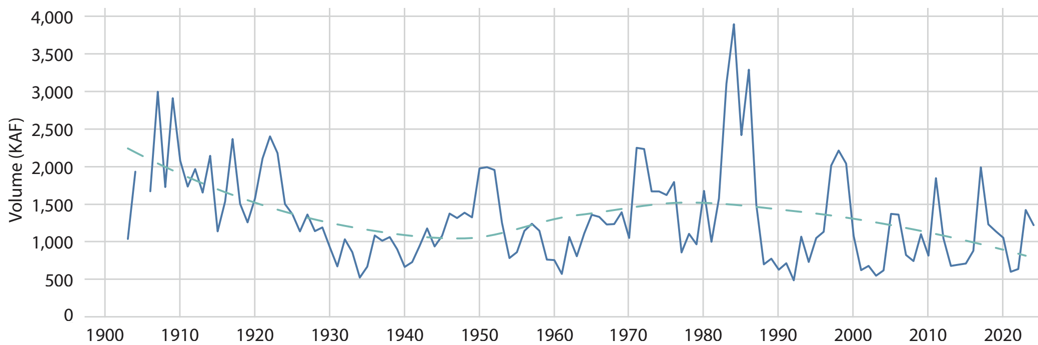
Headwater streamflow - Warmer temperatures, consecutive dry years, and declining groundwater storage have combined to reduce headwater streamflow in the Great Salt Lake Basin since the 1980s.

River Inflow to Great Salt Lake

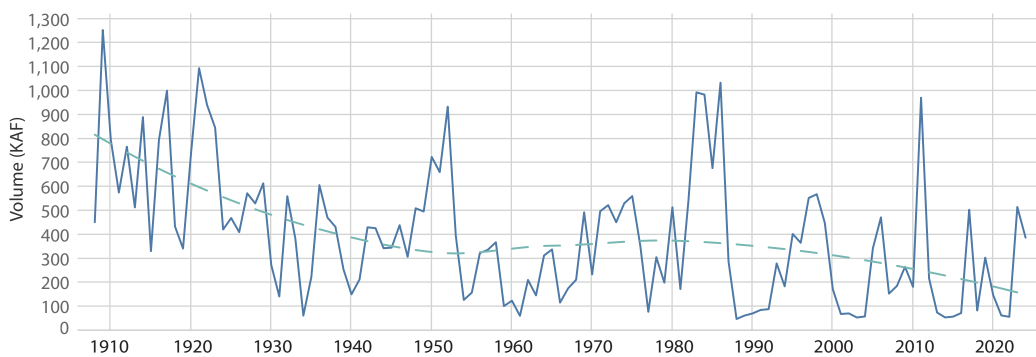
River inflow to Great Salt Lake is a function of total supply from headwater streams (pg. 11) minus consumptive use, known as depletion (pg 13). Inflows are highly variable, but have generally declined since 1900.

Figure 5: Bear, Weber, and Jordan River Streamflow, 1903-2024

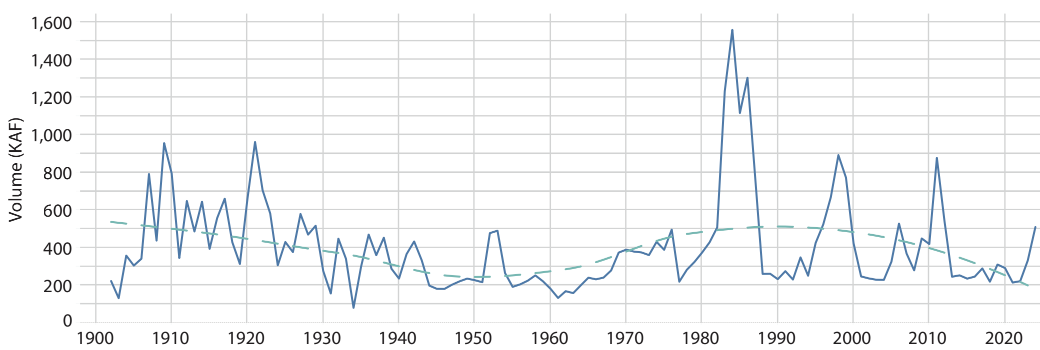
Bear River



Weber River



Jordan River



Sources: US Geological Survey. (2024). Bear River outflow (Gage 10127110 near Corinne, UT), Weber River outflow (Gage 10141000 near Plain City, UT), Jordan River outflow (Gage 10170490 with 1902-1943 modeled by Margaret Wolf, University of Utah).

Insights

Headwater streamflow/ total supply - Year-to-year variability in precipitation and air temperature drives variability in water supply. Warming air temperatures, consecutive dry years, and decreasing groundwater storage decrease runoff efficiency (the fraction of precipitation that becomes streamflow), further reducing streamflow relative to long-term averages.

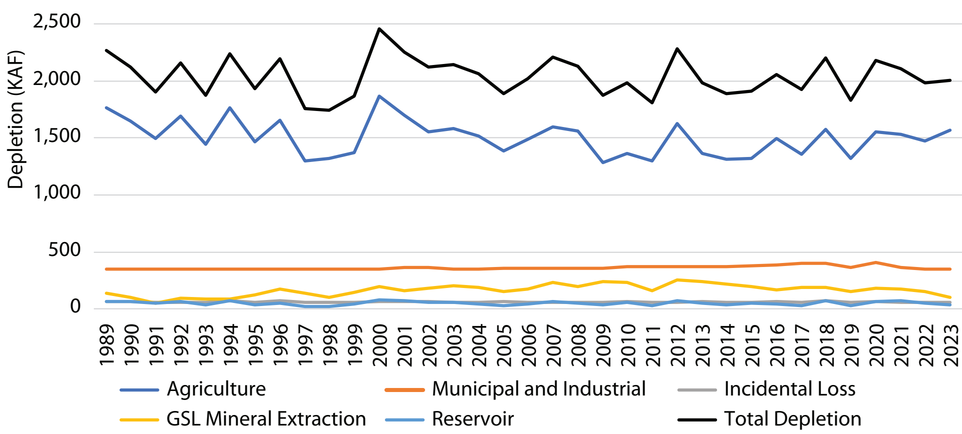
Diversions and depletions - Great Salt Lake inflows, measured at gages near the outlets of each major river draining into Great Salt Lake, are reduced due to diversions and upstream water use. These depletions increased dramatically in the 19th and 20th centuries, but have remained relatively stable from 1989 to the present.

Combined effect - These effects combine to reduce inflows to the lake, leading to lower lake levels.

Human Water Use

Total depletions show no long-term increase or decrease over the past 30 years, but fluctuate year to year. They range from a low of 1,800 KAF to a high of 2,600 KAF, averaging 2,217 KAF per year.

Figure 6: Human Water Depletion by Type, 1989-2023



Average Depletion (KAF/year)

Depletion Type	1989-1993	1994-1998	1999-2003	2004-2008	2009-2013	2014-2018	2019-2023
Agriculture- Includes all agricultural water depletions.	1,608	1,502	1,616	1,511	1,389	1,413	1,491
Reservoir- Represents evaporation from reservoirs (does not include Bear or Utah Lakes).	30	15	36	20	22	21	25
Incidental Loss- Includes depletions from riparian vegetation adjacent to canals and adjacent to flood irrigated fields, but not adjacent to natural water bodies.	36	38	37	35	35	37	35
Municipal and Industrial- Covers urban water depletions from commercial, industrial, institutional, and residential uses.	320	320	329	331	342	362	342
Lake Mineral Extraction- Incorporates lake depletions from all mineral extraction companies operating on GSL	70	100	152	164	199	166	127
Total Depletion	**2,064**	**1,974**	**2,169**	**2,061**	**1,987**	**1,998**	**2,021**

Source: Utah Division of Water Resources. (2024). Great Salt Lake Water Budget.

Insights

Depletion - Human water depletion is the amount of water used for beneficial purposes like agriculture or municipal use.

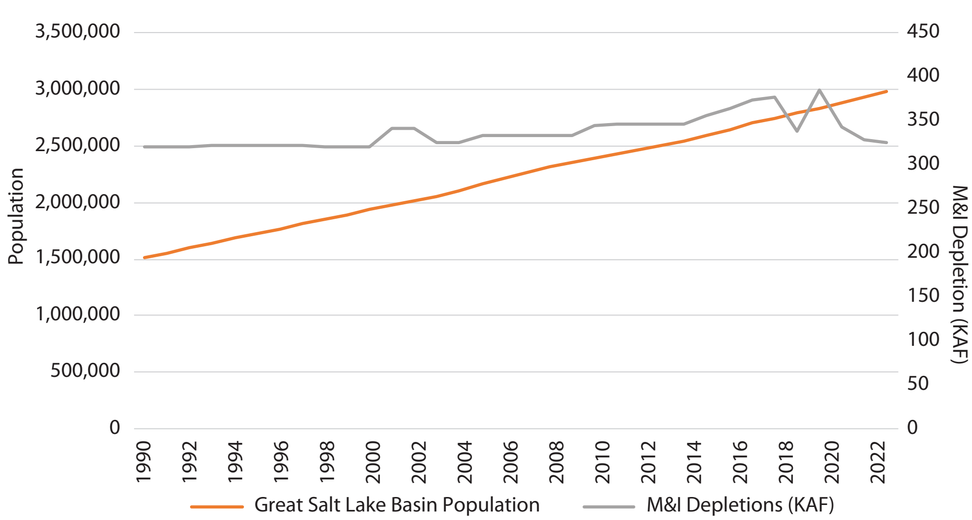
Agriculture - Agriculture depletes the most water in the basin, accounting for 71.3% of depletions over this period. These depletions have remained relatively constant since 1989.

Warmer and drier years - Human water use and total depletion tend to be greater in warmer and drier years.

Decrease in streamflow - Human water depletion reduces the amount of water that flows to Great Salt Lake.

Impact of conservation - Reducing water depletions can result in the recovery of Great Salt Lake to higher levels.

Figure 7: Population and Municipal and Industrial Water Use, 1989-2023



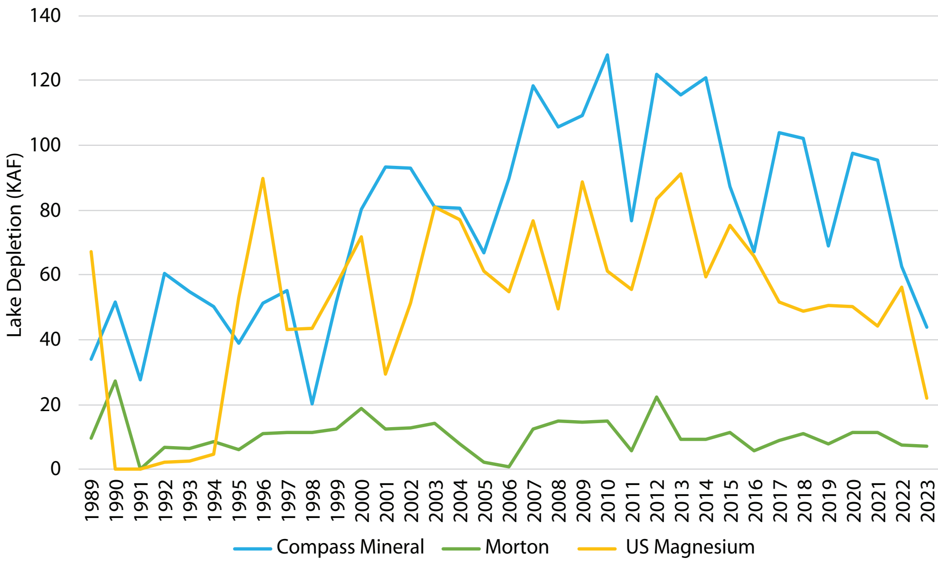
Sources: Utah Population Committee. (2024). State and County Estimates for Utah; Utah Division of Water Resources. (2024). Great Salt Lake Water Budget.

Insights

High population growth - In 1989, the population living in the Great Salt Lake Basin totaled 1.5 million people. By 2023, the population doubled to 3.0 million.

Near constant municipal and industrial depletions - Municipal and industrial depletions have not changed substantially since 1989. After peaking at 385 KAF in 2020, depletions declined to 325 KAF in 2023.

Figure 8: Mineral Extraction Water Depletions on Great Salt Lake, 1989-2023



Source: Utah Division of Water Rights. (2024). Utah Water Use Program Database.

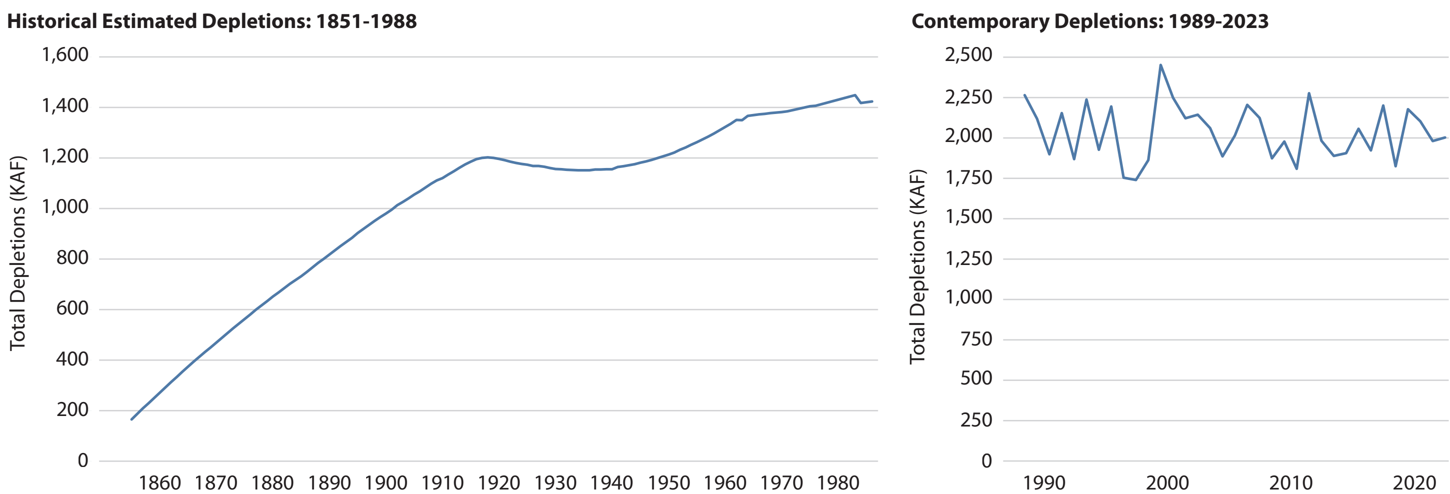
Insights

Variable mineral depletions - Mineral production activities fluctuate with market conditions, with water usage peaking in 2007 and trending downward since then.

Recent declines in depletion - Mineral operators faced new challenges due to the record low lake levels observed during 2022. Many operators could not operate at full capacity due to their limited ability to reach brines.

New legislation - During the 2024 Utah General Legislative Session, H.B. 453 was passed to address the reduction of water diversions from Great Salt Lake. Further detail is provided on page 22.

Figure 9: Historical and Contemporary Human Water Depletions



Source: Wurtsbaugh, W., et al. (2017). Decline of the world's saline lakes

Source: Utah Division of Water Resources. (2024). Great Salt Lake Water Budget.

Insights

Dramatic increase in human water depletion – Human consumptive water use in the Great Salt Lake Basin increased dramatically over the 19th and 20th centuries.

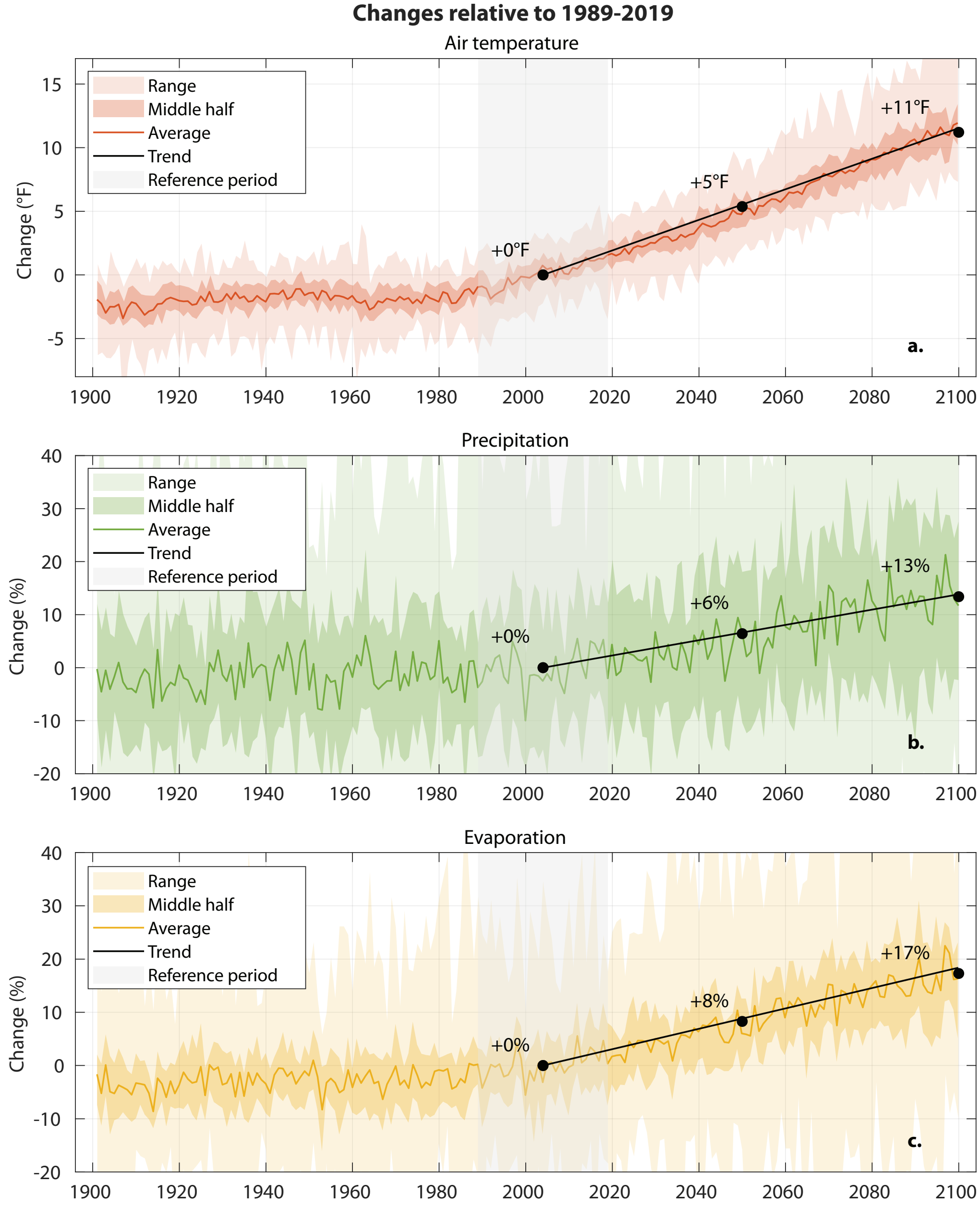
Unsustainably high depletions – While human depletions have remained relatively stable over the 1989-2023 period, they remain unsustainably high to maintain or restore Great Salt Lake to healthy levels.

Recent data are more reliable – Historical data of human water depletions in the Great Salt Lake basin provide important context for understanding long-term lake level dynamics and policy actions, but are less accurate than data from 1989 to present.

Future Water Availability

Cutting-edge climate models project that over the long term, expected increases in precipitation will be overwhelmed by rising temperature and evaporation, creating further challenges for the lake. The impacts of warming are already decreasing groundwater storage and runoff efficiency (page 11).

Figure 11: Projected Trends in Temperature, Precipitation, and Evaporation in the Great Salt Lake Basin, 2004-2100



Notes:

1. The analysis is based on a high greenhouse gas emission scenario referred to as Shared Socioeconomic Pathway (SSP) 585. Lower emission scenarios tend to produce similar changes but at smaller magnitudes.
2. There are 30 global climate models included in this analysis, developed by leading modeling centers in countries including the United States. The simulations were coordinated by the Coupled Model Intercomparison Project Phase 6 (CMIP6) and were analyzed by Courtenay Strong at the University of Utah.
3. Great Salt Lake is not explicitly represented at the grid spacings used in these global climate models. The analysis uses the grid point nearest the central latitude and longitude of the lake in each model.

Source: Strong, C. (2022). Department of Atmospheric Sciences, University of Utah.

Insights

High greenhouse scenarios - Under a high greenhouse gas emission scenario, 5°F of warming is projected by 2050, and 11°F is projected by 2100.

Increased precipitation - Warming is projected to increase precipitation because a warmer atmosphere can hold and deliver more water.

Increased evaporation - However, warming also increases evaporation, and that will tend to offset any water gains from precipitation.

Warmer temperatures - Warmer temperatures increase lake evaporation and human water needs.

Runoff efficiency and groundwater storage - If longer periods of consecutive dry years continue to occur in the future, runoff efficiency and groundwater storage will decline.

Planning for an Uncertain Future

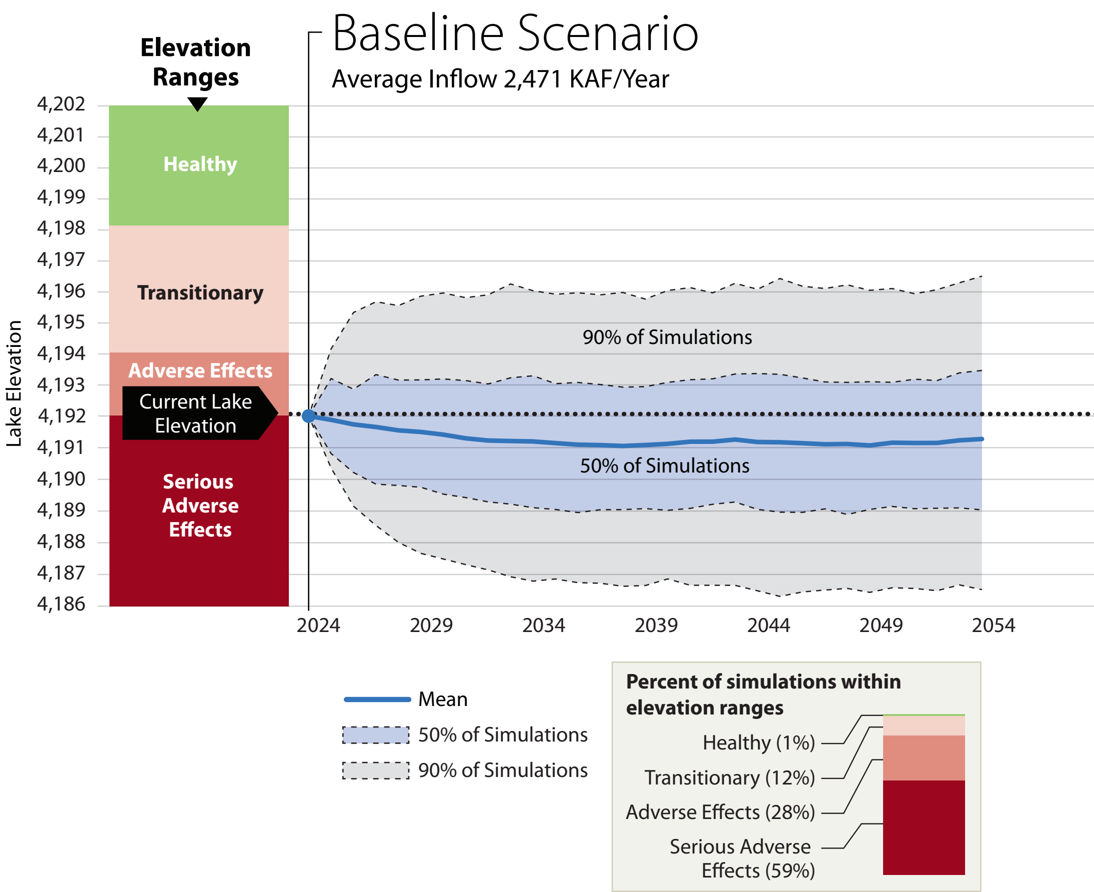
Future precipitation, inflows, and evaporation for Great Salt Lake are uncertain. Modeling efforts account for this uncertainty to assess the likelihood of different outcomes.

The following analysis used historical streamflow and climate data to produce 1,000 simulations of potential lake levels for the next 30 years. Annual inflow, precipitation, and evaporation values were randomly selected from the 2000 to 2024 historical inputs to represent hydrologic variability. The past 25 years were selected to represent the contemporary period with elevated temperatures and decreased inflow into Great Salt Lake.

Figure 11 shows the outcomes of three scenarios (from very low to very high water conservation levels) assuming all conserved water reaches the lake. None of these scenarios represent policy recommendations; they are intended to provide clarity on the long-term outcomes of different hypothetical boundary scenarios. Each scenario shows the mean simulation value with shading to represent variability in the projections. The scenarios are as follows:

- **Baseline** scenario assumes no additional inflows to Great Salt Lake from conservation.
- **Additional 250 KAF/year inflow** scenario considers an additional 250 thousand acre-feet (KAF) of inflow each year to the lake from water conservation.
- **Additional 770 KAF/year inflow** scenario shows the expected inflow needed each year to reach a mean lake elevation of 4,198 feet by 2054.

Figure 11: Projected Elevation of Great Salt Lake Given Different Conservation Strategies



Insights: Baseline Scenario

The average lake level in the baseline scenario shows continued declines – With no additional inflows to Great Salt Lake, the simulation mean shows a 0.8-foot decline in lake levels over the next 30 years.

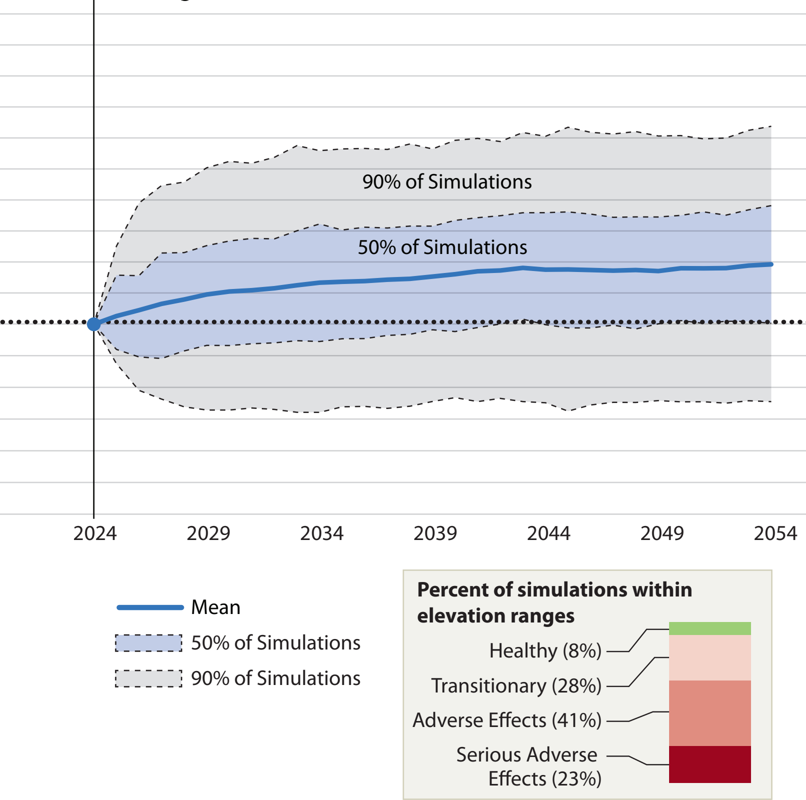
Likelihood of serious adverse effects for the baseline scenario – 59% of simulations fall into elevations with "serious adverse effects."

Other baseline scenario outcomes – 28% of simulations result in "adverse effects," 12% result in the "transitionary zone," and 1% result in "healthy lake levels."

Source: Tarboton, D. (2024). Utah Water Research Laboratory, Utah State University.

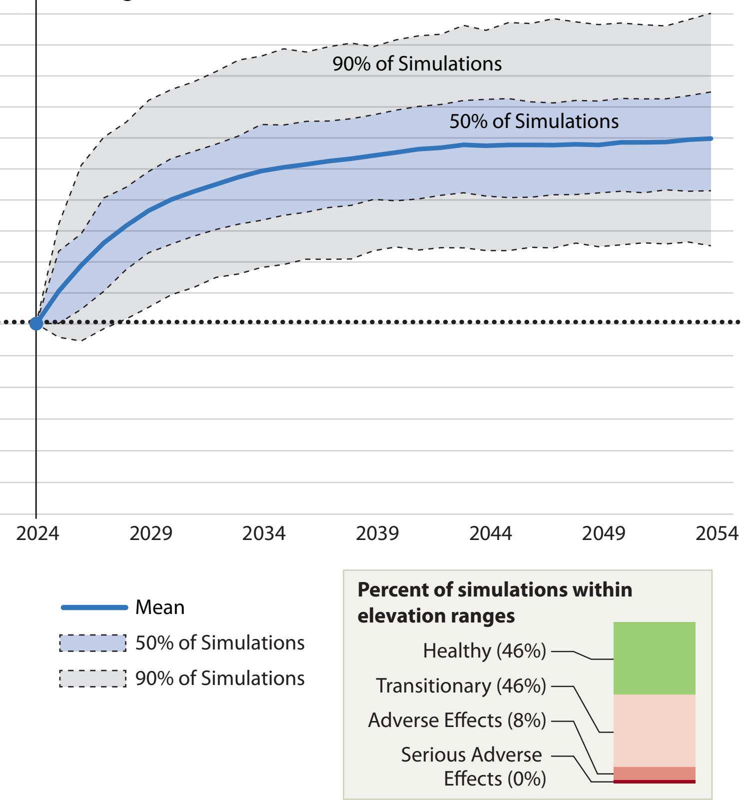
Additional 250 KAF/Year

Average Inflow 2,721 KAF/Year



Additional 770 KAF/Year

Average Inflow 3,241 KAF/Year



Insights: Additional 250 KAF/yr Scenario

The average lake level in the "additional 250 KAF/year inflow" scenario shows rising lake levels – The simulation mean shows a lake level rise of 1.9 feet by 2054. This would bring the lake to 4,194 feet and represent a reversal in the long-term downward trend in lake levels.

Other outcomes given an "additional 250 KAF/year inflow" – With additional inflows to the lake, the likelihood of elevations with "serious adverse effects" falls from 59% to 23%.

Insights: Additional 770 KAF/yr Scenario

The average lake level in the "additional 770 KAF/year inflow" scenario results in "healthy" lake levels by 2054 – The simulation mean shows a lake level rise of 5.9 feet, leading to a 2054 elevation of 4,198.0 feet.

Likelihood of healthy elevation for the "additional 770 KAF/year inflow" scenario – In 46% of simulations, the lake reaches healthy elevations by 2054. Another 46% of simulations result in the lake reaching the "transitionary" zone between 4,194 and 4,198 feet.

Other outcomes given an "additional 770 KAF/year inflow" - The number of simulations that result in a 2054 elevation in the "serious adverse effects" range falls to 0%.

KEY ISSUE PROFILES

Great Salt Lake Dust Hotspot Locations, Elevations, and Data Needs

Over 800 square miles of lakebed have been exposed as Great Salt Lake has retreated. When the surface is dry, and the winds are strong, dust plumes are commonly emitted from the exposed lakebed and move into the surrounding communities. Dust hotspots are most likely to occur in areas that have lost the protective crust, have little or no vegetation, and have an ample supply of fine particles (i.e., silt and clay).

Great Salt Lake dust plumes can have a significant impact on local air quality and can reduce the snowpack in the mountains throughout the basin due to enhanced melt rates. With more than 2.66 million residents living downwind of the lake, the dust poses a health hazard due to increased PM10 concentrations or due to chronic exposures to carcinogenic elements such as arsenic.

Figure 12: Great Salt Lake Dust Hotspot Locations

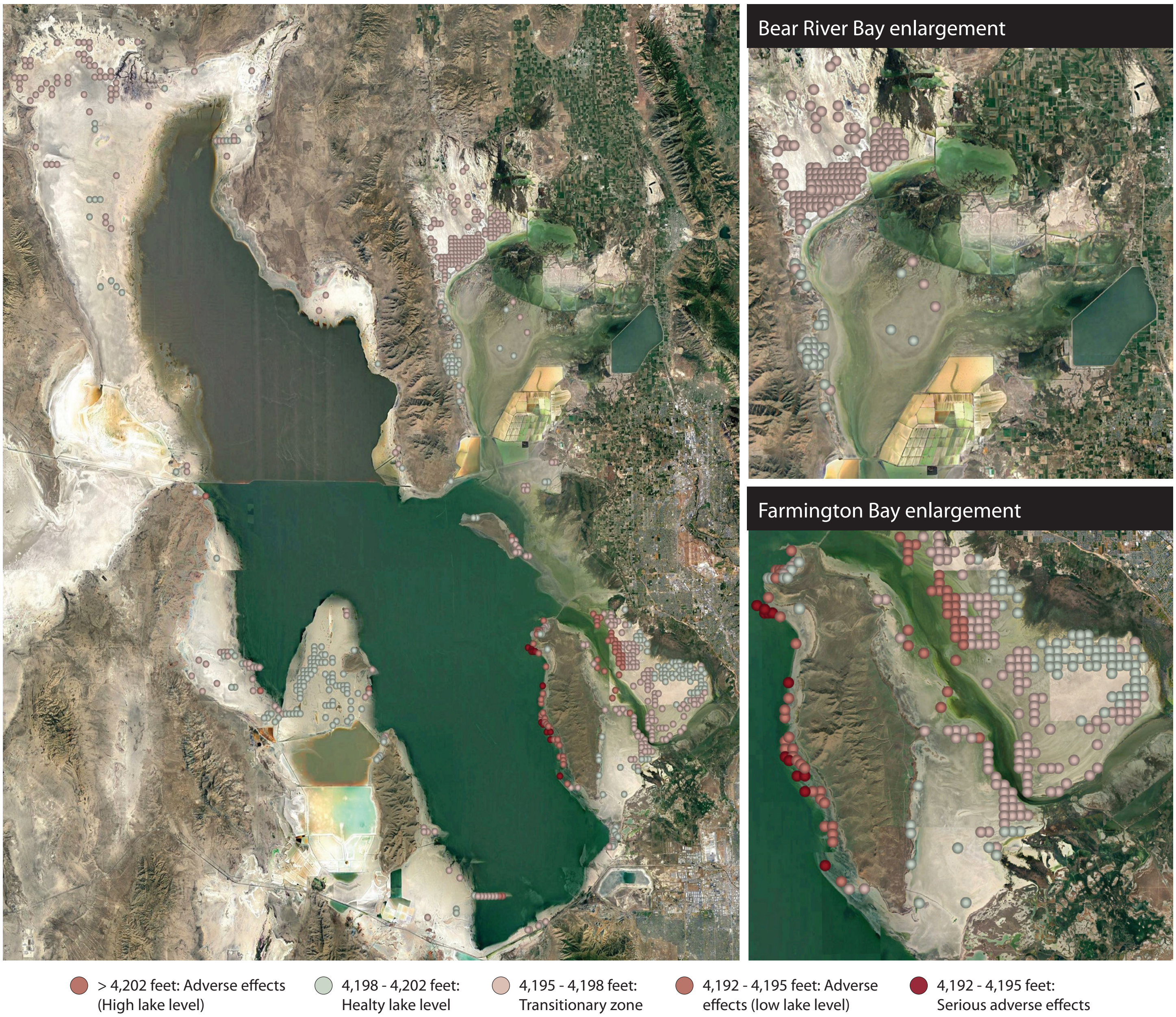
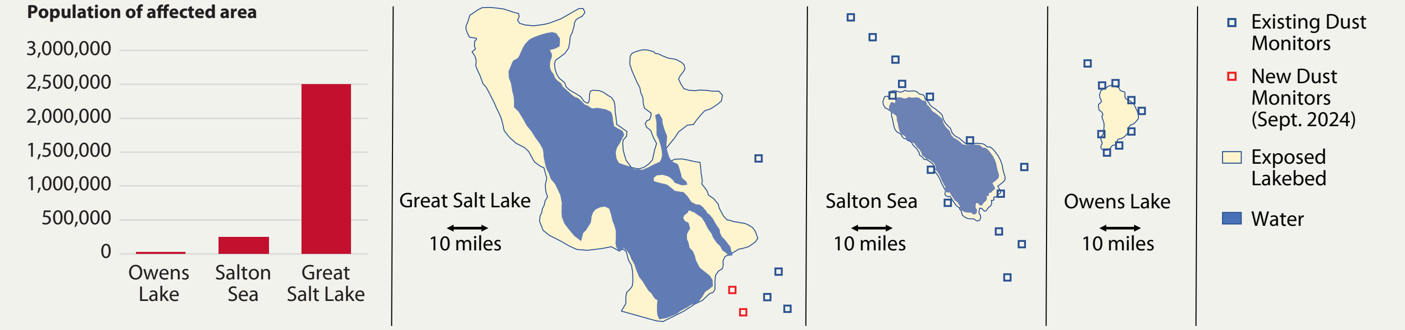


Figure 13: Dust Monitors at Great Salt Lake, Owens Lake, and Salton Sea



Source: Perry, K. (2024). Department of Atmospheric Sciences, University of Utah.

Dust Hotspot Locations

- Dust hotspots exist in all four quadrants of the lake, but are more common in Farmington and Bear River Bays (Figure 12), where rivers deliver fine sediments. Naturally occurring surface crusts protect up to 76% of the lakebed but are fragile and can easily be damaged through natural erosion or human activity. As a result, dust emissions from the lakebed are likely to become more frequent and severe over time if lake levels remain low.

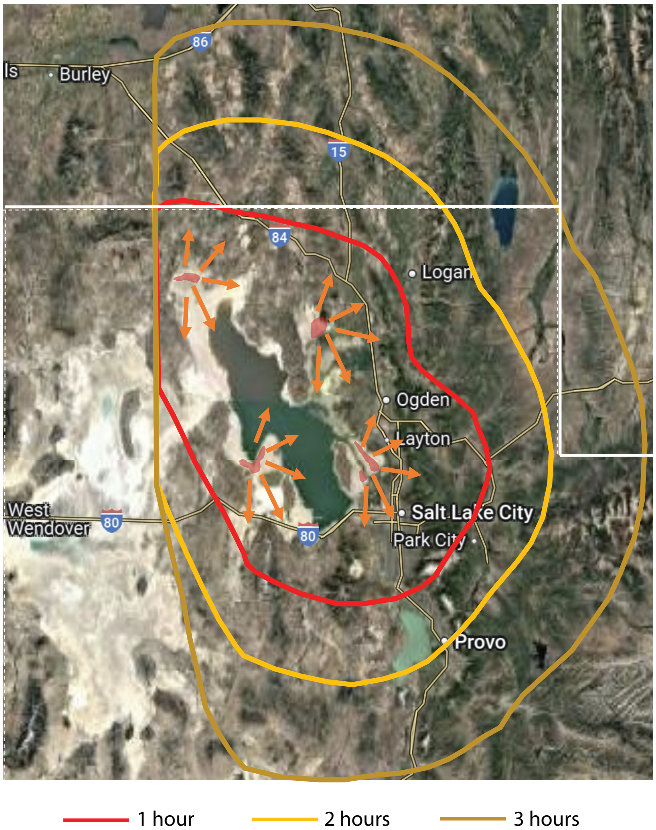
Dust Transport

- Although dust from Great Salt Lake can be generated by summertime thunderstorms, dust events are most commonly associated with the passage of cold fronts during the spring and fall. Prior to the passage of a cold front, strong winds from the south or southwest persist for 12-18 hours, pushing the dust to the north and northeast. After the frontal passage, the winds reverse for 3-6 hours, pushing the dust to the south and southeast. Thus, all communities throughout the Great Salt Lake Basin are downwind of the lake at some point.
- Dust emitted from the Great Salt Lake lakebed can remain suspended in the atmosphere for hours to weeks, depending on particle size. Large dust particles (i.e., PM10) gradually fall out of the atmosphere due to gravity over a period of hours to days. Smaller dust particles (i.e., PM2.5) remain in the atmosphere until removed by rain, which takes about two weeks on average. Thus, dust from Great Salt Lake can be transported thousands of miles.
- Winds associated with pre- and post-frontal dust events are typically greater than 25 mph. Thus, it typically takes less than an hour for Great Salt Lake dust to be transported to Wasatch Front communities in Salt Lake, Davis, Weber, Tooele, and Box Elder Counties. In addition, dust can reach Cache County and Utah County within 2 hours.

Dust Management

- In addition to increased monitoring, managing dust from existing hot spots and preventing the growth of additional hotspots by conserving, dedicating, and delivering additional water to the lake are essential next steps. The University of Utah, working with the Division of Water Resources and the Commissioner's Office, has undertaken research to identify ways to effectively manage and mitigate dust hotspots in the lake. That research is projected to be completed by the end of 2025.

Figure 14: Dust Transport from Great Salt Lake Lakebed



Sources: Google Earth Pro 7.3. (2024). Great Salt Lake; Perry, K. (2024). Department of Atmospheric Sciences, University of Utah.

KEY ISSUE PROFILES

Getting More Water to Great Salt Lake

The ability to deliver conserved water to Great Salt Lake through the Change Application process is a key tool in Utah's adaptive water management strategy. Change Applications also offer a mechanism for collaboration between water users and conservation efforts, balancing private water rights with public environmental needs for the lake.

Enabling Water Markets: Quantifying Conserved Water and Dedicating it with Change Applications

Water conservation from various sectors (agricultural producers, municipalities, and industry) may not benefit the lake if the water is used and depleted by downstream users. To ensure that conserved water makes it to the lake, large-scale conservation efforts must be paired with change applications that enable the state engineer to deliver the water past intervening users to the lake.

Generally speaking, the types of Change Applications targeted to benefit the lake fall into the following categories:

- **Changes on Leased or Acquired Water Rights**
  Water rights leased, donated, or otherwise acquired can have Change Applications filed in conjunction with certain state agencies (i.e., Forestry, Fire and State Lands; Wildlife Resources; and State Parks) that allow water to be used for beneficial purposes within the lake. These types of Change Applications have been most successful, amounting to over 288,000 acre-feet of water currently approved for dedication to the lake.
- **Split (i.e., Partial) Season Change Applications**
  Agricultural producers may be more inclined to lease their water rights for a portion of the year, dedicating the unused portion to the lake via a Split Season Change Application. Leasing water for only a portion of the year is a flexible tool that can be adapted to the needs of the producer and need not just be for just a "split season," which is a legal term used in the statute for Split Season Change Applications. To date, no Split Season Change Applications have been filed.
- **Water Banking**
  Water banks are a statutory mechanism that might provide greater flexibility to participants willing to dedicate water to the lake. These banks must be approved by the Board of Water Resources. Once established, a corresponding Change Application must also be approved to move water into the bank for uses approved in the bank's governing documents, including those that may benefit the lake. Currently, there are no Water Bank Change Applications within the Great Salt Lake Basin.
- **Saved Water Change Applications**
  Agricultural water optimization projects that result in a net decrease in water diversion or depletion may be eligible to file a Change Application that allows the quantification of "saved water." Producers who have saved water quantified in a Change Application may elect to dedicate the water to the lake, but they are not required to. To date, no Saved Water Change Applications have been received by the State Engineer.

The Significance of Distribution (i.e., Shepherding)

Distributing conserved water via a Change Application requires close oversight by the State Engineer to avoid unintentional harm or impairment to other water rights holders.

- **Measurement**
  The State Engineer must accurately measure water to verify that the conserved water is safeguarded from intervening diverters and delivered to the lake. This is accomplished via measurement devices installed on individual diversions and river gages that are strategically located.
- **Accounting**
  Accurate accounting ensures water is delivered to Great Salt Lake according to the approved Change Application. The State Engineer maintains detailed records of water diversions, changes (via Change Applications), and deliveries to ensure compliance with existing water rights. This accountability fosters trust among users and stakeholders, demonstrating that conserved water is managed transparently and effectively.

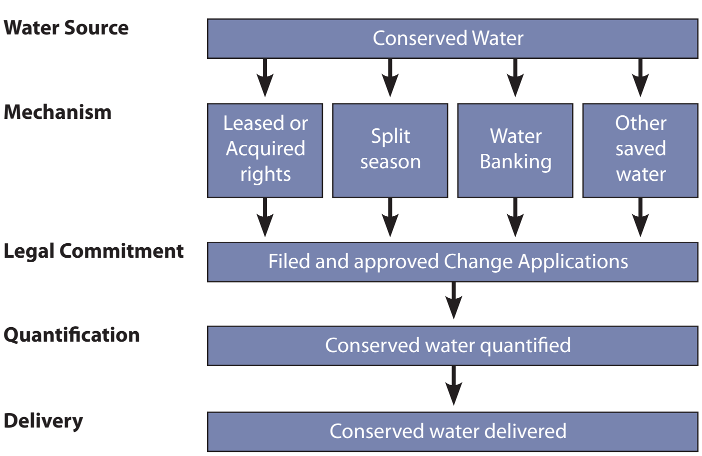
Progress on Getting More Water to the Lake

- **Change Applications Dedicated to Great Salt Lake**
  Currently, Change Applications amounting to over 288,000 acre-feet of water have been approved for beneficial use within the lake and its managed wetlands. It should be noted that this does not represent the actual amount of water delivered to the lake, nor is all of this new water that will flow into the lake for the first time. However, it is significant that water rights holders have gone through the process of changing their water rights for the benefit of the lake and its managed wetlands.
- **Great Salt Lake Basin Measurement Infrastructure Gap Analysis**
  The Division of Water Rights and Utah State University have completed the initial phases of a gap analysis to identify measurement shortfalls within the basin. Continued efforts to refine the analysis in areas immediately adjacent to the lake are underway.
- **Measurement Funding and Installation**
  The legislature has appropriated $1 million of one-time and $1 million of ongoing funds to install additional measurement infrastructure within the Great Salt Lake Basin. The Division of Water Rights is using the results of the gap analysis to coordinate the installation of needed measurement devices throughout the basin to ensure the delivery of dedicated water. The US Geological Survey and Bureau of Reclamation invested an additional $3 million in water measurement and analysis in the basin.

Potential Policy Levers

- **Greater Incentives**
  Utah should consider greater incentives for water rights holders to file Change Applications for conserved or saved water to benefit Great Salt Lake.
- **Secondary Metering Donations**
  Conservancy districts benefiting from the water savings associated with subsidized secondary metering efforts could dedicate a portion of the conserved water via Change Application.
- **Dedication of Effluent**
  Municipalities can conserve water to offset future demands and commit a commensurate amount of treated sewage effluent that would otherwise be available for reuse.

Figure 15: Getting Water to Great Salt Lake



KEY ISSUE PROFILES

Mineral Extraction on Great Salt Lake

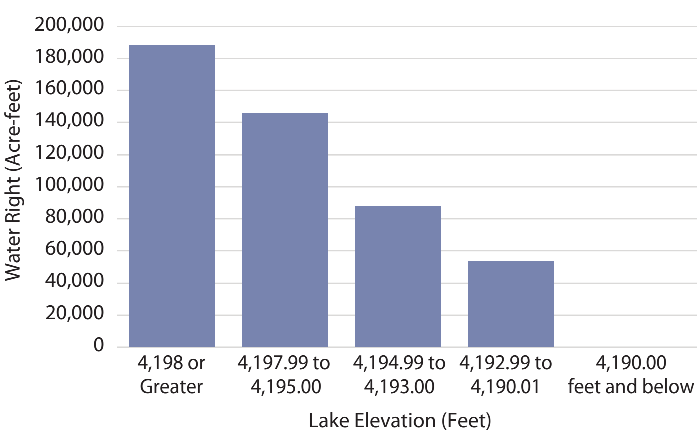
During the 2024 Utah General Legislative Session, H.B. 453 was passed to address the reduction of water diversions from Great Salt Lake, in addition to other provisions. The bill instructed the State Engineer to complete a water distribution management plan for water rights diverted below the meander line of the lake. The meander line distinguishes water diversions that occur on the lake compared to those that occur upstream.

H.B. 453 established a severance tax for minerals withdrawn from the lake and also created tax incentives for mineral companies that voluntarily agree to reduce water diversions.

After the passage of the bill, the Division of Forestry, Fire and State Lands (FFSL) began working with mineral companies to establish voluntary water reduction agreements.

- **Compass Minerals leadership** - The company was the first to enter into a voluntary agreement with FFSL.
- **Four voluntary agreements in 2024** - A total of four voluntary agreements were made in 2024 with Compass Minerals, Morton Salt, North Shore Limited Partnership, and Earth's Elements.
- **Permanent water donations to Great Salt Lake** - Compass Mineral and Morton Salt collectively donated 255,298 acre-feet of water rights to FFSL as a part of the voluntary agreements.

Figure 16: Progressive Water Rights for On-Lake Mineral Companies



Source: Utah Division of Forestry, Fire and State Lands. (2024). Voluntary Agreements with Great Salt Lake Mineral Producers.

- **Commitment from mineral producers** - In addition to the permanent water donations, Compass Minerals agreed to relinquish approximately 65,000 acres of leased land to FFSL. The relinquishment of land and donation of water rights from Compass Minerals and Morton Salt represent a commitment to keep water in Great Salt Lake when it is most needed.

Impacts of voluntary agreements

- **Base water rights** - Each mineral company retained a base water right that could be fully utilized when Great Salt Lake is at a healthy level at or above 4,198 feet. Compass Minerals retained 156,000 acre-feet of water rights, Morton Salt retained 32,578 acre-feet, and North Shore and Earth's Elements collectively retained 136.7 acre-feet.
- **Reduced water diversions at low lake levels** - As lake elevations drop, the amount of water diverted for mineral extraction progressively reduces to the point of no diversions when Great Salt Lake is below an elevation of 4,190 feet. Any saved water is dedicated to FFSL and will be used for in-stream flows to benefit the lake.

Water diversions at different lake levels

The following lake elevations reflect the total allowable diversion for all four operators at each lake level and the minimum amount of water that will be dedicated for in-stream flows.

These progressive water rights allow companies to operate normally when Great Salt Lake is at a healthy surface elevation, but require a reduction in diversions when lake levels decline. This innovative approach is flexible and balances the needs of industry with the needs of Great Salt Lake. It is important to note that many of these agreements were recently completed and are subject to the filing and approval of permanent change applications by the State Engineer. Additionally, these donations and progressive water rights do not take into consideration diversions that are non-depletive in nature.

KEY ISSUE PROFILES

Great Salt Lake's Economic Footprint

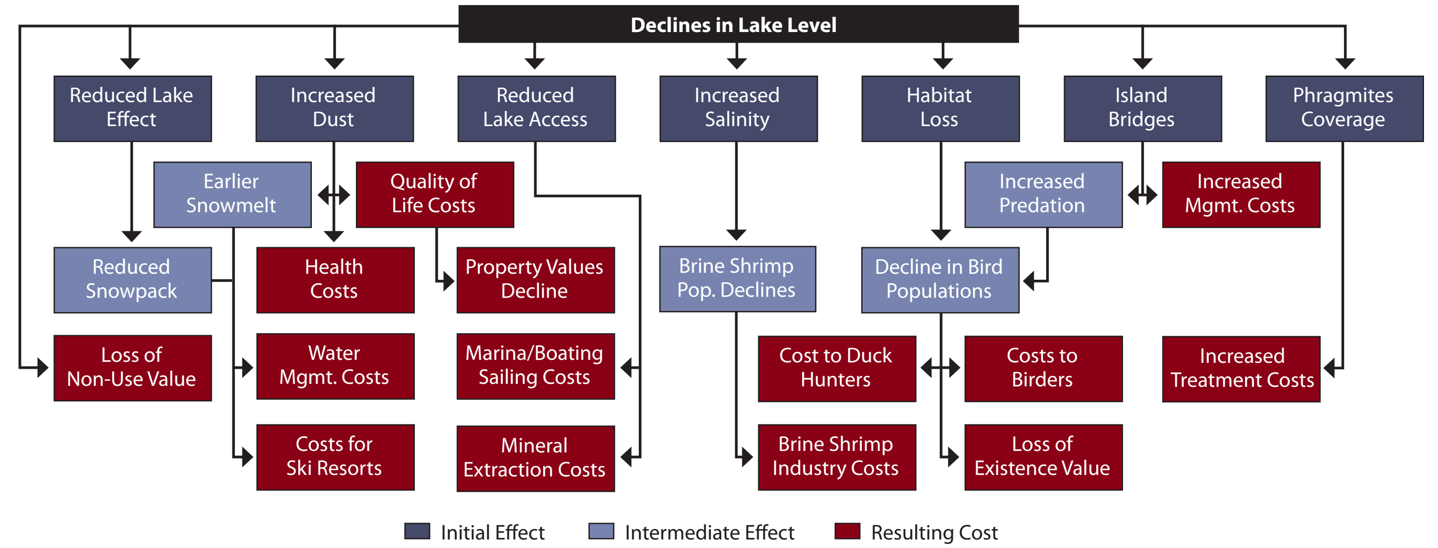
The Great Salt Lake Advisory Council, established by the Utah Legislature in 2010, commissioned two significant studies over the past 13 years on the economic contribution of Great Salt Lake: a 2012 study by Bioeconomics and a 2019 study by ECONorthwest. Both studies focus on different research questions and do not have directly comparable results. Although market and economic conditions have changed sufficiently to expect that these numbers have shifted over time, the findings reveal the general sources and overall magnitudes of potential benefits and costs of the lake.

The Great Salt Lake Strike Team gleans several useful insights from these studies about the economic footprint of the lake.

- **Economic benefits** – Great Salt Lake benefits the Utah economy in three distinct ways: industrial activity (mineral extraction and processing), aquaculture (harvesting and processing of brine shrimp), and recreation (broad spectrum of land- and water-based activities, as well as benefits to Utah's ski industry). The economic benefits tally $1.85 billion (2023$) in economic output annually to the Utah economy and approximately 7,700 jobs.
- **Cost drivers** – Another way to look at the economic footprint is to consider the costs of declining lake levels. These costs include reduced lake effect, increased dust, reduced lake access, increased salinity, habitat loss, new island bridges, and spread of invasive species. Figure 17, reproduced from the ECONorthwest study, traces these cost drivers.
- **Potential monetized costs** – The magnitude of potential costs from worst case water level declines in Great Salt Lake are estimated to be $1.69 billion to $2.17 billion per year (2019$), with job losses of over 6,500 positions (See Figure 17). Costs stretch across a broad swath of industries, recreational activities, health impacts, species, and quality of life attributes in the Great Salt Lake Basin. By far, the largest share of monetized costs stem from the mineral extraction industry.
- **Policy implications and limitations** – Reduced lake levels already impose economic costs on Northern Utah. In the extreme, these costs could rise to approximately $2 billion annually in monetized costs and threaten the business environment and life quality of residents. Benefits can be maximized and costs avoided through strategies and investments that maintain healthy lake elevation levels.
- **Limitations** – Some benefits and costs can be monetized; others cannot. The Bioeconomics and ECONorthwest analyses help decision-makers understand the various sources and magnitude of benefits accruing from the lake and potential costs under a worst-case scenario, but do not provide current or consistent accounting of the benefits and costs.

The Office of the Great Salt Lake Commissioner is working to update and augment these numbers through additional studies in the coming year and beyond.

Figure 17: Estimated Monetized Costs and Job Losses from Worst-Case Lake Elevation Levels, 2019$



Estimated Monetized Costs and Job Losses from Worst-Case Lake Elevation Levels, 2019$

Type of Cost	Potential Annual Cost	Potential 20-Year Costs	Potential Job Losses
Loss of Mineral Extraction Output	$1.3 billion	$19.3 billion	5,368
Landscape Mitigation Costs	$191.5 million to $610.4 million	$2.8 billion to $9.1 billion	N/A
Loss of Lake Recreation Output	$81.1 million	$1.2 billion	615
Loss of Brine Shrimp Industry Output	$67 million	$1.3 billion	574
Loss of Recreation Economic Value	$33.8 million to $81.9 million	$502 million to $1.2 billion	N/A
Health Costs	$6.6 million to $22.3 million	$98.2 million to $331.8 million	N/A
Loss of Ski Resort Spending	$5.8 million to $9.6 million	$86.3 million to $142.8 million	>0

Source: ECONorthwest and Martin & Nicholson Environmental Consultants. (2019). Assessment of Potential Costs of Declining Water Levels in Great Salt Lake.

Utah State University | The University of Utah | Utah DNR Natural Resources | UDAF | Utah Department of Environmental Quality | Great Salt Lake