Getting to know the Utah Lake Ecosystem

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Thank you for taking the time to learn about Utah Lake, the huge and unique waterbody at the heart of Utah Valley. Though it is the largest freshwater lake in the state, many in our community know little about its history, ecology, and importance to our future. As our valley grows, we need to understand Utah Lake so we can preserve and protect this keystone ecosystem for future generations.

While we know humans can live in harmony with Utah Lake (the Timpanogos Nation and their predecessors did so for thousands of years), the lake is facing unprecedented challenges. With 600,000 people now living in its watershed, Utah Lake suffers from harmful algal blooms, invasive species, and reduced water flow from diversions and climate change. The lake has been remarkably resilient to these pressures, and decades of coordinated restoration projects have helped the lake begin to recover.

Unfortunately, some people have tried to politicize and monetize Utah Lake by making unfounded claims about its status and future. We often see opinion pieces and social media posts that falsely describe a lake that is poisoned, gross, or dying. Most alarmingly, there are proposals being considered by state and local leaders that would destroy the natural characteristics of the lake with artificial islands and highways.

As a group of concerned researchers and residents of Utah Valley, we have put together this article to help deepen our understanding and improve our stewardship of Utah Lake. We draw on more than 100 scientific studies, including work presented at the first Utah Lake Symposium by researchers, managers, citizen scientists, and community leaders, including the Timpanogos Nation. We explore proven practices that could rejuvenate Utah Lake, address threats and challenges ahead, and highlight the innovative restoration projects that have made enormous progress.

We point out that no amount of ecological work can replace the need to rehabilitate our relationship with Utah Lake. The photographs in this document were generously contributed by residents of Utah Valley and the surrounding communities. If you want to dive deeper, visit utahlake.byu.edu and check out the references at the bottom of the document. If you find an error or know of a resource that we've missed, please let us know, and we'll update the article as soon as we can.

With gratitude and hope,

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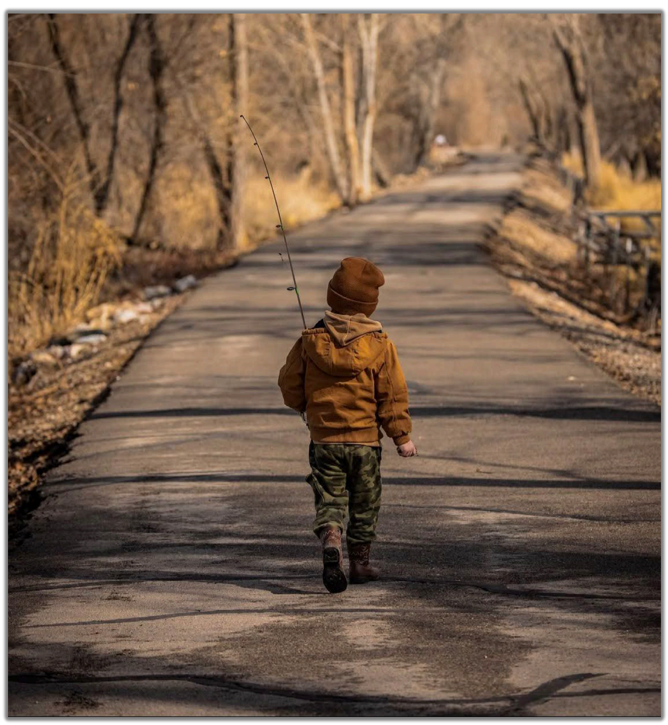

A child heads to Utah Lake to fish (Travis McCabe)

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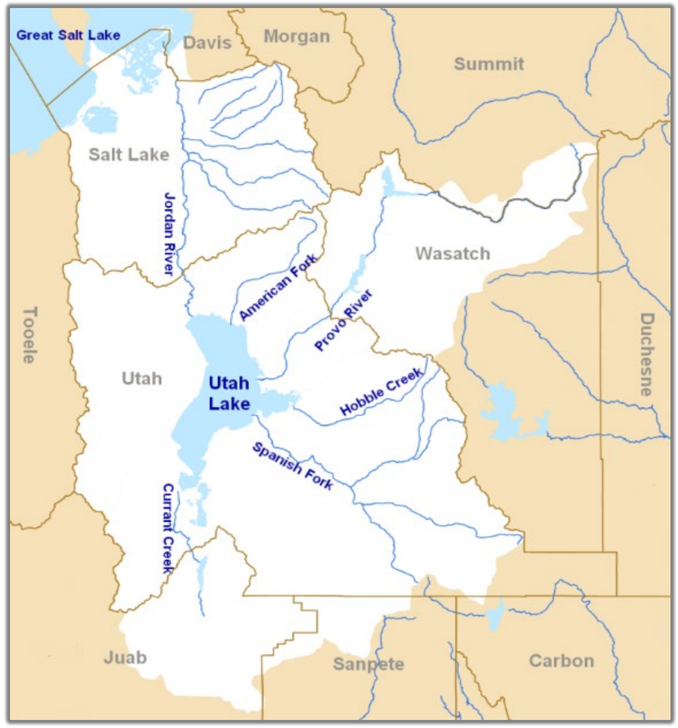
An American avocet hunts insects and other invertebrates in Utah Lake (Jeff Beck)

Quick facts about Utah Lake

Dimensions

- **Surface area:** ~145 square miles (3rd largest freshwater lake in the western U.S.)
- **Elevation:** 4489’ above sea level (this “Compromise level” was set by law in 1885 and updated in 1986)
- **Depth:** 9’ (average), 18’ (maximum)
- **Watershed size:** 2950 square miles



Map of the Utah Lake watershed. Data from the Utah Geospatial Resource Center

People

- **First settlement:** Unknown, but likely at least 20,000 years ago
- **Indigenous peoples:** The Timpanogos Nation of the Shoshone Tribe, Paiute, Goshute, and Ute
- **Current population:** ~600,000 in the watershed
- **Projected population in 2050:** 1,300,000

Biodiversity

- **Species:** >500 invertebrates, >400 diatoms, 226 birds, >150 algae and cyanobacteria, 49 mammals, 18 fish, 16 amphibians & reptiles
- **Habitat:** ~30,000 acres of wetlands, ~10 million fish, ~10 million migratory birds

Hydrology

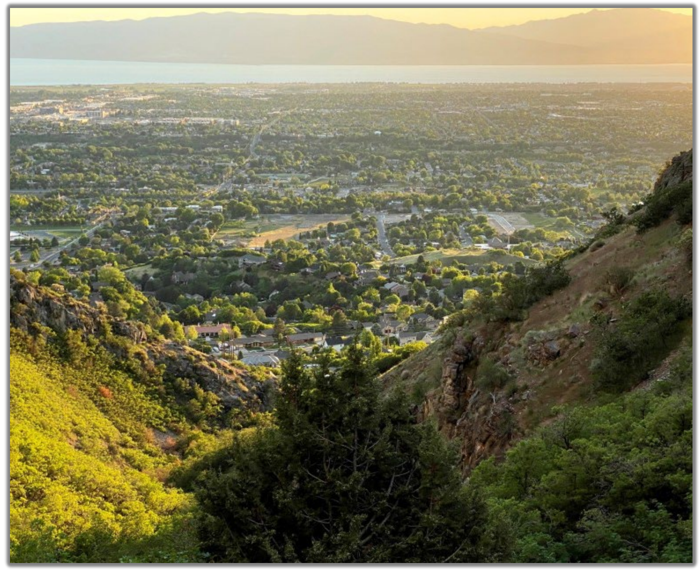
- **Water volume**: 902,000 acre-feet
- **Water inflow:** 930,000 acre-feet/year
  - Rivers: 45%
  - Groundwater: 41%
  - Direct precipitation: 14%
- **Water outflow:** 930,000 acre-feet/year
  - Jordan River: 46%
  - Evaporation: 38%
  - Groundwater: 16%
- **Water residence time:** 6 months

Sailboats embark from the Lindon Marina

Executive summary (a five-minute overview)

A VIBRANT OASIS AT THE HEART OF UTAH VALLEY

Utah Lake is a keystone ecosystem and the centerpiece of our community. This spectacular lake provides critical habitat, abundant recreational opportunities, and invaluable ecosystem services such as removing pollution and creating local precipitation. For example, as a part of the Great Salt Lake watershed, Utah Lake is habitat for 10 million migratory birds that fuel up or nest here every year. As a crucial link in the Wasatch Front's water system, Utah Lake supports everything from skiing at Sundance to growing our famous Utah cherries. Protecting this unique ecosystem is our duty and opportunity to ensure a flourishing Utah Valley for current and future generations.



Springtime view of Utah Lake from Little Rock Canyon, Provo

CENTURIES OF SUSTENANCE AND COMMUNITY

People have inhabited this region for 20,000 years or more. Before European settlement, Utah Lake was home to 13 native fish species, a different plant community, and dozens of native mollusks that created a unique food web. Utah Lake sustained Native Americans such as the Timpanogos Nation and later the Mormon settlers, who would not have survived their first winters without the lake's abundant fish and wildlife. Despite changes to the lake's hydrology and biology, Utah Lake remained the cultural center of Utah Valley with resorts, dance boats, and air tours throughout the 1900s.

Geneva Dance Hall and Resort, Utah Lake. Painted by art missionary John Hafen (1896). Courtesy of the Springville Art Museum.

AN ECOSYSTEM IN RECOVERY

Utah Lake is one of the most misunderstood ecosystems in our state. Contrary to false claims of pending destruction, Utah Lake has comparably good water quality and is on the road to recovery in many ways. The native June Sucker are rebounding, water flow has been increased by cooperative agreements, and wastewater improvements are reducing nutrient loading. Approximately 75% of the invasive carp and phragmites have been removed and harmful algal blooms are on the decline for most of the lake. We need to continue and expand restoration with research and collaborative projects.

Soaking in Saratoga Hot Springs to celebrate New Year's.

CLEAR AND PRESENT DANGER

Some of the misinformation about Utah Lake has been spread intentionally by developers who want to radically reengineer the lake. While the developers claim their projects would provide "silver bullet" solutions, drastic proposals to dredge the entire lake, create islands, or crisscross the lake with causeways would erase restoration progress and irreversibly damage Utah Lake. Based on similar megaprojects on other lakes, these proposals could cost taxpayers billions and deprive future generations of the lake's beauty and ecosystem services. In this time of dramatic change, we need evidence-based management and conservative legislation to protect and restore this unique, beautiful, and dynamic lake.

A juvenile northern harrier learns to hunt on the shores of Utah Lake (Travis McCabe)

PROGRESS AND PRIORITIES

Over the past 40 years, hundreds of projects have contributed to the conservation and restoration of Utah Lake. Wildlife protections, delta restorations, wastewater treatment, and invasive species removal are making measurable progress. Expanding support for conservation, outreach, and restoration will have big dividends for all the inhabitants of Utah Valley—human, fish, and otherwise.

Specifically, we recommend to:

1. Foster community connection and understanding through education and recreation
2. Create a permanent conservation easement around the lake to ensure ecological health, public access, and long-term quality of life for our rapidly growing community
3. Restore the lake's natural hydrology by returning more water to its tributaries and allowing natural seasonal fluctuations
4. Reduce pollutant flows to the lake by upgrading wastewater treatment and improving nutrient management in the watershed
5. Continue invasive species removal and habitat restoration in ecologically sound ways
6. Integrate the health and conservation of Utah Lake into strategic planning of future development in the valley
7. Protect the lake from dangerous proposals that threaten its health and our future
8. Support basic and applied research about the lake's ecology and sustainable practices for its watershed

Fishing at sunset in May on the east shoreline of Utah Lake. (Wyatt Peterson)

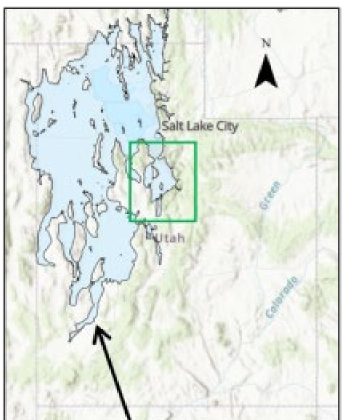
Frequently asked questions about Utah Lake

A view of the lake from Inlet Park, Saratoga Springs (Preston Holman)

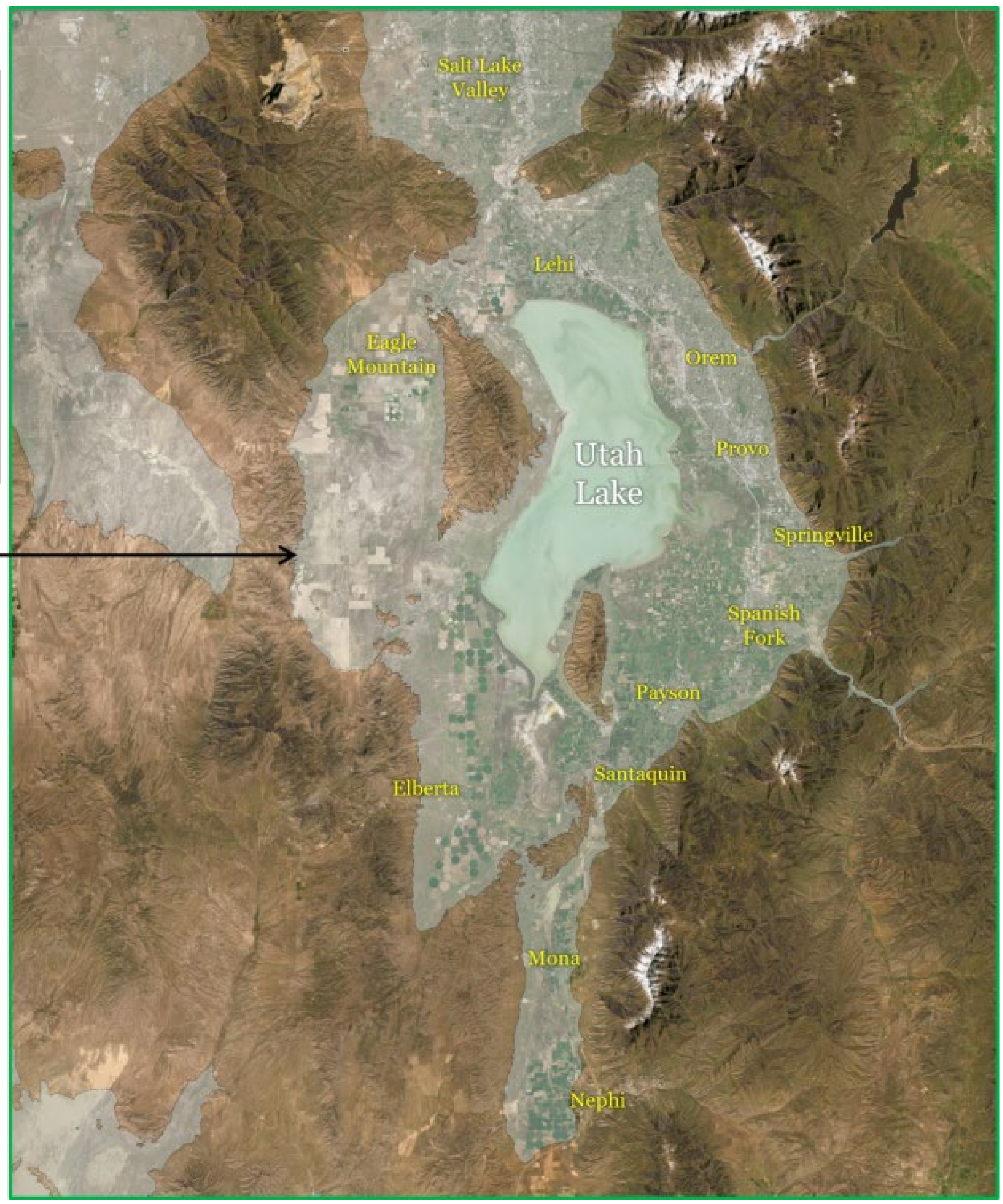
What is the history of Utah Lake?

THE DEEP PAST

Utah Lake has a long and fascinating geological and human history. For example, if you were standing on the shore of Utah Lake 20,000 years ago, you would be covered by 500 feet of water! At that time, an inland sea named Lake Bonneville covered much of Utah. Tributaries to Lake Bonneville deposited sediment that created a flat valley floor and benches where many of our towns and cities are now built. Like the Utah Lake system today, Lake Bonneville didn't have an outlet to the ocean. Around 15,000 years ago, water levels got so high that the lake spilled into the Snake River Valley in Idaho. In just a few days, much of the lake drained to the Pacific in the second largest known flood in geologic history.



Former extent of Lake Bonneville



The former extent of Lake Bonneville. After the Bonneville Flood drained much of the lake water to the Pacific Ocean 14,500 years ago, climate change led to the gradual drying of the lake until only the Great Salt Lake, Utah Lake, and Sevier Lake remained. Data from the Utah Geospatial Resource Center.

The drier climate after this Bonneville Flood resulted in the lake eventually shrinking until only the Great Salt Lake, Utah Lake, and Sevier Lake remained. From about 5,000 years ago until the 1800s, Utah Lake has fluctuated around its current elevation of 4,500’ above sea level.

THE PEOPLES OF UTAH LAKE

We note that there are multiple and sometimes-conflicting accounts of historical events in Utah. Differences range from minor spelling variations to major arguments about treaties and reparations. We are not historians but have done our best to provide a brief overview of the important but often unfamiliar history of the peoples of this region. We invite all readers to learn more and reflect on how we can build a better society together.

Painting Chief Walkara of the Timpanogos (Solomon Carvalho, 1854)

The Utah Lake area has been a crossroads of humanity for at least 20,000 years. Though we do not know the original names of the early cultures of the Great Basin, they are referred to as Pre-Clovis, Clovis, and Fremont peoples. Later, the Numic peoples (ancestors of the Shoshone and Paiute) were joined in about 1400 AD by the Athapascans (ancestors to the Navajo and Apache). Until the end of the 1800s, the Utah Lake area was primarily inhabited by the Shoshone, Paiute, and Goshute peoples (more detailed history here).

Pronghorn antelope on Utah Lake’s western shore (Jeff Beck)

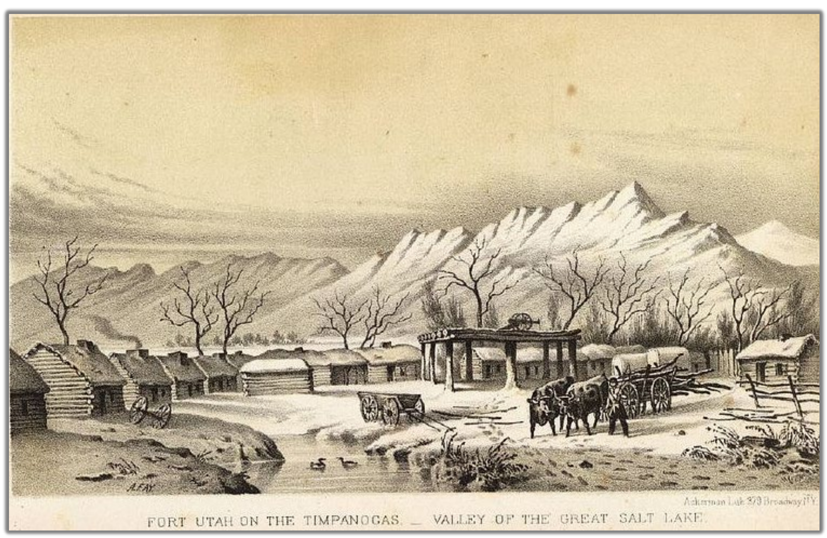
The first contact with Europeans is believed to have occurred in 1776, when Father Silvestre Velez de Escalante passed through Utah Valley. The Snake-Shoshone Timpanogostzis Nation (hereafter Timpanogos Nation) inhabited a large portion of central and eastern Utah at that time, led by Chief Turiunachi.

The Timpanogos and associated bands likely numbered 70,000 or more and often congregated around Lake Timpanogos, now known as Utah Lake. The lake was described as an oasis because of the abundant freshwater fish, water birds, and other wildlife that occupied its shallow waters, wetlands, and river deltas. The abundant reeds around and within the lake were known as *Eu-tah*, potentially the origin of the name Utah. Immature reeds were used for weaving, and mature reeds were used to make arrows. Though the Timpanogos are often mistakenly referred to as Ute, they are a part of the Shoshone Tribe (detailed history written by the Timpanogos here).

Lake Timpanogos (Utah Lake) is an island of water in the arid Great Basin (Justin Lehman)

In 1847, Brigham Young led the Mormon Pioneers into the Salt Lake Valley. The seven grandsons of Chief Turiunachi led the Timpanogos at that time, including Chiefs Sowiette, Walkara, Tabby, and Sanpitch. In good faith, the Timpanogos provided provisions and counsel to the newcomers. Chief Walkara wanted the settlers to move on, but Chief Sowiette convinced his brothers to allow the Mormons to stay in the Salt Lake Valley.

In early 1849, Young sent around 50 settlers south to establish Fort Utah on the banks of the Timpanogos River—later known as the Provo River. This settlement likely broke formal and informal agreements Young had made with the Timpanogos to preserve the area around Utah Lake for the Timpanogos. After only a few months of cooperation, conflict arose.



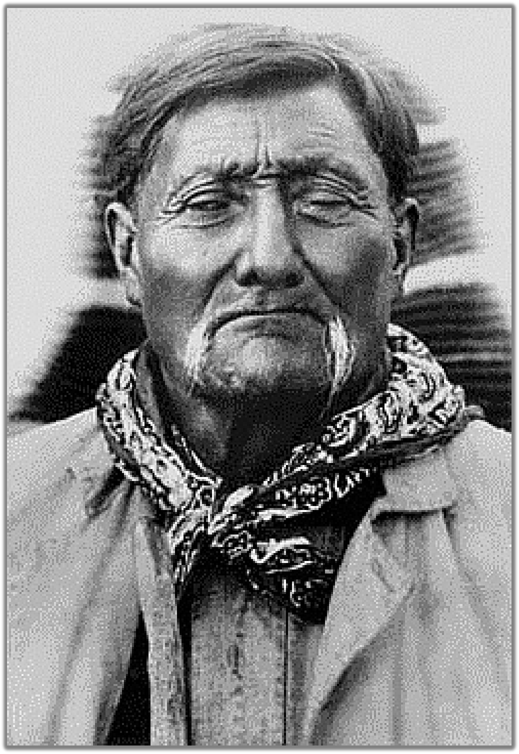
Drawing of Fort Utah by Howard Stansbury in 1852

In the winter of 1849-1850, a measles outbreak spread from the settlers to the Timpanogos. At the same time, three Mormon settlers murdered a Timpanogos man known as "Old Bishop" after accusing him of stealing a shirt. The murderers dumped Old Bishop's body in the Provo River fearing retribution from the Timpanogos and Brigham Young, who had warned the settlers not to engage in violence. When he was found, the Timpanogos confronted the settlers, who refused to turn over the murderers. They retaliated by taking livestock and threatening retribution.

After repeated letters and visits to Salt Lake, the settlers at Fort Utah eventually convinced Brigham Young to send the militia to exterminate all hostile Timpanogos men, though they did not disclose their murder of Old Bishop, which had instigated the conflict. Young's extermination order resulted in a series of violent conflicts over several years called Walkara's War. Dozens of Timpanogos and a few Mormon settlers were killed. The Timpanogos Chiefs and others negotiated and fought to protect their homeland and people, eventually resulting in a temporary truce between Walkara and Young in 1854.

A period of relative peace ensued between the Timpanogos and Mormon settlers, though frequent violent conflicts continued. During crop failures in 1855-1856, June Sucker from Utah Lake saved many settlers throughout the Mormon colonies from starvation.

Harvest of June Sucker and other native fish from the shore of Utah Lake in 1855. Courtesy of the June Sucker Recovery history.



Photograph of Chief Tabby, who negotiated peace in 1867

In 1865, tensions escalated again in what is called the Black Hawk War, which resulted in the death of hundreds of Timpanogos. There were brutal encounters throughout Utah Valley and the surrounding area. Chief Tabby eventually negotiated a peace treaty with Joseph Stacey Murdock, the local leader of the Mormon settlers who took and later married Secunup, the daughter of Chief Aeropean. Chief Tabby led the Timpanogos to join the Northern Shoshone in the Uinta Valley Reservation, which had been created by President Abraham Lincoln in 1861.

In the decades that followed, the Timpanogos were largely forgotten and still lack federal recognition today. In the 1880s, four Ute Bands were relocated to the Uinta Reservation, where they were recognized as the Ute Indian Tribe. Because the Timpanogos had been referred to as Utah Indians, many mistakenly assumed they were a part of the same group. The Timpanogos Nation lives to this day on the Uinta Valley Reservation and throughout Utah. They are led by Chief Executive Mary Murdock Meyer, who is a contributor to this article and the great great great granddaughter of Chief Walkara on her mother's side and Chief Aeropean on her father's side.

GROWING POPULATION AND GROWING PRESSURE

In the following century, Utah Valley saw rapid growth and change. Widespread agriculture and a growing population led to ditches, canals, and eventually the rerouting of the entire Provo River from Provo Bay to the northwest, where it currently enters Utah Lake. There were diversions in all the major tributaries to Utah Lake (Provo, Spanish Fork, American Fork, Hobble Creek, Benjamin Slough, and Currant Creek). Some tributaries became seasonally dry (Provo River) or permanently disconnected from the lake (Hobble Creek).

As the water flow to Utah Lake decreased, the pollution delivery skyrocketed. Sewage, industrial, and agricultural runoff from the surrounding cities and farms added nutrients, pesticides, metals, and other pollutants. These contaminants were dumped directly in the lake or were transported there by rivers and groundwater.

Chief Executive Mary Murdock Meyer, current leader of the Timpanogos Nation

Utah Lake in 1898. Photo courtesy of the Library of Congress.

In addition to the loss of water and increase in pollution, overfishing was causing large declines in the native fish populations. Up to that point, Utah Lake had been an incredibly productive fishery. After the completion of the Transcontinental Railroad—which enabled rapid transport of live fish—the settlers started introducing new species in an attempt to rejuvenate the commercial and subsistence fishery of Utah Lake. Black bullhead catfish were introduced in 1872. In 1883, there was an initial release of 200 baby common carp as a part of a U.S. Commission of Fish and Fisheries program. Largemouth bass followed in 1890. Some of these fish did reproduce rapidly, which put pressure on the native species and permanently changed the lake's food webs. The intentional or accidental introduction of plants such as phragmites, Russian olive, and salt cedar further changed the ecosystem.

Through all this change, Utah Lake remained important culturally, economically, and ecologically. Native and introduced fish species were a major food source, and the lake was the center of community activities. Resorts sprung up around the lake, including pavilions, a dance boat, horse tracks, and performance halls (for details about this period, check out the Utah Lake Legacy film produced by the June Sucker Recovery Implementation Program). In the 1900s, recreationalists took to the lake in sailboats, motorboats, and even airplanes.

ROCK BOTTOM

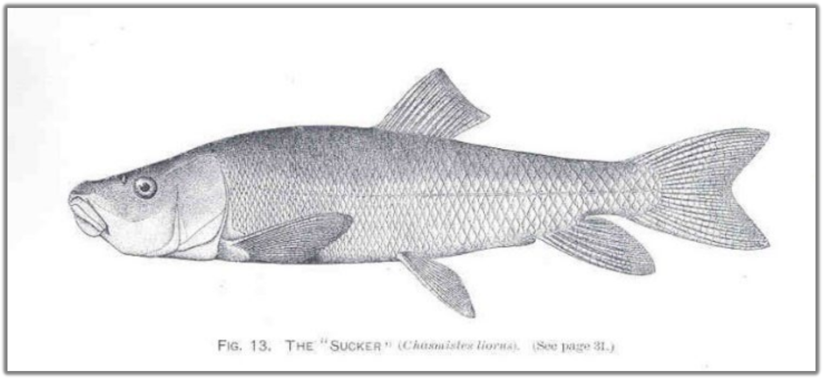
The darkest period ecologically for Utah Lake arguably occurred during the Dust Bowl of the 1930s. The lake level dropped 12 feet because of persistent drought conditions and new water diversions (including the world's largest pumping station at the time). Except for a few pools, Utah Lake was reduced to a dry lakebed. With no water in the lake, the Jordan River (Utah Lake's sole outlet) stopped flowing,

Utah Lake in 1935 at 12' below compromise. Photo courtesy of Roland Strong.

cutting off irrigation for much of Salt Lake County. Utah's governor drove a pickup truck across the lakebed to inspect the situation, declaring a state of emergency. The temporary loss of the lake modified local climate and devastated agriculture and property values in both Utah and Salt Lake counties.

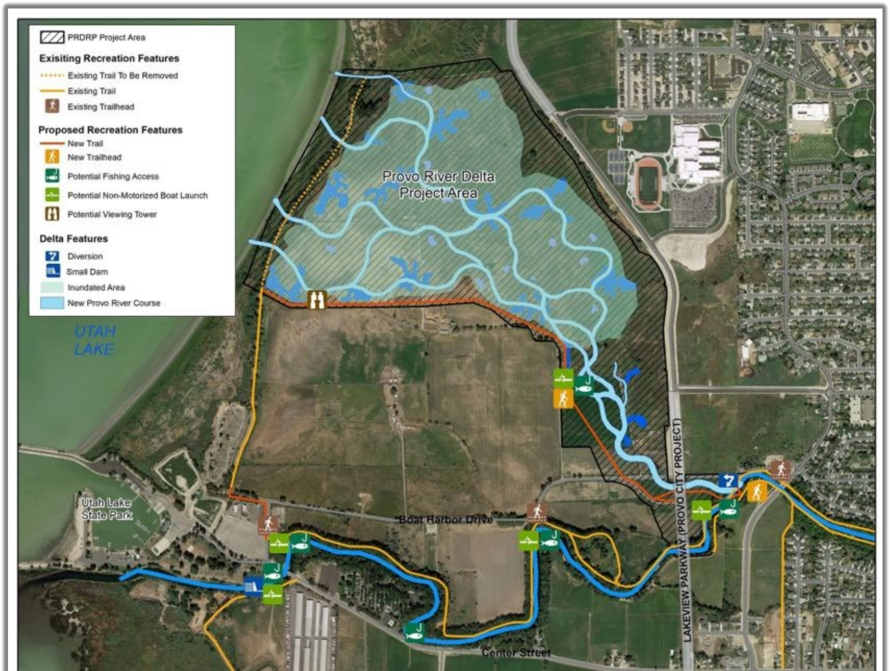
Together, the loss of water, increase in pollution, and introduction of invasive species caused permanent damage to the lake's biodiversity. The Utah sculpin went extinct and eight other native fish were extirpated (eliminated locally). Native mollusks and plants were also extirpated or pushed to extinction, triggering major changes in the aquatic and terrestrial environment that make up the Utah Lake ecosystem.

THE RIVER TO RECOVERY



The June Sucker, one of 13 native Utah Lake fish (David Starr 1891)

After the trauma of the lake drying out in the 1930s, management and governance of the Utah Lake watershed changed course. Limits on diversions were implemented and projects to measure and manage river flow were put in place. Coordination among communities increased with the creation of [major water projects](), including some that piped in water from the [Colorado River basin](), which is just to the southeast of the Utah Lake watershed. As the population grew, both state and federal [regulation of water quality]() led lakeside communities to start treating their wastewater in the 1950s, reducing nutrient pollution.



Map of the [Provo River Delta Restoration](), one of the many ongoing restoration projects in and around Utah Lake. Courtesy of Melissa

Conservation and restoration efforts kicked into high gear in the 1980s when the June Sucker—one of the last surviving native fish—was listed as an endangered species. June Sucker populations had dropped precipitously due to the cumulative effects of water diversions, pollution, and continued introduction of exotic species (white bass were introduced in 1956). When the June Sucker was listed as endangered in 1987, there were only a few hundred of the fish remaining in the lake. The June Sucker's endangered status led to greater funding and the coordination of restoration efforts involving regulators, water users, landowners, cities, wastewater facilities, and fisheries across the state.

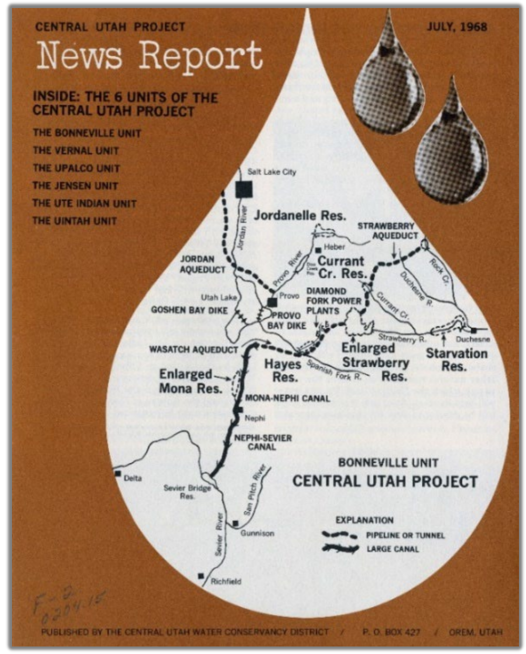
In 1999, nine local, state, and federal organizations agreed to a comprehensive program to restore the June Sucker. Working collaboratively, water flow was restored to the Provo River, Hobble Creek was reconnected to the lake, nutrient standards were tightened for wastewater, and habitat restoration improved the quality and amount of healthy lakeshore and lakebed. For example, state and local partners achieved ~80% carp removal and 70% phragmites control in less than a decade. Because of these collaborative conservation efforts at local, state, and federal levels, the June Sucker was downlisted from endangered to threatened in the winter of 2020/2021. This is only the third time in U.S. history a fish has been downlisted or delisted, and the recovery was recognized nationally as an example of how collaborative conservation should be done (news release).

Springville West Fields by Robert L. Marshall. This shoreline is near the Hobble Creek restoration project, which reconnected the river with wetlands in Provo Bay to create habitat and public access. Courtesy of Creek Road Studios.

DODGING SILVER BULLETS

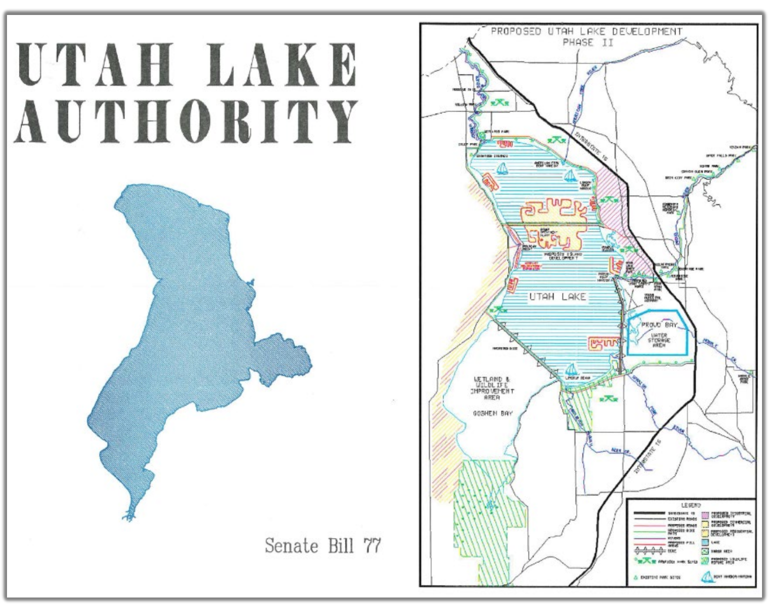
Over the past century, many major modifications to Utah Lake have been proposed. These "improvements" were well intentioned and often motivated by real problems. However, as is taught in both ecology and environmental engineering, "The chief cause of problems is solutions." Thankfully most of these drastic proposals have not come to pass, at least not as originally planned.

Starting in 1905, the [Strawberry Valley Project] built a reservoir and tunnel to bring water from the Colorado watershed into Utah Valley. The project stole water and land rights from the Ute Indian Tribe but was authorized quickly by the Secretary of the Interior. The water was used for hydroelectric plants and irrigation in Utah County but reduced water available for Colorado River users.



A 1968 Central Utah Project update shows planned changes to Utah Lake

In the 1940s, the enormous Central Utah Project ([CUP]) was planned to bring one million acre-feet of water from the Green River to the Wasatch Front. Though parts of the CUP are still under still underway, it was scaled back by more than 90% because of financial, technical, legal, and environmental issues. Informed by the "[demand-side]" hydrological thinking of the day, the CUP planned to reduce evaporation from Utah Lake by diking off Goshen and Provo bays, shrinking the lake by ~30%. Based on what we have learned from similar modifications in the Great Salt Lake and other water bodies, this would have disrupted local climate and damaged the lake's biogeochemistry and habitat.



This failed 1989 law intended to "harvest the lake's economic potential" by building causeways and artificial islands

A 1989 senate bill proposed to create a *Utah Lake Authority*. The new entity would have overseen development around and within the lake, including 30,000 acres of artificial islands and the diking of the bays. Thankfully, the bill never made it out of committee.

In 2018, the legislature passed the *Utah Lake Restoration Act*, authorizing the privatization of lands in and around Utah Lake in exchange for a promise of restoration. A proposal to build 18,000 acres of artificial islands is still at large based on this bill (See the "Who owns Utah Lake" section for details).

Why should we care about Utah Lake?

A sailboat crosses the north side of Utah Lake (Angie Hatch)

Utah Lake is more than just a scenic backdrop for selfies, though it does support a growing number of nature and event photographers. This lake is of enormous importance to Utah Valley culturally, ecologically, and economically.

In the vast, arid expanse of the Great Basin (200,000 square miles of landlocked mountains and valleys), Utah Lake is a vibrant oasis of water and wetland. The lake provides habitat for hundreds of invertebrates, 226 species of birds, 49 mammals, 18 fish, and 16 reptiles and amphibians. Its wetlands and shorelines are a keystone link in the Pacific Flyway, providing nesting or food for 10 million birds, including cranes, eagles, pelicans, and shorebirds that come from as far as Alaska and Patagonia. The deltas and lakebed are as productive as tropical rainforests per square foot, supporting rich food webs of plants, invertebrates (mollusks, insects, etc.), and consumers (fish, birds, amphibians, and people).

The lake freely provides ecosystem services that most of us never think about, supporting everything from skiing at Sundance, to growing our famous Utah cherries, to enjoying our clean mountain environment. For example, Utah Lake removes hundreds of tons of excess nutrients such as nitrogen and phosphorus from our wastewater every year, and it processes or stores other pollutants including arsenic, mercury, and sulfur from coal-fired powerplants. Utah Lake regulates our local climate, with its evaporation decreasing summer temperatures and providing a source of moisture for rain and

Parasailer and rafters enjoy the east shore of Utah Lake (Lanea Shutt) snow in the Wasatch and Uinta Mountains. Additionally, the water in and from Utah Lake protects our air quality by preventing the lakebed from becoming a major source of dangerous dust. This may not sound like a big deal, but areas that have neglected their terminal lakes (lakes without an outlet) such as Owen's Lake in California have ended up spending billions to protect air quality and snowpack from lakebed dust.

Utah Lake also provides world class recreational opportunities (check out the Utah Lake Commission's list of 29 things to do at Utah Lake). The number of motor and sailboats on the lake is increasing, and improved access now allows the launching of canoes, kayaks, and rafts along most of the east shore. Marinas around the lake provide access for boaters who sail, water ski, kayak, windsurf, fish, and hunt.

Boaters enjoy the south end of Utah Lake (Jared Tamez)

Most fish and birds in Utah Lake are safe to eat, and you can check current consumption advisories here. The growing trail system is improving access to shorelines and wetlands for all members of our community to spot wildlife, catch fish, paddleboard, or just enjoy the beautiful environment. A large group of professional and amateur photographers work on Utah Lake. Nature, family, and event shoots are extremely popular, with the Utah Lake Photography clubs on Facebook and Instagram claiming nearly 2,000 members.

Many in our valley also recognize the spiritual importance of Utah Lake. These lands and waters were sacred to the Timpanogos Nation and other indigenous peoples as well as the Mormon Pioneers who would not have survived their first winters without the bounty of the lake. Whatever our personal history and beliefs, conserving the unique beauty and functions of Utah Lake reverences these lands and brings our community together.

What was Utah Lake like ecologically before European settlement?

We are still learning a lot about the ecological history of Utah Lake, but what we do know provides important context for current conservation and restoration efforts.

The native fish that lived in Utah Lake before European settlement. Only fish 1, 2, and 9 currently live in the lake, though all but fish 3 still survive elsewhere. Courtesy of the Utah Lake Commission.

One of the biggest changes in the lake is the loss of native species and the introduction of invasive ones. Virtually every group of plants, animals, and microorganisms have been affected. Only two of the original 13 native fish species survive in Utah Lake, and the loss of native mollusks (snails, mussels, and clams) continues to this day. Combine this with changes in both water and land plants, and Utah Lake is a very different ecosystem than the Native Timpanogos would have experienced.

Fifteen non-native fish species, including carp, walleye, bass, catfish, and most recently pike have become established in the lake, where they now eat other fish, compete for resources, and disturb the lakebed. Likewise, the non-native common reed *phragmites* was introduced as a decorative plant, but it came to dominate waterways in the Great Salt Lake watershed, including Utah Lake. These changes in ecological community have altered the Utah Lake ecosystem, and restoration targets need to consider the loss and introduction of the species that make up the Utah Lake community. Despite what we see in movies, both extinction and the establishment of invasive species are effectively permanent.

A bald eagle hunts in the invasive phragmites reeds (Travis McCabe)

The historical clarity of Utah Lake is a point of continued research. While lake cores do show a shift in lake clarity in the 1960s or 1970s when algae became dominant, two factors suggest that Utah Lake has always been relatively cloudy. First, the unique hydrology of the lake causes the constant formation of calcite in the water, which removes phosphorus and creates the lake's milky color. This nutrient removal and cloudiness protect the lake from more severe algal blooms thanks to evaporation, which concentrates minerals in the lake water (think of hard water scale deposits on a boiling pan). Second, because Utah Lake is so large and shallow, wind action can easily stir up sediment from the lakebed. Because Utah Lake stays well mixed and oxygenated, this wind-stirred sediment reduces light penetration and can even remove nutrients by adsorption. However, Utah Lake was likely clearer in the past because:

1. There was greater water flow to the lake through rivers
2. There was less nutrient delivery to the lake and consequently less algal growth
3. There were no carp
4. There was more submerged vegetation along the lakeshore
5. There were more native invertebrates that filtered the water

In summary, even before European contact, the lake was likely a beautiful milky or muddy color for much of the year, except for during snowmelt and periods of calm when clams, chironomids, and other filter feeders might have temporarily cleared the water.

The hydrology of Utah Lake was very different before the water projects of the 1900s. The lake level used to fluctuate more depending on the time of year and amount of snowmelt. Being a large shallow lake, small changes in water level translated into a dynamic shoreline and system of wetlands around much of the lake. This created habitat and enhanced nutrient removal by plants and microorganisms. Humans now control the amount of water getting to the lake—diverting much of the natural flow and importing water from outside of the basin with pipelines and tunnels. This has the advantage of providing water during drought years and protecting human buildings around the lake, but it comes at the cost of degrading habitat and harming species that depend on natural fluctuations in water flow.

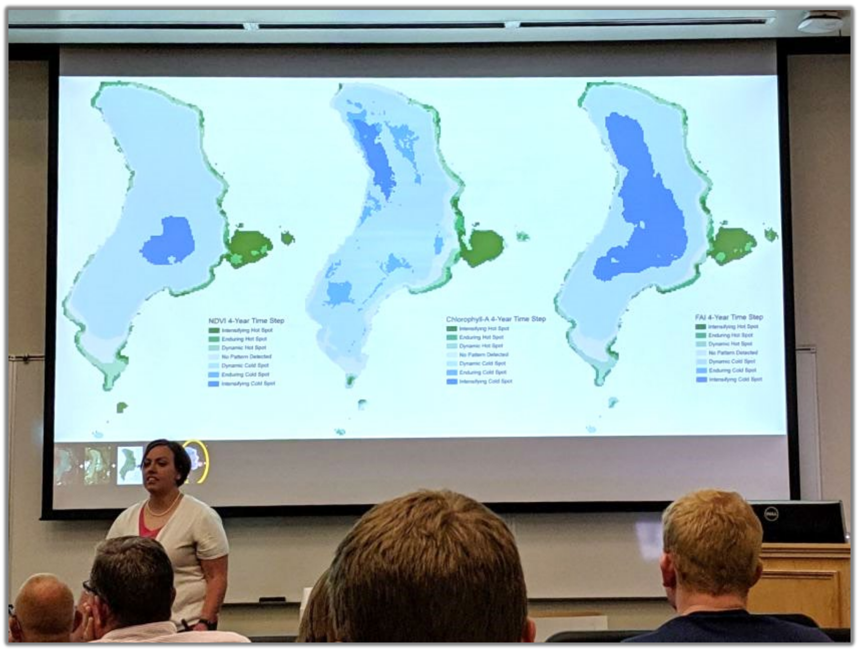
One thing that hasn't changed substantially is the depth of the lake. Utah Lake has always been shallow. Its bathymetry (underwater topography) was determined by Lake Bonneville, which deposited thick sediments that now make up the living lakebed. Despite claims that Utah Lake used to be deeper, analysis of sediment cores show it has always been a huge and shallow waterbody and that sediment deposition rates have not changed dramatically since before European arrival (see section on dredging for more detail).

Dr. Janice Brahney from Utah State University collects a sediment core from Utah Lake as part of the Utah Lake Water Quality Study

Why does Utah Lake have algal blooms?

THE GLOBAL NUTRIENT OVERLOAD

Like many waterbodies in the U.S. and globally, Utah Lake has been overfertilized, creating a condition called *eutrophication*. Almost everything humans do—from growing food to using fossil fuels to flushing the toilet—adds nutrients to the environment. Because of this global nutrient overload, approximately 2 in 3 freshwater and estuarine ecosystems worldwide are experiencing various levels of eutrophication. When an ecosystem is overfertilized or *eutrophic*, there can be an overgrowth of algae and cyanobacteria (another family of photosynthesizers). Besides being unsightly, these blooms can be harmful in two ways. First, the cyanobacteria can produce powerful toxins that can sicken people and animals who are exposed to the water. Second, the overgrowth can create so much organic material that oxygen gets depleted in the water, creating a *dead zone* where no fish or other animals can survive.



Shanae Tate (M.S. BYU) presents a 35-year satellite analysis of algal bloom intensity on Utah Lake

Given the amount of nutrients in Utah Lake, it is classified as hypereutrophic—the highest award in a contest you don't want to win. However, Utah Lake only experiences occasional blooms usually only over a portion of the lake. In fact, Utah Lake was just ranked in the lowest category of algal bloom severity and persistence by a nationwide satellite study this year—cleaner than many lakes and reservoirs in Utah. This raises the question, why doesn't it have more frequent and severe blooms?

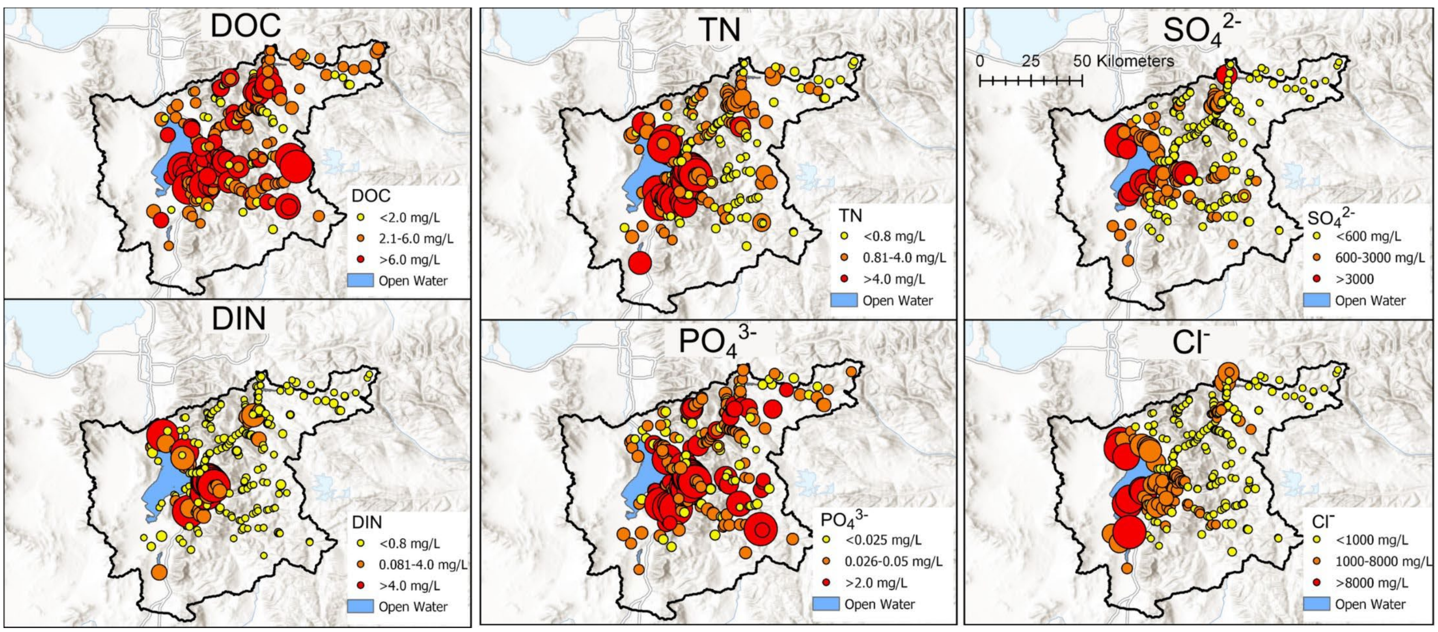
The answer is that the characteristics of Utah Lake make it extremely resilient to algal blooms. Three factors prevent the lake from looking like pea soup year-round. First, the cloudy water of the lake limits light availability, slowing growth of both algae and cyanobacteria below the lake surface. Second, the high rate of evaporation causes constant formation of calcite, which scrubs nutrients from the water or make them difficult for the algae to use. Third, the shallow and wide bathymetry of the lake means that even when blooms occur, they don't create a dead zone because the water is so well mixed. The shallow, well-mixed water also limits the release of phosphorus and other pollutants from the sediment, which become mobile when oxygen is depleted (see section on dredging).

Ultimately, the characteristics that people complain about the most are some of Utah Lake's most important assets.

SOURCES OF NUTRIENTS IN THE UTAH LAKE WATERSHED

So where are the nutrients coming from? Congratulations, you just asked **the most controversial question about Utah Lake!** It is true that we still have a lot to learn about nutrient cycling in Utah Lake, and we need continued research. However, there is an emerging picture of where nutrients come from and how they affect the lake system.

More than a decade ago, the Utah Division of Water Quality commissioned a comprehensive study of Utah Lake nutrients to answer this question. They found that 77% of the phosphorus came from wastewater treatment plants, with the remaining portion coming from agricultural and urban runoff and natural sources. Like any research project, this study had its limitations, for example, it didn't measure stormwater inputs into the lake. Predictably, some people and organizations challenged the finding that nutrients are mainly from wastewater, and the debate has been raging ever since. Some have claimed that dust deposition from the West Desert or nutrient release from the sediment are much more important than nutrients from human wastewater. The scientific process requires people to challenge each other, so these alternative explanations are actually very useful. Let's test them against the available evidence.



Maps of nutrient and solute concentrations in the Utah Lake watershed. For both nitrogen (N) and phosphorus (P), concentrations are highest in the urban and agricultural portions of the watershed, indicating human sources (Jones et al., 2021).

First, it's important to know that not all nutrients are created equal. The total amount of phosphorus or nitrogen in the water can be much larger than the fraction that is available for algae and cyanobacteria. Additionally, many forms of nutrients are bound up in organic materials or protected by mineral compounds. It is only the free and *reactive* nutrients (such as phosphate, nitrate, and ammonium) that can easily be used by algae and cyanobacteria. It is true that dust and river water are often high in total nutrients because of the types of rocks in our mountains, but these natural sources are usually very low in reactive nutrients. This has been confirmed by several studies, including a large citizen

A research technician collects incubation bottles from one of the Utah Lake study locations. Gabriella Lawson (M.S. BYU), Samuel Bratsman, and Zachary Aanderud led the largest nutrient experiment ever on Utah Lake in 2019-2020 as a part of the Utah Lake Water Quality Study.

science project that collected samples from nearly all the waterbodies in the watershed. On the other hand, wastewater outflows contain the yummiest imaginable nutrients in wonderfully clear water—a perfect recipe for a bloom.

More convincingly, there is a distinct human fingerprint where the blooms are occurring. While blooms are infrequent and have actually decreased for most of the lake over the past 35 years, there are persistent hot spots in Provo Bay and the east shoreline where wastewater treatment plants discharge into the lake. If dust or the natural sediment were causing the blooms, we would expect a consistent pattern across the whole lake, or even more powerful blooms on the west and south side of the lake where there is more dust deposition.

But are we sure that reducing wastewater nutrients would help? **This is likely the second most controversial question about Utah Lake!** Some people have claimed that because nutrient levels are so high in the lake, even if we reduced human inputs, it wouldn't make any difference. Like the dust and sediment arguments, this is a reasonable hypothesis, but it isn't supported by the evidence.

A series of nutrient addition and removal experiments just finished last year have definitively shown that nutrients are the factor that limits blooms throughout the year in all portions of the lake. This likely comes back to the total versus reactive nutrient question. While Utah Lake is high in total nutrients (TP and TN), the available fraction of those nutrients is low enough to limit the initiation and spread of blooms for most of the year.

A water-skier shows off his vintage Utah Lake t-shirt. Though the lake has less "scum" today, it's hard to shake the reputation.

WHAT CAN WE DO TO REDUCE THE BLOOMS?

If nutrients are causing the blooms, what is the best way to reduce nutrient availability in the lake? **You can now shout controversy BINGO because this question is just as contested as the last two!**

If you express nutrient concentration in Utah Lake as a mathematical formula, you'd get something like this:

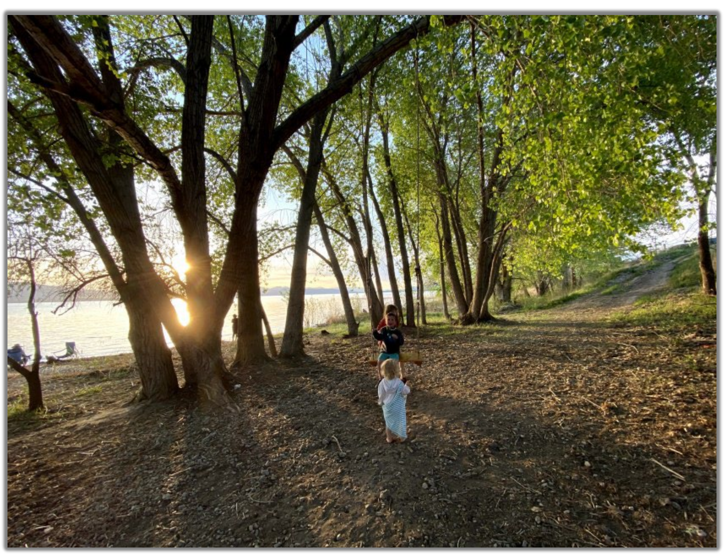
$$Nutrient\ concentration = \frac{(\text{nutrient input to the lake } - \text{nutrient removal in the lake})}{\text{water flow to the lake}}$$

Even if you don't love math, you can hopefully see that there are multiple ways of reducing nutrient availability. First, we could continue working with farmers and cities to reduce water use, allowing more natural flow to the lake. Second, we could lower nutrient inputs by improving wastewater treatment, reducing stormwater inputs, and improving agricultural practices. Third, we could enhance nutrient removal processes by restoring wetlands, protecting the lakebed, and dismissing any proposals that would reduce evaporation such as building islands. Fourth, we could continue researching nutrient cycles in the lake and testing targeted interventions in high-risk bays and marinas, such as restoring food webs, localized dredging, chemical treatment, and algae harvesting. Fifth, we could do all the above. Pro-tip from a teacher: pick all the above.

Sandhill cranes nesting on Utah Lake. (Chuck Castleton)

LOOKING TO THE FUTURE

While nutrients are clearly a big part of the problem, remember that everything is connected in complex ecosystems. Water temperature and lake level are strongly [correlated with the severity of blooms](#) on Utah Lake, with worse blooms in warmer years when the water level is low. Two factors likely contribute to these correlations. First, algae and cyanobacteria can replicate faster in warmer water. Second, because wastewater nutrient inputs are constant (in flood and drought, we all use the toilet about the same), the lake experiences higher nutrient concentrations in low water years. These interactions highlight both opportunities and threats. On the threat side, climate change and more demand for agricultural water are making it harder to prevent blooms on Utah Lake. On the opportunity side, we could get more bang for our buck if we both reduce nutrient



Children play on the lakeshore in Vineyard inputs by upgrading treatment plants and increase natural water flow to the lake by cooperating with farmers and cities.

There is one point about Utah Lake nutrients that we hope is agreed upon: divisions and finger pointing are not helpful. Though wastewater plants are often viewed as villains, we are all part of the problem (everyone poops). We need to view the wastewater plants as indispensable allies, not enemies. They have already implemented many measures to reduce nutrient pollution, including tertiary treatment in some plants. We should thank them for their progress and provide the resources to further reduce nutrients. We also need to look upstream (figuratively) of the treatment plants. To get where we want to go, we need integrated approaches that manage nutrient sources at the watershed level, not only at the end of the line. This is a challenge but also a huge opportunity based on experience from other areas affected by blooms. Implementing nutrient reduction and recapture strategies could create local business opportunities, increase our water and nutrient security, reduce our water and fertilizer expenses, and result in a cleaner and healthier environment.

Cooperation on nutrient and water management will only become more important in the future. The population of the Utah Lake watershed is expected to double by 2050. We are not going to make progress unless we exercise great foresight and investment now.

If we live in a desert, why do we have such a huge lake?

First off, Utah Valley isn't technically a desert. With just over 17" of precipitation annually, central Utah is solidly in the *semiarid* zone (deserts have less than 10" of precipitation). But the question of why Utah Lake exists is still a great one. In the huge expanse of the dry Great Basin, Utah Lake is a rare gem of freshwater and vegetation. Like most things about it, the hydrology of Utah Lake is complicated and fascinating.

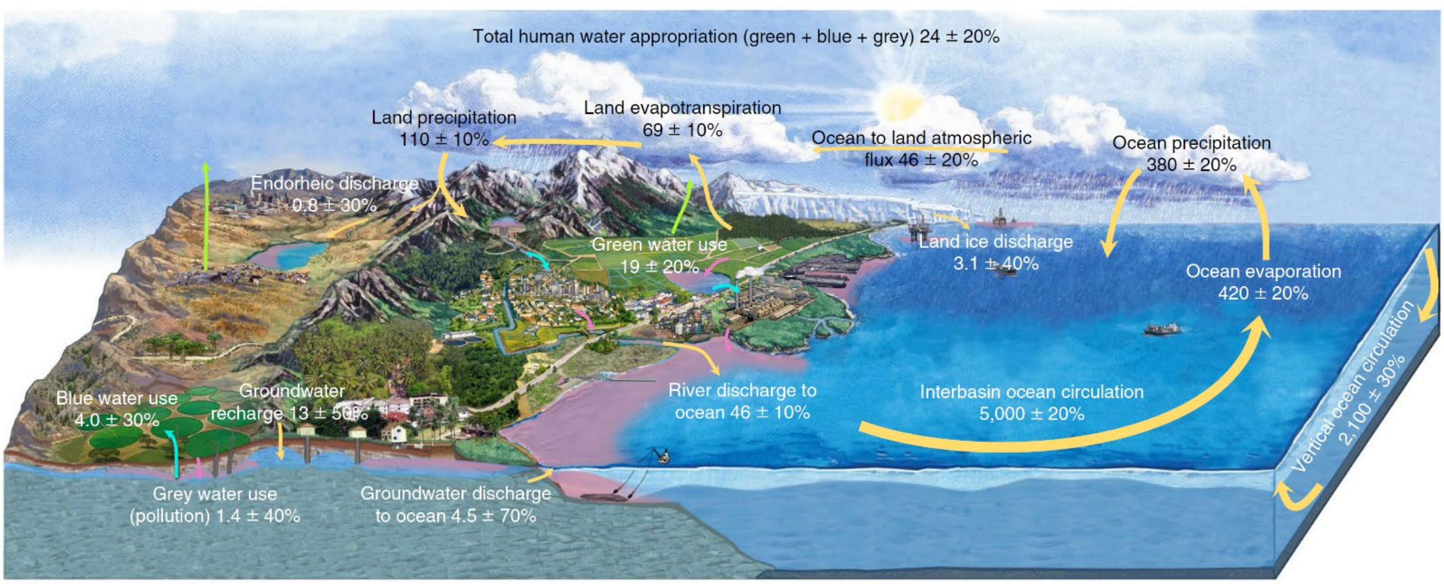
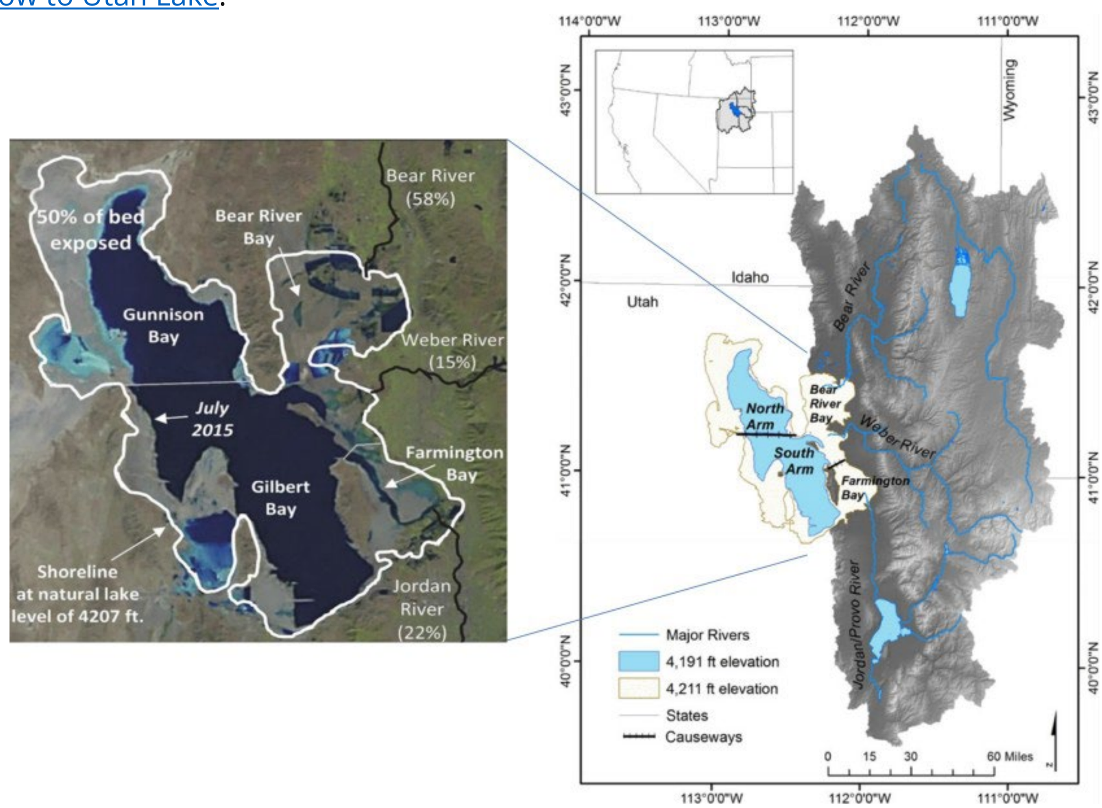


Diagram of the global water cycle, showing the importance of upwind evaporation for endorheic or terminal basins like Utah Lake and the Great Salt Lake. Units are in thousands of cubic kilometers of water per year (Utah Lake contains approximately 1 cubic kilometer of water). (Abbott et al. 2019).

Because this area is relatively dry, one of the distinguishing characteristics of Utah Lake is its enormous watershed (area of land that contributes runoff and groundwater to the lake). Nearly 3,000 square miles of mountains and valleys are needed to provide enough water flow to keep Utah Lake wet. Compare that to Lake Tahoe, which has about the same area as Utah Lake but only a 500 square-mile watershed! Because it drains such a huge area, Utah Lake is very sensitive to changes in land use, water diversions, and climate.

There are three basic ways that water gets to Utah Lake: 1. Rivers and streams flow into the lake (45% of inflow), 2. Groundwater seeps into the lake through springs and sediments (41%), and 3. Rain and snow fall directly into the lake (14%). Now that we know how water gets into the lake, where does it go from there? Just like the inflows, there are three major options: 1. Lake water flows through the Jordan River toward the Great Salt Lake (46% of outflow), 2. Lake water evaporates back to atmosphere (38%), and 3. Lake water seeps back into the ground, mostly toward the north (16%). Though these inflows and outflows seem straightforward, they are very difficult to measure, and we are still learning a lot about the lake's hydrology. In fact, a study came out last year that more than tripled estimates of groundwater flow to Utah Lake!



Maps of the Great Salt Lake watershed showing the size of the lake at different elevations. The level of the Great Salt Lake reached 4,190' in July of 2021. Credit: Wayne Wurtsbaugh and team at USU.

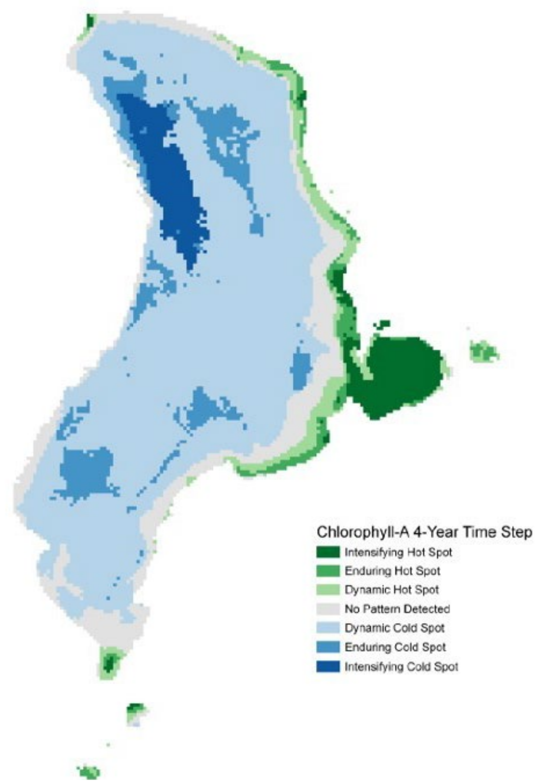
Some people wrongly assume that evaporation and river flow to the Great Salt Lake are wastes of water. When you understand the hydrology of the lake, you see that these water flows are crucial to maintaining a thriving and healthy local environment. First, water that evaporates from Utah Lake provides an important source of downwind rainfall and snow. In fact, landlocked areas like ours receive more than two thirds of their precipitation from upwind evaporation and transpiration from land and lakes. In the water cycle, nothing is wasted! Second, this evaporation increases local humidity and decreases temperature (like a giant evaporative cooler). In a single year, evaporation from the lake sucks about a trillion megajoules of energy from the atmosphere—that's enough energy to power all of Utah's electricity for 6.5 years! Third, the water flowing through the Jordan River valley is the lifeblood of the Great Salt Lake. Like Utah Lake, the Great Salt Lake provides invaluable habitat and serves as a cornerstone of Utah's identity and economy. Fourth, evaporation from Utah Lake is an important release valve when water levels get too high. For example, in the spring of 1983, record snowpack led to catastrophic flooding along the Wasatch Front. The construction of Jordanelle Reservoir in the 80s and 90s was partly motivated by the need to avoid downstream flooding during high water years.

While terminal lakes are drying up around the world, mainly because of excessive diversions, we need to protect the Utah Lake and Great Salt Lake to avoid air pollution, loss of habitat, loss of tourism, and damage to local quality of life. Climate change has already made our droughts more intense and precipitation less reliable. Looking to the future, we will need to reduce water use and eliminate greenhouse gas emissions to preserve our beautiful and unique environment (see this how-to guide). Utahns currently use more water per capita than almost any state in the U.S., leaving us lots of room for improvement in agricultural, urban, and domestic water use.

Is Utah Lake getting better or worse?

This is one of the most important and complex management questions. Unsurprisingly, the answer is it depends on what you are talking about.

Let's start with the harmful algal blooms (see the section on blooms for more detail). You may have recently heard about the blooms that affect parts of Utah Lake most years. Increased public awareness of blooms is a good thing, but it's important to remember that this does not mean blooms are a new or worsening problem. Over the past 35 years, the overall amount and duration of blooms have decreased, likely due to improved wastewater treatment and restoration of water flow to the lake. However, blooms in Provo Bay and on the east shore are persistent hot spots with blooms occurring in 30 of the last 34 years. Because the trails and marinas along the east shore are where most people interact with the lake, there is a widespread belief that things are getting worse. This is reinforced by the fact that when a bloom appears, it gets a lot of media attention, but when a bloom disappears (usually just a week or two later), most people never hear about it. We can accelerate the decline of algal blooms by reducing wastewater, urban, and agricultural nutrient sources and increasing water flow to the lake.



Satellite analysis of chlorophyll (an indicator of algal blooms) over the past 35 years. Blue colors indicate a decrease in blooms, gray colors show no trends, and green colors indicate an increase in blooms (Tate 2020).

While we cannot bring the many extinct Utah Lake species back from the dead, we can establish more natural water quantity and quality to restore some of the extirpated (locally eliminated) species and work to manage the invasive species such as carp and phragmites. The invasive species removal programs have made immense progress—removing around 75% of the invasive carp and phragmites. However, invasive removal is an uphill battle. There are virtually no examples of the complete elimination of invasive species from an area as large as the Utah Lake watershed. We can reduce numbers through direct removal and restoration of native competitors, but it is likely impossible to completely remove the carp and phragmites that now inhabit our lake. This is not completely a bad thing, because both of these species provide ecosystem services, including collecting and removing nutrients and other pollutants, and serving as habitat and food for other species.

A belted kingfisher looks for a meal in Utah Lake (Travis McCabe)

Talking about habitat and wildlife, the story is more straightforward. The restoration efforts surrounding the June Sucker and other species have been extremely successful. Minimum fish flows have been established for Provo River and Hobble Creek, creating access to habitat even during the worst drought years. Likewise, large areas of wetland and delta habitat have been created or protected, and this is only increasing with current conservation projects. Fish, birds, and the people who love them are very happy with the notable improvements in the Utah Lake ecosystem over the past few decades.

The iridescent skin and unmistakable smile of a juvenile June Sucker. This endemic fish went from no reproducing adults in the late 1990s to more than 4,000 spawning in 2021 (Riley Nelson).

There is another dimension of Utah Lake that is perhaps as or more important than the ecology and hydrology: our community's relationship with the lake. Thirty years ago, it was very common to spend time on and around Utah Lake. Many of us grew up swimming, fishing, waterskiing, and camping around Utah Lake. Even though the ecological status of the lake is better today than it was then, many people have negative attitudes towards the lake and visitation is low. This has opened the door to proposals to dredge the entire lake, make radical changes to governance, or even cover it with artificial islands. These extreme proposals are a symptom of our loss of connection and understanding with this beautiful waterbody. One of the most important things we can do for Utah Lake is to talk about it, share our photos, and invite our friends to experience this unique ecosystem themselves.

Undated photo of a motorboat on Utah Lake. Courtesy of the Utah State Historical Society.

Who owns Utah Lake?

The State of Utah is legally responsible to manage Utah Lake. The Utah Division of Forestry, Fire, & State Lands (FFSL) is the agency tasked with overseeing the lakebed. Lands, lakebeds, and riverbeds protected by the state in this way are referred to as *sovereign lands*. The state holds and manages sovereign lands according to the *public trust doctrine*, a legal principle that has been established by multiple sources, including the Utah Constitution, state legislation, state common law, and possibly federal constitutional law. The public trust doctrine requires Utah to act as a trustee to hold the lake for the benefit of all Utahns—present and future. However, the state's authority and responsibility to protect Utah Lake in this way have been challenged multiple times in recent history.

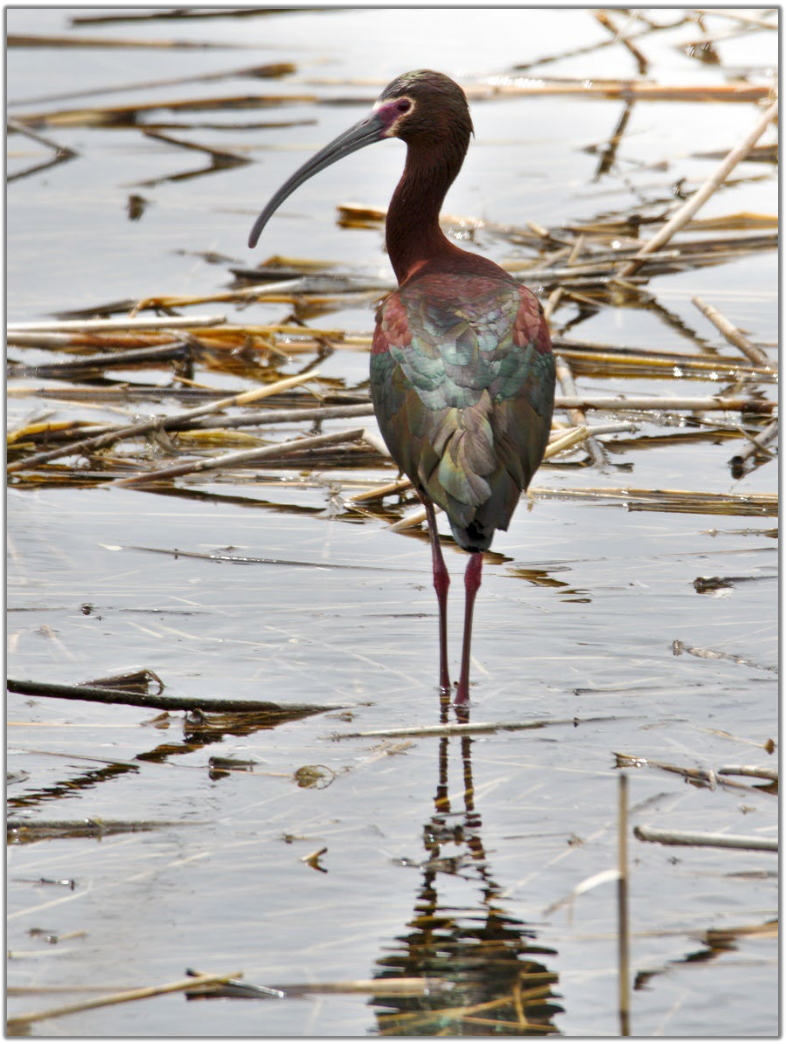
During the 1970s oil crisis, the U.S. federal government issued oil and gas leases for drilling underneath Utah Lake. Local citizens and lawmakers were alarmed that this could cause pollution and permanent damage to the lake. The

A child plays on the steps of the Utah Capitol

Utah government filed a lawsuit that was finally decided in the U.S. Supreme Court in 1987. The Supreme Court upheld Utah's responsibility and right to the bed of Utah Lake, reaffirming that Utah acquired the lakebed and other sovereign lands at statehood under the equal footing doctrine.

Disputes over Utah Lake and other nearby waterbodies have further clarified legal responsibility. In 1990 the Utah Supreme Court ruled that the *"essence of [the public trust] doctrine is that navigable waters should not be given without restriction to private parties and should be preserved for the general public for uses such as commerce, navigation, and fishing."* The court specified that even leasing of these lands can be invalidated. A 2019 ruling by the Utah Supreme Court specified that *"the abdication of the general control of the state over lands under the navigable waters of an entire harbor or bay, or of a sea or lake. . . is viewed as a gross infringement of the public trust doctrine."*

The most overt and effective challenge to the public trust doctrine started in 2017. A limited liability company wanted to build 20,000 acres of artificial islands within Utah Lake. The company—misleadingly named *Lake Restoration Solutions*—proposed to destroy the lake's natural characteristics by creating deeper channels, disturbing healthy sediment, altering water circulation, and killing all the fish in the lake. They claimed that this "restoration" was necessary because of nutrient-laden sediment, despite multiple lake coring studies that have shown Utah Lake's sediment has natural levels of nutrients (see the section on dredging). They proposed to pay for the radical reengineering of the lake by selling real-estate on the islands, where they planned to house up to 500,000 people.



Aware of Utah Lake's controversial legal footing, a white-faced ibis tiptoes across the reeds (Russell Hatch)

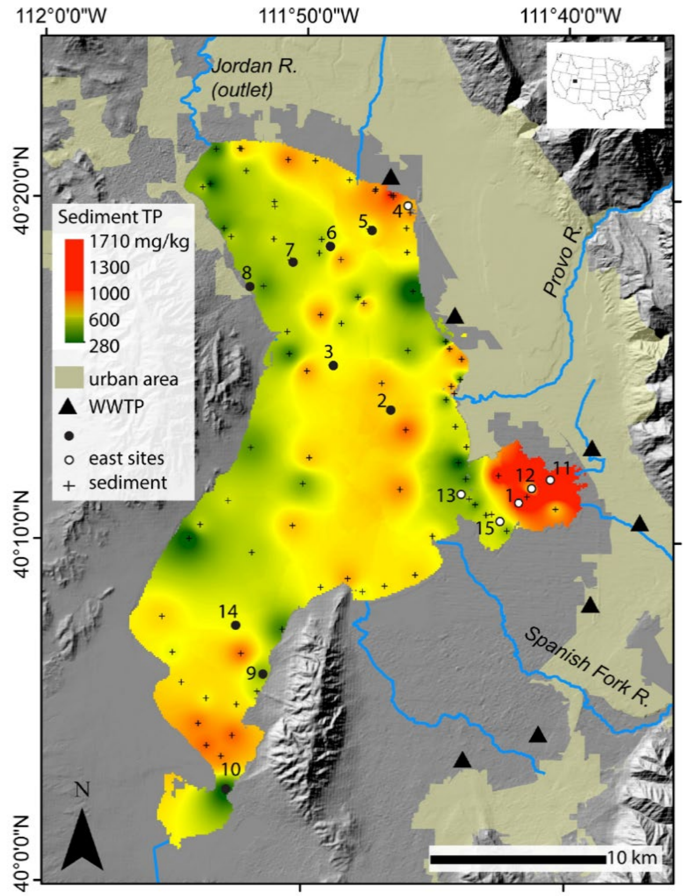
In 2017, the company pitched the islands plan to state legislators and lobbied them to pass a law allowing the transfer of the lakebed to a private corporation. In January of 2018, Representative Mike McKell of Spanish Fork introduced the Utah Lake Restoration Act (H.B. 272), which would allow the state to dispose of sovereign lands in exchange for a promise of "comprehensive restoration" for the lake system. Despite the law's clear constitutional problems and the infeasibility of the island proposal, H.B. 272 passed with overwhelming support in both the house and senate. This law—now codified as U.C.A. § 65A-15—hasn't yet been tested in court, but if the legislature attempts to transfer large portions of the lakebed to private parties, they would almost certainly run into legal barriers. For example, the transfer must not interfere with the existing public trust doctrine, and it would be reviewable by the state courts, who have previously policed the doctrine quite strictly. Though the financing, legality, engineering, and ecology of the island proposal are dubious at best, the proposal remains at large (see section on threats to Utah Lake).

Over 500 concerned citizens held a rally opposing islands and calling for better legal protections for Utah Lake on February 7th, 2022 (Decker Westenburg of the Daily Universe)

In addition to the public trust doctrine in state law, several federal environmental statutes regulate changes to lake management. The National Environmental Policy Act (NEPA) requires thorough environmental assessments before large engineering projects can move forward. NEPA specifically mandates an environmental impact statement (EIS), which takes an average of 4.5 years to complete. Given its unprecedented scope, a massive ecosystem engineering proposal like the islands project should be expected to be among the longest ever NEPA processes, potentially lasting more than a decade. Additionally, dredging or filling Utah Lake or adjacent wetlands would require deniable permits and significant study under U.S. law (33 U.S.C.A. § 1344). Any action that may affect endangered or threatened species, such as the June Sucker, would require consultation and input from still *more* federal agencies, and actions seen as too risky may be precluded by certain Endangered Species Act provisions (16 U.S.C.A. § 1536(a)(2)).

Does Utah Lake need to be dredged?

If you've ever talked about Utah Lake on social media, chances are someone proposed to dredge the lake and "start over." There is something intuitive and attractive about this argument, but as usual, the reality is much more complex. Before getting into the nitty gritty details of dredging, let's look at the unique geology and sediment of Utah Lake.



Multiple coring studies have found that the sediment of Utah Lake has natural levels of phosphorus, except areas receiving wastewater effluent (e.g., Abu-Hmeidan et al., 2018 and Randall et al., 2019)

The silt, clay, gravel, and cobbles below Utah Lake go very deep. There is likely around 10,000 ft of unconsolidated sediment underneath the lake. This material and the bedrock under it are dissected by multiple seismically active folds and faults, part of the reason why Utah Lake has so many springs.

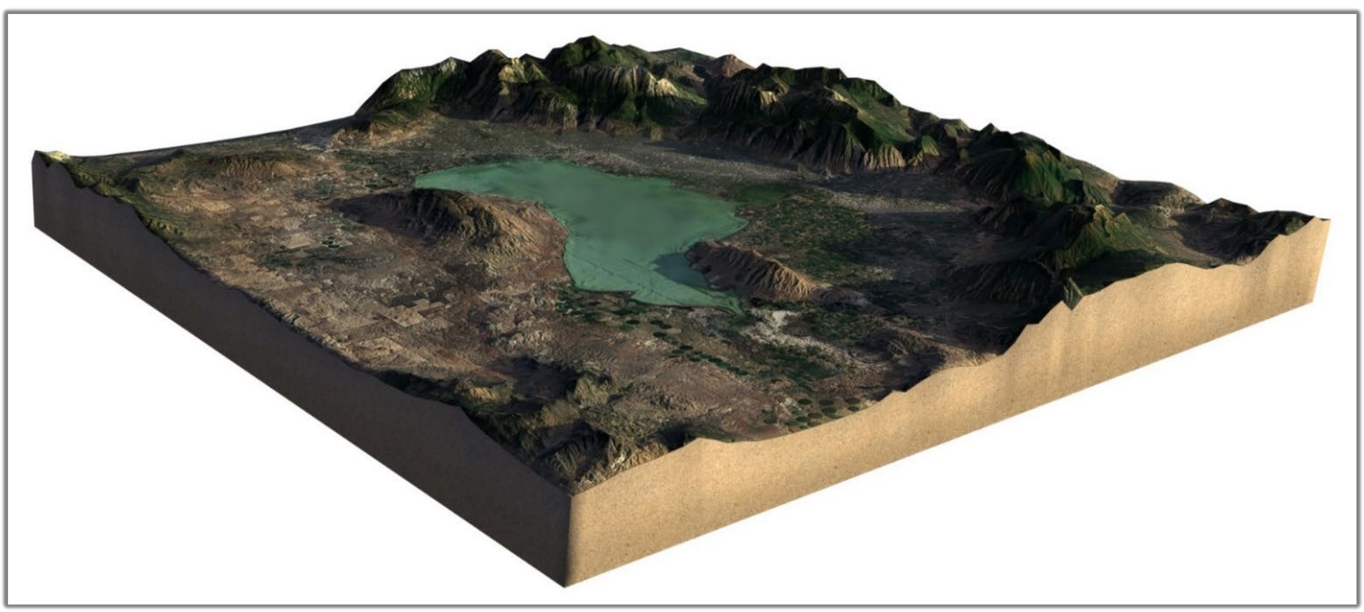
There is a widespread but incorrect belief that the lakebed is heavily polluted with nutrients and that the lake is filling up with sediment. Multiple studies have shown that most of the lakebed has natural levels of phosphorus and very low levels of other pollutants in the sediment. Concerning the claim that Utah Lake is filling up with sediment, this is technically correct, but the question is, how quickly? Rates of sedimentation (accumulation of material on the lakebed) in Utah Lake are extremely slow, ranging from 1 to 2 mm a year. This means that it takes around 25 years for the lakebed to rise an inch, which is very similar to the deposition rate of the past 10,000 years based on lake core studies.

A snowy plover hunts for invertebrates. This is one of thousands of species that depend on the productive sediment of Utah Lake (Jeremy Bekker).

A red-winged blackbird calls from atop a cattail. Aquatic vegetation such as cattails helps concentrate and remove pollutants in the water and sediment (Travis McCabe).

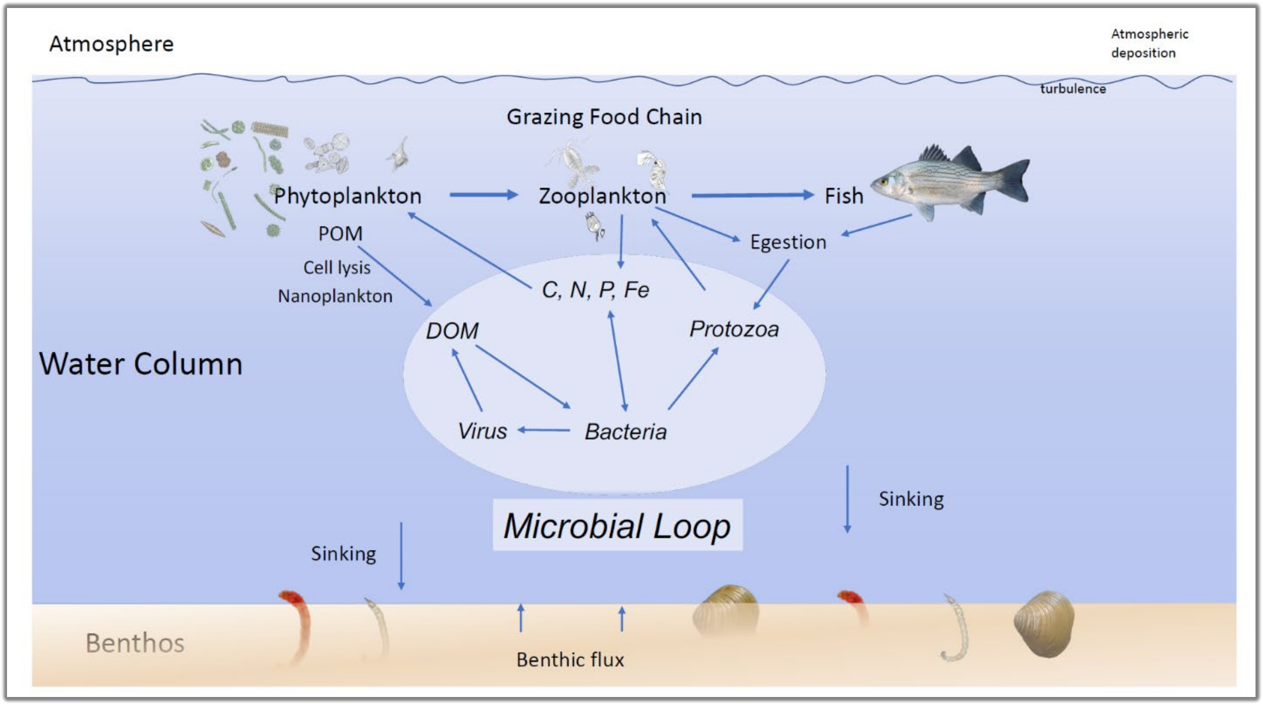
Another common misconception is that the Geneva Steel mill and wastewater outflows have irreparably polluted the lake. The mill operated from 1944 to 2001 and did produce air, soil, and water pollution, mainly from the coal used in the steelmaking. However, settling ponds contained most of the pollution on land, and heavy metal concentrations in lake water and sediment are generally low. For example, sediment concentrations of lead range from 10 to 40 mg/kg, and copper and zinc concentrations range from 10 to 100 mg/kg (Williams, 2021). These levels are well below the EPA's limits of 420 mg/kg for lead, 4300 mg/kg for copper, and 7500 mg/kg for zinc. Utah Lake's clean sediments can be attributed to the lake's natural characteristics and improved management of pollutant sources in its large watershed.

Now that we have some background, let's talk about the proposals to dredge Utah Lake. Dredging is the excavation of material from an underwater environment. It is most often used in marine environments such as ocean ports to keep channels open for large ships. *Environmental dredging* is the targeted removal of material contaminated with persistent pollutants that pose a risk to human health or the environment. While lakebed sediments are extremely effective at removing or immobilizing most pollutants, there are some "forever chemicals" that can require mechanical cleanup.



A 3-dimensional rendering of Utah Lake from the southwest

Whether for navigation or environmental cleanup, dredging has serious downsides. First, it damages the community of organisms in and on the lakebed. These bottom-dwelling or benthic organisms have amazing abilities to remove or immobilize pollution, including excess nutrients, organic pollutants, and some harmful metals. The benthic community plays such an important role in purifying the lake water that it is often described as the lake's liver. Utah Lake has a particularly vibrant and productive lakebed, with thousands of tons of chironomids, clams, and oligochaete worms forming the foundation of the lake's food web. These unsung heroes support Utah Lake's highly productive fishery and help keep sediments in relatively good shape despite decades of nutrient loading.



A simplified food web and nutrient diagram for Utah Lake showing links between water quality and lakebed (benthic) processes (Richards 2021)

Dredging has been compared to clearcutting because of how drastically it disrupts the benthic community and natural hydrology of the sediment. These disturbances often create higher rates of nutrient release after dredging than before. Consequently, the use of dredging to remove excess nutrients is rare and controversial. For example, the world's largest nutrient dredging project (Lake Taihu in China) has not reduced algal blooms, and the most recent review of restoration techniques for large eutrophic lakes does not even mention dredging.

Another problem with dredging is that it can unearth natural and artificial compounds that were safely stored in the sediment. Lakes receive large amounts of dissolved and particulate material from rivers, groundwater, and atmospheric deposition. Most of this material is harmless or even beneficial, such as the sediment and natural nutrients that support the lake's habitat and food webs. However, potentially toxic chemicals also make

Light from Saratoga Springs reflects off a partly frozen lake (Mandy Jensen)

their way into lakes. For example, coal burning and gold mining release mercury and other heavy metals into the atmosphere, arsenic and selenium levels can be naturally or artificially high in groundwater, and a host of human-made compounds such as persistent organic pollutants and petroleum products can make their wat to lakes in stormwater and wastewater. Biological and chemical processes in the lake water and sediment can deactivate, break down, or bury most of these pollutants. However, many pollutants are sensitive to changes in oxygen. This means that dredging can trigger large releases of toxins that can last for years or decades. Consequently—except for rare cases of extreme pollution—the best practice is to allow sediments to naturally stabilize pollutants in the lake while working to eliminate external sources. In time, contaminated material is further protected as it is covered by clean sediment, a process called *natural capping*.

While most discussion of Utah Lake dredging revolves around removing pollutants, there are also proposals to dredge for recreational and development purposes. This is particularly alarming because deepening the lake would destroy the distinct hydrology and biogeochemistry that have helped protect it from human pressure. A deeper lake, divided into multiple basins could quickly stratify (separate into layers due to temperature and salinity), potentially creating a hypoxic dead layer and killing most animal life in the hypolimnion (deep water) and lakebed. As mentioned above, changes in oxygen could also trigger the release of nutrients and toxins from the sediment, with reactive phosphorus and methylated mercury being of particular concern.

A great blue heron and a Cooper's hawk hunt amid invasive phragmites in Utah Lake (Travis McCabe)

In other wide and shallow lakes, including the Great Salt Lake, the construction of deeper channels, causeways, or artificial islands has created a suite of expensive and damaging unintended outcomes. On Utah Lake itself, there are areas that have been dredged, deepened, and divided, which can give an imperfect but useful peek into how this intervention could affect the lake. The marinas and portions of Provo Bay have been dredged for a variety of reasons, and these are the areas with the most severe algal blooms—often the initiation points for lake-wide blooms. Interventions that reduce water circulation and disturb the sediment are likely to exacerbate blooms among other unintended outcomes.

As in medicine, our first restoration goal must be to do no harm. Decades of restoration in Utah Lake and around the world teach us that we should be extremely cautious before changing the fundamental characteristics of this unique water body.

Waves of water in the lake and sky (Kathy Van Wagoner)

There are also legal, financial, and technical barriers to dredging Utah Lake. Because it is expensive and environmentally damaging, dredging is carefully regulated by multiple state and federal laws (see section on who owns Utah Lake). The environmental impact statement for a project as large as dredging Utah Lake would likely take a decade or more.

It would also be the largest and most expensive freshwater dredging project in the history of the U.S. Currently, the Hudson River Cleanup holds that title, with 2.7 million cubic yards of sediment removed over 10 years. According to the proponents of the artificial island project, dredging Utah Lake would require removal of approximately 1 billion cubic yards of sediment. That would make the project 370-times larger than the already enormous Hudson River project and 27-times larger than the Lake Taihu mega-dredging boondoggle in China. This could easily cost $10 billion while providing no ecological benefit to the lake.

Rather than dredging, we should follow best practices in lake restoration by reducing pollutant delivery to Utah Lake, preserving a healthy microbial and invertebrate community in the lakebed and lakeshore, and restoring more water flow to the lake.

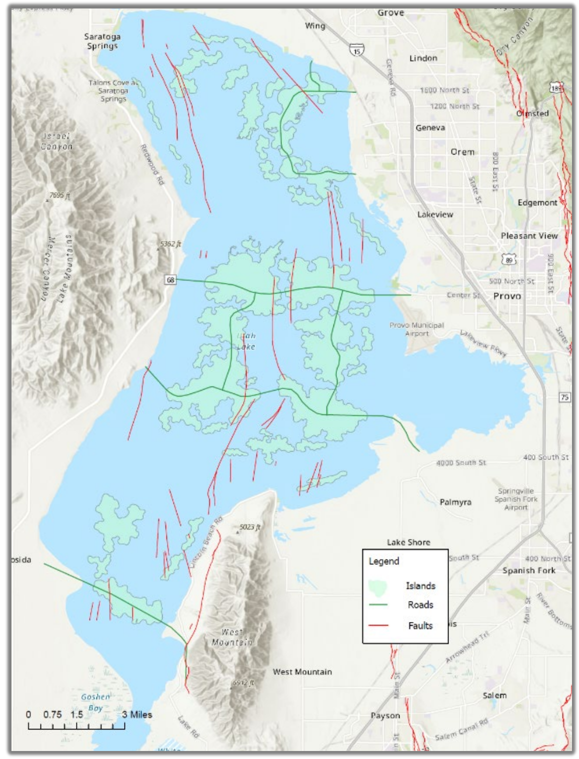
Lake ice buckles against the shore (Justin Lehman)

What are the biggest threats to Utah Lake?

Though many aspects of the Utah Lake system are improving, there are real threats ahead.

The most urgent risk is the island proposal we mentioned in the *Who owns Utah Lake* section. A Delaware company called Lake Restoration Solutions (LRS) is proposing to dredge a billion cubic yards of lake sediment in what would be the world's largest dredged island project (here is a link to their dredging application). LRS alleges that their "Utah Lake

Restoration Project" is an all-in-one solution for all the lake's problems, real and imagined. The flaws in this proposal have been enumerated in detail elsewhere, including this letter of warning with 117 signatories and this expert analysis of the LRS application. Briefly, it depends on a false pretense that the lake is dying, it ignores virtually everything we know about the lake's ecology, and it would change the nature of Utah Lake so drastically our ancestors wouldn't even recognize it.



Map of Utah Lake showing the proposed development overlain on major seismic faults in the lake. Data from LRS's application and the Utah Geological Survey.

LRS claims their project would remove all invasive species, create a deep and clear lake, and "save" billions of gallons of water by reducing the surface area of the lake, though they provide few technical or scientific details. The application does not specify a timeline, but LRS has previously estimated 15 to 30 years of near-constant dredging and construction in and around the lake. Should they succeed in building their island city of up to 500,000 people, it would create societal risks such as liquefaction, perpetual settling of buildings and roads in the lake's thousands of feet of unconsolidated sediment, and disruption of transportation and development for the entire region.

Ecologically, the project would remove all three of the natural protections that make Utah Lake resilient to nutrient loading (cloudy water, evaporation, and a shallow and wide bathymetry—see section on algal blooms). The dredging and island creation would destroy 95% of the lakebed and alter the lake's hydrology, chemistry, and biology. These actions would almost certainly erase decades of restoration and render Utah Lake permanently dependent on costly human interventions, some of which are acknowledged in the application such as mechanical water circulators.

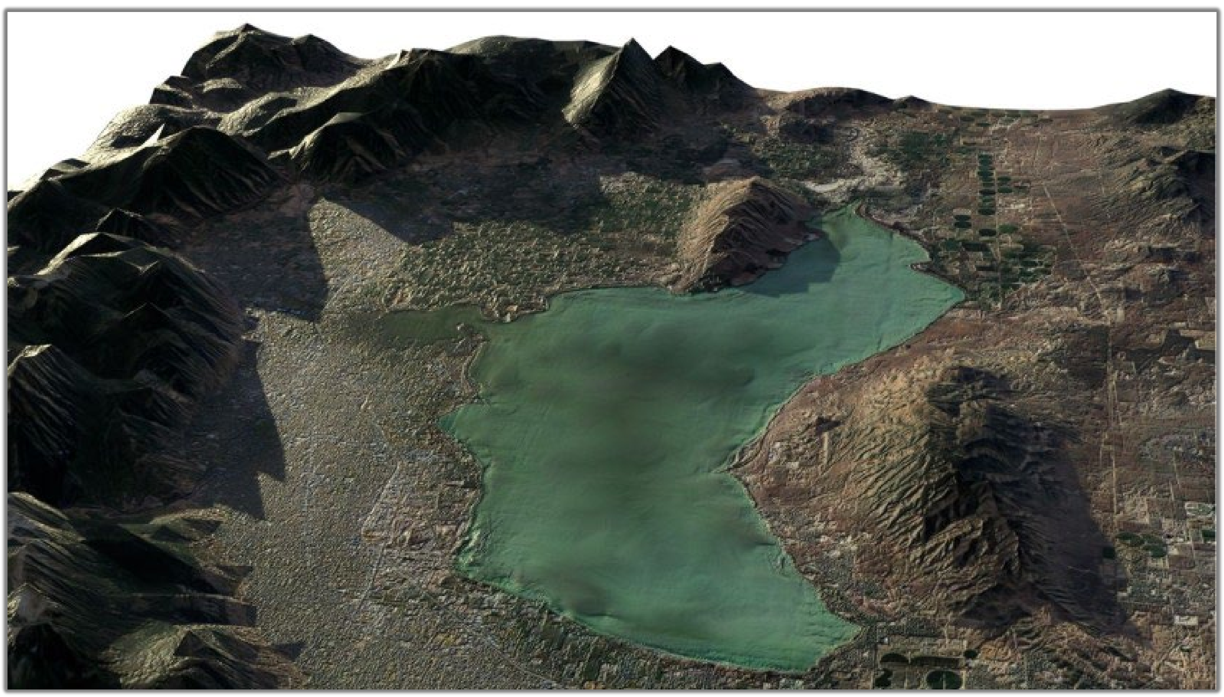
A boy reminds us not to mess up the lake (Travis McCabe)

The project also raises profound cultural, spiritual, and aesthetic concerns. If we allow Utah Lake to be destroyed for profit, it would blast a cultural crater so deep in the heart of our community that our ancestors and children would never let us rest. This highlights the most puzzling question about the project: how has it gotten this far? It has come to light that the proposal has received substantial support from the legislative and executive branches of Utah state government, including a $10 million loan guarantee, letters of support for nearly a billion dollars of federal loans, and a purpose-built law to facilitate the land transfer (The *Utah Lake Restoration Act*). We should pause to reflect on how a project with such little merit and so much risk convinced so many to support it. As stewards of Utah Lake, how can we ensure something like this never happens again?

More generally, these kinds of "moonshot" projects with big promises and undisclosed investors have been proposed before. Right here in Utah Valley, we flirted with the idea of a ski resort behind Y Mountain for more than 30 years. The money never panned out and the project only produced bankruptcy and a heap of wasted taxpayer dollars. These "silver bullet" solutions are usually just what they seem: too good to be true. Real ecological restoration requires meticulous diagnosis, peer-reviewed science, community engagement, and long-term collaboration. The June Sucker Recovery Implementation Program has a clunky name, but it is a fabulous example of how restoration should be run. Another great model is the Everglades Restoration Initiatives.

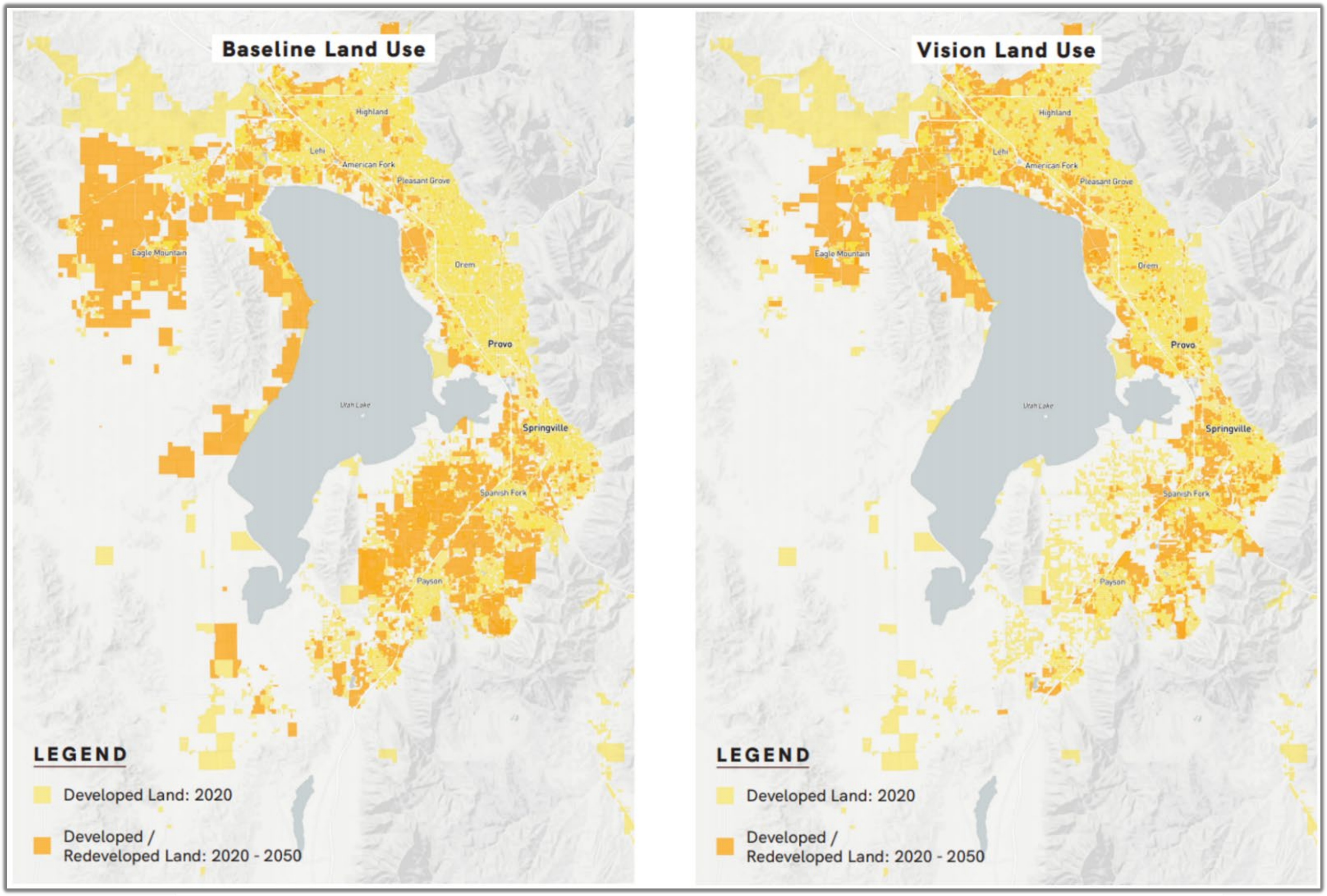
An American kestrel keeps watch over Utah Lake (Travis McCabe)

Another proposed change to the lake is less obviously bad than the island project. A new *Utah Lake Authority* is being considered by the legislature with the stated goals of increasing resources available for lake restoration and improvement. The bill failed last year because of a lack of buy-in from local cities and water users. There are plenty of improvements to the governance of Utah Lake that should be discussed, but it remains unclear why the "authority" structure is the right model for long-term restoration and conservation.



3-D render of the lake from the north showing the extent of urban and agricultural land use in the surrounding area. Even without artificial islands, Utah Lake has a big crowd to please.

There are other threats to Utah Lake beyond islands and legislation. Population growth and development around the lake could destroy habitat and increase nutrient loading. Unless growth is guided wisely and strategically, things could get worse for Utah Lake in a big way.

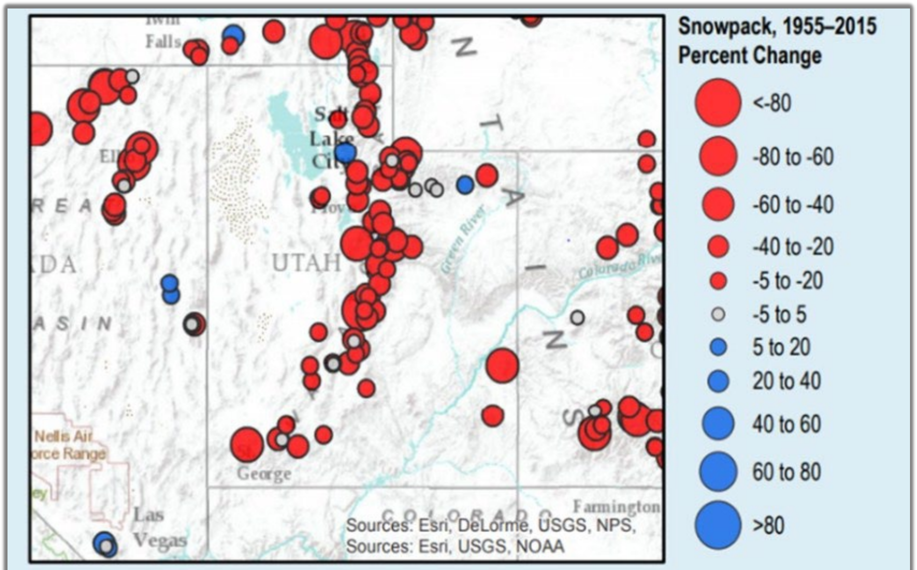


Maps by Envision Utah showing the difference between unplanned sprawl (left) and strategic growth (right). Both scenarios account for the same increases in valley population.

One of the lessons from lake restorations around the world is that we need a holistic approach to Utah Lake that considers water, nutrients, and food webs within the lake and in its large watershed. Wetlands should be permanently conserved around the lake, and we need an ambitious watershed-wide nutrient and water management plan. Across diverse lakes, reducing nutrient inputs and restoring natural hydrology have proven highly effective. In the lake itself, we should prohibit major modifications such as causeways and islands, which have proven extremely problematic. For example, the causeway and dikes in the Great Salt Lake triggered unexpected changes that led to economic damages and the most toxic concentrations of methylmercury ever observed.

Because our valley is growing so quickly, we need transparent and coordinated development plans to ensure availability of housing, a high quality of life, and conservation of critical natural areas. If water is returned to the lake's tributaries and nutrients are removed from wastewater via enhanced treatment, growth is not incompatible with a vibrant and recovering Utah Lake.

Another serious threat for Utah Lake is climate change. We are currently in the most extreme megadrought (>10-year dry period) in the last two millennia. This megadrought has been supercharged by [human disruption of the climate](). Likewise, yearly wildfire extent in the southwestern U.S. has doubled since 1984 because of higher temperatures and drier fuels. While natural wildfire is an indispensable part of the Utah Lake ecosystem, megafires can create another source of nutrients to the lake (video of [megafire effects on Utah Lake]()).



Trends in April snowpack, 1955–2013. Snowpack has declined at most monitoring sites in Utah and the Upper Colorado River Basin. Source: EPA.

Direct measurements of snowpack in Utah's mountains show an average decline of 20% since the 1950s, with 92% of all sites decreasing

Looking into the future, climate models project that the Utah Lake watershed will continue to receive approximately the same amount of precipitation as in the past. However, this precipitation will be less consistent, and there will be a shift from snow to rain. At the same time, increased evaporation and demand for irrigation water will result in less water available to sustain Utah Lake and the downstream Great Salt Lake. We need to be looking ahead and [working on climate solutions now]() to ensure that our lake can continue to thrive.

A sailor on the lake blanketed in wildfire smoke (Derrick Thurman)

The final threat to the lake is societal apathy and disconnection. There are rampant misconceptions about Utah Lake, including beliefs that the lake is unusable, irreparable, or good for nothing. These beliefs have stopped many in Utah Valley from visiting and caring about Utah Lake. Thankfully, individuals and groups such as the [Utah Lake Conservation Coalition]() are educating our leaders and helping our community turn back to the lake. We invite you to help in this effort by learning more, visiting the lake, and sharing what you experience with your neighbors and leaders.

What can be done to improve and protect Utah Lake?

Around and within Utah Lake, dozens of restoration projects are ongoing, and our community is rediscovering the wonder and beauty of Utah Lake. The diverse lake projects are led and supported by individual citizens, cities, the county, the state, and the federal government. Even more conservation and restoration projects are on the horizon, ranging from expansion of trails and access points to the creation of new water laws that favor conservation.

Community members gather on a Saturday morning to collect water samples from throughout the Utah Lake watershed as a part of the Utah Lake Research Collaborative.

Continuing and expanding existing conservation efforts could have large payoffs for the status and future of Utah Lake. Here are eight prioritized recommendations:

1. Rehabilitate our cultural connection with the lake through outreach, education, and experiences with the lake
2. Create a permanent conservation easement around the lake to ensure ecological health, public access, and long-term quality of life for our rapidly growing community
3. Increase river flow to the lake through better water laws and conservation by water users, including farmers, industries, and cities
4. Reduce pollutant flows to the lake by upgrading wastewater treatment and improving urban and agricultural runoff management in the watershed
5. Continue invasive species removal and habitat restoration in ecologically sound ways
6. Integrate the health and conservation of Utah Lake into strategic planning of future development in the valley
7. Protect the lake from dangerous proposals that threaten its health and our future
8. Support basic and applied research about the lake's ecology and sustainable practices for its watershed

A snowy egret hides in the reeds (Russel Hatch).

Lights reflect off the water while Mount Cascade looms in the background (Chuck Castleton)

How can I learn more?

1. The Utah Lake Commission maintains the official website for Utah Lake, which has great photos, blog posts, and even a podcast on science, restoration, and recreation: utahlake.org
2. The June Sucker Recovery Implementation Program has great articles, photos, and activities: June Sucker Recovery
3. The Utah Reclamation Mitigation and Conservation Commission has excellent information on Utah Lake and its connected rivers and wetlands: URMCC
4. The Wikipedia page on Utah Lake has some good basic information and links to other resources: Utah Lake Wikipedia
5. The Central Utah Water Conservancy District has some great card games and activities that can help you learn about and protect Utah Lake and its watershed: CUWCD
6. The Provo River Delta project is seeking to restore habitat for the June Sucker and other species: Provo River Delta
7. The Valley Visioning project commissioned by the Utah County Council of Governments provides excellent resources on possible futures for Utah Valley, including development around Utah Lake: Envision Utah

Shards of ice on the east shore (Jared Tamez).

Ancient Remnant

Mighty sentinels once threatened
By the overspill
A dwindling reminder
Of Ancient Bonneville

A forgotten reflection
Of times when we weren't here
Now a smaller body
Shifting from year to year

Life force in the desert
For native tribes for years
Refuge in the mountains
For searching pioneers

Unique in all its features
From its closed watershed
And salty destination
To its shallow bed

Churned by wind
Warmed by sunlight
Surrounded by mountains
Frequented by bird in flight

Other nearby bodies
Are artificial, manmade
But this water body
Needs no upgrade

We are stewards of history
Charged with preserving
Not polluting
A watery memory worth conserving

By Sierra Nichols

Gulls scatter in the mist from a dock on Utah Bay (Chuck Castleton).

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For all of us, becoming indigenous to place means living as if your children's future mattered. To take care of the land as if our lives, both material and spiritual, depended on it.

ROBIN WALL KIMMERER

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A kite surfer races across the lake (Wyatt Peterson).

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Sunrise from West Mountain (James Westwater).

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A sailboat speeds across Utah Lake during a yacht race (Derrick Thurman)

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Ice piled on the lakeshore by the wind (Jared Tamez)

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An American white pelican peers from a perch on the lake (Jeff Beck)

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Shadow and reflection at sunrise (Jeff Beck)