WALKER LAKE ECOSYSTEM

RESEARCH AND MONITORING
SUMMARY REPORT
2006–2013

LAHONTAN NATIONAL FISH HATCHERY COMPLEX | U.S. FISH AND WILDLIFE SERVICE | NOVEMBER 2013

Executive Summary

With the goal of restoring Walker Lake and with support of the Desert Terminal Lakes Program, the U.S. Fish & Wildlife Service, Lahontan National Fish Hatchery Complex (USFWS) has guided an eight-year investment to characterize the ecological health of Walker Lake. From its outset, this program has envisioned a rigorous, comprehensive and integrated baseline assessment of Walker Lake that will increase the understanding of the Walker Lake ecosystem and guide conservation actions. The USFWS has contracted with scientists, agencies and organizations to conduct research and monitoring that will inform the development of conservation strategies for Walker Lake.

The integrated body of work has included: 1) biochemical analysis to better understand this complex lake system and the changes it is undergoing; 2) long-term monitoring of the near-shore lake bottom (benthic) community of insects that serve as food resources to fish and birds; 3) determination of salt toxicity thresholds for benthic insects and of impacts on Lahontan cutthroat trout (LCT) survival and growth; 4) hydro-acoustic and netting surveys of the lake's tui chub population and its response to changing inflow and salinity (as total dissolved salts or TDS) levels; and 5) water bird surveys to track trends in bird use on Walker Lake and provide an indicator of lake ecosystem health.

The work conducted to date has significantly added to our knowledge of the Walker Lake ecosystem. The program has documented changes that have occurred in the aquatic ecosystem as Walker Lake's TDS level has to risen to 20,000 mg/l. Stocking efforts for the LCT no longer occur and LCT have not been recorded in at least several years, and have likely disappeared from the lake. If the TDS level continues to rise, it is anticipated that within 1–2 years, the tui chub may disappear from the lake as well. The loss of tui chub will have a negative impact on migratory fish-eating birds. The food-base of the lake has changed as well and some important food sources for fish have already disappeared, and loss of others appears imminent.

Location of the Walker Lake in the Walker Basin. Base from U.S. Geological Survey digital data, 1:24,000 and 1:100,000; 1978–88.

The lesson of Great Basin wetlands and lakes is that they are resilient and able to absorb boom and bust cycles. Walker Lake has experienced severe declines in the past 2,100 years and recovered with a full suite of native species. Researchers involved in the USFWS-funded work are confident that with increased inflows and decreasing the TDS level, aquatic life of the lake's unique ecosystem can recover and continue to provide tremendous benefits to native species and the local economy.

These historic periods of drying occurred when the Walker Lake basin was an intact watershed where the

Walker Lake © Scott T. Smith / Scott@ScottSmithPhoto.com

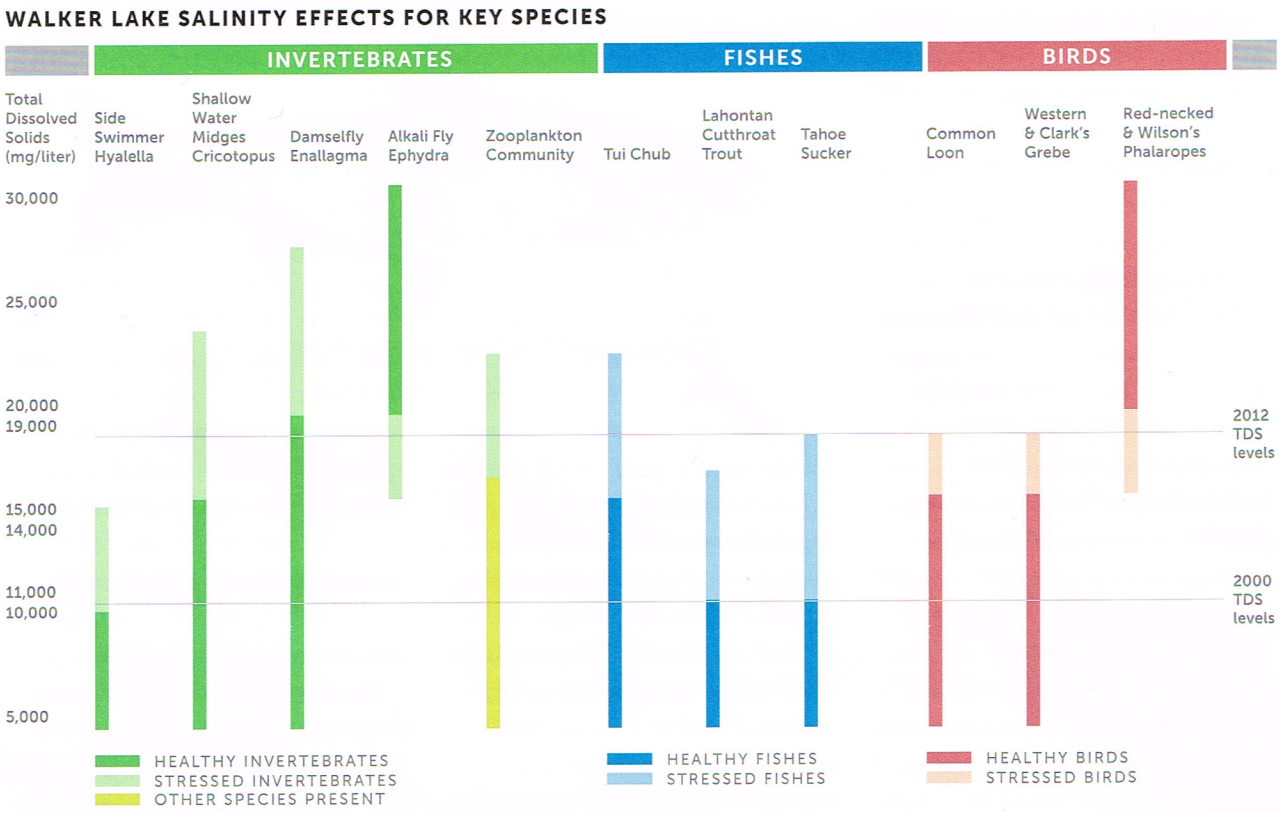


FIGURE 1. Walker Lake Salinity Effects on Key Indicator Species. Lighter shading in certain columns indicates a trend of decreasing abundance of the particular taxon. These are estimates and not absolute thresholds. The concept for this figure is attributed to D. Herbst (2012).

lake and river were connected and the river corridor had a healthy riparian forest. The Walker River ecosystem has declined due to sedimentation, channel incision, loss of riverside forest, and water diversions. Effective river restoration, enhanced instream flows and improved stewardship will create a healthier Walker River and improve the Lake's ecosystem.

Walker Lake — Historical Overview

Walker Lake is one of a handful of desert terminal lakes occurring around the globe that are fresh enough to support fish as the top aquatic predator. Nevada is fortunate to host Walker and Pyramid Lakes that are distinguished by having a specially-adapted fish community including Lahontan cutthroat trout.

Lahontan cutthroat trout evolved in the Pleistocene Lake Lahontan that covered much of western Nevada 9,000–15,000 years ago. Walker Lake is a remnant of this ancient lake, and has dried up or become a shallow lake twice in the past 2,100 years.

Beginning in 1852, agricultural development and associated diversions, led to the reduction of Walker River inflow into Walker Lake. By the early 1900s the Walker River supported the irrigation of at least 100,000 acres of agricultural lands, leading to a rapid decline in Walker Lake's surface elevation. The diversions and later dams led to the extirpation of Walker Lake's LCT.

Walker Lake has dropped more than 150 feet in elevation or slightly more than the height of the Bruce Thompson Federal Building in Reno. The lake's volume has decreased from 10 million to less than 2 million acre-feet, a loss of 2.6 trillion gallons.

A terminal lake has no outlet, so as the volume decreases the level of dissolved salts, TDS, rises. The TDS level in the late 1800s was 2,500 mg/l making Walker Lake a relatively fresh-water lake. By late 2013, the TDS level had climbed to 20,000 mg/l, a level that is lethal for the LCT and the lake's famous LCT fishery.

State of the Lake — A Tipping Point?

Over the past eight years, the USFWS has guided a research and monitoring program to better understand the Walker Lake ecosystem. When the work began in 2006 the TDS level was 14,000 mg/l, and due to low inflows into the lake, the TDS level reached 20,000 mg/l by late 2013. This decline in the lake ecosystem prompted the USFWS and Nevada Department of Wildlife (NDOW) to end stocking LCT in 2008. By 2010 NDOW reported no LCT in their creel census and the USFWS was no longer catching them in their nets.

With the TDS level reaching 20,000 mg/l, the research clearly indicates that the Walker Lake ecosystem will continue its rapid decline, without increased fresh water inflows into Walker Lake (see figure 2). The zooplankton community, reduced to just three salt-tolerant species, is at risk of disappearing. The tui chub population, already stressed by the elevated TDS level, have not successfully reproduced in recent years, and may disappear as the lake reaches 22,000 mg/l.

Lahontan Cutthroat Trout, illustration © Joseph R. Tomelleri

The decline of the lake's fish population, particularly the lack of young tui chub, has led to the disappearance of the lake's large number of common loon, and Western and Clark's grebe who feed on younger and smaller tui chub. The loss of adult tui chub will eliminate the primary food source for birds such as American white pelican and double-crested cormorants, which will make Walker Lake unsuitable as a habitat for a number of fish-eating birds.

The lake's invertebrate community, an important driver for fish and birds, has been altered and is expected to change dramatically as alkali flies (*Ephydra*) replace salt-stressed shallow water midges (*Cricotopus*) and damselflies (*Enallagma*). The side swimmer scud *Hyalella* has already disappeared.

Figure 1 summarizes the changes to the lake's species composition as TDS levels have increased. All the species in the lake are interdependently linked by a relatively simple food web. Losses of individual species can cause a ripple effect through the system as predators (fish, birds, larger invertebrates) decline when prey disappear or change from one species to another. It is easier to know what has changed and harder to predict the future, yet based on knowledge of other saline systems in the Great Basin, it is reasonable to expect that we will see changes in the invertebrate and avian communities among other fauna. A current example of a more saline terminal lake is Mono Lake. This lake is devoid of fish and has a wildlife community largely comprised of eared grebes, phalaropes and gulls that rely on the alkali fly and brine shrimp for their food. Walker Lake is historically a freshwater system, and to continue on the current path

LAKE ELEVATION VS. TOTAL DISSOLVED SOLIDS (TDS)

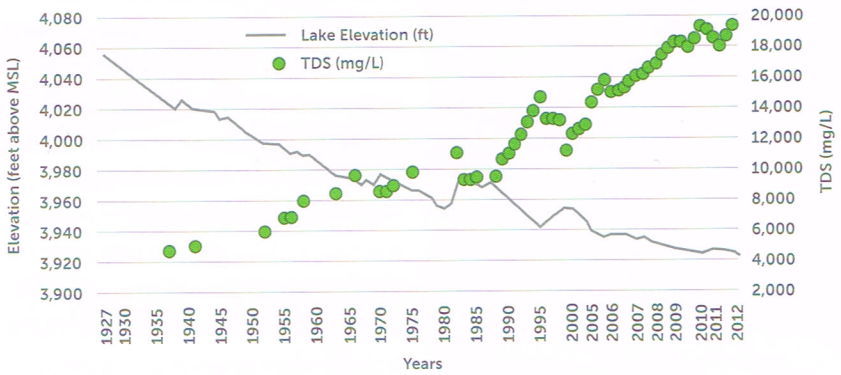


FIGURE 2. Walker Lake elevation and TDS levels over time.

would mean the loss of a very rare habitat of the American West.

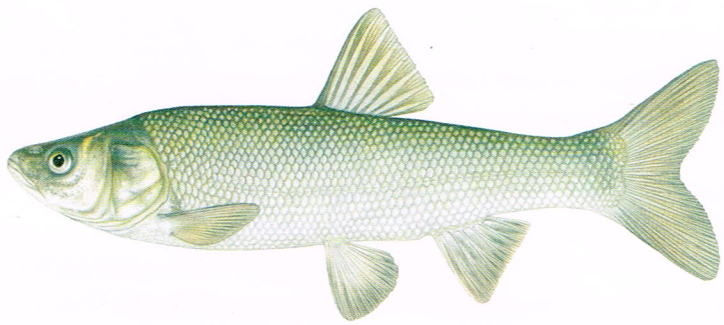
Decline of Walker Lake's Fishery

Long renowned for its fishery, Walker Lake's native fish fauna are on the verge of being extirpated from the lake. Tahoe suckers were last recorded in 1984, LCT were last stocked in 2008 and assumed gone by 2010, and tui chub, the most common fish is no longer reproducing in the lake and will become critically stressed as the TDS level climbs over 20,000 mg/l.

Tui chub have been an abundant prey source for LCT and a broad array of fish-eating bird species such as American white pelican, double-crested cormorant, common loon, and Western and Clark's grebes among others. Their abundance has been well documented since the 1950s constituting 85–99% of the fish caught in gill net surveys. There is evidence that the increasing TDS level in Walker Lake is having negative impacts on tui chub. Dead adults were reported by researchers when salinities reached 19,000 mg/l and no evidence of new recruitment was found. Jellison and Herbst suggest that tui chub may be extirpated from Walker Lake in the near future should current trends continue.

Records from the mid-19th century indicate an abundance of LCT in Walker Lake with reports of 20-pound, 3-foot long fish being caught. There were reports in the late 19th century that LCT were declining, and the causes identified were the placement of diversion dams creating obstructions combined with a large commercial fishery. In the 20th century, the building of Bridgeport Dam (1923), the Yerington Weir (1929), and Weber Dam (1937) gradually closed off LCT's access to historic spawning grounds in the upper portions of the Walker River basin. By 1929 reduced Walker River flow lead to a 43% decline in Walker Lake's volume compared to 1882. By 1963 the lake volume was 70% less than 1882 and the TDS level was 8,440 mg/l.

The last stocking of LCT by USFWS and NDOW into Walker Lake occurred in 2008 when TDS levels reached 16,000 mg/l. A high stocking mortality was documented and no stocking has occurred since that year. The USFWS will resume stocking when the TDS level drops below 16,000 mg/l.



Tui Chub, illustration © Joseph R. Tomelleri

Changes in Walker Lake's Zooplankton and Macro-Invertebrate Community

Walker Lake's rapid changes, including rising TDS level and falling lake level are affecting the viability of benthic invertebrates that supply food to native fish and birds. The Sierra Nevada Aquatic Research Laboratory's Dave Herbst has been monitoring Walker Lake since 2007. To help better understand the lake's complex ecosystem, he has conducted a long-term monitoring study of the benthic littoral macro-invertebrate community, along with benthic algae and water birds.

The research has helped increase our understanding of the dynamics of the Walker Lake ecosystem with a particular emphasis on the benthic macro-invertebrate community. This community creates a productive food web along the rocky shores and submerged plant beds. The zooplankton and macro-invertebrates such as midges, side swimmers, damselflies and other insects, are an integral part of the food web supporting tui chub, LCT and birds.

The declining lake level has caused changes in habitat availability, with reduced cover of rock substrate and widgeon grass (*Ruppia*), while the increasing salinity is leading to physiological toxicity in the lake's zooplankton and macro-invertebrate community. The rocky shoreline and shallow habitats are rich in aquatic life and loss of those habitats and rising salt content will negatively impact survival and growth of the benthic invertebrate community. The lake's rising salinity level has lead to the loss of at least nine of the zooplankton species and

Walker Lake © Scott T. Smith / Scott@ScottSmithPhoto.com

the remaining three species are at risk to further increases in salinity.

Figure 1 shows the transition that is occurring as side swimmers (*Hyalella*) have disappeared. Shallow water midges (*Cricotopus*) are experiencing stresses and may disappear within several years given current trends, followed by their main predator, the damselflies (*Enallagma*), if the TDS level continues to rise.

Changes in the Bird Community

Walker Lake has long been recognized as an important site for migratory and wintering birds. The lake's aquatic insects and fish provided a tremendous food source for a range of water birds.

Great Basin Bird Observatory (GBBO) initiated regular waterbird surveys of western terminal lakes, including Walker Lake in 2012. In addition, GBBO will analyze historical and recent Walker Lake bird data in order to better understand changes in how birds utilize Walker Lake.

Initial data indicates that the decline of the lake's fishery, due to the increasing TDS levels, has had a major impact on the number and diversity of birds using the lake. Tui chub are the key prey item for fish-eating birds on Walker Lake. The loss of recruitment and younger tui chub year classes in the past decade has likely reduced the number of common loon, as well as western and Clark's grebes. A number of other fish-eating birds such as double-crested cormorants and American white pelican are able to eat larger-sized tui chub and as long as adult chub remain, these birds will have a food source at the lake. It is reasonable to expect that if conditions do not change in the coming year that all tui chub, the last remaining fish species, will be gone, and as a result fish-eating birds will abandon Walker Lake.

Birds at Walker Lake do not only

Common Loon © Lee Karney / U.S. Fish and Wildlife Service

feed on fish, there are many bird species that rely on the abundant aquatic insects, especially along the lakeshore. Numerous duck species such as northern shoveler, gadwall, ruddy duck, and redhead congregate in large numbers along with tens of thousands of coots. The lake's changing invertebrate population, such as midges and damselflies, will also likely lead to changes in the number and types of birds that feed along the shoreline for these and other insects. If the TDS level continues to increase, it reasonable to predict that alkali flies (*Ephydra*) will become more common and serve as an important source of food for birds, including species like Wilson's and Red-necked phalaropes that have not been numerous in the past, but occur in large numbers at nearby saltier Mono Lake.

American White Pelican © Robert Burton / U.S. Fish and Wildlife Service

What Does the Future Look Like?

The Desert Terminal Lakes Act is providing a major investment in the ecological health of the Walker Lake basin, including water rights acquisition and leasing, aquatic and riparian restoration, and ecological research and monitoring. The future for the Walker Lake ecosystem is bright given these investments.

Walker Lake has gone through natural fluctuations in the past several thousand years, although nothing as dramatic as the drop in the past century. The impending inflows of acquired water rights, if in sufficient quantity, combined with restoration of natural river function will allow a recovery of the range of natural species found at Walker Lake.

The long-term maintenance of a TDS range in Walker Lake of an optimal 8,000 mg/l to a less optimal level of 12,000 mg/l is necessary to conserve Walker Lake and the array of native species it supports. In addition to reducing the TDS level, scientists maintain that restoring the natural variability of spring and early summer fresh water inflow is critical. These inflows provide fish and aquatic invertebrates with important spawning and habitat conditions.

Continued research and monitoring of the Walker Lake ecosystem will provide critical information to guide the lake's restoration to one of Nevada's premier natural treasures benefiting both people and wildlife.

ACKNOWLEDGEMENTS

The USFWS appreciates the support that has been provided by the Desert Terminal Lakes Act under the leadership of Senator Harry Reid. Numerous agencies, organizations and researchers have been an important part of this research and monitoring program, including Nevada Department of Wildlife and the Walker River Paiute Tribe as members of the Fisheries Improvement Team, as well as the Desert Research Institute, Great Basin Bird Observatory, Sierra Nevada Aquatic Research Lab, and University of Nevada Reno. The Bureau of Reclamation has been an important partner in providing funding to the USFWS from the Desert Terminal Lakes Program.

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American White Pelicans © Robert Burton / U.S. Fish and Wildlife Service