DIPS
DONNER LAKE
INTERAGENCY
PARTNERSHIP FOR
STEWARDSHIP

2023
STATE OF
DONNER LAKE

MARCH 2024 – DRAFT

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1. Executive Summary

The Donner Lake Interagency Partnership for Stewardship (DIPS) was formed to implement a coordinated stewardship plan to protect and enhance the long-term ecological and community health of Donner Lake. This State of Donner Lake Report provides a comprehensive overview of the lake's historical and contemporary context and analyzes key ecological and community indicators to guide development and implementation of the comprehensive Stewardship Plan.

The section on Geo-Physical and Ecological Indicators and Trends provides a comprehensive overview of the physical and ecological characteristics of the lake and its surrounding basin. It covers factors that influence the lake's ecology, including climate, air quality, water conditions, chemical composition, and ecosystem biology. The report highlights the importance of snowpack in governing the lake's water level and nutrient loading, as well as the impact of air pollution from wildfires on the lake's thermal structure and algal production. It also discusses water temperature, transparency, and chemical conditions, as well as ecosystem production and aquatic biology. The report emphasizes the need for continued monitoring and research to understand the lake's ecological health and inform conservation efforts.

The section on Community Indicators and Trends provides insights into the contemporary setting around the lake, including land use and development activity, recreational use, trash and waste management, transportation, and calls for service. It highlights the importance of monitoring development trends, managing recreational use, particularly at popular venues and at peak times, implementing proper waste management facilities and practices, enhancing transportation options, and addressing community concerns through continued monitoring and management. The report also highlights the critical and sensitive nature of the nearshore environment.

The report recommends increasing funding for research efforts, conservation projects, and infrastructure improvements to support the long-term health and sustainability of Donner Lake and its surrounding watershed. Collaboration among stakeholders through the Donner Lake Interagency Partnership for Stewardship can facilitate ongoing effective management.

2. Introduction and Purpose

Donner Lake is a treasure. This glacial mountain lake is at an elevation of 6,000 feet, 7 miles long, over 300 feet deep (at its deepest), and with a watershed of over 14 square miles. Its high-quality water not only provides the needed water supply, but is home to myriad aquatic species and fisheries. Its surrounding watershed hosts numerous terrestrial species, habitats, and recreational opportunities. The lake offers residential, business and recreational land uses of all types, a rich indigenous and recent history, and is fundamental to the region's local economy. Perhaps, just as important, is how Donner Lake contributes to the area's core identity and sense of place.

Yet, by comparison with Donner's sister lake to the southeast, Lake Tahoe, Donner Lake gets a fraction of the funding, with Tahoe garnering over $23 million in State and federal funds since 2021 alone. Donner Lake has historically seen very few research efforts, and, until recently, had not enjoyed an inter-agency structure to manage the lake's valuable natural and cultural resources.

It is within this backdrop that the key landowners and stakeholders (see complete list in section 2.1) formed the Donner Lake Interagency Partnership for Stewardship (DIPS). The goal of the partnership is to implement a coordinated stewardship plan to protect and enhance the long-term ecological and community health of Donner Lake guided by ecological and community indicators in a dynamic State of Donner Lake Report. This document is the first written iteration of the State of Donner Lake report.

The State of Donner Lake report has the following specific objectives:

1. To understand Donner Lake's ecological and cultural complexity;
2. To establish a baseline of ecological and community/socio-economic indicators for the lake and surrounding basin;
3. To identify and fill important data and information gaps;
4. To provide a scientific basis for the comprehensive Stewardship Plan and the on-going execution of that Plan by multiple agencies and organizations; and
5. To serve as a vehicle to communicate this information broadly for future funding opportunities, further studies and research, and new facilities, programs and project investments to ensure the sustained health of the lake and its watershed.

3. Donner Lake Interagency Partnership (DIPS)

3.1. DIPS Purpose, Membership, History and Approach

The Donner Lake Interagency Partnership for Stewardship (DIPS) was established in 2021 as an inter-agency collaborative to protect and enhance the long-term ecological and community health of Donner Lake and its watershed. The nine organizations that originally formed the partnership represent major landowners and water rights owners at the lake, local and State agencies with authorities and responsibilities for the lake and its environs, and non-profit organizations dedicated to watershed protection and land conservation. In 2022, these Core Team members signed a Charter committed to the long-term monitoring, management and stewardship of Donner Lake through policies, programs and actions undertaken by the signatories and others. The initial Core Team of DIPS are:

- California State Parks
- Tahoe Donner Association
- Town of Truckee
- Truckee Donner Land Trust
- Truckee Donner Public Utility District
- Truckee Donner Recreation and Parks District
- Truckee Meadows Water Authority
- Truckee River Watershed Council
- Truckee Sanitary District

The Core Team acts as the governing body of DIPS with responsibility for overall strategic direction, to participate in resource mobilization efforts, to consider and develop programs and projects, to serve as a public education and community engagement body, and approve inclusion of new Core Team members. The Truckee River Watershed Council serves as the facilitator and secretary of DIPS. DIPS has met every quarter since 2021.

DIPS is committed to a transparent approach designed to engage with stakeholders involved in Donner Lake. To this end, DIPS has held two community Open Houses (on December 7, 2022 and November 14, 2023) to inform local businesses, residents and community members about the stewardship work, seek input and advice, and allow for collaborative partnerships to further the Stewardship Plan's goals. DIPS has also held four Stakeholder Workshops to engage with local, regional, State and federal agencies and local non-profit stakeholders to inform them of lake activities and progress and to seek valuable input (November 7, 2022, November 10, 2022 and two on February 5, 2024).

The many Donner Lake stakeholders include, but are not limited to agencies, businesses and individuals with interests and/or responsibilities for aspects of Donner Lake. These include individual home and business owners, the California Department of Transportation, California Department of Fish and Wildlife, Lahontan Regional Water Quality Control Board, Nevada County Sheriff, Union Pacific Railroad, the Washoe Tribe of Nevada and California and various local homeowners' associations. Stakeholders are

welcome at all DIPS meetings and workshops, encouraged to provide input on the stewardship plan and share data and information about Donner Lake.

Photo 1 and 2. Community members at a recent DIPS Open House

3.2. Relationship of the State of Donner Lake Report and the Stewardship Plan

The State of Donner Lake and the Stewardship Plan are designed to be dynamic tools, updated periodically and used by DIPS and others to understand and help make decisions for the lake and the surrounding area.

One of the initial tasks undertaken by DIPS was to identify the potentially relevant topic areas that might form the essence of the State of Donner Lake data collection work and the Stewardship Plan. **Figure 1** illustrates this initial list of issues and topics agreed to by DIPS. This list is by no means inclusive and should remain fluid and dynamic as new information, issues and concerns arise.

Figure 1. Key topics identified by DIPS Core Team

The State of Donner Lake encompasses a broad range of data collection and monitoring efforts ranging from geo-physical and ecological indicators such as water quality and fisheries to community indicators such as recreational use of the lake, transportation and facilities. Data collection, monitoring and analysis of ecological indicators has been led by Zachary Bess PhD candidate under the direction of Dr. Sudeep Chandra. Community indicators are collected and tracked by DIPS Core Team members. This report is meant to be updated annually to track trends and understand long term lake health and potential changes and impacts. The State of Donner Lake informs and supports the Stewardship Plan for the lake.

The Stewardship Plan establishes the purpose, goals, indicators and a series of policies, programs and actions to ensure long term health of the lake. It serves as a guide for management decisions of the Core Team, either individually or collectively, and also a blueprint for long term stewardship for all stakeholders and those interested in the health of the lake. The Stewardship Plan was initially developed by DIPS during 2021-2022.

Figure 2 shows the relationships between the DIPS Core team, the State of Donner Lake, the Stewardship Plan, and additional stakeholders playing key roles in the lake and watershed.

Figure 2. DIPS framework for developing the Stewardship Plan, engaging stakeholders, and implementing activities for the long-term ecological and community health of Donner Lake.

Stewardship Plan Goals

The full text of the Donner Lake Stewardship Plan can be found in the Appendix to this report. The following broad goals from the Plan offer a summary of the Plan and how it guides future policies, programs and actions.

Goal 1. Collaborative, Multi-Agency Structure: Plan, fund and implement a multi-agency stewardship plan that encourages a commitment to common goals, balances competing and evolving interests and increases coordination between organizations.

Goal 2. Water Quality, Supply and Use: Ensure water resources and related infrastructure are maintained to meet and exceed water quality standards and protect beneficial uses.

Goal 3. Ecological Health: Improve ecological health and resiliency to benefit nature and humanity by protecting, improving, and restoring aquatic, riparian and upland areas.

Goal 4. Cultural and Historic Resources: Protect and preserve cultural and historic resources that represent and foster an appreciation for Donner Lake's rich history and diverse populations through cooperation, monitoring, education, research, and public awareness.

Goal 5. Recreational Use and Capacity: Provide a range of high-quality outdoor recreational opportunities that are socially, economically, and ecologically sustainable for present and future generations through coordinated planning, facility improvements, conservation, and maintenance.

Goal 6. Transportation, Safety and Parking: Provide access to safe, affordable, accessible, and sustainable transportation systems, improving road safety, and expanding public transportation options without impacts to lake resources.

Goal 7. Economy and Development: Support planned development and redevelopment of residential and commercial uses that are compatible with neighborhoods, environment, culture, and people.

4. Ecological, Historical and Global Context

4.1. Donner Lake Geographic Context

Donner Lake is a freshwater mountain lake located just east of the Sierra Nevada crest within the Town of Truckee, California. The DIPS area of interest, shown in **Figure 3**, is bordered on the north by Interstate 80 and unincorporated Nevada County, on the south by the Union Pacific Railroad and unincorporated Placer County, on the east by the Town of Truckee, and on the west by Donner Summit and the Sierra Crest. The lake is at an elevation of approximately 6,000 feet and has a depth of 328 feet at its deepest point formed through a mix of glacial action and faulting. It is approximately 3 miles long, ¾ mile wide and 7 miles around. The water surface covers approximately 960 acres.

Figure 3. DIPS geographic area of interest.

The lake and its basin are home to significant natural and cultural resources, home to a vibrant resident and seasonal population, serve as a major transportation corridor through the Sierra Nevada, and is an important water supply reservoir for northern Nevada. Donner Lake provides many recreational opportunities ranging from hiking and fishing to boating of all types, picnicking, swimming, and active recreation. The lands surrounding the lake are also home to thriving commercial businesses and residential neighborhoods.

Over the past 150 years, Donner Lake and the Basin have experienced physical and ecological impacts associated with natural resource use, development of major transportation infrastructure and land use development. More recently, pressures have intensified the strain on the lake, including climate change, population growth, and increased recreation and transportation demands. Despite these changes, much of the watershed's area is managed as permanent open space and there have been extensive

resource management and restoration activities to improve the health of the ecosystem.

Donner Lake is managed and stewarded by various agencies, organizations and jurisdictions including the members of DIPS. These include agencies and organizations that own and manage land, water rights, and/or facilities around the lake, as well as other stakeholders such as homeowners' associations, private businesses and regulatory agencies.

4.2. Geo-physical Context

The following section is derived from the Donner Basin Assessment, 2016.

Donner Lake is a cirque lake formed by the recession of glaciers at the end of the Pleistocene epoch approximately 10,000-12,000 years ago, similar to Fallen Leaf Lake, Independence Lake, and Emerald Bay. The scouring movement of the melting ice carved the lakebed as it moved east from Donner Summit toward the Truckee River . The western half of the lake is relatively deep, shaped by the cirque of the ancient glacier. In contrast, the eastern end of the lake is shallower, shaped by the terminal moraine of the glacier. See **Figure 4**.

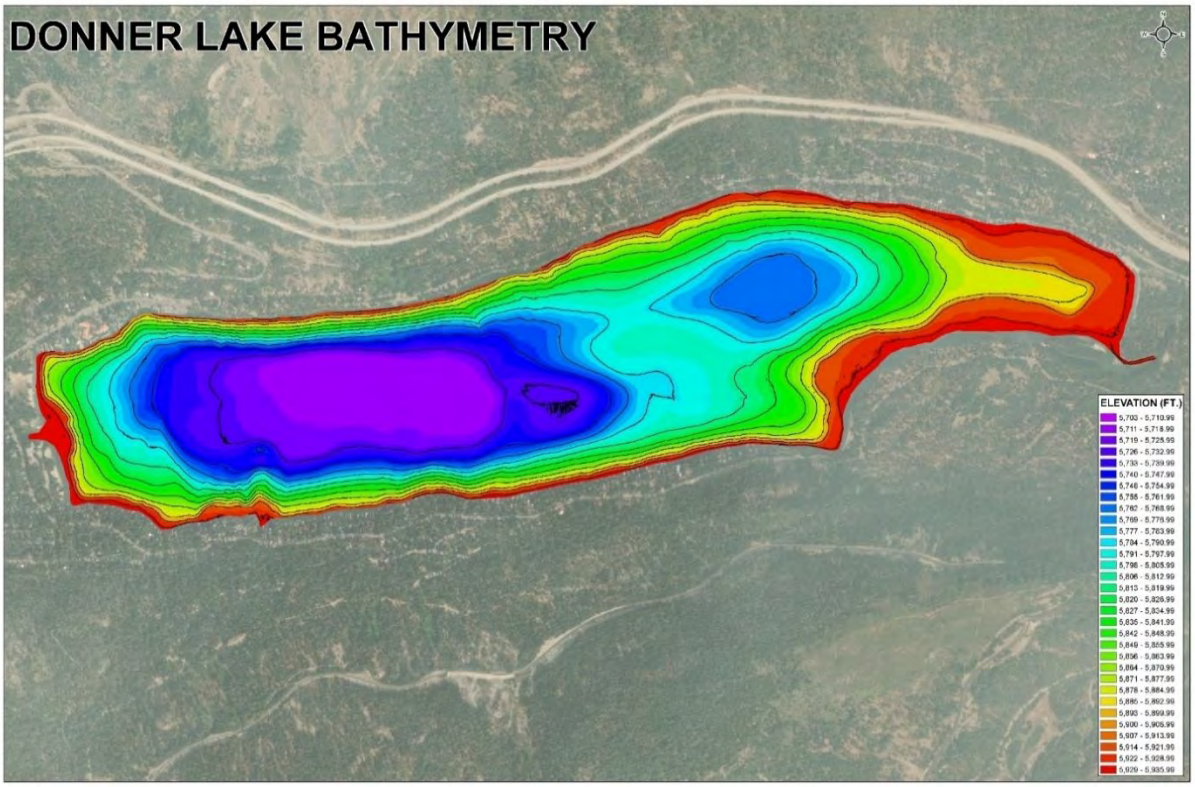


Figure 4. Donner Lake bathymetry reflects scouring movement of glaciers 10,000-12,000 years ago. Credit: Truckee Meadows Water Authority

Donner Lake captures runoff and snowmelt from 14.3 square miles of the Donner Basin. The majority of the flow entering the lake comes from Summit Creek, Gregory Creek and Lakeview Canyon, as well as runoff from smaller sub-basins.

4.3. Historical context

The following summary of Donner Lake history is based on the Donner Basin Assessment (2016) Land Use History Workbook. A more detailed historical narrative is provided in the Assessment and numerous books and articles.

The Donner Basin has a long history of human use. Washoe and Southern Maidu (or Hill Nisenan) peoples occupied and traded in the area for more than 10,000 years, but the Washoe origin story puts them in the area from the beginning. The Hill Nisenan peoples likely only occupied the areas around the Donner Basin during hunting, fishing and plant collecting efforts, after which they would return to their permanent villages along the western slope of the Sierra. The Washoe people had more established camps and communities in the Donner Basin area and made extensive use of Donner Creek for fishing. Communal fishing practices included temporarily damming the creek to harvest fish from the stream. The Washoe also hunted large game and gathered edible plants and medicinal roots in the surrounding landscape.

Beginning in the 1840s, west-bound emigrant travelers began utilizing the Overland Emigrant Trail which traverses the north side of Donner Lake on its way to Donner Pass. Much of the history of emigrant travel through the area centers on the failed journey of the Donner Party, which became trapped at Donner Lake during the winter of 1846 to 1847. Much of the group perished over the winter.

Preliminary road development in the area began with the construction of the Dutch Flat and Donner Lake Wagon Road which opened over Donner Pass in 1864 to provide supplies for the first proposed transcontinental railroad alignment. Way-side inns were constructed to accommodate travelers and spurred early development within the Donner Basin. The road eventually became part of the Lincoln Highway in the 1910s, renamed the Victory Highway and then U.S. Route 40. A re-routed portion of U.S. 40 located to the north of Donner Pass was incorporated into the new interstate highway system and became Interstate 80 in 1964.

The first transcontinental railroad passes through the Donner Basin to the south of Donner Lake and continues to operate today. Construction began in the Donner Basin area in 1864 and was completed over Donner Pass by 1869. This involved the creation of seven tunnels within the two-mile section of rail east of Donner Summit. The railroad stimulated economic activities that included logging, commercial fishing, the ice industry and recreation.

Timber harvesting began in the Donner Basin in 1864 with the construction of a sawmill at the edge of Donner Lake. Demand for timber was fueled by the railroad and by 1881 timber had largely been cut out. After this, logging operations around Donner Lake were limited to mostly small-scale enterprises.

Starting in the 1860s, the outlet of Donner Lake was artificially dammed to support the logging industry, and subsequent dams were constructed to generate a water-supply reservoir for downstream users. Construction involved dredging a canal at the eastern end of Donner Lake. Plans were developed to build a sequence of four dams in the Donner Basin to capture flows from Cold Creek, but they were never pursued to fruition. The present-day

concrete dam was constructed in 1929 by the Donner Lake Company. The dam is located approximately 1,600 ft east of the lake's original outlet and raised water levels roughly 12 feet above the natural lake level of 5,924 ft. Partial water rights were transferred from the Donner Lake Company to Sierra Pacific Power Company and Truckee Carson Irrigation District between 1924 and 1943. The Truckee Meadows Water Authority now owns nearly all water rights in Donner Lake.

Upon the completion of the railroad, ice operations were established along the perimeter of Donner Lake and on tributaries to provide ice to Californians and people across the country. As much as 35,000 tons of ice were harvested in a single year at Donner Lake. Artificial ice ponds were also established near the east end of the lake, and a dam on Donner Creek was constructed to divert water from Donner Creek into the ponds in the 1890s.

Donner Lake and Donner Creek originally supported a strong fishery for the Washoe people. Commercial fishing began around the time of the completion of the railroad in the 1860s. By 1870 the dam at the Donner Lake outlet was obstructing fish runs. A trout-breeding farm was established in 1871 using three natural and three artificial ponds to raise fish for commercial production. In 1878 the State fish commissioners ordered stockings of non-native species (eastern trout, salmon and whitefish). In 1901 fish ladders were added to the Donner Lake Dam and sport fishing began rising in popularity (Richards 2006).

Small resorts and hotels were established around Donner Lake in the 1860s. Residential subdivisions began as early as the 1910s, with many lots built out by the mid -1950s to 1960s. By the 1920s the Truckee/Donner Pass region began to develop into a recreation-based economy.

The development of public utilities in the Donner Basin area began with the installation of a telegraph line over Donner Summit between 1865 and 1866. Two power transmission lines were built over Donner Summit in 1923 and 1937. A gas pipeline was installed in 1956. In 1997, the pipeline developed a leak in Summit Canyon and contaminated Summit Creek. Additionally, a major fiber optic cable runs through the basin and local water and sanitary sewer networks are present.

4.4. Dam Operations

Donner Lake was first dammed in the late 1860's. The present-day dam was initially built in 1929 and is currently owned and operated by the Truckee Meadows Water Authority (TMWA) for water supply for municipal, industrial and hydropower uses. This dam augments the lake's natural storage by increasing the water surface elevations of the lake by approximately 11.8 feet, creating 9,500 acre-feet of storage capacity.

While its primary management objective for Donner Lake is water supply, TMWA must also meet flood control requirements (per California's Department of Water Resources Division of Safety of Dams). Between November 15 and April 15, TMWA is required to leave the two outside gates of its dam open. This typically lowers water surface elevations to a level approximately 5,929 feet during the winter months.

Outside of these flood control requirements, TMWA generally seeks to maximize storage within Donner Lake. Starting in the spring, typically after April 15, TMWA begins storing

additional water in the reservoir as the spring snowmelt and precipitation contribute greater flows to the lake. Exceptions to the April 15 start time during critically dry years (e.g., in 2014 TMWA started filling the reservoir in early March) or years with exceptional snowpack (gates can be closed later). Storage usually reaches a maximum near the cessation of the spring snowmelt period, with lake levels typically peaking between late May and early July.

Since 1988, TMWA has also followed an informal agreement with the California Department of Fish and Wildlife (CDFW) to maintain base flows in Donner Creek for ecological purposes. If flows in Donner Creek measured at the USGS gauge at Highway 89 are below 5 cubic feet per second (cfs), TMWA is expected to provide at least 3 cfs of that total flow via releases from Donner Lake. If flows at Highway 89 are greater than 5 cfs, TMWA is expected to provide at least 2 cfs. TMWA maintains these ecological flows at all times except when lake levels are extremely low and there are dire water supply concerns downstream.

Furthermore, the lake is regulated by the 1943 Donner Lake Indenture Agreement which prohibits any releases above minimum flows during June, July, and August if the lake level falls below 5,932 feet. TMWA typically maintains high lake levels through the end of the summer for the benefit of local residents and recreational purposes. From the time of peak storage (usually late-May to early July) to the end of the summer (typically end of August or early September), lake levels are typically affected only by releases for ecological flows, incoming runoff from precipitation and evaporation. In early fall, typically between September and November, lake levels are drawn down for water supply (a combination of agricultural, municipal, industrial and hydropower) purposes and in preparation for meeting flood control requirements. See **Figure 5** for Donner Lake water surface elevations for select years.

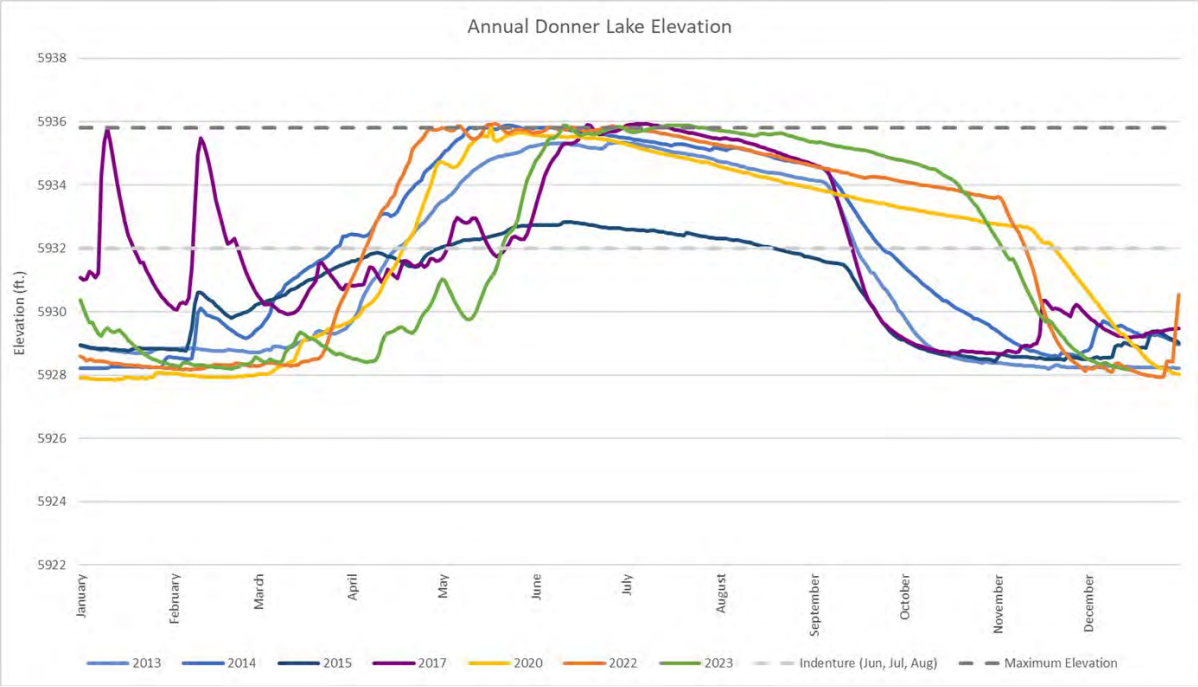


Figure 5. Donner Lake water surface elevations for select years. Credit: Truckee Meadows Water Authority

4.5. Global pressures: Climate Change, Snowpack, Fire, Drought and Flooding

Climate change projections and subsequent impacts for the Sierra Nevada vary widely based on future emissions scenarios and other factors. Consistent among most projected impacts is an increase in temperatures, an increase in the proportion of precipitation that falls as rain, a decline in average snowpack accumulation, an earlier melting of accumulated snowpack, and increased wildfire hazards (see Belmecheri 2015, California Energy Commission 2015, Dettinger et al. 2004, Luers et al. 2006, Maurer 2007, Stewart et al. 2004, Town of Truckee, Climate Ready Truckee, 2020). Climate change, and resulting changes in human behavior and resource management, will likely have significant impacts on both the physical processes and ecological conditions in the Donner Basin.

Changes to snowpack levels and stream flow conditions will likely be significant, and are arguably already occurring. Water year 2015 is considered to have been a 500-year record low snowpack (Belmecheri 2015). Reductions in snowpack by the end of the century could be as high as 70-90% (California Energy Commission 2015, Luers et al. 2006). As snowpack formation declines, runoff volumes during the winter months will increase. Warmer temperatures will also likely result in earlier snowmelt and earlier peaks in spring stream flows in the Donner Basin. This in turn will likely influence how Donner Lake is managed as a reservoir as earlier gate closures may be necessary to fill the reservoir's typical impoundment capacity.

The historic alterations to the land discussed above result in altered vegetation composition and structure of the forest, including unnaturally dense stands, and dead and dying trees that have been stressed by heat, drought and pathogens. This has led to a change in the natural fire regime. In general, fires are more frequent, larger and hotter. Stand-replacing crown fires are more common. The result is loss of habitat, increased sedimentation, altered hydrology, and smoke that is harmful to humans, as well as fish and wildlife. The Mosquito fire of 2022, and the Caldor and Dixie fires of 2021, demonstrate the magnitude of the threat facing the region, and justify an urgency to address the issue.

From record temperatures to proliferating wildfires and decreased snowpack, climate change poses an immediate and escalating threat to the region’s environment, economic strength, and public health. The region is affected by more intense dry and wet periods under warmer conditions, which lead to extended and more frequent periods of drought and flooding. More intense atmospheric river storms and periodic shortages in runoff and water supply, as well as substantial changes in runoff patterns and timing, impact the region. This affects groundwater recharge as well as water supply in downstream communities. Climate change impairs healthy ecosystems.

A healthy ecosystem provides cultural, social, and economic benefits that local communities rely on for agriculture, tourism, recreation, fishing, and other industries. Finally, as temperatures increase in other regions of California and the intermountain west, the “climate refugee” effect is beginning to impact our region, driving increased visitation during high heat events and driving changes in regional markets such as recreation and real estate.

5. Contemporary Setting

5.1. Regional and local population trends

Nevada County population grew rapidly from the early 1980's to the early 2000's. Truckee's population followed a similar pattern, with significant growth beginning in the early 1990's, continuing for the next 15 years before leveling off somewhat in the past 20 years (**Figure 6**). The Town of Truckee became an incorporated community in 1993.

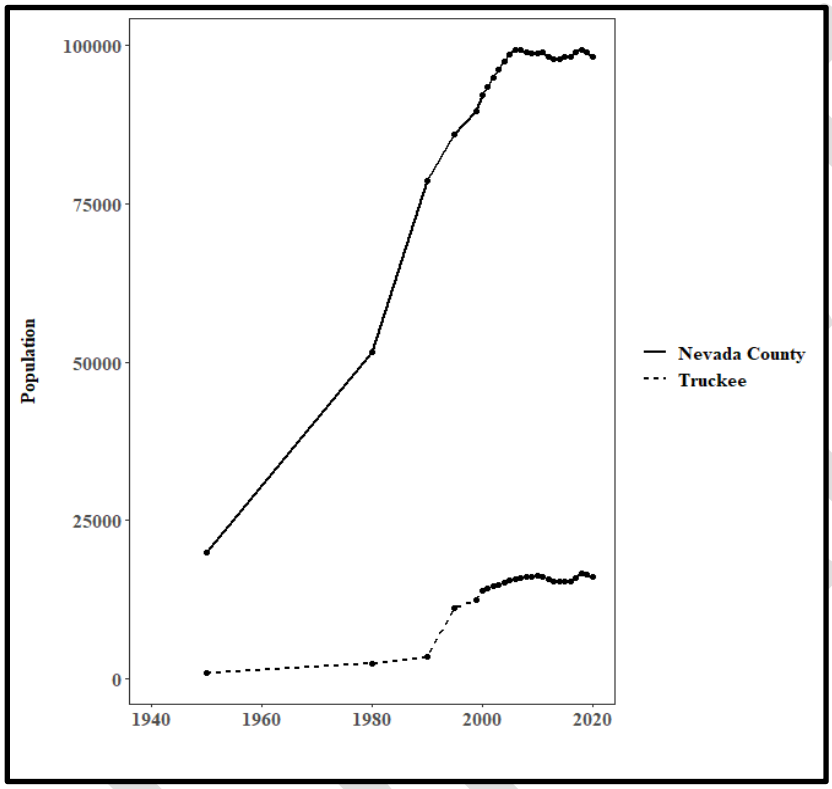


Figure 6. Population growth in Truckee and Nevada County since 1950. Data source: www.mynevadacounty.com/378/Demographic-Information-About-the-County

However, these data do not tell the entire story. Much of the historic land use development and residential (and commercial) growth around Donner Lake occurred 1950-80 with incremental growth around the lake since that time. Since the 1990's much of the contemporary residential development in Truckee has been seasonal/second home use, so resident population figures underrepresent the potential use or impact around the lake. Across Truckee as a whole, nearly 55% of the Town's housing units are considered "vacant" and most are seasonal/second home and/or rental units. Seasonal or second home use around Donner Lake is considerably higher than the Town average. Peak weekends in the summer and winter can see the population of the Town (and consequently around the lake) double or triple in size. Recreational visitation of the lake is also of interest and noted in a subsequent section of this report.

5.2. Land Uses and Zoning

The Town of Truckee recently completed and adopted its 2040 General Plan for the Town as a whole. While it is out of scope of this report to analyze or summarize that document, it is useful in understanding the current and future land use and growth around Donner Lake as a community sub-area. **Figure 7** below from the 2040 General Plan provides the overall Town goal for the lake area: "…to protect the lake as a natural, scenic, and recreational resource and create a neighborhood center that serves residents and visitors."

In addition, **Figure 7** shows the adopted land use designations from the General Plan and provides a narrative about how the Plan views the lake's future. Rural residential, very low and low density residential make up the vast majority of developed land use designations around the lake, with patches of commercial, medium high density residential and developed recreation.

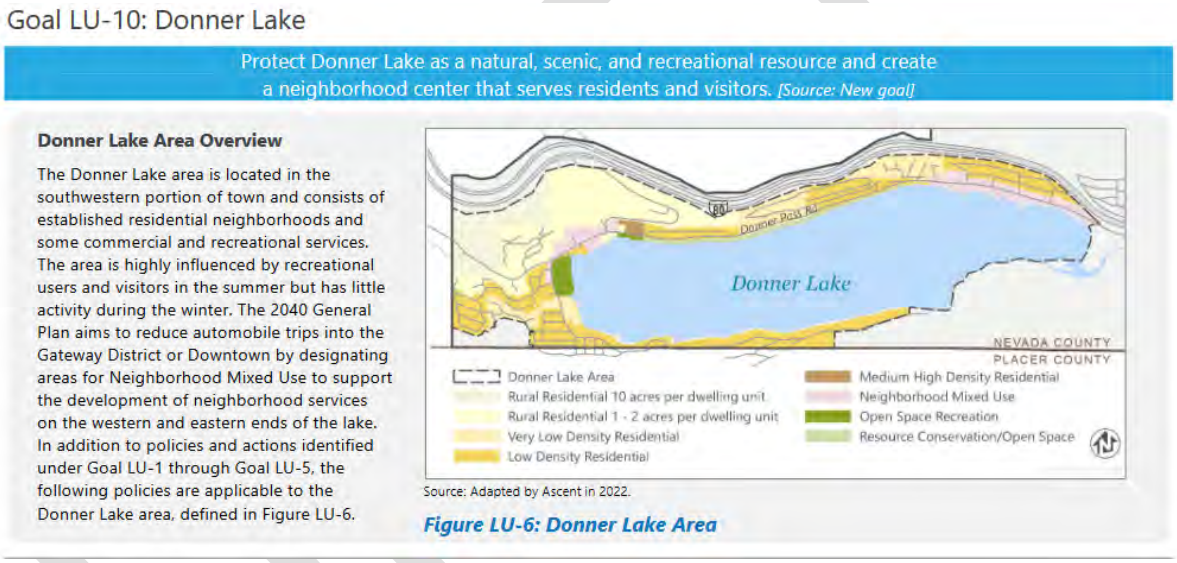


Figure 7. Town of Truckee 2040 General Plan overall goals for Donner Lake. Source: Town of Truckee.

When one views the larger DIPS study area, much of which is in unincorporated Nevada County, the consolidated zoning map depicted in **Table 1** and **Figure 8** provide a more comprehensive picture. Nearly two-thirds (65%) of the area is either designated as forest, recreational land/public facility or the lake itself. Approximately 1,047 acres of the total area are residentially zoned (22%) and only 33 acres are commercially zoned (under .1%). It should be noted that much of the "Other" zoned area is permanently protected open space owned by the Truckee Donner Land Trust.

Table 1. Total acres of land zoned for each generalized purpose. Source: Town of Truckee as of 3/3/2022.

Zoning Group	Total Acres
Forest	1,780
Residential	1,047
Recreation	481
Commercial	33
Other	594
Lake	834
Total	**4,769**

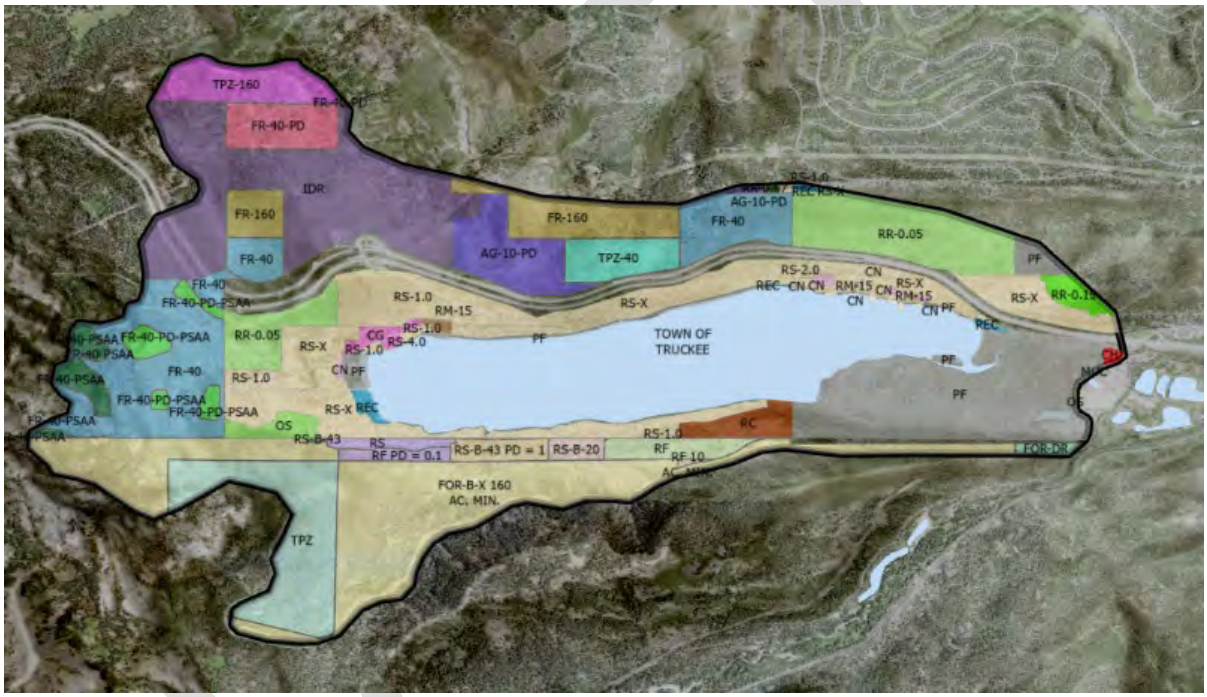


Figure 8. Nevada County, Placer County, and Town of Truckee combined zoning classification map. See appendix for zoning codes. Source: Town of Truckee as of 3/3/2022.

Of the residentially planned and zoned land, the vast majority is lower density types of single-family homes (**Table 2** and **Figure 9**), and much of that represents seasonal/second home use. While major land use changes are rare and occurs slowly around the lake, it is critical to monitor and track land use change over time. Potential for increased grading, erosion and sedimentation, higher traffic and parking volumes, increased impervious surface, higher lake use and visitation and loss of vegetation and habitat can all impact resources at the lake. Conversely, redevelopment and additions can provide environmental benefits because of improvements in required storm water run-off and erosion control technology and regulations.

Table 2. Total available housing by type of dwelling. Source: Town of Truckee as of 3/3/2022

Type of Dwelling	No. of Housing Units
Apartment	12
Condo	105
Multi-Family Residential	8
Single Family Residential	883
Unknown	6
Miscellaneous Residential	42
Total	**1,056**

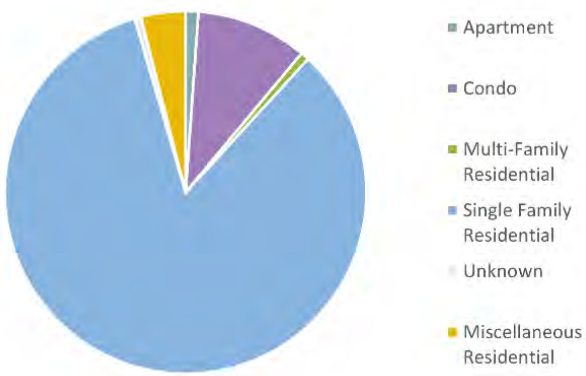


Figure 9. Proportion of available housing stock by type of dwelling as of 2022.

5.3. Land and Facilities Ownership around the Lake

The following agencies and organizations represent major land and facilities owners around the lake (**Figure 10**). The many private owners of single-family homes, apartments and condominiums and businesses of various types are not shown here. All these organizations are represented in the DIPS membership.

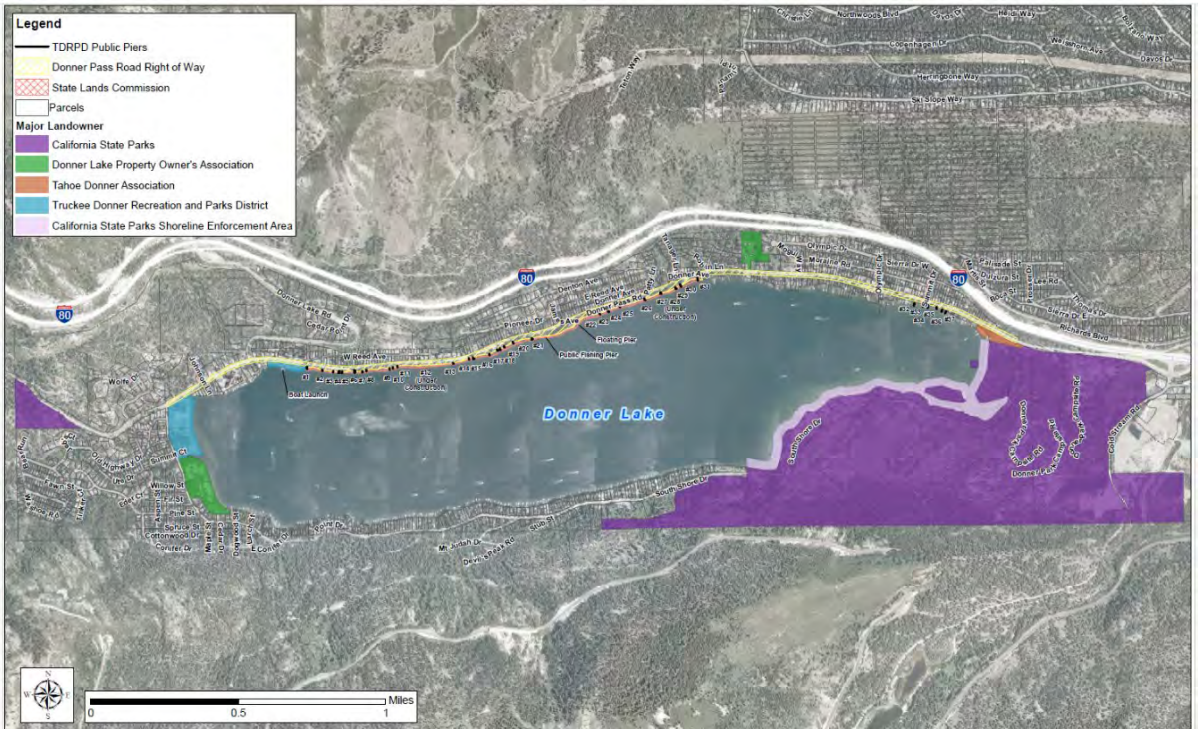


Figure 10. Map of major landowners around Donner Lake. Source: Town of Truckee as of 2022.

- ***California State Parks Department***: Donner Memorial State Park is located on the east end of Donner Lake, encompassing *3,293* acres and including 1.5 miles of frontage on Donner Lake and Donner Creek. The park includes the High Sierra Crossing Museum and Visitor Center; Administrative Offices; Pioneer Monument; several park residences and trailer/mobile home pads; maintenance buildings; 18.5 miles of non-motorized trails; 4.4 miles of paved roads; 24 miles of unpaved roads; 1-mile lakeside interpretive trail; 78 picnic sites (3 ADA); multiple comfort stations (1 ADA); 147 campsites (12 ADA); campfire center; 60 car parking lot at the Visitor Center (3 ADA); 15 car parking lot at China Cove (1 ADA); 75 paved parking spaces (2 ADA) and 75 roadside/dirt parking throughout Day Use area; and 5 bridges.
- ***Donner Lake Property Owners Association***: The Association maintains and operates private beach facilities on the west shore of Donner Lake for the enjoyment of members and guests.
- ***Tahoe Donner Association***: The homeowner's association manages and maintains the private members-only Tahoe Donner Beach Club Marina on the east end of Donner Lake. Facilities include the beach and marina with boat house building, boat storage/camp building, check-in kiosk, 2 small sheds, dumpster storage structure, 11 boat and trailer parking spots, 34 regular parking spots, boat launch, storage racks to accommodate 150 kayaks and SUPs, and 3 floating docks.
- ***Town of Truckee***: The local government manages and maintains approximately 17 miles (150 acres) of paved roads and right-of-ways around Donner Lake. The Town also manages the MS-4 storm water permit to allow for grading and construction; on behalf of the Regional Water Board.
- ***Truckee Donner Land Trust***: The local land trust has led the way to conserve and protect open space in Schallenberger Ridge on the south side of the lake, Donner Summit Canyon and Black Wall on the west, Billy Mack and Johnson Canyons on the northwest, and Bucknam Tract on the north. Current facilities maintained by Land Trust in these areas are the Donner Lake Rim Trail, Johnson Canyon trailhead information kiosk and dog waste station, Donner Summit Canyon Trail and trailhead dog waste station, and the Creekside Woods trailhead dog waste station.
- ***Truckee Donner Public Utility District:*** The local utility district provides water and electricity to the Donner Lake area. Facilities include multiple pump stations, tanks, casings, and miles of pipe in addition to two 12-inch diameter freshwater intake pipeline into Donner Lake reserved for use in emergency situations. TDPUD also owns 990 acre-feet per year of water rights at Donner Lake.
- ***Truckee Donner Recreation and Park District***: This special district manages and maintains multiple facilities at the lake. Thirty-seven public piers located along the north side of the lake are available year-round on a first come basis. The Donner Boat Ramp located on the northwest end of Donner Lake includes a 2-boat lane-wide boat ramp, restrooms, fish cleaning station and parking lot. It is open year-round, staffed May-September, and unstaffed October-April. Shoreline Park is located on the north shore

and features an all-access fishing pier, picnic tables, shoreline fishing, and parking. West End Beach is a 12-acre day-use beach with tennis and pickle ball court, boat storage, pavilion, entrance gate, staff building/restrooms, basketball court, beach volleyball court, playground, picnic areas, horseshoe pits, and parking lot. It is typically staffed May-September.

- ***Truckee Meadows Water Authority***: The water purveyor for Reno, Sparks and Washoe County owns 9,500 AF of water rights at Donner Lake, owns and operates West End dam and auxiliary water supply infrastructure.
- ***Truckee Sanitary District***: Facilities for the local sanitary district include 7 main lift stations at Donner Lake to convey sewage from South Shore Drive, through 11,200 feet of force mains, clockwise around the lake to discharge at Deerfield Drive, wet well for sewage collection, dry well with two independent pumps, and 10,000 gallon overflow tanks.

5.4. Roads and bridges

In addition to the construction of the railroad in the 1800's, major road development brought significant changes to the area. On the north side of the lake, Interstate 80, its on and off ramps and storm water drainage was the most significant. Additionally, there are 17 miles of public roads around the lake owned and maintained by the Town of Truckee, concentrated on the northeast and west ends of the lake. Other public roadways in the DIPS study area that impact the lake are managed by State Parks, Placer or Nevada County, and a few other entities such as the Truckee Donner Recreation and Park District. Finally, there are many smaller private roads serving primarily residential areas scattered around the lake. **Figure 11** broadly depicts the lake basin's road system.

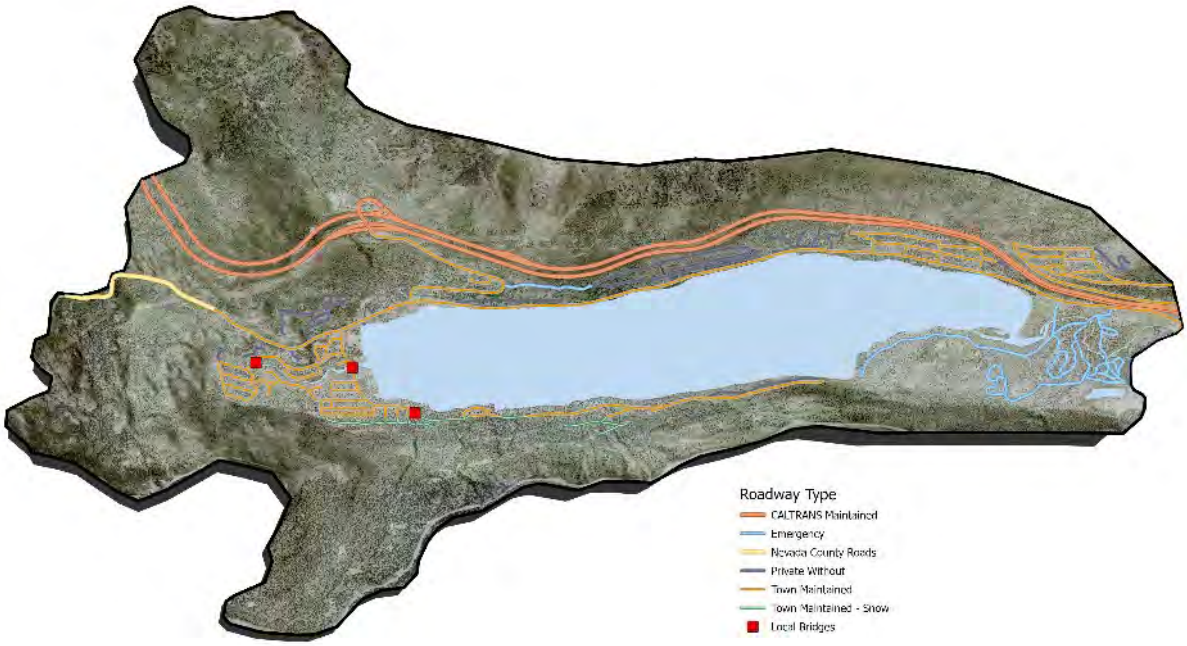


Figure 11. Roadways and local bridges within the Donner Lake study area. Source: Town of Truckee as of 3/3/2022.

Figure 12 shows the many unpaved roads around the basin as of 2018. These may be old logging or pioneer roads, fire access and fuel breaks, utility access, used as trails or mountain bike routes, and other uses. Like their paved counterparts, unpaved access roads can exacerbate erosion, create sediment that can flow into tributaries and the lake, and offer opportunities for revegetation, habitat restoration, improved drainage features, and closure or improved grading.

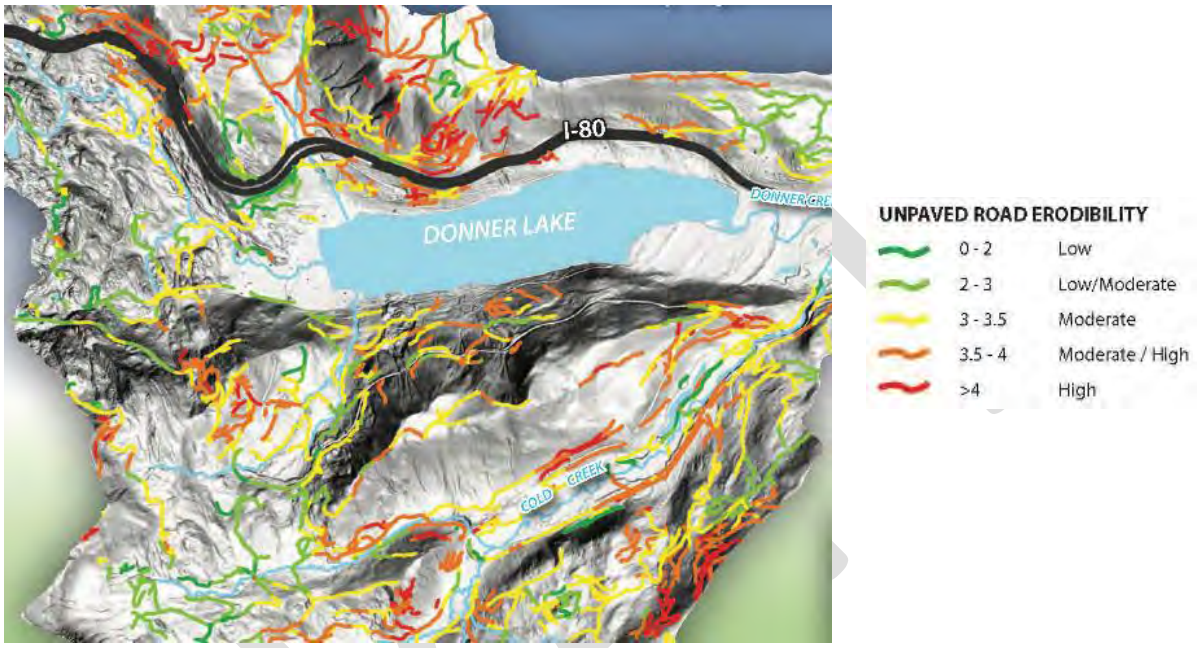


Figure 12. Unpaved roads within the Donner Lake study area. Source: Donner Basin Assessment, 2018.

It is critical to monitor not only road development and reconstruction, but maintenance and management activities. These roads altered the surrounding drainage network and runoff and erosion patterns above the lake. Like all mountain lakes, Donner Lake is highly susceptible to sediment related water quality issues. Donner Lake is listed as impaired for polychlorinated biphenyls (PCBs), and chlordane and arsenic, however water quality data on these constituents is sparse. Opportunities to update, repair and improve basin storm drainage along and "downstream" of the freeway and in roadways adjacent to and above the lake are essential.

5.5. Impervious surface

Figure 13 shows the principal areas of impervious surface around the lake. Roads, bridges, paved parking lots, buildings/rooftops, sidewalks and other paved surfaces reduce the natural landscapes' capacity to absorb and percolate rainwater and melting snow. This can accelerate the timing and amount of storm water run-off. This in turn can cause localized flooding and ponding, increased transport of water pollutants (from vehicles, structures, construction sites, sands and salts applied during the winter, etc.) that can make their way into natural water bodies, and impact local water quality, vegetation and habitat.

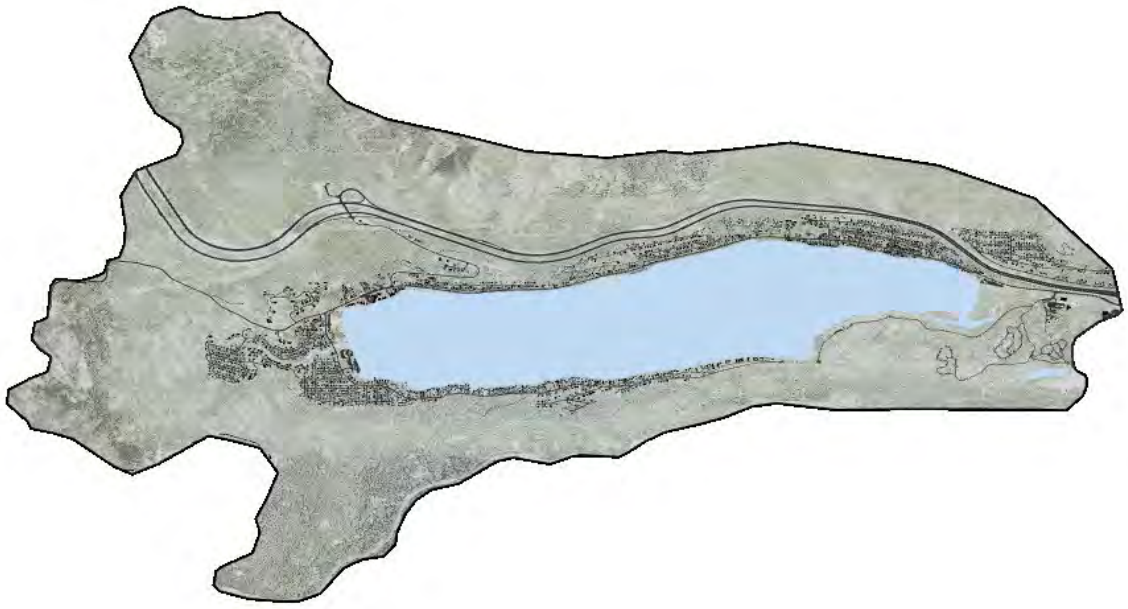


Figure 13. Impervious surfaces within the Donner Lake study area are shown in dark gray and black coloration. Source: Town of Truckee as of 3/3/2022.

As noted in **Table 3 and Figure 14**, there are just over 200 acres of impervious surfaces around Donner Lake, with paved roads and structures making up the majority. With up to date, well maintained low impact storm water treatment infrastructure (e.g. bio-swales, retention areas, rain/snow gardens), water quality and sediment impacts can be substantially reduced, but much of Donner's infrastructure and construction dates back to an earlier era when storm water facilities were not as well regulated, designed or built.

Table 3. Acres of impervious surface by type of surface. Source: Town of Truckee as of 3/3/2022.

Type of Impervious Surface	Total Acres
Structures	67
Paved Driveway	36
Paved Parking	14
Paved Road	151
Total Acres	**201**

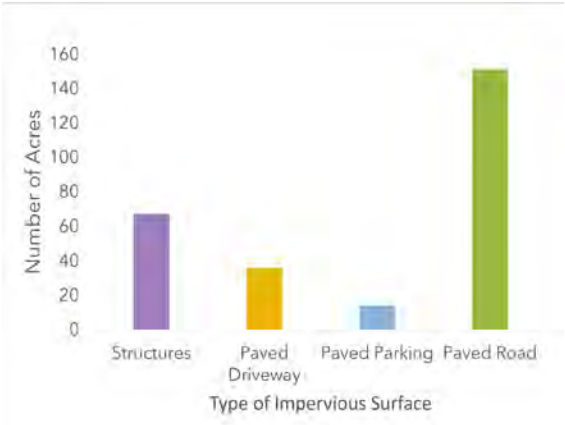


Figure 14. Acres of impervious surface by type of surface.

5.6. Storm water facilities

The major storm water facilities around the lake are shown in **Figure 15** and **Table 4**. There are 11 large detention basins including those serving I-80, a significant number of ditches and culverts, and 156 storm water outfalls into the lake or tributaries. The map depicts their generalized locations. Most of these facilities are owned and maintained by the Town of Truckee or Caltrans, while some are within the State Park, TDRPD's West End Beach, or other agency or organizations' property.

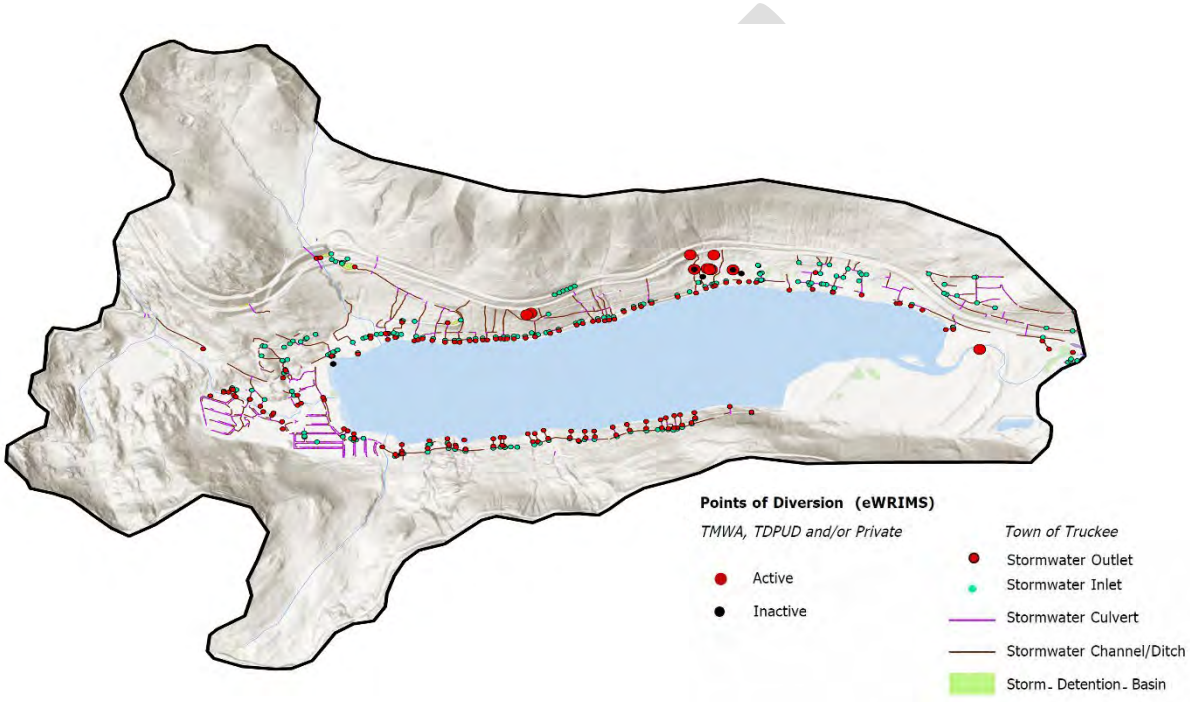


Figure 15. All active and inactive points of stormwater diversion within the Donner Lake study area owned and/or managed by the Town of Truckee, TMWA, TDPUD and private ownership. Source: Town of Truckee as of 5/29/2023.

Table 4. Storm water infrastructure within the Donner Lake study area. Source: Town of Truckee as of 3/3/2022.

Storm water Infrastructure	Count	Linear Feet	Square Feet
Outfalls	156		
Storm Manholes	9		
Inlets	221		
Culverts (includes driveway culverts)	711	31,650	
Ditches	652	81,882	
Large Detention Basins (includes I-80 basins)	11		86,000

5.7. Public and Private Docks

Keeping long term track of the number, location, and status of docks in the lake is valuable for several reasons: (1) docks provide much needed public access to recreation at the lake; (2) docks in disrepair can lead to water quality impacts through erosion along the shoreline; (3) likewise, as aging docks are rebuilt, past issues with impediments, loss of vegetation, erosion, rusting and other issues could be corrected; and (4) presence of docks, especially public, create demand for parking and visitation at key shoreline locations, particularly during the busy summer months. This can lead to issues of crowding, safety, bank instability/further vegetation loss, and trash and related issues.

Historically the California State Lands Commission regulated/permitted private dock construction activity below the historical low water in concert with the Town of Truckee, while the Town was in charge above the low water line. In 2021, the State Lands Commission ceded regulatory authority to the Town through its land use and building permit processes.

Figure 16 shows the locations of 37 public piers all located on the lake's north side and 225 permitted private piers scattered around the lake. The public piers are managed by the Truckee Donner Recreation and Park District. TDRPD repairs and replaces selected docks each year based on need and resource availability.

Table 5. Number of docks by private versus public owner. Source: Town of Truckee as of 3/3/2022.

Owner	Total
Truckee Donner Rec and Park	37
Private	225
Total	**262**

Figure 16. Private and public docks within the Donner Lake study area.

6. Donner Lake Geo-Physical and Ecological Indicators and Trends

The section on Geo-Physical and Ecological Indicators and Trends provides an overview of the physical and ecological characteristics of Donner Lake and its surrounding basin. It covers a wide range of factors that influence the lake's ecology, including climate, air quality, water conditions, chemical composition, and ecosystem biology. The information presented in this section is based on historical and contemporary data collected through various monitoring methods and offers valuable insights into the current state of the lake's ecological health. By analyzing these indicators and trends, we can gain valuable insights into the current state of Donner Lake and identify areas of concern and potential opportunities for improvement. In each of the following figures, the sampling location is noted with a star on the graphic of Donner Lake.

6.1. Climate and snowpack

Regional climate has a large influence on the ecology of Donner Lake. Snowpack (measured as snow water equivalent (SWE), or the amount of water within snow) governs the lake's water level, the timing of lake mixing, summertime thermal structure of the lake, the length of the growing season for algae, and nutrient loading to the lake. A record of SWE allows us to understand the influence of climate on the lake. UC Berkeley's Central Sierra Snow Laboratory near Donner Pass has collected one of the longest records of snowpack in the Sierra Nevada, measuring annual SWE since the early 1900s (**Figure 17**). Historic April 1st SWE measurements fall into 3 categories: 1) above-average (above the blue line) SWE, average SWE (37.3 inches), and below-average SWE (below the blue line) snow water content observed on April 1st. Due to the high elevation of the watershed, the snowpack shows no major long-term decline, indicating the potential throughput of water in the Donner Lake watershed. However, in recent decades and especially since 2010, SWE has generally been below average, indicating the potential for the watershed and its vegetation to be drier compared to in previous decades.

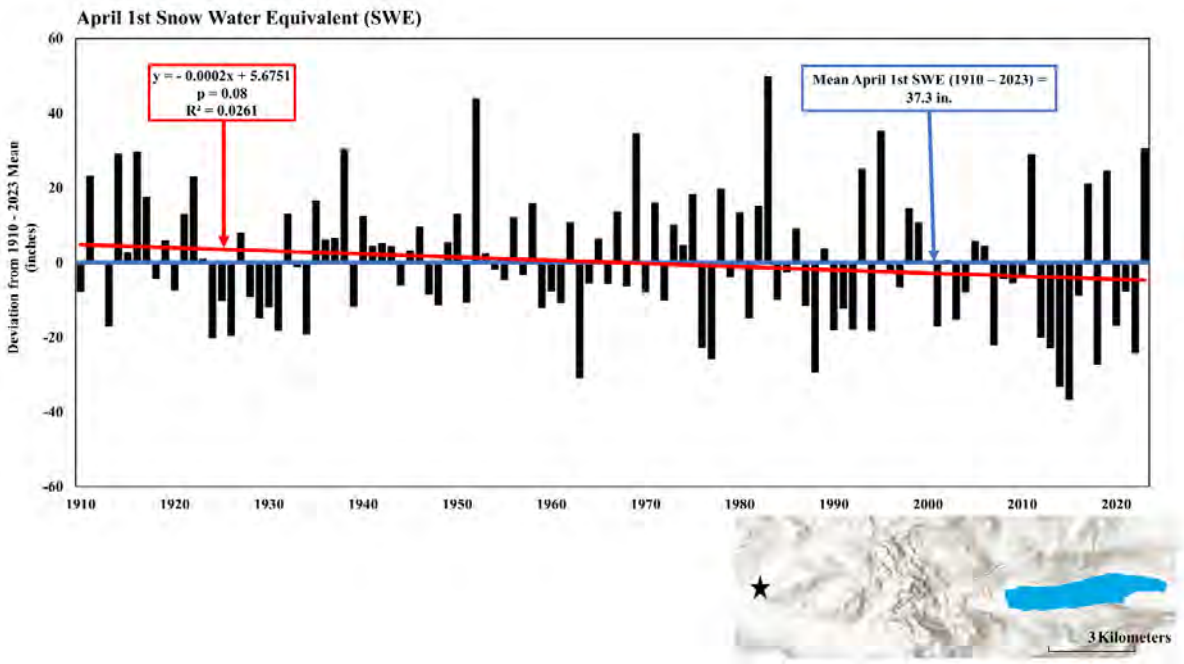


Figure 17. Snow Water Equivalent at Donner Pass, CA as measured on April 1st, 1910 to present. Source: UC Berkeley Central-Sierra Snow Laboratory.

The Sierra Nevada receives its precipitation most often as snow from Fall to Spring. Hydrologists measure the amount of snow that falls throughout the Water Year, starting on October 1 and ending on September 30th. Historically, snowpack SWE values are generally greatest from March to April, and the mean maximum SWE from 1984 to 2020 was approximately 30 inches (black line). The contemporary studies undertaken to evaluate the condition of Donner Lake occurred in 2021 to 2023. The first two years of this study (**Figure 18**; 2021 in blue and 2022 in green) had SWE values from January to April that were similar to the historical average. However, the water year 2023 (red) had a snowpack that was much greater than both the historical mean and 2021-2022.

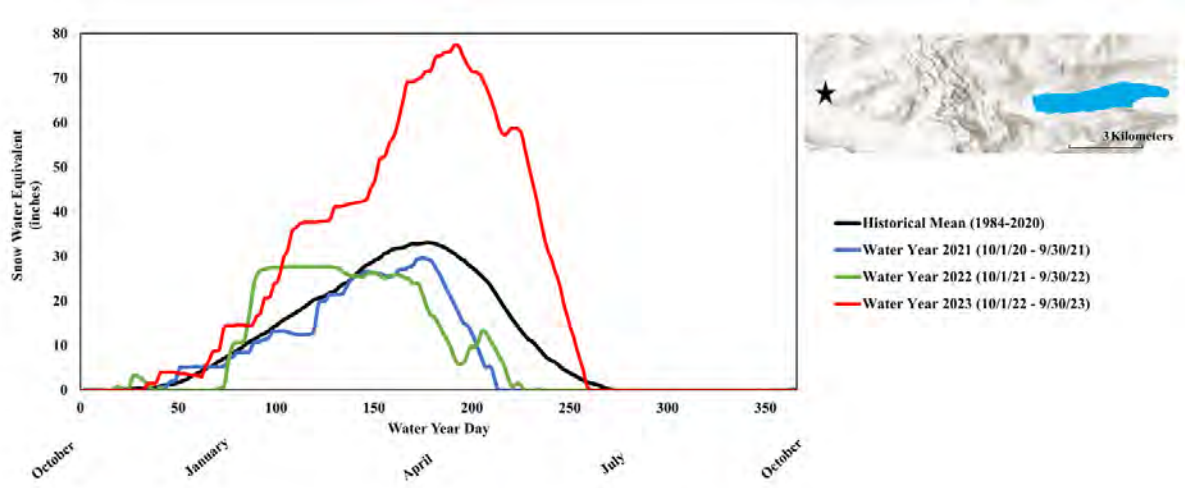


Figure 18. Snow Water Equivalent by month at Donner Pass, CA, Water Years 2021-2023 compared to historical mean (1984-2020). Source: UC Berkeley Central-Sierra Snow Laboratory.

6.2. Air Quality and Wildfire Smoke

Photo 3. Donner Lake Lagoon during the 2022 fire season.

Air quality and the particulates in the atmosphere can influence how many nutrients are deposited in the watershed and lake. Air pollution from regional wildfires also has the potential to obstruct solar radiation that would otherwise reach the lake. This can impact the thermal structure of the lake. Changes in the amount of light irradiating on the lake can also influence algal production and the animals living in the lake that prey upon algae. Air quality sensors measuring the concentration of air particulates (diameters > 2.5 microns) show the influence of wildfires in the airshed of the lake from mid to late summer in both 2020 and 2021. Decline in air quality in 2022 is also significant but for a shorter period of the summer compared to 2020 and 2021 (**Figure 19**). Changes to the air quality of the airshed, particularly during the years with lower SWE values, show how wildfire burning can influence Donner Lake.

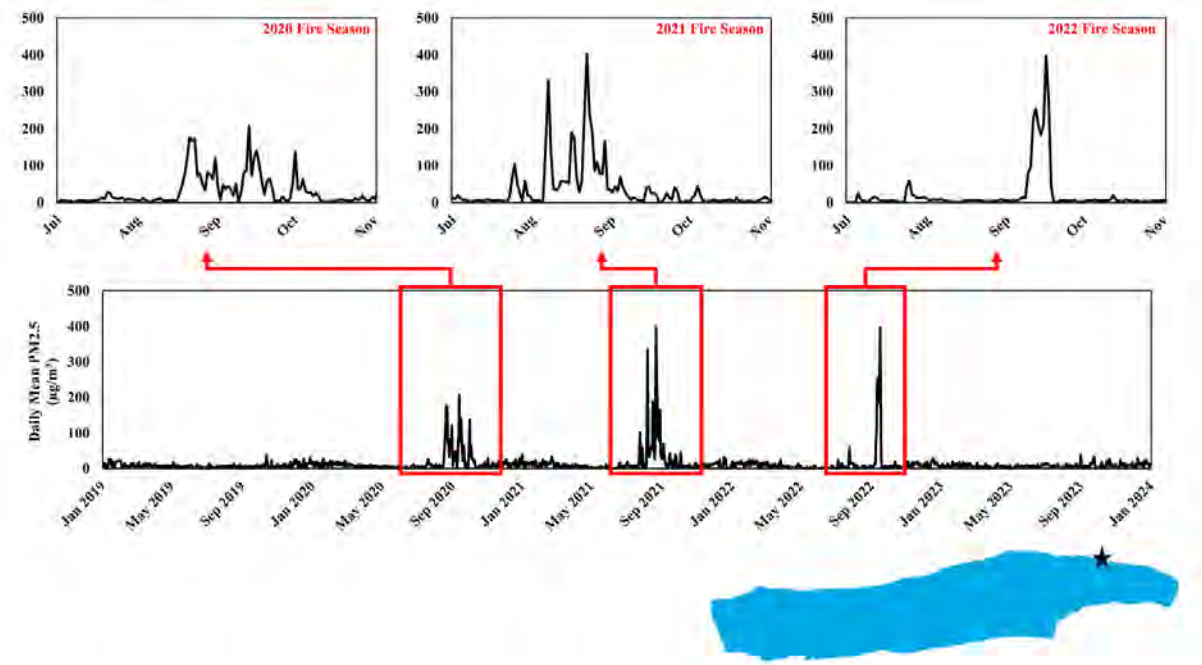


Figure 19. Air quality North Shore of Donner Lake January 2019-January 2024. Source: Purple Air Sensor.

6.3. Physical conditions

6.3.1. Water temperatures

Water temperature governs the plant, animal, and bacterial production in the lake along with the distribution of fishes. In addition, water temperature influences the rate of chemical reactions and transformations which can influence the state of nutrients in the lake (**Figure 20**). Temperature measurements along a depth profile (shallow to deep) indicate when a lake is stratified with a shallow warmer layer of water, transitional water in middle depths, and colder water temperature towards the bottom. Measurements of water temperature along the profile can also serve as an indication of

water mixing which typically occurs in our mountain lakes in the Spring and Fall. However, the timing of lake mixing can change depending on snow content and climatic conditions. Finally, water temperature governs how much gas can be in water including oxygen where colder water contains more oxygen compared to warmer water.

Historical (1973 and 2010) and contemporary (2021-2023) water profiles in Donner Lake indicate a typical pattern for mountain lakes in our region. The lake is most stratified in mid-summer and less stratified in spring and fall. In mid-summer, the mixed upper layer can reach 10 to 11 meters depth. In the fall, the mixed upper layer is gradually eroded by deeper mixing. Near-surface, mixed-layer water temperatures can reach 20 to 22 degrees Celsius in the summer, typical for mountain lakes in this region. Below the transitional thermocline, water can reach temperatures as low as 4 degrees Celsius, especially in years with high SWE and spring inflows. Long-term monitoring of temperature profiles will be important for understanding the connections between climate (air temperature, precipitation) and lake conditions.

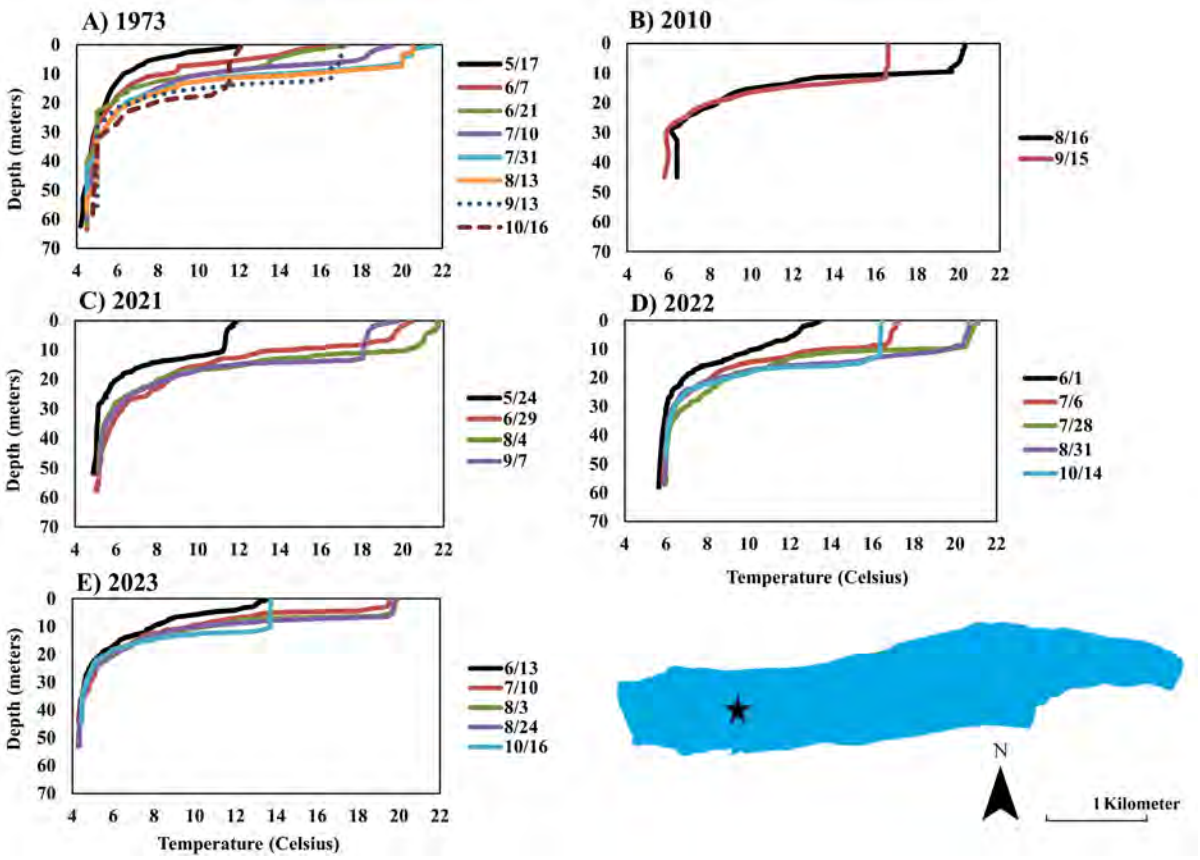


Figure 20 (A-E). Offshore water tmperature at Donner Lake, select years 1973-2023. Source: Global Water Center, UNR.

6.3.2. Water transparency and light conditions

Lake transparency or clarity is important for several physical and biological processes.

First, transparency dictates the energy budget and temperature structure of the ecosystem. Second, transparency can dictate the distribution of biological species, including algae and fish, within the lake. The lake's transparency can change the algal concentrations in the lake, the delivery of sediment particles from the watershed to the lake, and the amount of dissolved matter produced by or delivered to the lake. Understanding the changes to the lake transparency can help us understand the state of the ecosystem. Transparency can be measured using a Secchi disc that is lowered into the water until it disappears. The depth at which the disk can no longer be seen is the Secchi transparency. Repeated measurements over time show how the lake clarity is changing. Light can also be measured with a radiometer that measures specific wavelengths of light, such as photosynthetically active radiation (PAR), the type of light radiation that drives photosynthesis in plants. This light is also visible to humans. Often, limnologists calculate the 1% light depth (the depth where only 1% of light from the surface penetrates the water) to determine the maximum depth of plant production in a lake.

Historical measurements of Donner Lake's clarity from 1973 indicate seasonal changes in clarity as measured by a Secchi disk (**Figure 21**). A white Secchi disk can be seen to depths of generally 5 to 7 meters in spring and early summer. However, clarity increases throughout the summer such that the Secchi disk can be seen at a depth of 12 meters from July to August. The deepest Secchi depth ever observed in Donner Lake was in August 2022 (13.5 meters) while the shallowest was in May 1973 (5.0 meters). Decreases in transparency can be caused by a variety of factors such as high snowpack runoff (2023), or increased runoff of nutrients and sediment or smoke from wildfires (summer 2022). One percent PAR depths at Donner Lake suggest that plant production may have been as deep as 23.9 meters in August 1973 and as deep as 21.1 and 18.8 meters in 2021 and 2022, respectively. However, the maximum 1% PAR depth observed in water year 2023 was only 16.3. These measurements indicate that both clarity and light transmission are highly variable in the lake, likely driven by the particles delivered to the lake during spring inflow and algal production in the lake. Longer-term monitoring of clarity using both Secchi disk and more precise light instrumentation can provide a robust understanding of water quality conditions in the lake over time.

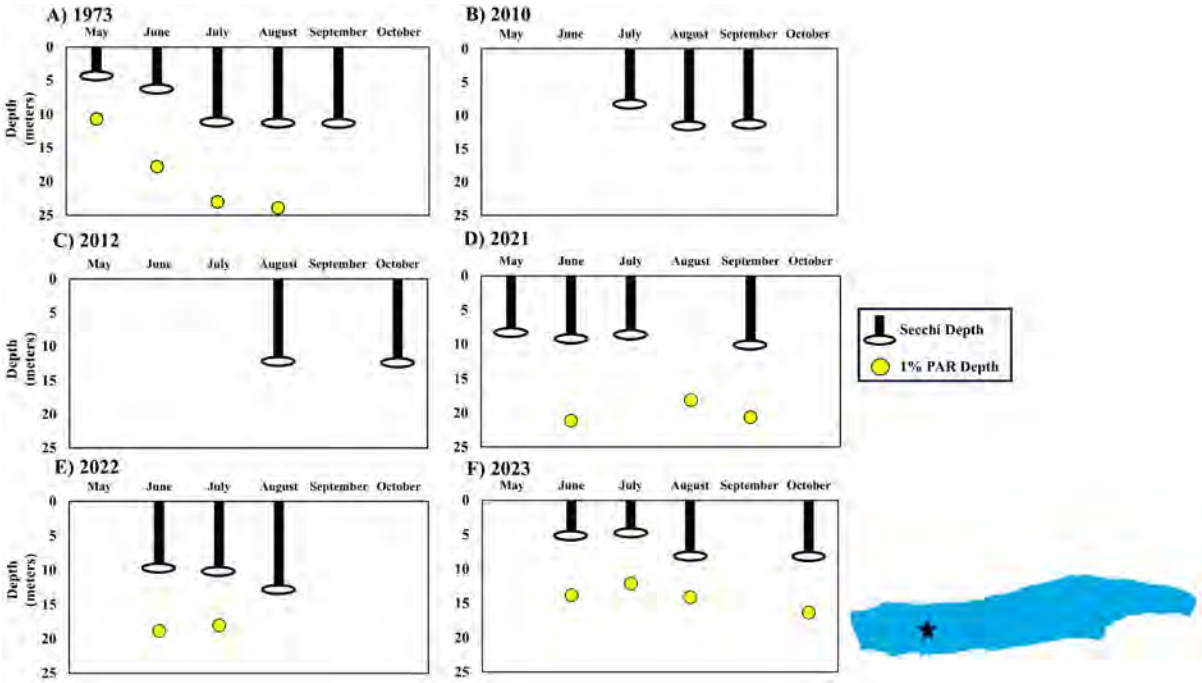


Figure 21. Water clarity at Donner Lake, select years 1973-2023. Source: Global Water Center, UNR.

6.4. Chemical conditions

6.4.1. Oxygen

Dissolved oxygen plays an important role in the survival of fishes and invertebrates within a lake and controls chemical reactions within the water. The oxygen near the bottom of the lake can be low due to bacteria's consumption of organic matter. Cold-water trout can be stressed or killed when oxygen is reduced below 2 milligrams/liter. In addition, the availability of certain nutrients such as phosphorus can increase due to the "liberation" from iron complexes. We can also use oxygen profiles to determine the location of the maximum plant and algal production since oxygen is a key product of photosynthesis (light-driven reactions that produce carbon).

Historic (1973) and present (2021-2023) dissolved oxygen profiles show well-oxygenated conditions (**Figure 22**). There are strong, seasonal oxygen dynamics similar to what is observed in other transparent, deep mountain lakes in the region. Oxygen concentrations are highest in the surface mixed layers during spring runoff in May to early June and decrease throughout the summer. At moderate depths (15-20 meters), oxygen increases, suggesting an area of maximum algal biomass but also a zone of temperatures that transitions to colder waters.

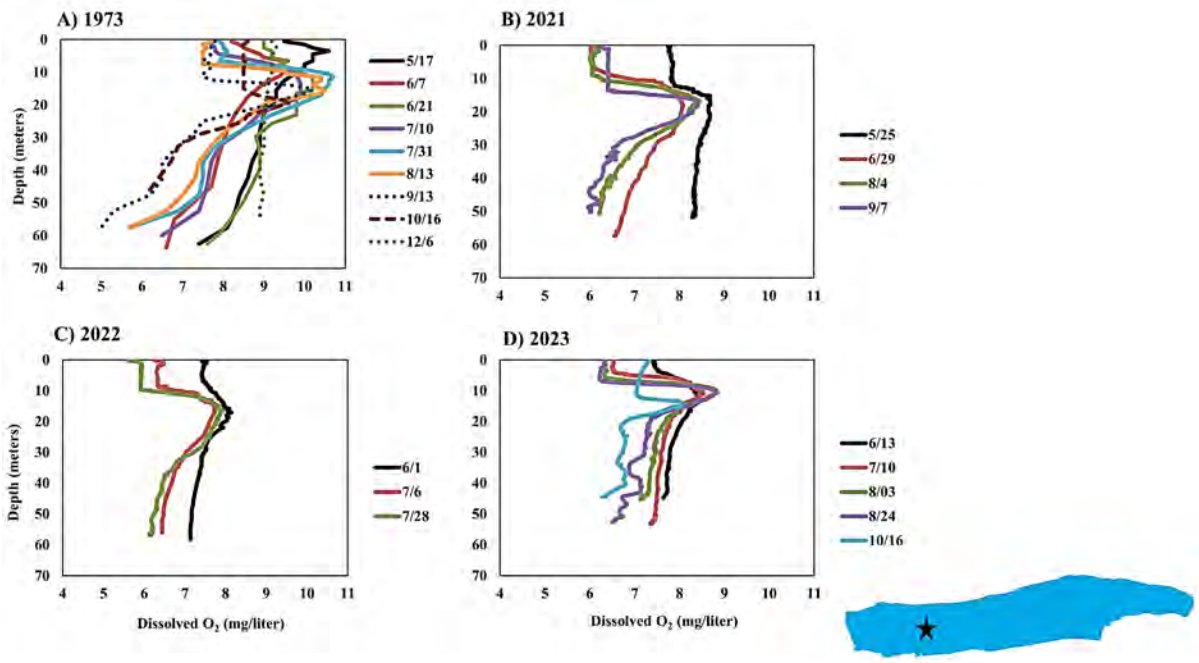


Figure 22. Dissolved Oxygen at depth at Donner Lake, select years 1973-2023. Source: Global Water Center, UNR.

Using automated probes, we collected high-frequency measurements of oxygen concentration and water temperature in two shallow areas of the lake (**Figure 23** and **Figure 24**). In general, nearshore water temperature is highest in July and August. In 2021, however, summer water temperatures cooled in mid to late summer, presumably due to increased wildfire smoke in the basin (see 6.2 Air Quality and Wildfire Smoke). Nearshore oxygen concentrations reflect daily shifts in oxygen with higher concentrations during the day when sunlight drives photosynthesis and nearshore algal growth. In 2021, on the northeast shore of the lake, there were more variable oxygen concentrations while the lake was cooling, and smoke conditions increased in the airshed. Continued monitoring of nearshore oxygen and calculations of algal and bacterial production is valuable for understanding how climate or introduced species influence water quality and nearshore algal and bacterial growth. Recent evidence from other clear water lakes suggests that nearshore water quality is degrading but the exact reasons are multifold.

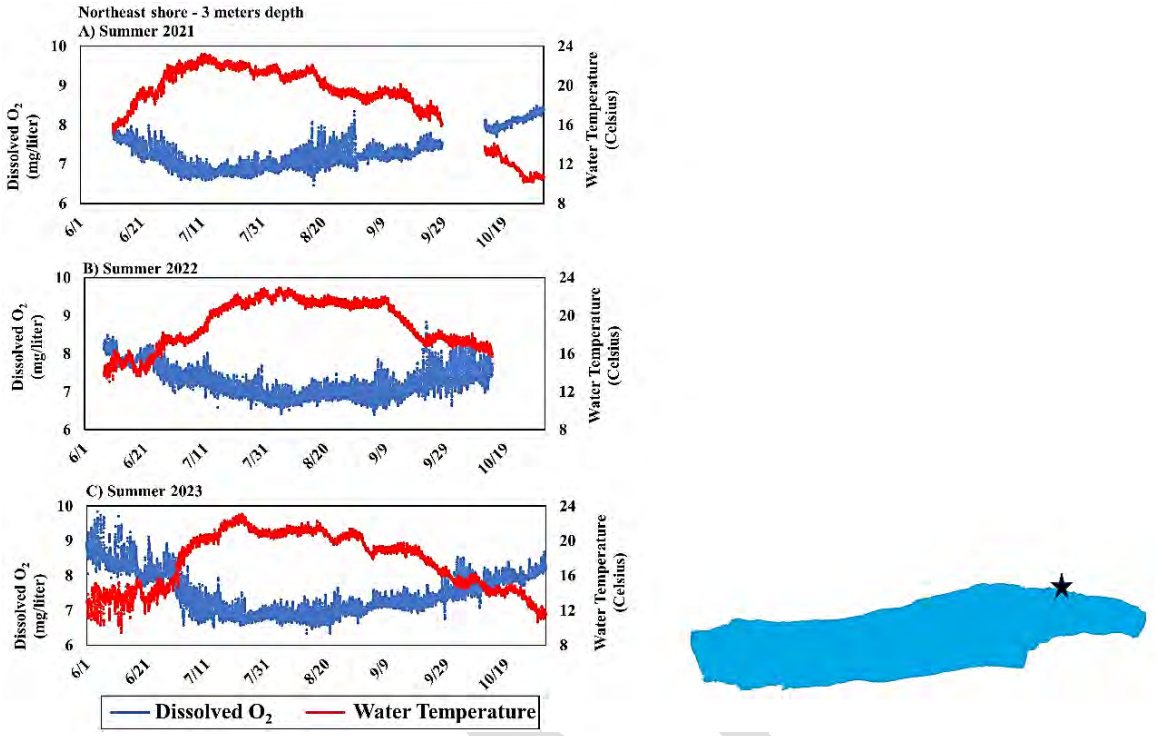


Figure 23. Dissolved Oxygen and Water Temperature on the North Shore of Donner Lake, 2021-2023. Source: Global Water Center, UNR.

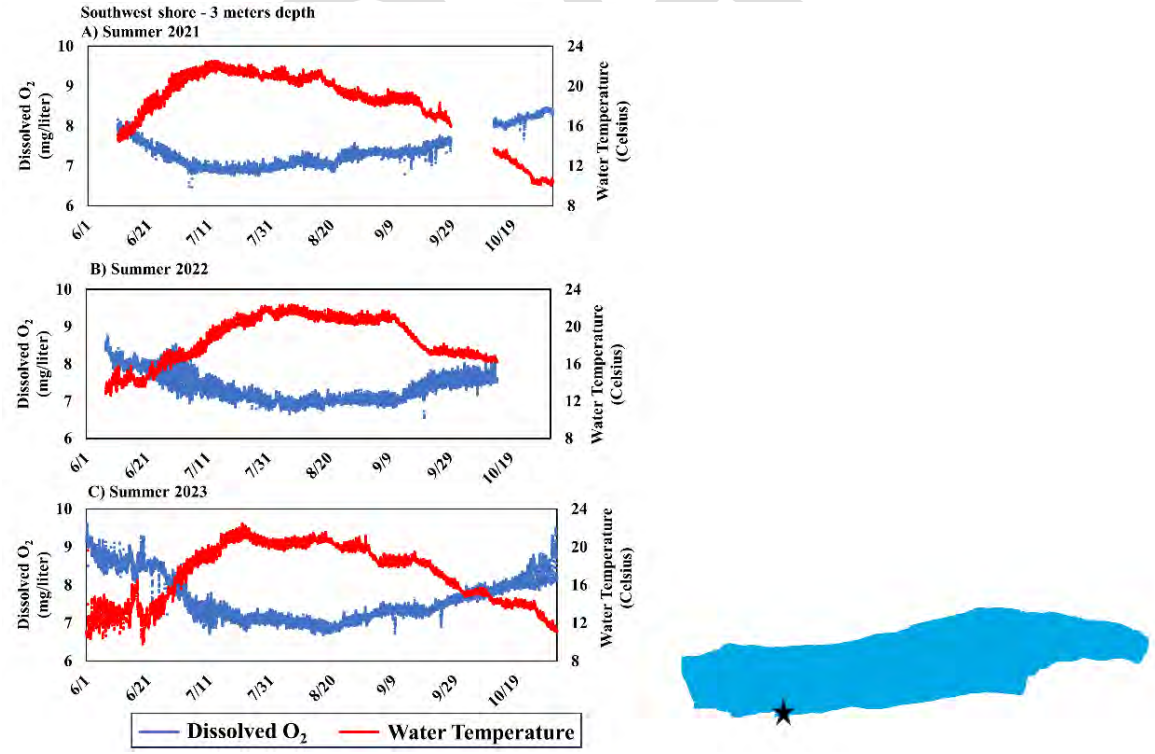


Figure 24. Dissolved Oxygen and Water Temperature on the South Shore of Donner Lake, 2021-2023.Source: Global Water Center, UNR.

6.4.2. Nutrients

Lake water is composed of many chemicals (nutrients) derived from the geology and soils and deposition from the airshed. Life is dependent upon many of these nutrients. Therefore, it is essential to know what nutrients are in the lake water. Two essential elements for life are nitrogen and phosphorus. Nitrogen is found in proteins and muscles and is excreted in waste; phosphorus is found in DNA and cell walls and is used for energy by all organisms. However, not all nutrients are needed by organisms at the same concentration. In general, much more carbon is needed than nitrogen, and more nitrogen is required than phosphorus. Plants and other life forms cannot use carbon, nitrogen, and phosphorus in their elemental form, but they can use the different forms found in nature. Therefore, concentrations of measure concentrations of nitrate (NO_3^-), ammonium (NH_4^+), and phosphate (PO_4^{3-}) are instead measured as these are the forms of nitrogen (N) and phosphorus (P) that plankton and plants can more readily acquire. This is a measurement of all the possible sources of nitrogen and phosphorus in the water and comes from living and dead sources.

Nutrients can change with depth, the timing of snowmelt entering the lake, and deposition from ash and smoke particles from wildfires. Thus, looking at a snapshot of the nutrients at a single time point can be helpful to see the status of the lake at that moment, but there are ways of looking at chemical nutrient data that are more informative. One way is by looking at a depth profile, taking samples of water from different depths and comparing their nutrient concentrations. In Donner Lake, profiles are taken at 0, 2.5, 5, 7.5, 10, 12.5, 15, 20, 30, and 50 meters deep.

In **Figure 25**, several patterns can be observed with regard to the nutrients. Each of these patterns reflects the fact that summertime oxygen concentrations are relatively high in Donner Lake. For instance, ammonium concentrations are generally low as would be expected in high-elevation lakes such as Donner Lake where oxygen concentrations are generally high. The high concentration of oxygen allows for organisms to take up the ammonium as a nutrient throughout the water column, leaving behind only trace amounts of ammonium. The concentrations of both phosphorus and nitrate are likewise reflective of the oxygen profile throughout the water column. Specifically, the high concentrations of oxygen in the upper water column allow for nitrifying bacteria to produce nitrate while slightly lower oxygen concentrations deeper in the water column lead to relatively lower nitrate concentrations. Likewise, the availability of oxygen keeps phosphate concentrations low by reacting with the phosphate to produce precipitated phosphorus that sinks into the sediment.

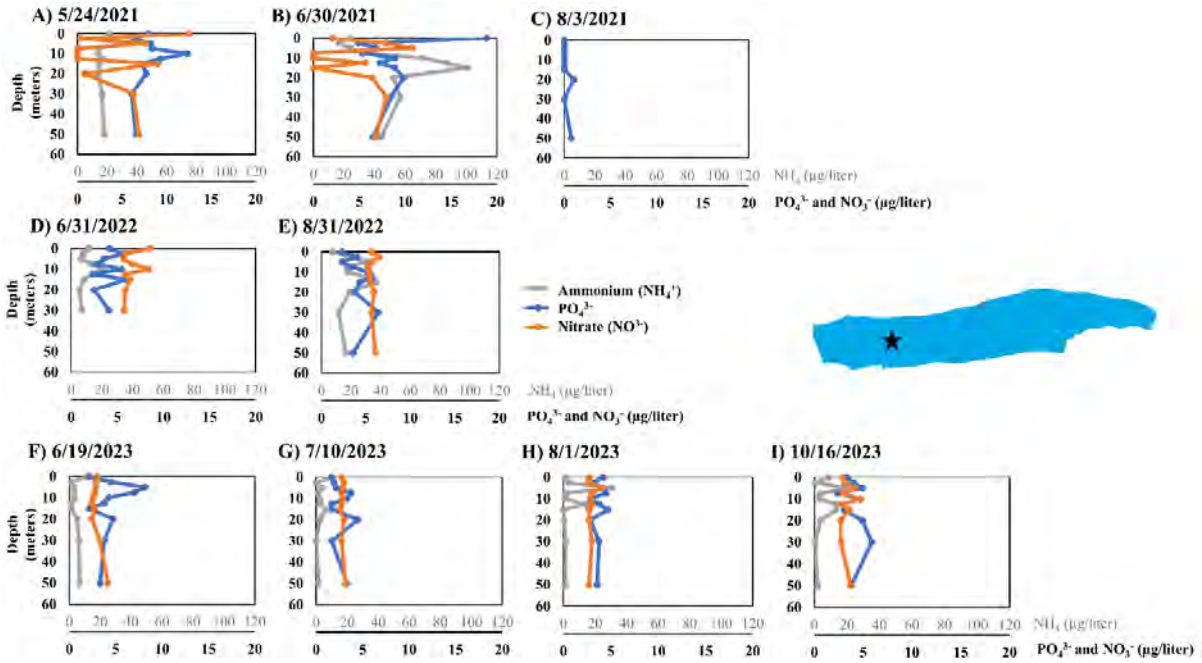


Figure 25 (A-I). Nutrients at depth at Donner Lake, 2021-2023.Source: Global Water Center, UNR.

6.5. Ecosystem production and biology

Measurements of algae and bacteria production can serve as an indicator of water quality. There are several ways of estimating the production of phytoplankton (open-water algae), and periphyton (bottom algae), and bacteria that form biofilms along the bottom. For instance, measurements of chlorophyll a, the plant pigment necessary for performing photosynthesis, can be made. However, this method does not reflect the true amount of production and instead only reflects the amount of algae rather than the photosynthesis performed. Other methods include measuring the amount of carbon fixed by algal cells using carbon tracers or estimating production by evaluating the oxygen from the water. Rate changes of production measured with oxygen can only occur if there are sufficient bacteria and algae to change the signal of oxygen. Since the bottom of the lakes can have more bacteria and algae compared to the open water, this method is suitable for an ecosystem such as Donner Lake.

6.5.1. Algal and bacterial ecosystem productivity

From the open water profiles, we can see the development of deeper water algal biomass during the summer (**Figure 26**). In general, deep water algal biomass, measured as chlorophyll a, increases from early to late summer as the lake stratifies in temperature and there is an increase in surface light. The patterns are similar across years (2021-2023). However, there is a larger concentration of phytoplankton biomass in July 2023, likely due to the increased snowpack in winter 2022-2023 that delivered nutrients to the lake during spring 2023 runoff.

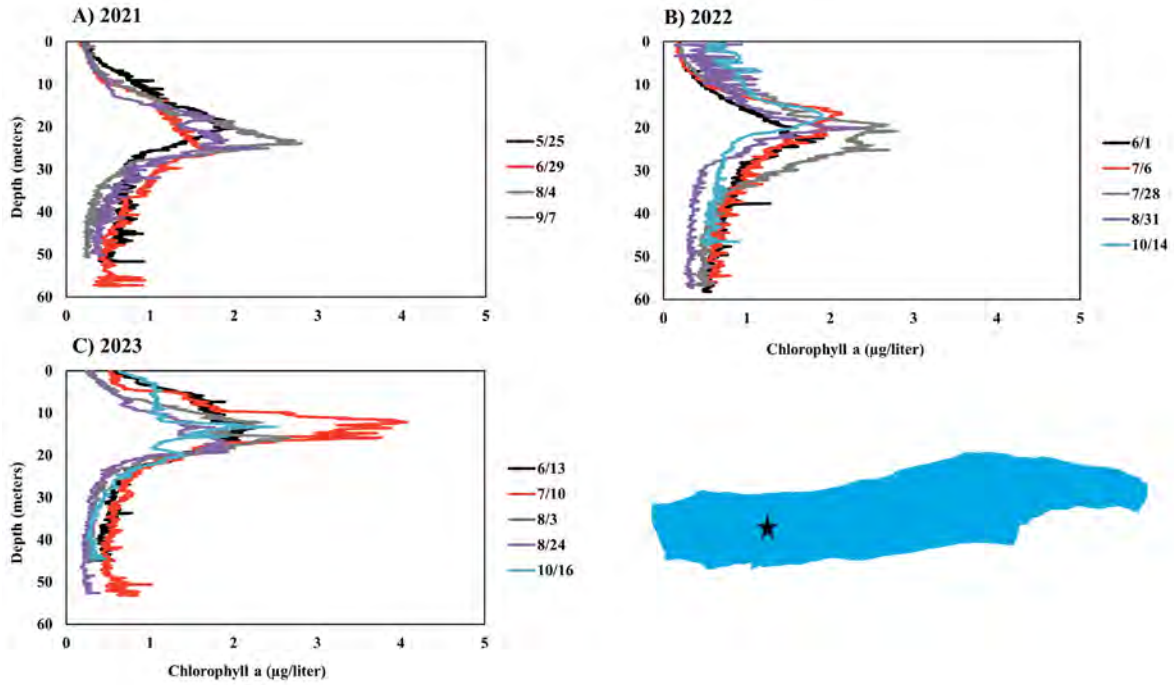


Figure 26. Chlorophyll a at Donner Lake, 2021-2023. Source: Global Water Center, UNR.

Measurements of open-water productivity using carbon tracing were historically performed at Donner Lake and again in 2021. These measurements are obtained by conducting experiments with tracers in the cells of phytoplankton. As seen in **Figure 27**, historical experiments (1983-85) showed higher phytoplankton (open water algae) production compared to recent times (2021). Production is typically maximized in the top 10 meters and develops during the summer growing season.

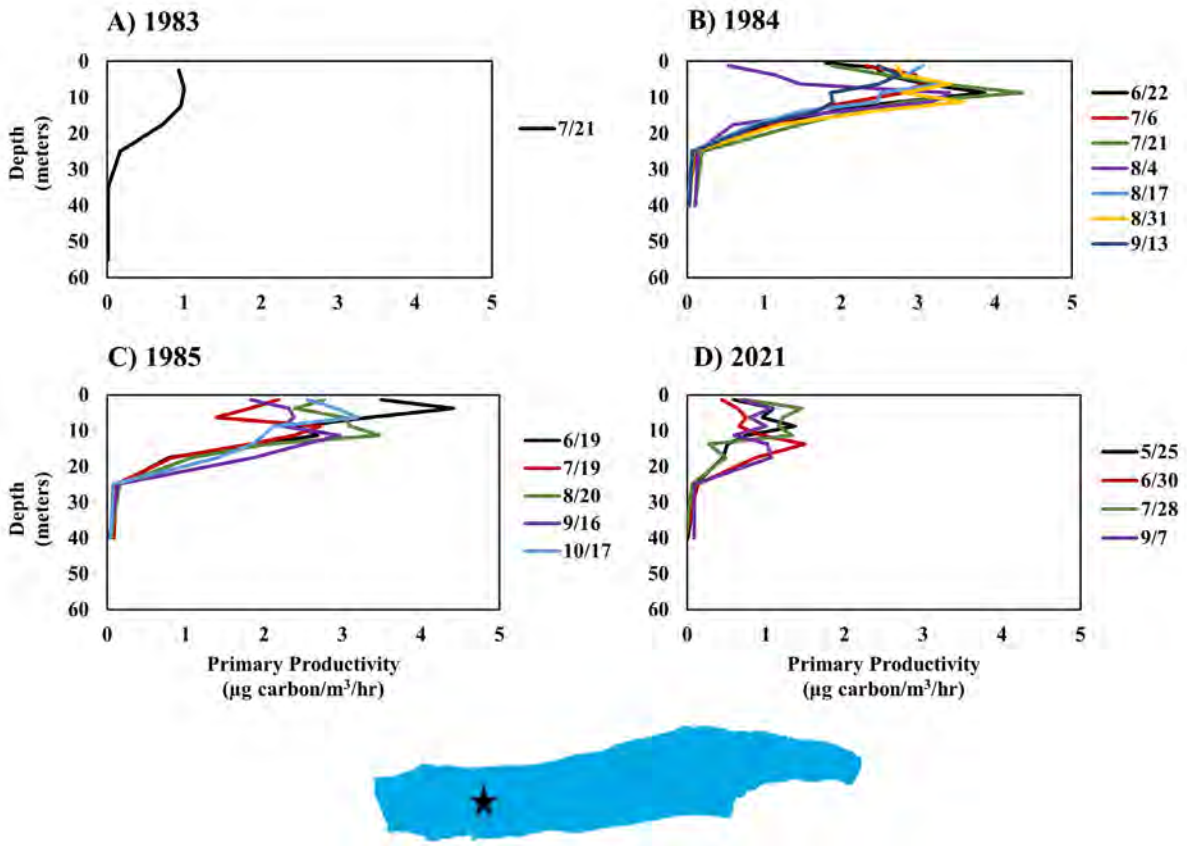


Figure 27. Primary Productivity at Donner Lake, 1983-1985 and 2021. Source: Global Water Center, UNR.

Algal production, algal respiration, and bacterial respiration can be modeled in the nearshore zone using high-frequency measurements of water temperature and oxygen. These models calculate production and respiration using the climate of the region (air temperature, solar radiation, relative humidity, wind, and air pressure), the transparency of the lake, nearshore temperature, and nearshore oxygen. The models calculate 1) Gross Primary Production (GPP), the amount of oxygen produced through photosynthesis; 2) Ecosystem Respiration (ER), the amount of oxygen consumed by all microbial nearshore organisms consuming oxygen through respiration, and 3) Net Ecosystem Productivity (NEP), the net difference between gross primary productivity and ecosystem respiration. Therefore,

Net Ecosystem Productivity (NEP) = Gross Primary Productivity (GPP) – Ecosystem Respiration (ER)

The model results show that nearshore productivity and respiration vary little throughout the summer and between the study years (2021, 2022, and 2023). Throughout the summer, the amount of oxygen consumed through respiration consistently exceeds the amount of oxygen produced through photosynthesis, resulting in Donner Lake's nearshore microbial organisms consuming more oxygen than they produce (the black lines in **Figure 28**). Additionally, nearshore productivity and

respiration are not influenced by the presence of smoke in the atmosphere (the red line in **Figure 28**).

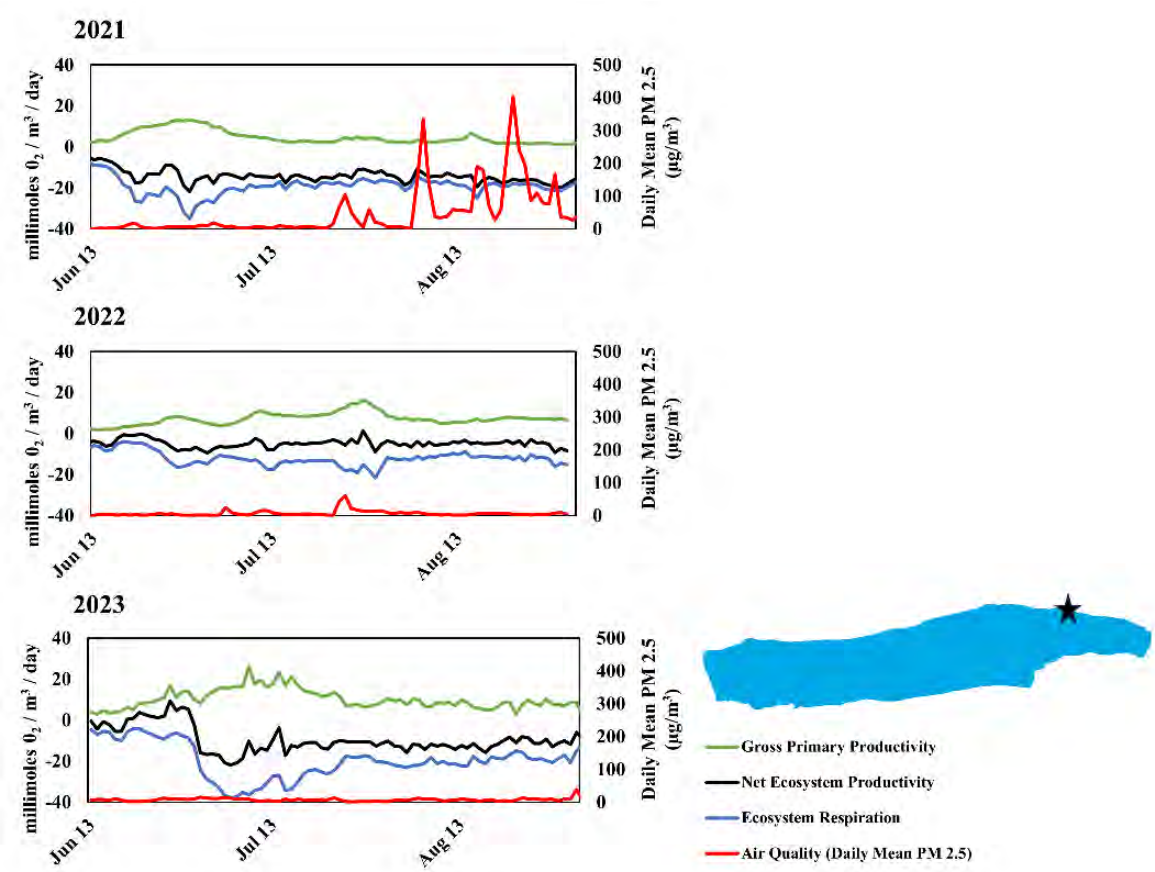


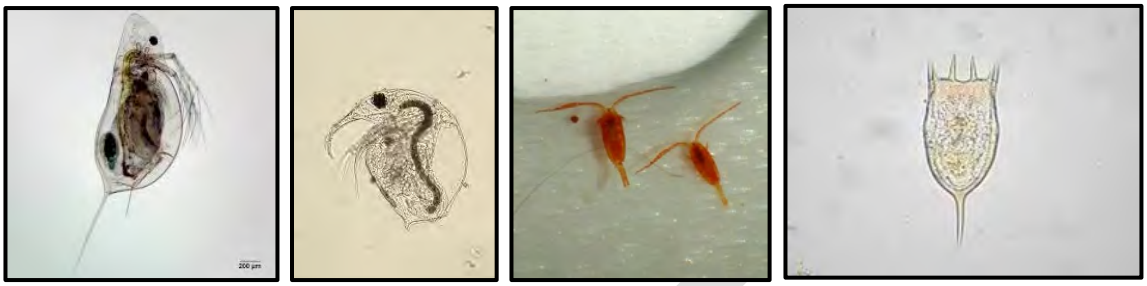
Figure 28. Gross Primary Productivity (GPP), Net Ecosystem Productivity (NEP), Ecosystem Respiration (ER), and Air Quality at Donner Lake, 2021-2023. Source: Global Water Center, UNR.

6.5.2. Invertebrates of the open water (zooplankton)

Zooplankton, or small animals living in the water column, serve as an important component of the food web in lakes. They occupy the middle of the food web, sometimes increasing water clarity by eating particles. Some zooplankton, like *Daphnia* and *Bosmina,* can reproduce through asexual cloning, while others, like copepods, require sexual reproduction and go through a series of transitional growth stages (e.g., nauplii to copepodids to adults). Zooplankton exhibit daily vertical migrations in the lake, moving into the deep waters in the day and rising towards the surface at night. Mysids, large zooplankton introduced to Donner Lake in the mid-1960s, can migrate horizontally and vertically to the deepest depths of the lake each day.

The native zooplankton in Donner Lake are *Daphnia, Bosmina*, copepods (*Diaptomus*, cyclopoids), *Kellicotia, Keratella, and Polyarthra* (**Figure 29**). Their densities are highest in late summer (August), but highly variable over years (**Figure 30**). Sometimes, lower densities are observed at the beginning of the growing season (e.g., June and July 2023)

due to cooler water temperatures caused by the larger snowpack-based inflows.



Bosmina

Daphnia ***Diaptomus*** ***Keratella***

Polyarthra (Top)
Bosmina (bottom)

***Mysis* shrimp**

Figure 29. Native and non-native zooplankton in Donner Lake.

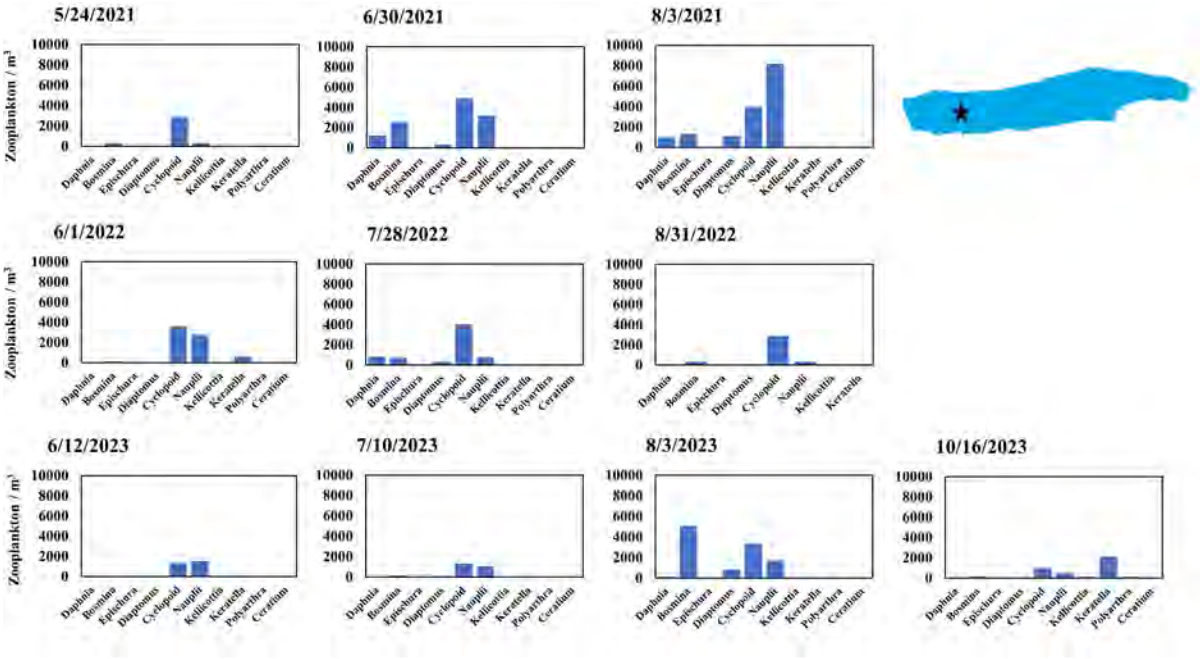


Figure 30. Zooplankton densities at Donner Lake, 2021-2023. Source Global Water Center, UNR.

The non-native mysids can migrate vertically and horizontally. Therefore, we sampled these mysids across the lake at 5 locations during the nighttime when they have migrated out of the deep bottom waters (**Figure 31**). The length of a mysid is approximately the diameter of a quarter. Despite their small size, they are excellent visual predators, feeding on other zooplankton and serving a food item for fishes like kokanee salmon, juvenile trout, and forage fishes. They can live for more than 2 years. Recent densities of mysids (2021-2023) in Donner Lake are similar to what was observed historically (1978-1980). In early summer, measurements of telson lengths show the presence of two cohorts (small juveniles and large adults). By fall, these two cohorts become indistinguishable due to the growth that the juveniles experience throughout the summer.

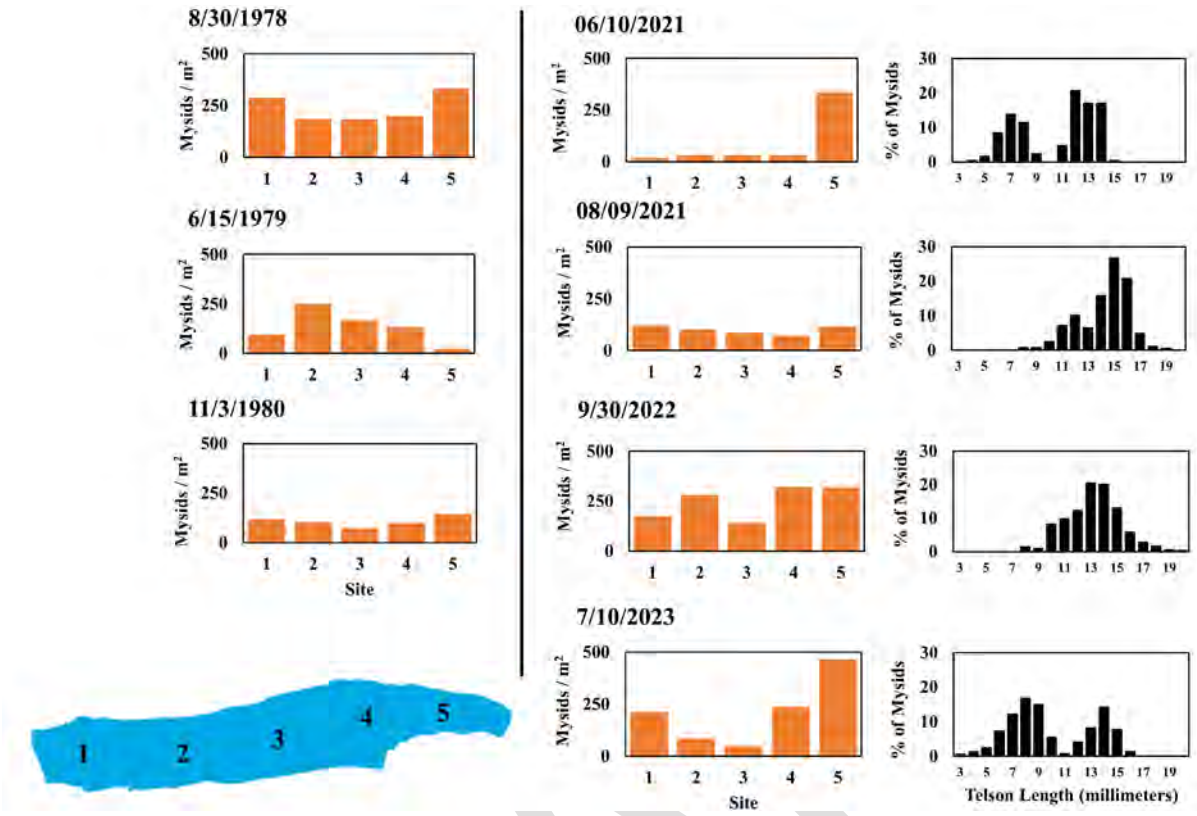


Figure 31. Mysis shrimp density at various location, 1978-1980, 2021-2023, and Telson length, 2021-2023. Source: Glabal Water Center, UNR.

6.5.3. Invertebrates along the lake bottom

Living along the lake bottom, invertebrates play important roles in recycling nutrients and organic matter, controlling films of algae and bacteria, supplying energy into the food web, and supporting fish production. Invertebrates are found in all sizes (ranging from the size of a tip of a pencil to the size of a hand) and shapes and can live on hard and soft sediments. Recently, as clear water lakes like Donner Lake are greening along the shoreline with filamentous algae, scientists have become interested in understanding the changes in the invertebrate community through space and time. Even with the limited sampling of invertebrate communities from Donner Lake, we see that invertebrates can be identified from shallow to deep waters (**Figure 32**). Stoneflies (*Plecoptera*), native pea clams (called *Pisidium*), and midges (Chironomidae), dominate the upper 10 m of water, and the midges dominate across all sampled depths.

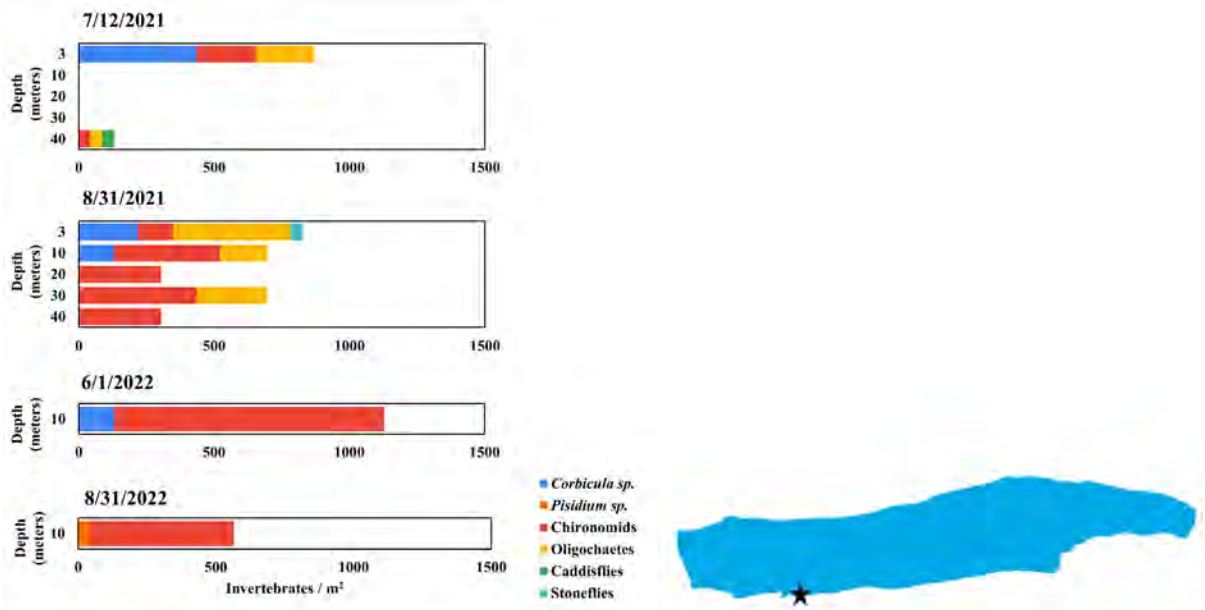


Figure 32. Invertebrates at various depths at Donner Lake, 2021-2022. Source: Global Water Center, UNR.

Invasive Asian clams (*Corbicula fluminea*) were first discovered in the Lower Truckee River near Pyramid Lake in the early 1980s and within Lake Tahoe in the early 2000s. They can become as large as the diameter of a quarter. One clam can produce hundreds of thousands of offspring, allowing them to rapidly colonize new environments. Predatory fishes offer little control due to the difficulty in digesting clams due to their hard shell. The clams can peddle and filter-feed algae, but they may be selective in the particles that they ingest. Research from Lake Tahoe suggests that they facilitate nearshore algal blooms as clams excrete nutrients that may stimulate algal growth due to their selective feed on particles. Our surveys suggest that clams have expanded along the shoreline of Donner Lake over a 10-year period since initial surveys were conducted in 2011 (**Figure 33**). Considering that researchers are finding that the nearshore zones of many high-transparency lakes are greening with time, focusing on the nearshore benthic ecology of Donner Lake could be an important area of conservation-based science if the lake's nearshore appears to be green over time.

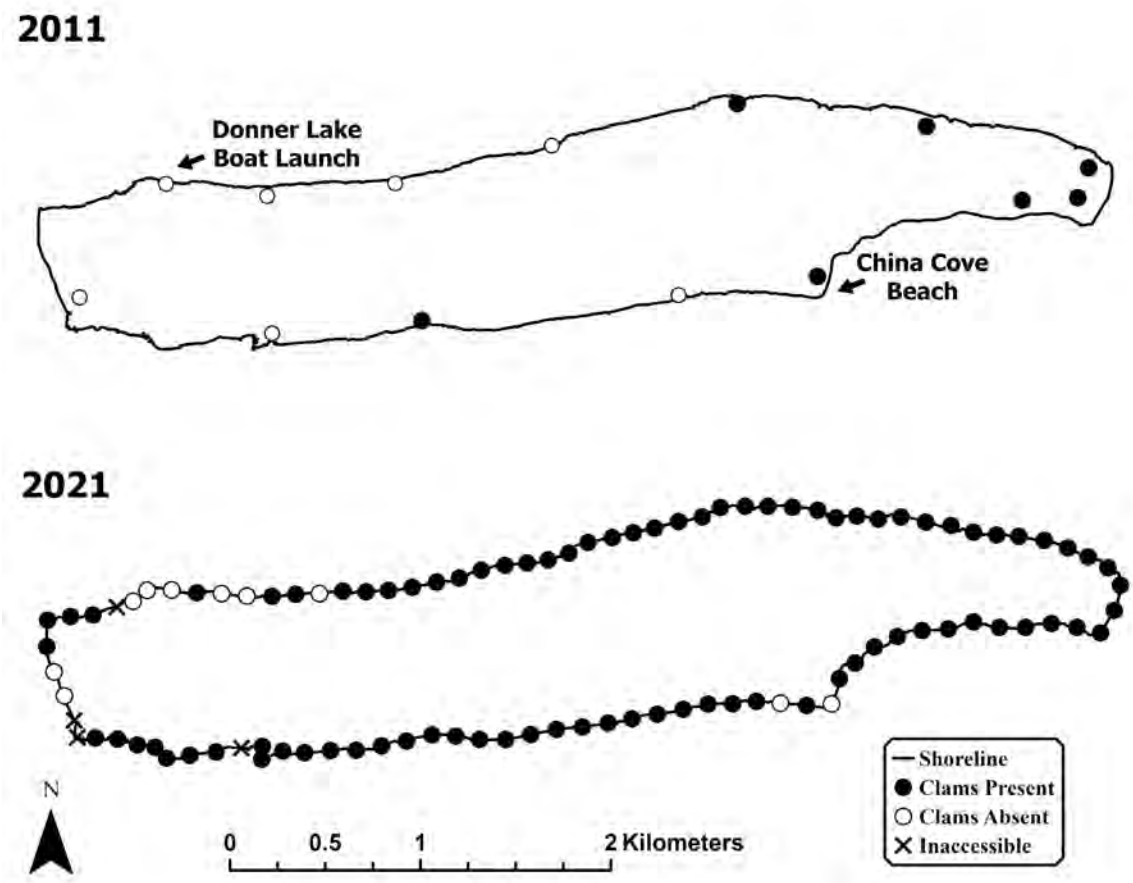


Figure 33. Presence of invasive Asian clams at Donner Lake, 2011 vs 2021. Source: Global Water Center, UNR.

Invasive crayfish (*Pacifasticus leniusculus*) were introduced into the Tahoe watershed in the late 1800s and multiple times through the 1930s. They can reach the size of a human hand and are relatively long-lived at this size, reaching age of up to 10 years. Initial studies suggested this cold water crayfish was largely an herbivore (eating films of algae and bacteria), but it is increasingly recognized that this crayfish is an omnivore and may be controlling and promoting the growth of algae during certain seasons in Lake Tahoe. In Crater Lake, they can increase algae concentrations by grazing invertebrates such as snails and releasing algae from predation, resulting in a decrease in nearshore water quality. Other studies have shown that crayfish can migrate across the lake bottom seasonally, living in the deeper waters in winter and in the shallow waters in summer. Therefore, they likely play a very important role in controlling the invertebrate community in the lake. Donner Lake crayfish can be distributed across the bottom to depths of up to 30 meters, with maximum densities varying inter-annually (**Figure 34**). The population is dominated by males. Monitoring crayfish densities over time (early and late summer) can give an indication of the conditions of the bottom of the lake. However, due to their long-lived nature and distribution, future monitoring over time is needed.

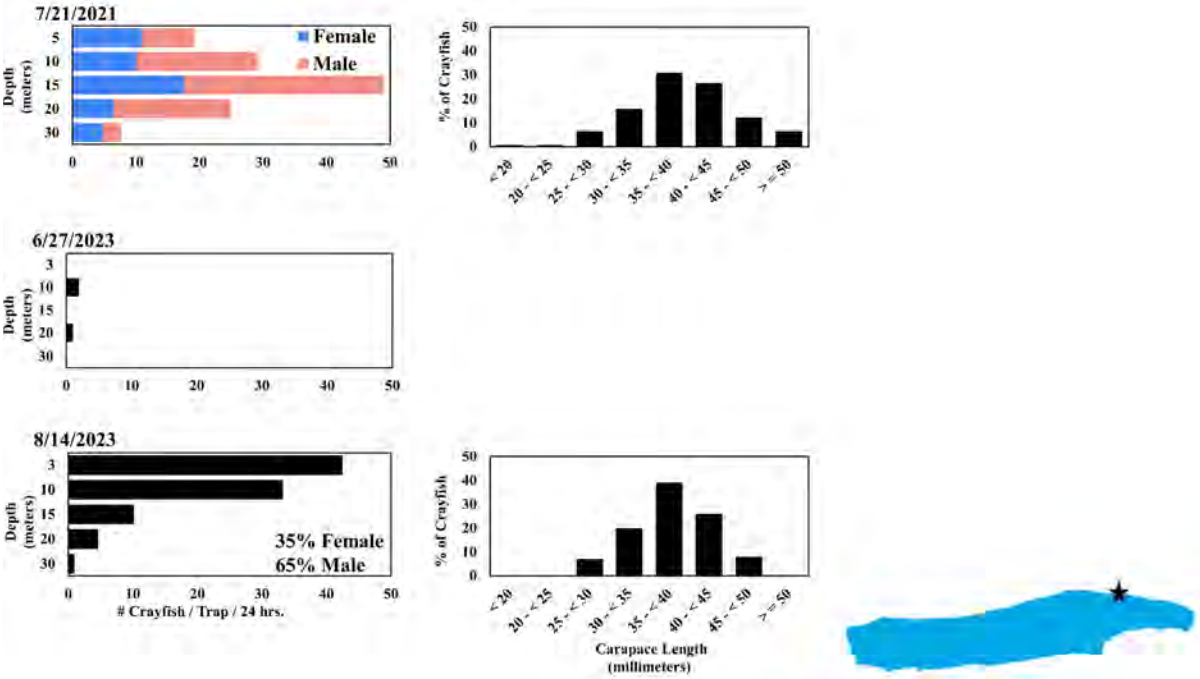


Figure 34. Crayfish densities at various depths on the North Shore of Donner Lake, 2021 and 2023. Source: Global Water Center, UINR.

6.5.4. Fishes

The fish community was sampled with nighttime deployment of gill nets. The Donner Lake fish community historically consisted of 7 fish taxa and 4-5 nonnative, naturalized game fishes (**Figure 35**). The fishes come in all shapes and sizes with the predators dominated by nonnative, naturalized game fish (lake trout and brown trout). They can be found generally at 15-45 depth, but this might depend on the time of year and water temperatures (**Figure 36**). We did not catch native Lahontan cutthroat trout which have been extirpated from the Truckee watershed since the late 1930s. Likewise, we did not catch mountain whitefish in our netting despite that this species was found in Donner Lake, Fallen Leaf Lake, and Lake Tahoe in the early 2000s. Because introduced lake trout are highly predatory, lake trout may be controlling the whitefish populations in the lake. We also did not catch Paiute sculpin since the methods we use do not select for these fishes. However, Paiute sculpins were not observed in the stomachs of any lake trout nor any brown trout. These are highly efficient predators and may control the numbers of sculpins in the lake. Lake trout feed on other fishes, crayfish and, to a lesser extent, mysid shrimp. In contrast, kokanee salmon feed on native zooplankton and invasive mysids (**Figure 37**). As expected, brown trout are feeding on crayfish and other fishes. It is rare to have a fish monitoring program for the lakes in the region despite the importance of lake fish in influencing the ecology of lakes. Developing a program that incorporates fish collections and tries to understand the dynamics of Paiute sculpin and mountain whitefish could be important in untangling water quality dynamics over time.

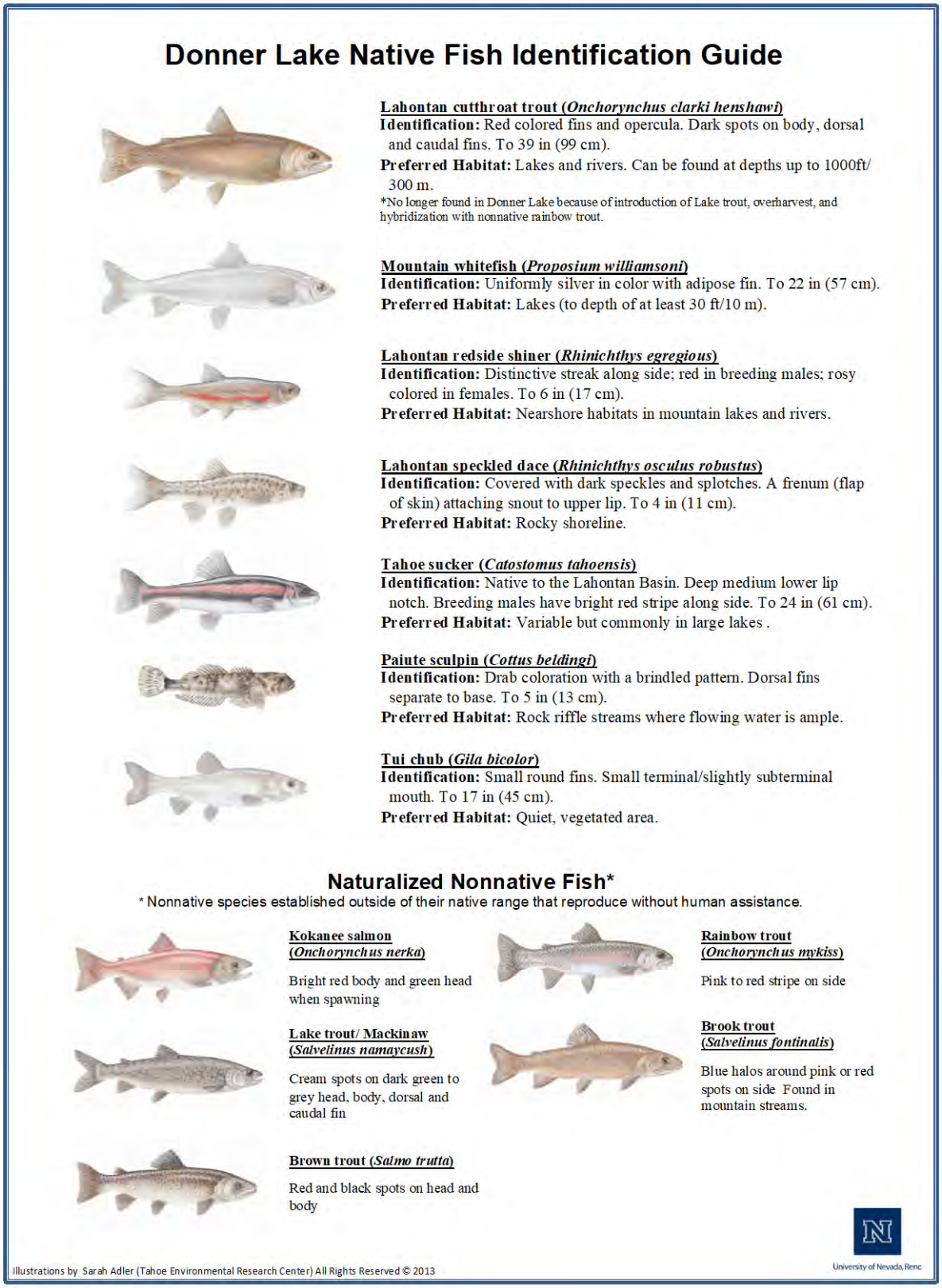


Figure 35. Donner Lake Fish Identification Guide. Source: Global Water Center, UNR.

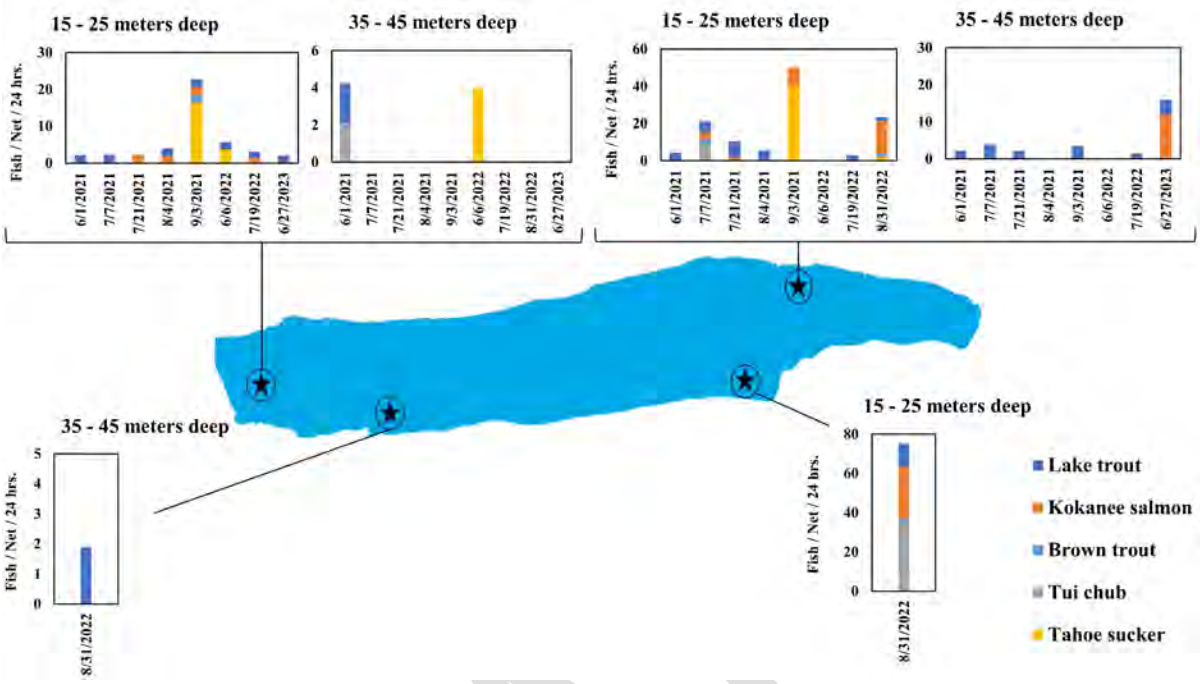


Figure 36. Fish catch at various locations and depths in Donner Lake, 2021 and 2022. Source: Global Water Center, UNR.

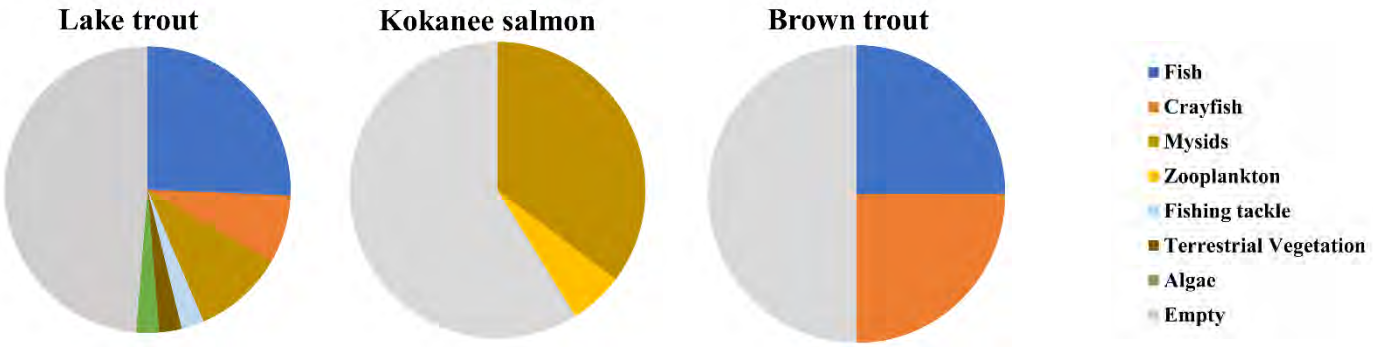


Figure 37. Stomach contents of lake trout, kokanee salmon, and brown trout at Donner Lake, 2021 and 2022. Source: Global Water Center, UNR.

6.6. Summary of findings

- ✓ The long-term record of the snow water content near Donner Pass indicates a highly variable snowpack across years. Years within the last decade have exhibited increasingly drought-like conditions. Owing to the high elevation of Donner Lake's upper watershed, it may be that the snowpack at these upper elevations is more stable compared to snowpack at lower elevations. Snowpack changes over time may be due to climate, but changes to the snowpack in mid-to-low elevations are likely to continue. Our study

captured snow years with both average and high snow water equivalent, giving us an opportunity to understand water quality conditions in the ice-free season.

- ✓ Air quality decreased with wildfire smoke in the basin. This seems to be consistent in the basin across the years. Air quality was reduced during the drought years of 2021 and 2022. We recommend continuing to monitor air quality to understand how air quality may influence surface light conditions and nutrient concentrations in the lake.

- ✓ Compared to historical conditions measured in the 1970s, Donner Lake's water high transparency in 2021 and 2022 may be reflective of water quality improvements. However, years with large snowpack exhibit reduced clarity. The lake's clarity, measured from spring to summer and across years, is connected to the regional climate and resulting snowpack which is highly variable. To understand and quantify water transparency and the lake's thermal structure, long-term focal studies are needed to document transparency across years and seasons. This would allow for developing a statistical trend rather than focusing on specific years and data points. This recommendation is similar to the approaches recommended for the Lake Tahoe monitoring program. While the Secchi disk is an easy tool for measuring water clarity, modern methods of measuring light wavelengths at depth are recommended. These include the measurement of photosynthetically active radiation (PAR) and ultraviolet light, which is sensitive to understanding connections related to organic matter in the water and fish health.

- ✓ The lake continues to exhibit the development of physical temperature structure common to the deep lakes in our region. The summer temperature of the mixed surface waters and deep water is connected to climate-driven snow water content. To some extent, the surface water may be connected to nighttime air temperatures, which have increased with climate change. To understand the influence of climate driven responses from changing snowpack and wildfire smoke in the airshed, water temperature profiles and the examination of physical structure should continue into the future.

- ✓ Nearshore and offshore monitoring of temperature and oxygen can indicate water quality conditions over time. Oxygen can be used to understand production zones at depth in the lake and along the nearshore. Oxygen and conditions in the nearshore can be more variable when air quality and light conditions are diminished in the airshed.

- ✓ Production in the nearshore zone is relatively consistent across years and can be determined using high-frequency measurements of oxygen, temperature, light, and weather data. Considering that transparent lakes are exhibiting a global decline in their nearshore water quality condition, we recommend continuing to measure nearshore water quality conditions. Additionally, measuring aspects of specific nearshore taxa (e.g., crayfish densities) that can influence nearshore water quality will be informative. Developing a comprehensive understanding of the invertebrate communities over time will require a significant financial investment since invertebrates are variable in space and time (within seasons and across years). We do not recommend embarking on this

monitoring but instead recommend using indirect measures for understanding water quality conditions like high-frequency probes and monitoring crayfish.

- ✓ Fishes in Donner Lake are like other lakes in the region, like Lake Tahoe and Fallen Leaf Lake, except for mountain whitefish and Paiute sculpin. We do recommend continued summer monitoring of fish populations over time to understand if there are changes in the lake food web that can influence lake water quality. Perhaps a focal study to locate mountain whitefish could be of interest.

7. Donner Lake Community Indicators and Trends

This section on Donner Lake Community Indicators and Trends provides an overview of the contemporary setting around Donner Lake. It explores various aspects such as recent development activity, recreational use, trash and waste management, transportation, and calls for service. The section aims to provide a better understanding of the community dynamic around Donner Lake and the trends that are shaping its development. By examining these indicators and trends, we can gain a better understanding of the influences on the health and dynamics of the Donner Lake community. The section also highlights the importance of monitoring peak periods of activity, the impact of recreational use on the lake and its infrastructure, and the need for stewardship and outreach efforts.

7.1. Recent Development Activity

As noted earlier, major development around Donner Lake began in the 1860's. Residential subdivisions began in the 1910s, with many lots built out by the 1960s. Nonetheless, some new single family home construction, redevelopment and additions continue at a moderate rate today. **Table 6** and **Figure 38** show Town of Truckee development permits at Donner Lake from 2018-2020 and 2021-2023, which mirror typical recent trends throughout Town. Deck-Dock-Patio Cover and Residential Additions or New Single-Family are the primary development activities. It is essential to monitor development trends around the lake because of concerns for additional land or water related impacts as noted earlier. It is worth noting that today's requirements for grading, drainage, impervious surface, erosion control and construction are considerably more stringent and protective than decades earlier, and so reconstruction, rebuilt driveways and access ways, decks and docks can (and do) improve conditions around the lake incrementally.

Table 6. Development permits issued within the Donner Lake study area by type 2018-2020 vs 2021-2023. Source: Town of Truckee as of 3/7/2024.

Type of Permit	2018-2020	2021-2023
Commercial – New/Remodel	2	2
Deck-Dock-Patio Cover	49	49
Demolition	17	7
Driveway	5	1
Grading	13	6
New Detached Structure	0	3
Residential Addition	21	18
Residential – New Other	4	0
New Single-Family Residence	26	15
Residential Dwelling Conversion	2	2
Total	**139**	**103**

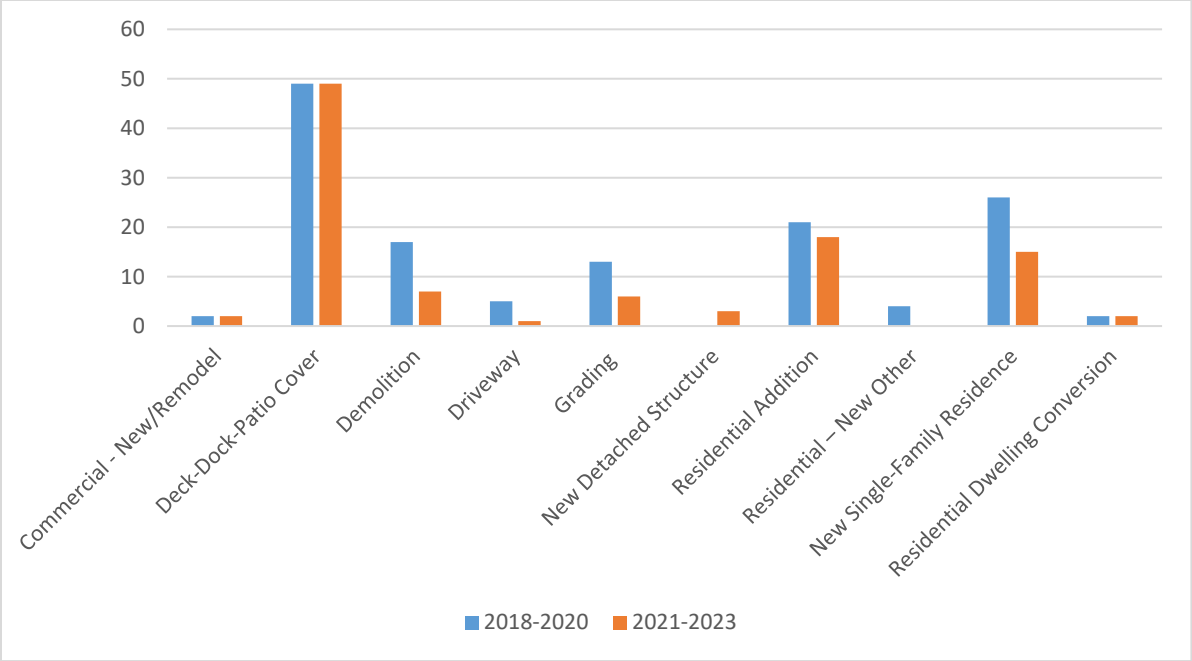


Figure 38. Development permits issued within the Donner Lake study area by type 2018-2020 vs 2021-2023.

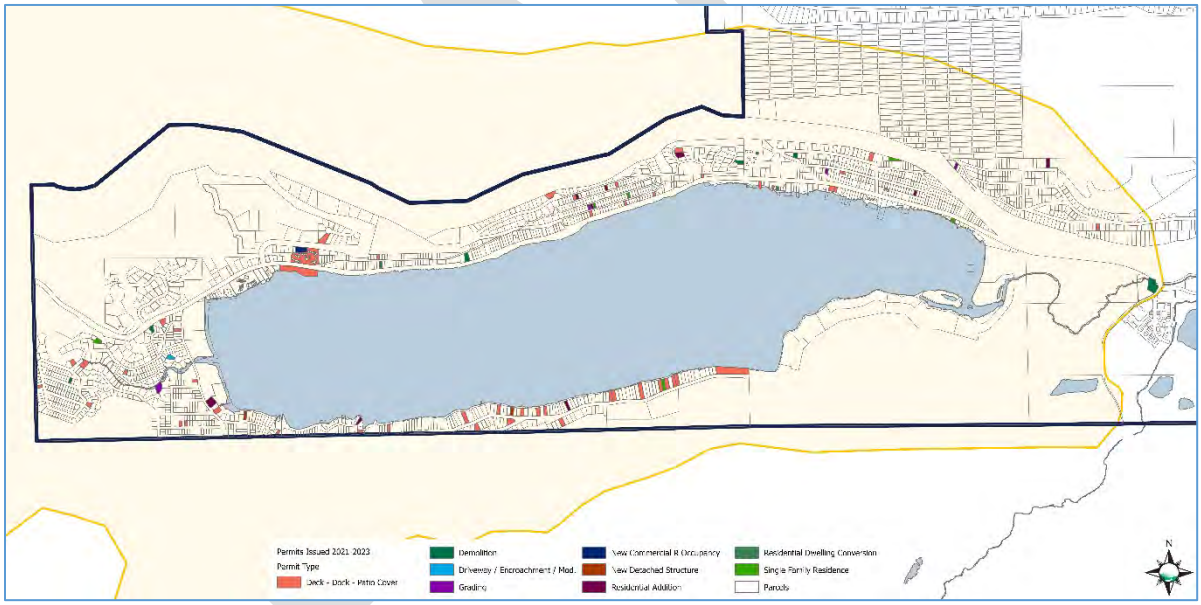


Figure 39. Map of development permits issued by type for 2021-2023.

7.2. Recreational Use

7.2.1. Paid Admissions and Major Events

Figure 40 and **Figure 41** provide insights into visitation patterns and trends at the lake. Although only focused on paid admissions and memberships at the State Park, West End Beach, and the Tahoe Donner marina, they do show the overall pattern of steep visitor peaks in the summer, particularly throughout July and early August. Declines in

August/September 2021 are likely due to the smoke and nearby wildfire conditions. Data also show a steady increase in paid visitation at the State Park 2018-2022, before decreasing in 2023. TDA began limiting admissions with a reservation system in 2022 as reflected in **Figure 41**. These recreational use numbers do not account for private homeowner visitation, visits to HOA facilities like the Donner Lake POA beach, or recreation users biking or hiking through, stopping at docks or pull outs, etc.

Table 7. Paid admissions by month between 2018-2023 for TDA, TDRPD, and State Parks**. Source: TDA, TDRPD, State Parks as of 2/28/2024.*

Month	2018	2019	2020	2021	2022	2023
May	12,782	11,446	16,170	33,181	21,448	10,391
June	54,975	56,923	54,399	101,611	56,308	44,599
July	112,724	106,045	109,673	144,961	102,137	126,621
August	72,207	88,835	101,915	60,675	82,239	81,032
September	33,842	37,358	48,316	21,342	40,534	31,446

** TDA limited admissions with a reservation system starting in 2022.*

*** State Parks user estimates based upon day use, overnight use, and annual passes. Does not include non-paying walk-ins which are estimated to make up a significant proportion of usership.*

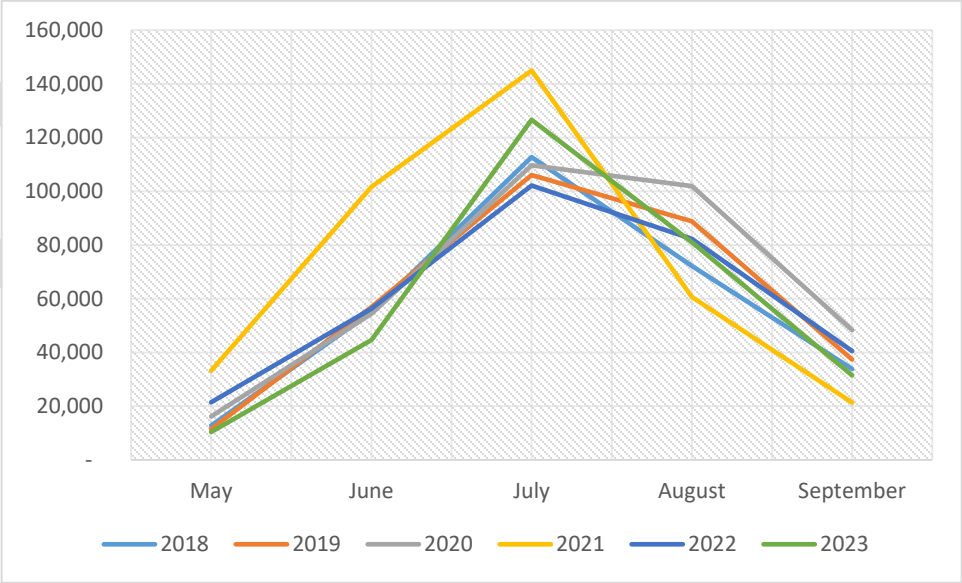


Figure 40. Paid admissions by month between 2018-2022 for Tahoe Donner Association, Truckee Donner Recreation and Parks District, and California State Parks.

Table 8. Padi admissions between 2018-2022 for TDA, TDRPD, and State Parks**. Source: TDA, TDRPD, State Parks as of 2/28/2024.*

Organization	2018	2019	2020	2021	2022	2023
TDA	41,852	36,614	42,586	39,930	35,374	33,459
TDRPD	54,648	55,451	55,776	51,368	14,510	38,367
State Parks	237,852	258,625	278,546	331,801	342,985	264,409
Total	**334,352**	**350,690**	**376,908**	**423,099**	**392,869**	**336,235**

** TDA limited admissions with a reservation system starting in 2022.*

*** State Parks user estimates based upon day use, overnight use, and annual passes. Does not include non-paying walk-ins which are estimated to make up a significant proportion of usership.*

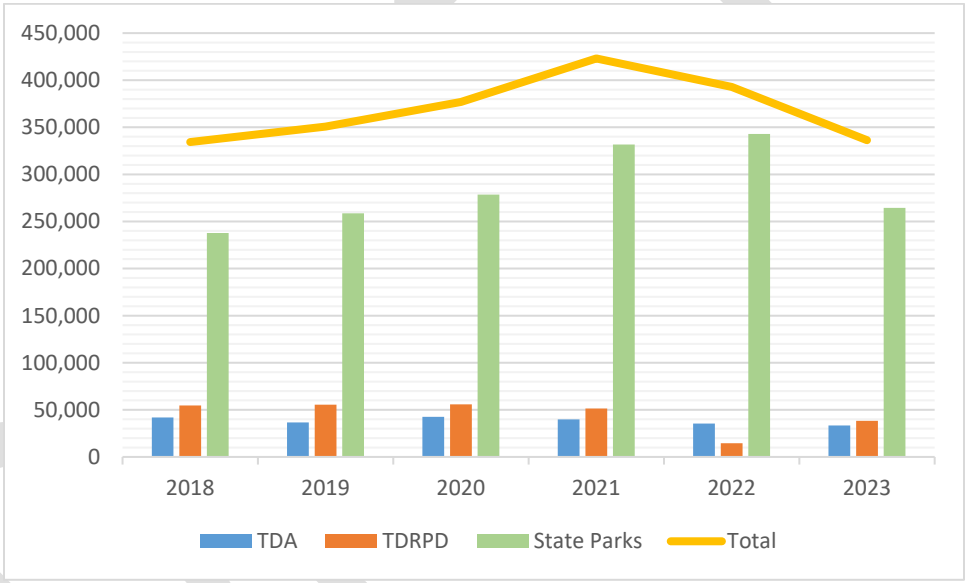


Figure 41. Paid admissions between 2018-2022 for Tahoe Donner Association, Truckee Donner Recreation and Parks District, and California State Parks.

Also telling in terms of facilities capacity and crowding are the handful of major events noted in **Table 9**. While we do not indicate total numbers, anecdotal estimates place events like July 4th far higher than any other specific day/time period.

Table 9. Large annual events in the Donner Lake study area. Source: Town of Truckee as of 3/7/2024.

Event	Organizer	Date	Location
July 4th Fireworks	Truckee Donner Rec and Park	July - 2018, 2019, 2022	West End Beach
Donner Lake Triathlon	Big Blue Adventure	July - 2018, 2019, 2021, 2022	Donner Lake
Donner Lake Open Swim	Sierra Nevada Masters	August - 2018, 2019, 2021, 2022	Donner Lake

7.2.2. Boat Launches, Watercraft Rentals and AIS Certification

Other recreational statistics that can offer insight into overall use at the lake are the number of boats launched at the Recreation and Park District's boat launch the trends on watercraft rentals at the Tahoe Donner marina and West End Beach. **Table 10** and **Figure 42** show a notable increase in boat launches during the first two years of the COVID pandemic before returning to pre-pandemic levels in 2022 and 2023. There are two privately owned boat launches owned by local homeowners' associations which are not accessible to the public. The figures below do not include private boat launches or rentals.

Table 10. Boat launches at TDRPD boat ramp and Aquatic Invasive Species Certificates by year. Source: TDRPD as of 2/28/2024 and Truckee Police Department, Truckee Regional Aquatic Invasive Species Prevention Program as of 3/7/2024.

	2018	2019	2020	2021	2022	2023
Drop in Launches	1,982	1,764	2,077	1,752	1,707	1,241
Pass Holder Launches	25	331	703	1,047	305	930
Commercial Boat Launches	0	5	8	0	29	36
Total Boat Ramp Launches	**2,007**	**2,100**	**2,788**	**2,799**	**2,041**	**2,207**
AIS Certificates	1,548	1,400	985	1,314	1,177	1,089

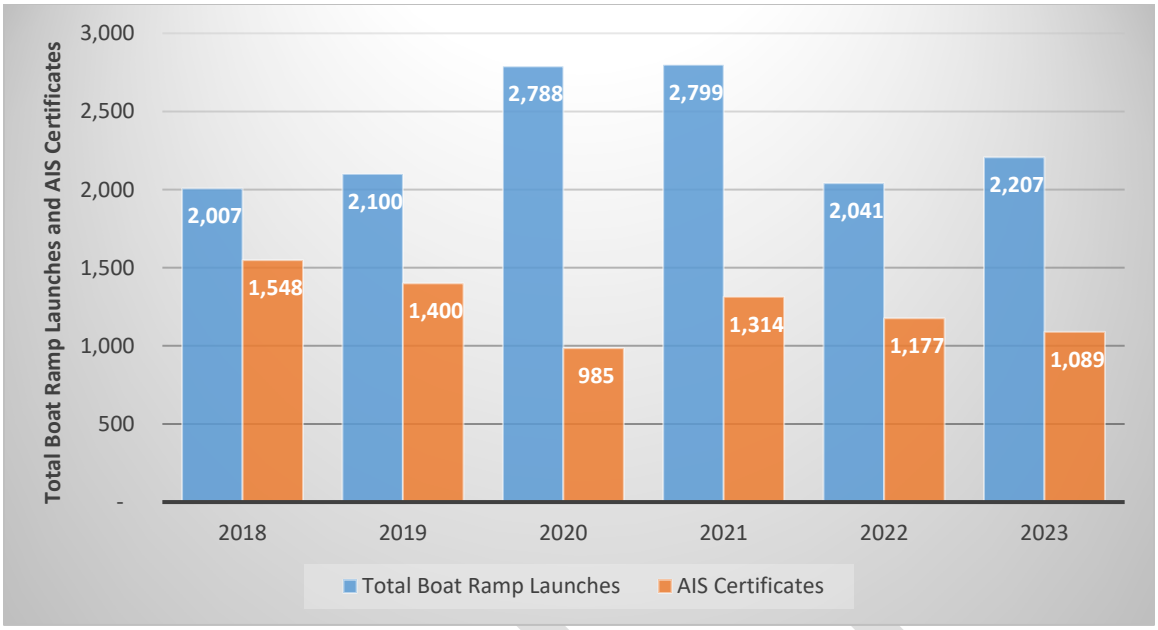


Figure 42. Boat launches at TDRPD boat ramp and Aquatic Invasive Species Certificates by year.

Included in **Table 10** and **Figure 42** are Aquatic Invasive Species Certificates issued by year. Prior to any motorized and/or trailered watercraft being launched into Donner Lake for the first time for the season, the owner or operator must submit a self-inspection form to the Town of Truckee and obtain an inspection sticker for the watercraft. Inspections are to help prevent the introduction of aquatic invasive species such as quagga mussels, Asian clam, and Eurasian watermilfoil which can degrade aquatic ecosystems, inhibit recreation, and damage infrastructure and equipment. TDRPD staff check for inspections stickers between May-September, however the Boat Ramp is unstaffed in the off season and not closed to the public. Any boat launch during this time requires self-registration and adherence to all inspection regulations. **Table 10** and **Figure 42** show that AIS inspections are not trending with boat launches.

Meanwhile, the declining number of boat rentals resulting from concession closures during COVID have been recovering in the past two years (**Table 11** and **Figure 43**). These are primarily for non-motorized watercraft rentals and do not include the private concessionaire at the Donner Lake Marina and Donner Memorial State Park who rents both motorized and non-motorized watercraft.

Table 11. Watercraft rentals by year. Source: TDRPD and TDA as of 2/28/2024.

Organization	2018	2019	2020	2021	2022	2023
TDA	5,784	4,833	1,821	3,218	2,889	2,849
TDRPD	2,408	2,143			1,512	1,594
Total	**8,192**	**7,026**	**1,821**	**3,218**	**4,401**	**4,443**

*TDRPD suspended boat rentals for 2020 and 2021.

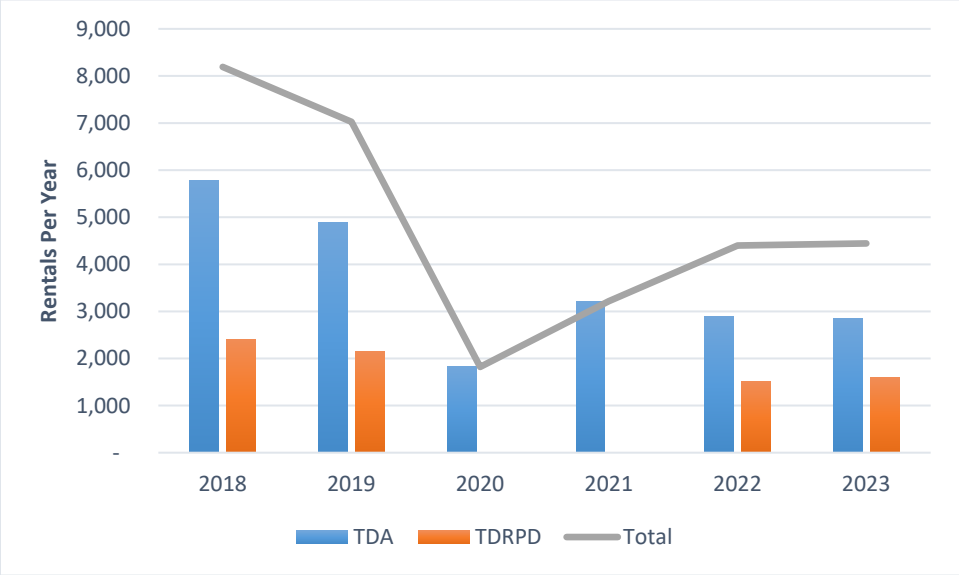


Figure 43. Watercraft rentals by year.

According to TDRPD, 84% of boaters at the lake are motorized and 16% are non-motorized. According to a 2018 California Boating Facility Needs Assessment, people use the following boat type while recreating at Donner Lake:

Table 12. Motorized vs Non-motorized boats in Donner Lake. Source: 2018 California Boating Facility Needs Assessment

Motorized		Non-Motorized	
75%	Powerboats	44%	Kayaks
10%	Inflatable boats with motor	39%	Stand up Paddleboards
10%	Bass Boats/John Boats		

7.3. Trash, recycling and waste

7.3.1. Sewage flows and services

Monitoring sewage flows offers unique insight into the total population in and around the lake at any given time. This is particularly useful data in terms of visitors and residents not accounted for in "paid recreational admissions" and for winter time visitation when paid admissions might not be tracked. The steep peaks during holiday weekends like Labor Day and July 4th in summer and President's Day and the Christmas/New Year's holiday time in winter are evident in **Figure 44** below. Flows can double or triple during these times. Also evident are decreased visitation during the fires of 2021.

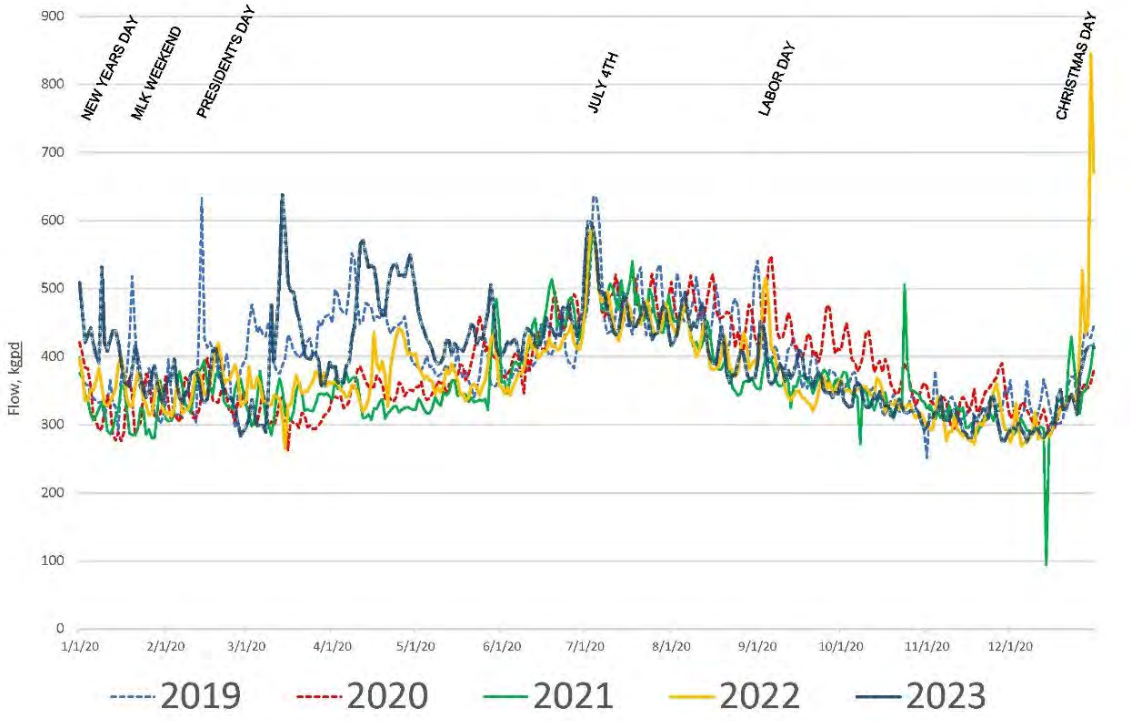


Figure 44. TSD daily sewage flows within the Donner Lake study area. Source: TSD as of 3/6/2024.

7.3.2. Trash and recycling collection

The local trash collection company is not able to disaggregate data for Donner Lake from other neighborhoods. But in 2023, we gathered data from State Parks and TDRPD (**Table 13** and **Figure 45**). Not surprisingly, trash and recycled materials collected rise and fall with recreational use peaks. Mirroring recreational paid admissions, trash collection peaks in July and August (although August is artificially high due to one extra collection period). However, this data does not account for overflowing dumpsters and trash cans. During the major weekend peaks and big events like July 4th, waste collection facilities are often overwhelmed. This is a concern not only for the lake's natural beauty and human enjoyment, but litter can also endanger the environment and wildlife.

Table 13. 2023 trash collection by month for State Parks and TDRPD in cubic yards. Source: TDRPD and CA State Parks as of 2/28/2024.

Month	State Parks (CY)	TDRPD West End Beach (CY)*	TDRPD Shoreline & Boat Ramp (CY)*
Jan-Apr	64	0	0
May	184	0	0
June	700	96	24
July	706	192	24
Aug	706	240	30
Sept	360	96	24
Oct	88	90	30
Nov-Dec	32	0	0
Total	**2,840**	**714**	**132**
Combined CSP/TDRPD Annual Trash (CY)			**7,372**

* TDRPD only collects June through October each year.

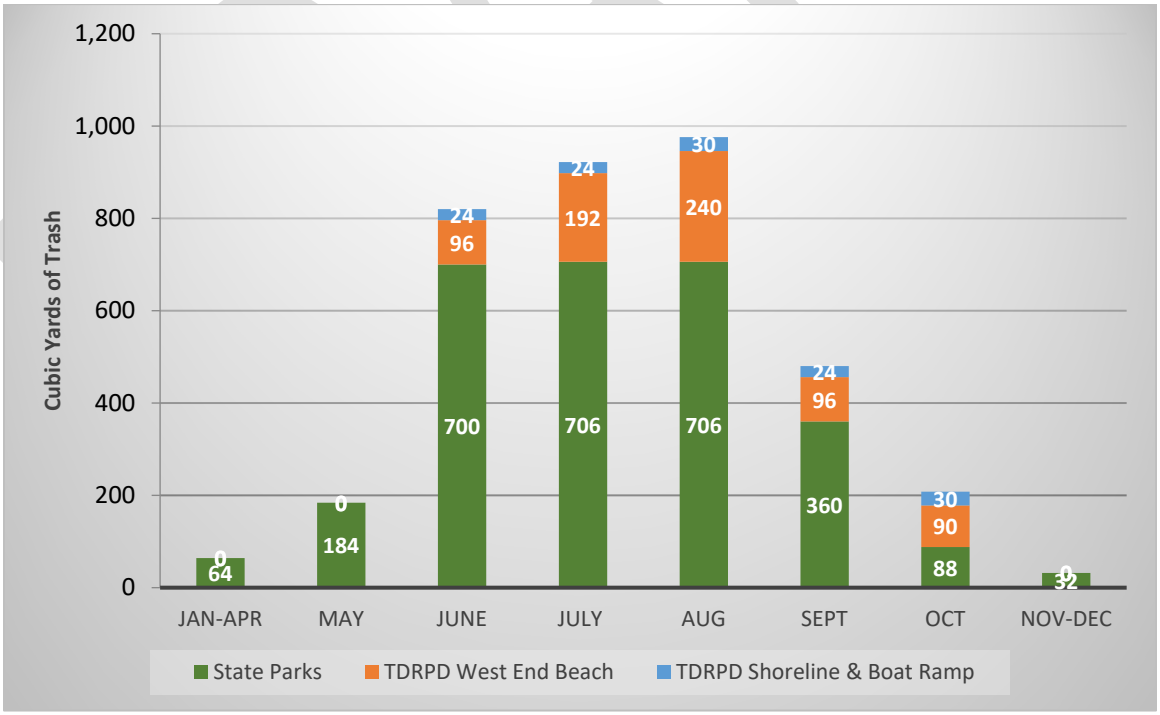


Figure 45. 2023 trash collection by month for State Parks and TDRPD in cubic meters.

7.3.3. Underwater trash

In 2020 Clean up the Lake, a non-profit working to combat litter above and below the water, completed an underwater circumnavigation of Donner Lake, removing over 5,151 pounds of accumulated trash from perimeter of the lake. In 2022, CUTL repeated the 6 miles of circumnavigation and 5 deep-water dives, surveyed invasive species and algal blooms along the shoreline, and identified survey transects at greater depths to determine litter accumulation rates at deeper zones. They collected 6,857 pounds of trash, primarily at the public boat launch and piers on the north shore. They also confirmed algal growth and invasive species at numerous locations. They plan to return to Donner Lake in 2024.

Table 14. 2022 underwater trash collection by material type. Source: Clean Up The Lake, Donner Lake Monitoring, FY22 Summary

Material Type	Total Weight (lbs)	Total Count (#)
Glass/Ceramic	3,426	1,622
Rubber	1,622	460
Metal	1,108	1,531
Wood	319	285
Plastic	206	2,410
Cloth	162	245
Paper/Cardboard	2	197
Foam Plastic	0.2	14
Other	11	112
Total	**6,857**	**6,876**

7.4. Transportation

Traffic and parking are consistent concerns at Donner Lake driven by concerns about safety, overcrowding, pollution, and excess erosion. Truckee Area Rapid Transit operates a single route to serve Donner Lake along Donner Pass Road from West End Beach to Donner Memorial State Park and points east (**Figure 46**). **Table 15** and **Figure 47** depict the ridership of public transit service at the lake. In 2022 in partnership with the Town of Truckee, TART began providing the new point to point, on-demand TART Connect Also in 2022, the Tahoe Donner Association began offering a shuttle service from the Truckee High School parking lot to the Beach Club Marina July-September. Other potential transportation initiatives include launching an e-bike share for the east end of Donner Lake and a shuttle for the 4th of July. Since 2020, ridership has been increasing consistently.

Figure 46. Map of public bus route with points indicating bus stops. Source: Town of Truckee as of 3/3/2022.

Table 15. Transit riders within the Donner Lake study area by year (July-June). Source: Town of Truckee and TDA as of 3/7/2024.

Year (June-July)	TART Onboard	TART Offboard	TART Connect*	TDA Shuttle**
2018-2019	2,499	2,221		
2019-2020	1,772	1,677		
2020-2021	1,307	2,478		
2021-2022	3,020	2,740		
2022-2023	5,895	4,454	1,642	
2023-2024				3,413

* TART Connect is based on Donner Lake Percentage of total TART Connect Ridership. No specifics on on/off board locations.
**TDA Shuttle rides are for July-September 2023.

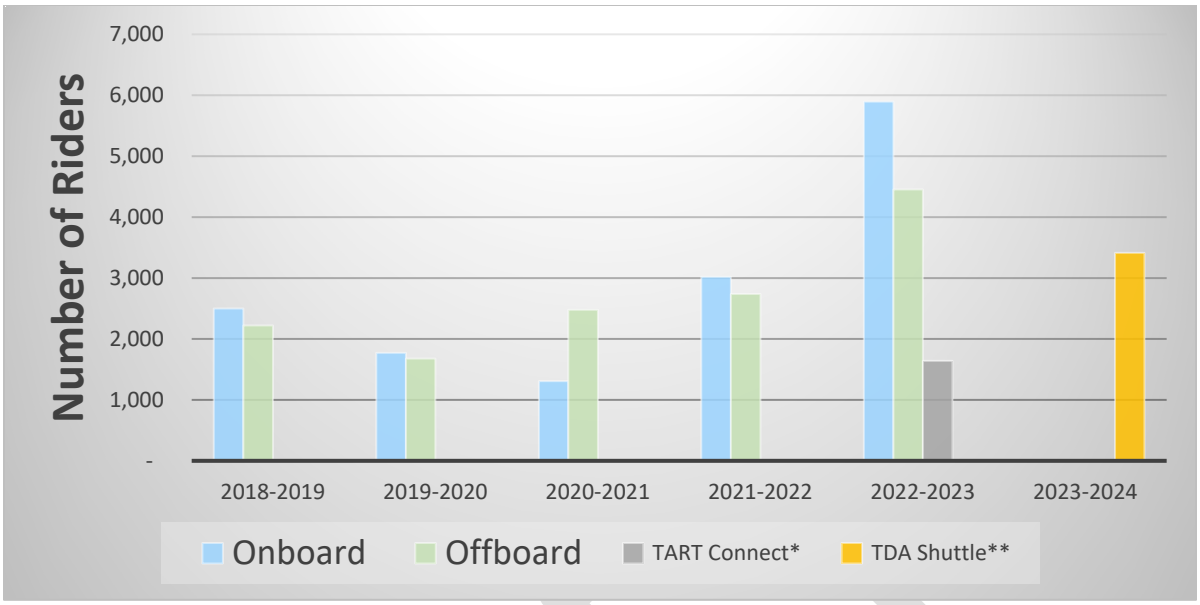


Figure 47. Transit riders within the Donner Lake study area by year (July-June).

7.5. Calls for Service

Calls for service refer to the requests made to the Truckee police department by members of the public for assistance with various issues or emergencies. At Donner Lake, they can be a proxy for how the local population is feeling about issues of overcrowding and use. Overall, the total number of calls, calls about parking and calls about noise have decreased over the past several years. However, calls about boating have increased since 2021. (**Table 16** and **Figure 48**)

Table 16. Calls for Service from Donner Lake area to Truckee Police Department by year and reason for call.

Reason for Call	2018	2019	2020	2021	2022	2023
Boat	41	60	36	34	46	64
Parking	76	57	60	80	50	28
Noise	51	59	53	58	8	3
Total	**168**	**176**	**149**	**172**	**104**	**95**

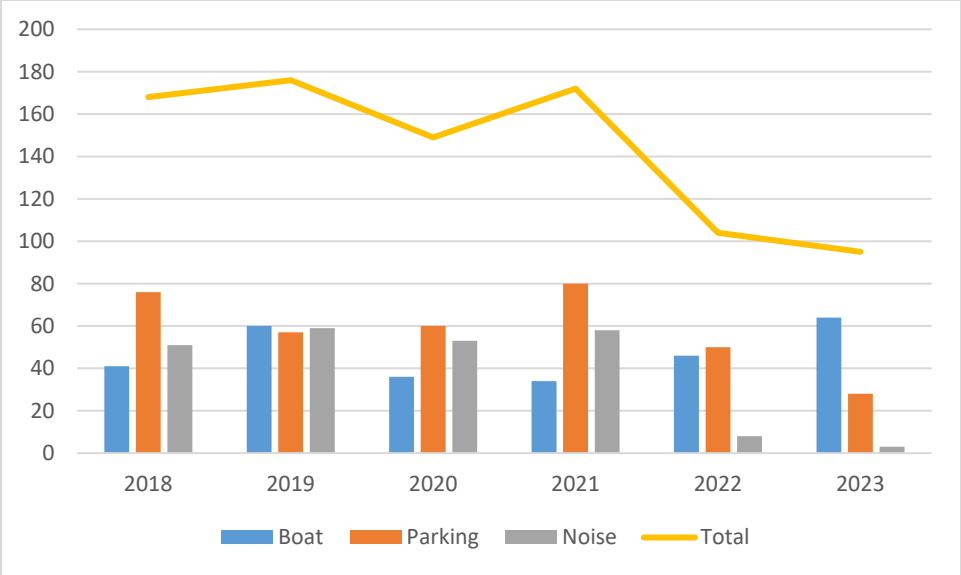


Figure 48. Calls for Service from Donner Lake area to Truckee Police Department by year and reason for call.

7.6. Summary of findings

With only a few years of data, including the atypical pandemic years, definitive trends and conclusions about the Donner Lake community indicators may be premature. But, several important generalizations merit continuing monitoring and consideration:

- ✓ It's all about peak times. Whether it is recreational crowds at beaches and boat launch facilities, trash, sewage flows, traffic, noise or waste products added to the lake, multiple indicators point to peak summer weekends, major event days and peak winter weekends as posing immediate threats to the lake and potentially stressing infrastructure capacities.

- ✓ Land use and development changes are very limited in the basin focused on repairs, additions, auxiliary structures like docks and decks, and a few major redeveloped residential properties or new construction. But, when projects are undertaken, new requirements and technologies offer opportunities to redress past storm drainage problems and erosion issues, provide revegetation opportunities, reduce impervious surfaces and take related actions that benefit the lake.

- ✓ The Donner Lake basin is far from a "pristine natural mountain lake," with significant historical impacts, economic activities, and past and current infrastructure of all types (e.g. transportation, recreation, commercial, utilities, etc.). Yet, despite the potential impacts, there are stewardship opportunities through investment improved infrastructure and maintenance, restoration and management.

- ✓ Recreational use is significant for a variety of activities, but is highly focused at peak time periods (mid-summer weekends, holidays) and locations (e.g. docks, launches,

beaches, developed parks, accessible shoreline areas). Monitoring peak activity and specific places is of utmost interest.

- ✓ Managing the nearshore environment is essential, especially near popular recreational locations. Whether it is underwater trash, water quality impacts, or invasive species, the nearshore zones adjacent to West End beach, the boat launch area, State Park beaches, public piers and elsewhere show the most obvious impacts and opportunities for restoration or facility improvement.

8. Conclusions and Looking Toward the Future

Based on the data and findings presented in this report, several key conclusions can be drawn regarding the health and trends in Donner Lake.

1. Climate and Snowpack: The long-term record of snow water content near Donner Pass indicates a highly variable snowpack across years. While the snowpack at higher elevations in the watershed shows no major long-term decline, recent decades have seen below-average cumulative snowpack, indicating potential drier conditions and more precipitation as rain not snow compared to previous decades. This trend may have implications for the water level, thermal structure, and nutrient loading of the lake.

2. Air Quality and Wildfire Smoke: Air quality in the Donner Lake area is influenced by regional wildfires, which can impact the thermal structure of the lake. Measurements of air particulates show a decline in air quality during the summer months, particularly in years with lower snowpack. Continued monitoring of air quality is recommended to understand its influence on surface light conditions and nutrient concentrations in the lake.

3. Physical Conditions: Water temperature governs the ecology of Donner Lake, including plant and animal production, nutrient state, and gas content. Long-term monitoring of temperature profiles is important for understanding the connections between climate and lake conditions.

4. Water Transparency and Light Conditions: Clarity and light transmission in Donner Lake are highly variable and influenced by factors such as snowpack runoff, nutrient and sediment runoff, and wildfire smoke. Long-term monitoring using more precise light instrumentation is recommended to provide a robust understanding of water quality conditions over time.

5. Chemical Conditions: Dissolved oxygen plays a crucial role in the survival of fish and invertebrates and controls chemical reactions within the water. Oxygen profiles show strong seasonal dynamics, with highest concentrations in the surface mixed layers during spring runoff. Nutrient concentrations vary with depth and are influenced by snowmelt, deposition from ash and smoke particles, and oxygen profiles. Continued monitoring of nutrient concentrations using depth profiles is recommended for a more informative understanding of water quality.

6. Ecosystem Production and Biology: Measurements of algae and bacteria production serve as indicators of water quality. Algal biomass increases during the summer, while open-water productivity has decreased in recent years. Zooplankton and invertebrates play important roles in the food web and nutrient cycling. Native and non-native species have been identified in Donner Lake, with densities varying seasonally and inter-annually. Fish populations consist of both native and non-native species, with non-native game fish dominating the predator role. Continued monitoring of fish populations is recommended to understand changes in the lake's food web and water quality

dynamics.

7. Development and Use: Development activity around Donner Lake has been ongoing since the 1860s, but has been relatively stable in recent years, with some new construction and redevelopment occurring.

8. Recreational use at Donner Lake is significant, with peak visitation occurring during the summer months. Overall, the data suggests that there is a need for continued monitoring and management of development and use around Donner Lake to ensure the preservation of its character and the sustainability of its resources.

9. Managing the nearshore environment is essential, especially near popular recreational locations. Whether it is underwater trash, water quality impacts, or invasive species, the nearshore zones adjacent to West End beach, the boat launch area, State Park beaches, public piers and elsewhere show the most obvious impacts and opportunities for restoration or facility improvement.

In conclusion, the findings from this study provide valuable insights into ecological and community trends in Donner Lake and its surrounding basin. These are baseline studies of ecological and community/socio-economic indicators for the lake and should continue into 2024 and beyond. Continued monitoring and long-term studies are crucial for understanding the complex interactions between climate, water quality, and ecosystem dynamics in the lake. This knowledge will be essential for effective management and conservation efforts to ensure the long-term health and sustainability of Donner Lake and its surrounding watershed.

It is recommended to increase funding for Donner Lake to support research efforts, conservation projects, and infrastructure improvements. Enhancing data collection and monitoring efforts will provide valuable information for decision-making and future planning. In particular, it is recommended to continue monitoring snowpack, air quality, water transparency, temperature profiles, water quality, fish populations, and invertebrate communities to better understand the lake's ecosystem and water quality. Monitoring development trends, addressing peak period recreational user issues, monitoring waste management infrastructure, and enhancing transportation options are also recommended. Developing strategies to address climate change impacts, preserving cultural and historic resources, maintaining sustainable land use planning, and improving storm water management are also recommended. Fostering collaboration among stakeholders through the Donner Lake Interagency Partnership for Stewardship (DIPS) is important for effective management.

Appendix A: List of Acronyms and Abbreviations

Caltrans	California Department of Transportation
State Parks	California Department of Parks and Recreation, Sierra District, Donner Memorial State Park
DIPS	Donner Lake Interagency Partnership for Stewardship
HOA	Homeowners Association
TART	Tahoe Area Rapid Transit
TDA	Tahoe Donner Association
TDLT	Truckee Donner Land Trust
TDRPD	Truckee Donner Recreation and Park District
TMWA	Truckee Meadows Water Authority
Town	Town of Truckee
Truckee PD	Truckee Police Department
TRWC	Truckee River Watershed Council
TSD	Truckee Sanitary District
TTF	Truckee Trails Foundation
TTSD	Tahoe Truckee Sierra Disposal
UPR	Union Pacific Railroad
USFS	U.S. Forest Service
VTT	Visit Truckee Tahoe

Appendix B: Zoning Codes

Zoning Type	Town of Truckee	Acreage	Nevada County	Acreage	Placer County	Acreage
Commercial	CG (General Commercial)	19.2				
	CH (Highway Commercial)	4.06				
	CN (Neighborhood Commercial)	9.84				
Forest	RC (Resource Conservation)	44.02	FR (Forest)	722	FOR (Forest)	623.36
			TPZ (Timberland Production Zone)	168	TPZ (Timberland Production Zone)	222
Other	MUC	0.23	AG (General Agriculture)	122		
			IDR (Interim Development Reserve)	472		
Recreation	PF (Public Facilities)	435.62				
	OS (Open Space)	28.59				
	REC	16.61				
Residential	RS (Single Family Residential)	606.5			RF	69.09
	RR (Rural Residential)	289.03			RS	75.79
	RM (Multi-Family Residential)	6.67				
Lake		834.4				

Appendix C: 2022 Stewardship Plan

Please visit the TRWC library at https://www.truckeeriverwc.org/library/ or go directly to the Donner Lake Interagency Partnership for Stewardship (DIPS) – 2022 Stewardship Plan.

Appendix D: Donner Basin Assessment

Please visit the TRWC library at https://www.truckeeriverwc.org/library/ or go directly to the Donner Basin Assessment Final Report.