Summary Report: 2022 and 2023 Lake Tahoe Nearshore Documentation Project

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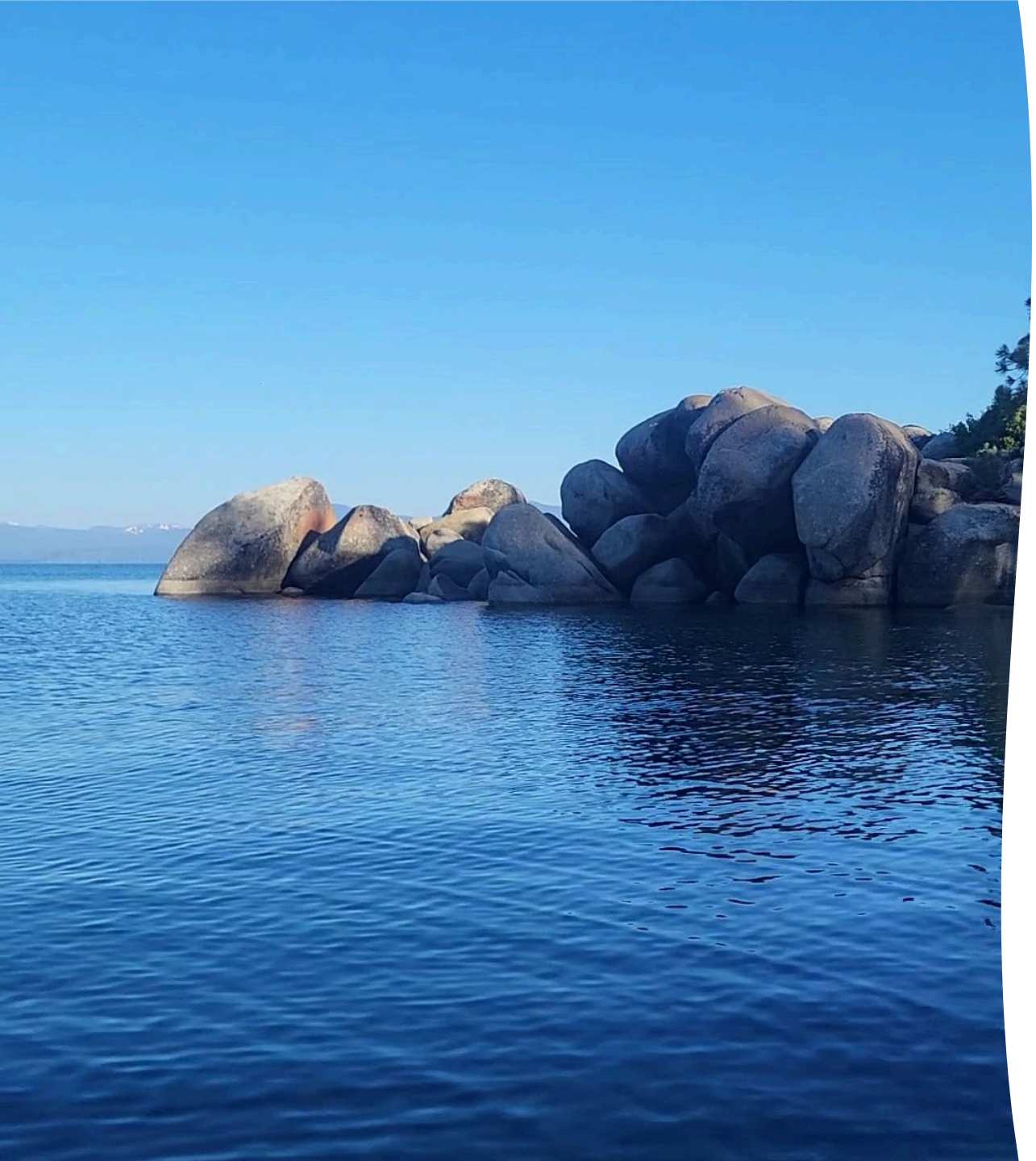
At a Glance: Executive Data Summary

Parameter	2022	2023
Survey Period	Jul 26th - Aug 2nd	Jul 25th - Aug 1st
Miles Surveyed	88 miles	102 miles
Surface and Sub-surface Images	31,262	31,304
Mean Lake Surface Elevation	6,224.3	6,228.1
WQ Measurements Taken	156,310	156,520
Turbidity Mean	0.764 FNU	0.574 FNU
Disolved Oxygen Mean	6.762 mg/L	7.350 mg/L
Temperature Mean	16.168°C	16.173°C
Total Wildlife Observations	641	*10,622

*Includes 8000 unidentified fry



Introduction and Purpose

The EarthViews Conservation Society, in partnership with the Tahoe Fund, undertook a two-year nearshore image mapping project to monitor and analyze the ecological dynamics of the nearshore of Lake Tahoe. The aim was to observe changes in the nearshore region, particularly in light of the dramatic lake surface elevation increase resulting from record snowfall and subsequent melt in 2023.

Methods

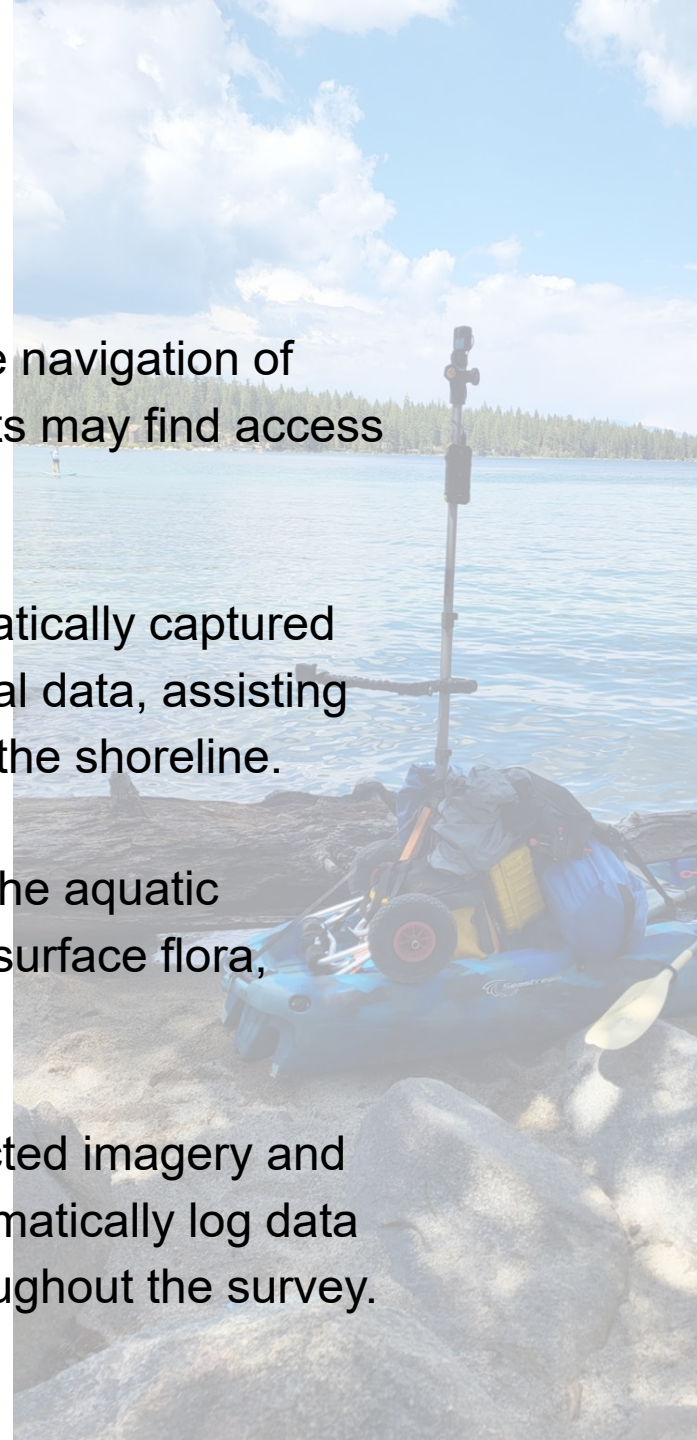
Imagery Collection

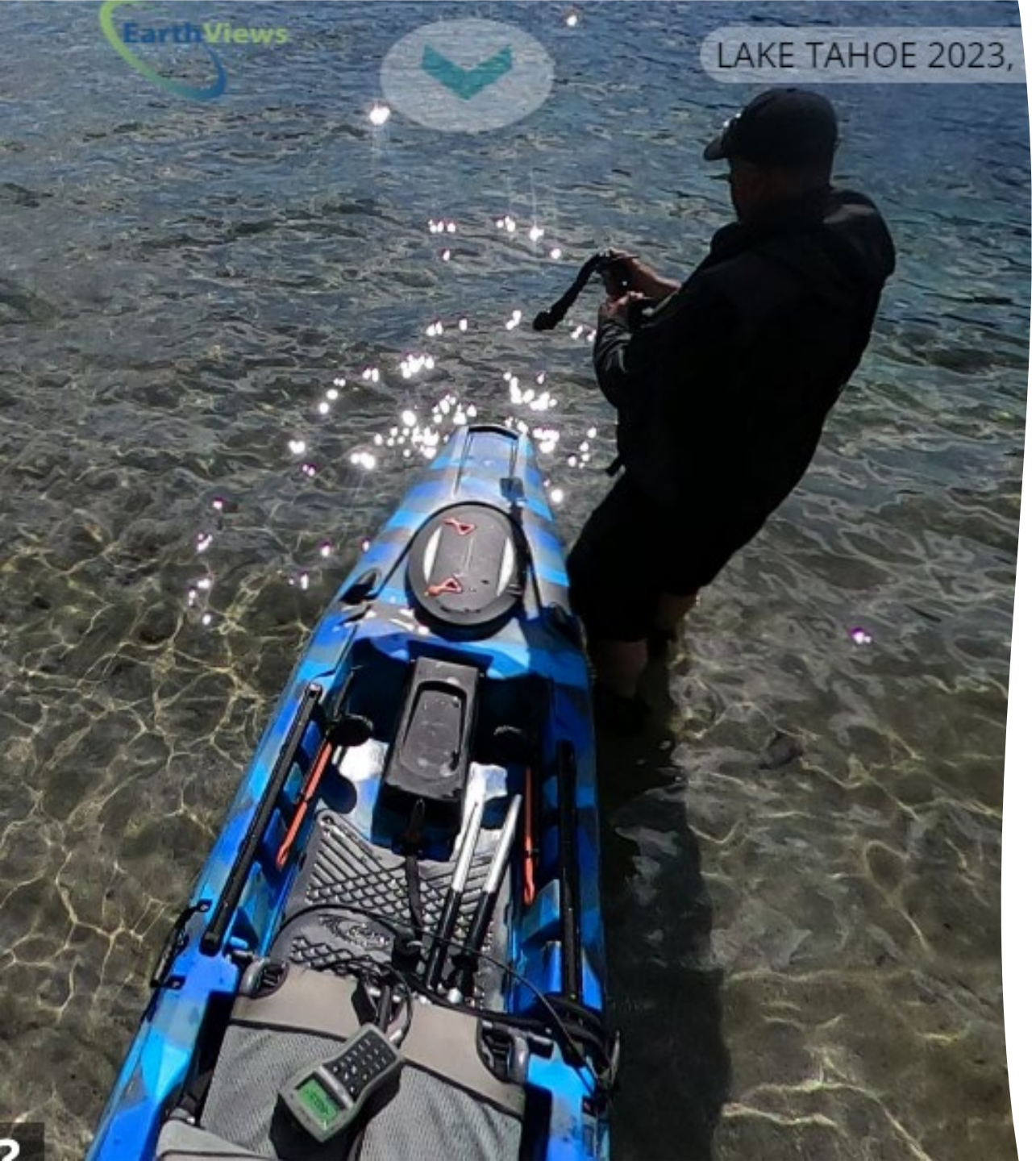
Data Collection Platform: A specially-equipped kayak was deployed to enable close navigation of Lake Tahoe's nearshore areas, particularly focusing on regions where traditional boats may find access challenging due to depth or bathymetry.

Above-water Imagery: Utilizing state-of-the-art high-resolution cameras, we systematically captured panoramic (360-degree) imagery of the shoreline. This provided comprehensive visual data, assisting in understanding the landscape, flora, fauna, and any human-made structures along the shoreline.

Subsurface Imaging: Dedicated underwater cameras were employed to document the aquatic conditions beneath the water surface. This effort was vital to get insights into the subsurface flora, fauna, and the overall health of the lake's nearshore ecosystem.

Synchronization and Data Logging: To ensure precision in data mapping, all collected imagery and measurements were synchronized with GPS waypoints. This system was set to automatically log data points at 10-second intervals, ensuring consistent and accurate geo-referencing throughout the survey.





Water Quality Assessment

As an integral part of this survey, water quality metrics were measured in tandem with imagery collection. Employing advanced sensors and testing tools, we gathered real-time data on various parameters essential to understand Lake Tahoe's health. This encompassed metrics like turbidity, temperature, and dissolved oxygen levels, among others.

Data Integration

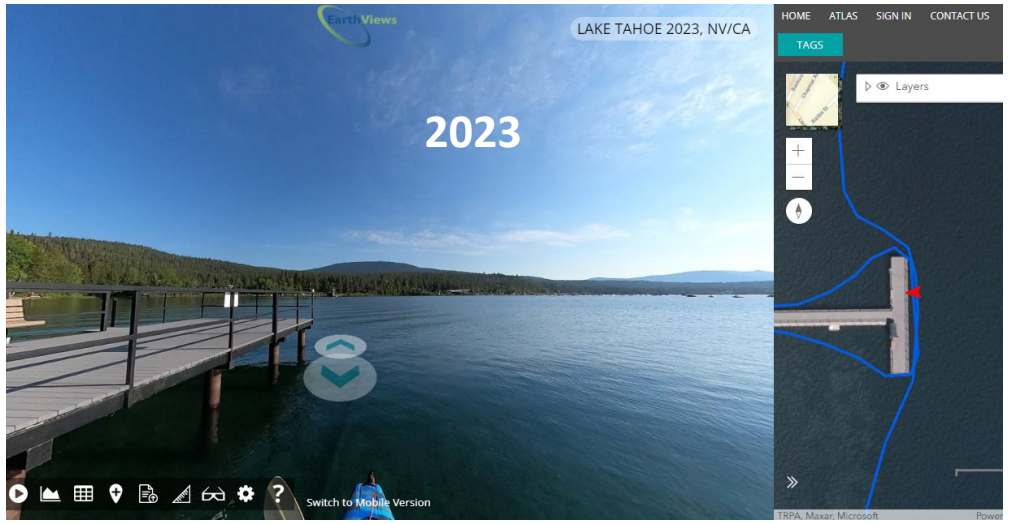
Following the field collection, all gathered data underwent a meticulous integration process to create an immersive mapping platform that provided visual context for the data.The GPS-referenced imagery and water quality measurements were compiled into a unified database to make the information available online.

Link to ShoreView map location above - https://arcgis.earthviews.com/public/lake-tahoe-0723#8514

Results

Image Mapping (ShoreView Map): As shown above an immersive map was created from surveys conducted in 2022 and 2023 using over 15,000 above water 360-degree panoramic images and 15,000 below water sub-surface images collected during each year. Water quality measurements were taken in concert with the images. Geolocated animal counts were also added as a layer on the map. As shown above the map provides access to all the data and imagery.

Survey Period: We circumnavigated the Lake scanning the nearshore and collecting data during late June and early July 2022 and 2023. Surveys were conducted from June 26th to July 2nd during 2022 and June 25th to July 1st during 2023. The weather conditions were fair during both years although wind conditions were higher during 2022. Cloud cover and thunderstorms occurred towards the late afternoon of June 27th during 2023. However no measurable precipitation occurred. Overall survey conditions were similar during both years.



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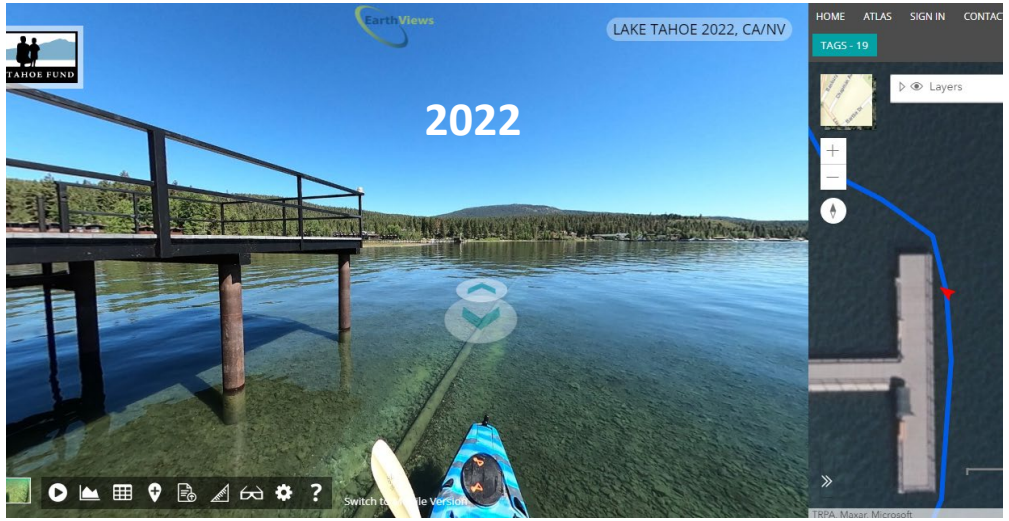
Lake Surface Elevation:

In 2022, Lake Tahoe experienced its third consecutive year of drought, as documented by the UC Davis State of the Lake Report. However, 2023 marked a shift in this trend. The basin recorded unprecedented snowpack levels during the winter, leading to a significant runoff. By the time of our 2023 survey, this had resulted in a rise in the lake's surface elevation by nearly four feet compared to the previous year.



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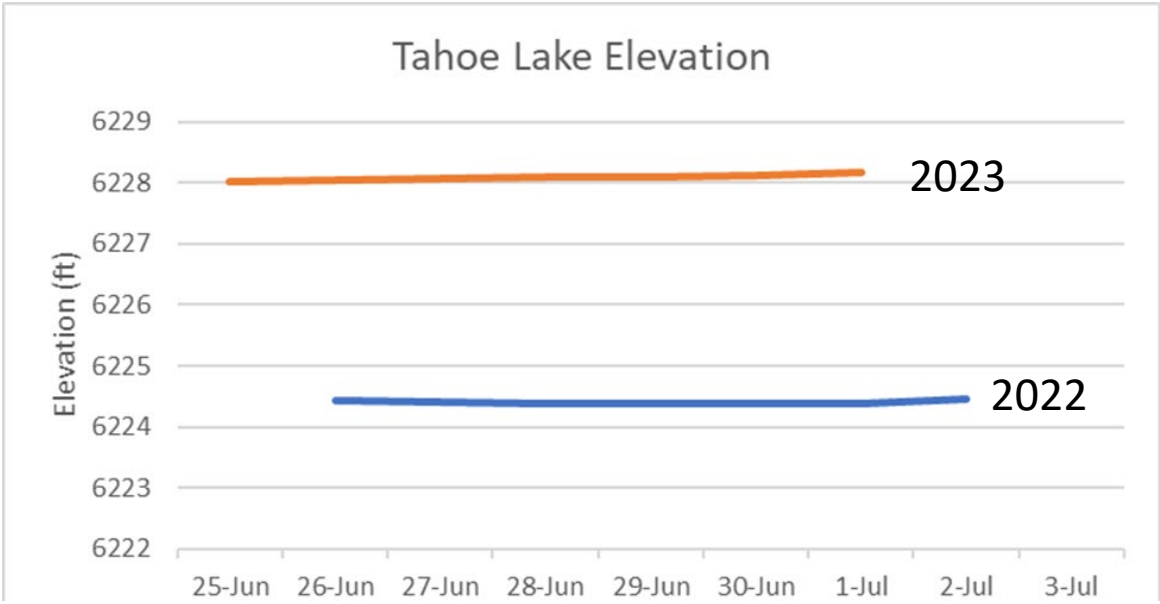

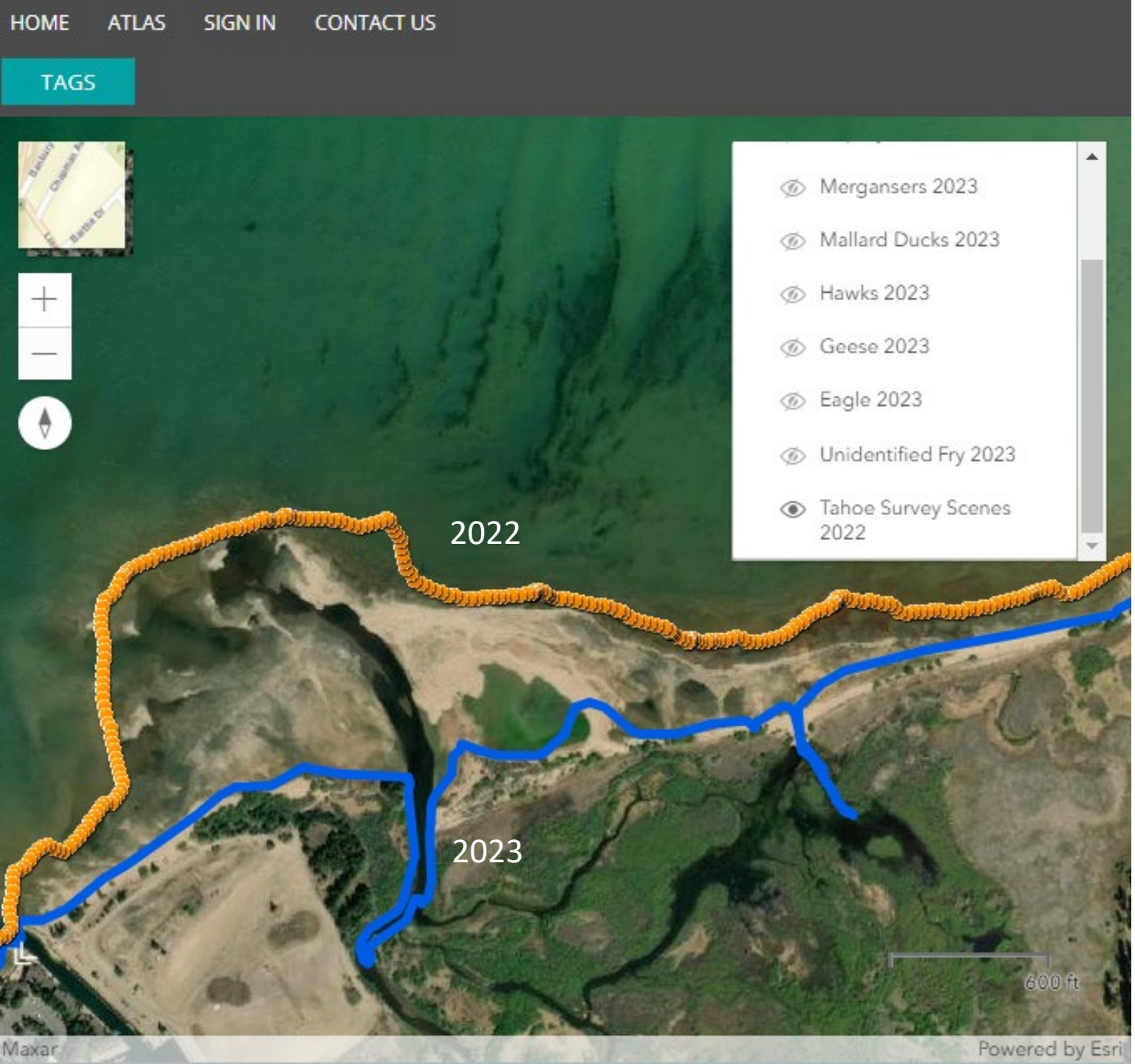

Survey Track: Eighty-eight miles of nearshore were surveyed during 2022 as compared to 102 miles during 2023. This difference is likely due to the change in shoreline access as a result of the higher lake elevation 2023. Higher lake surface elevation increased lake area as well as habitat availability providing access to previously unavailable shoreline structure, streams and coves. Areas of the lake previously unavailable because of shallow water were able to be accessed during 2023.

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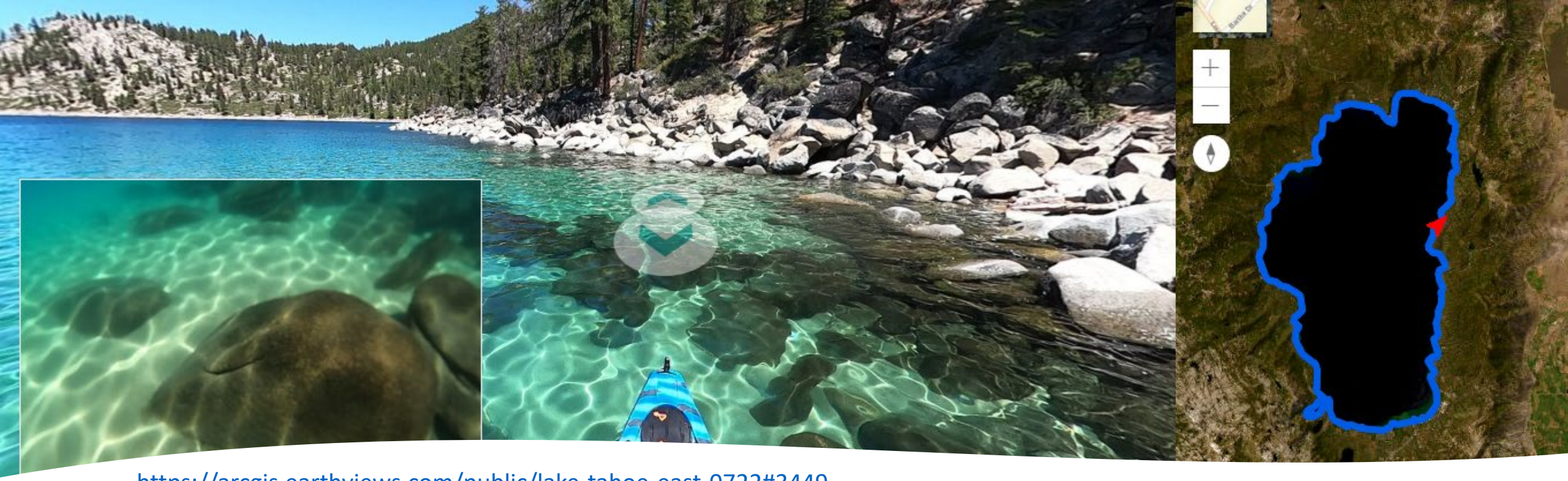

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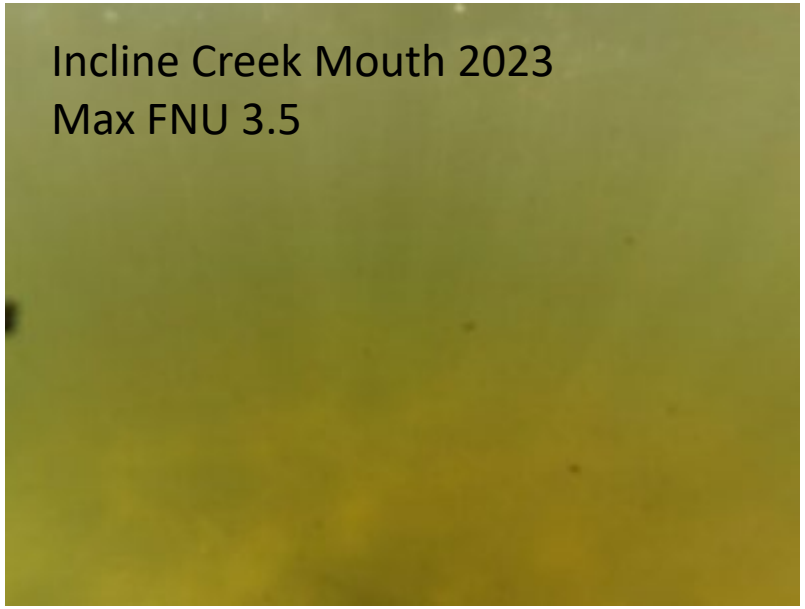
Water Quality

While the survey encompassed several parameters, including conductivity and total dissolved solids, this report specifically focuses on three pivotal water quality parameters: turbidity, temperature, and dissolved oxygen.

Lake Clarity (Turbidity): Lake clarity assessment in the nearshore environment is different from that of more traditional pelagic surveys conducted on Lake Tahoe. Whereas a secchi disc is used to assess lake clarity in the deep pelagic areas of the lake and a long historical record exists of these measurements for Lake Tahoe. Nearshore areas are too shallow for secchi depth measurement so refracted light measurements called FNU's are collected from a water quality meter. Although spot surveys have been conducted in the nearshore that have measured light refraction turbidity in shallow areas of the Lake over the years, there has not been a year-on-year lakeside comprehensive linear survey of the type conducted during surveys conducted in 2022 and 2023 before.



From the turbidity data presented:

There's a reduction in mean turbidity from 2022 to 2023, with values decreasing from 0.764 FNU to 0.574 FNU. The maximum turbidity value in 2022 was notably high at 27.8 FNU, compared to a much lower 3.5 FNU in 2023. The standard deviation, a measure of data variability, was significantly higher in 2022 (2.1253 FNU) compared to 2023 (0.3176 FNU), indicating more variability in turbidity values in 2022.

Is there a significant difference between the two years? Yes, there is a significant difference in turbidity between the two years. The mean turbidity decreased from 2022 to 2023, in other words water clarity increased. Additionally, the maximum turbidity and the variability of measurements (as indicated by the standard deviation) were much higher in 2022 compared to 2023. This suggests not only a general reduction in turbidity in 2023 but also a more consistent set of turbidity readings that year.

Parameter	2022	2023
Total observations	14,865	14,175
Mean turbidity	0.764 FNU	0.574 FNU
Median turbidity	0.300 FNU	0.500 FNU
Range	0 to 27.800 FNU	0 to 3.500 FNU
Standard Error	0.017 FNU	0.003 FNU
Standard Deviation	2.125 FNU	0.318 FNU

From the temperature data presented:

The nearshore temperatures of Lake Tahoe showed only slight variations between 2022 and 2023. In 2023, there was a marginal increase in both the mean and median temperatures compared to 2022. The temperature range in 2023 was also narrower, indicating fewer extreme temperatures than in 2022. The reduced standard deviation and standard error in 2023 suggest a more consistent temperature profile for that year relative to 2022.

Parameter	2022	2023
Total observations	15,502	14,994
Mean temperature	16.168°C	16.173°C
Median temperature	16.150°C	16.180°C
Range	7.770°C to 24.880°C	7.210°C to 20.280°C
Standard Error	0.146°C	0.013°C
Standard Deviation	1.824°C	1.600°C

https://arcgis.earthviews.com/public/lake-tahoe-east-0722#8021

From the Dissolved Oxygen data presented:

Dissolved Oxygen (DO) levels in Lake Tahoe's nearshore saw an increase from 2022 to 2023. The 2023 data recorded both a higher mean and median DO compared to 2022. Moreover, 2023 showcased a broader range in DO values, which is evident from its higher maximum value and slightly increased minimum value when compared to 2022. The higher standard deviation in 2023 also indicates a wider spread of DO values around the mean. The increased DO in 2023 could have potential ecological implications, supporting a more oxygen-rich environment for aquatic life in Lake Tahoe's nearshore regions.

Parameter	2022	2023
Total observations	15,513	14,986
Mean DO	6.762 mg/L	7.350 mg/L
Median DO	6.730 mg/L	7.210 mg/L
Range	4.76.0 mg/L to 9.980 mg/L	5.100 mg/L to 11.530 mg/L
Standard Error	0.005 mg/L	0.007 mg/L
Standard Deviation	0.658 mg/L	0.812 mg/L

Animal Counts

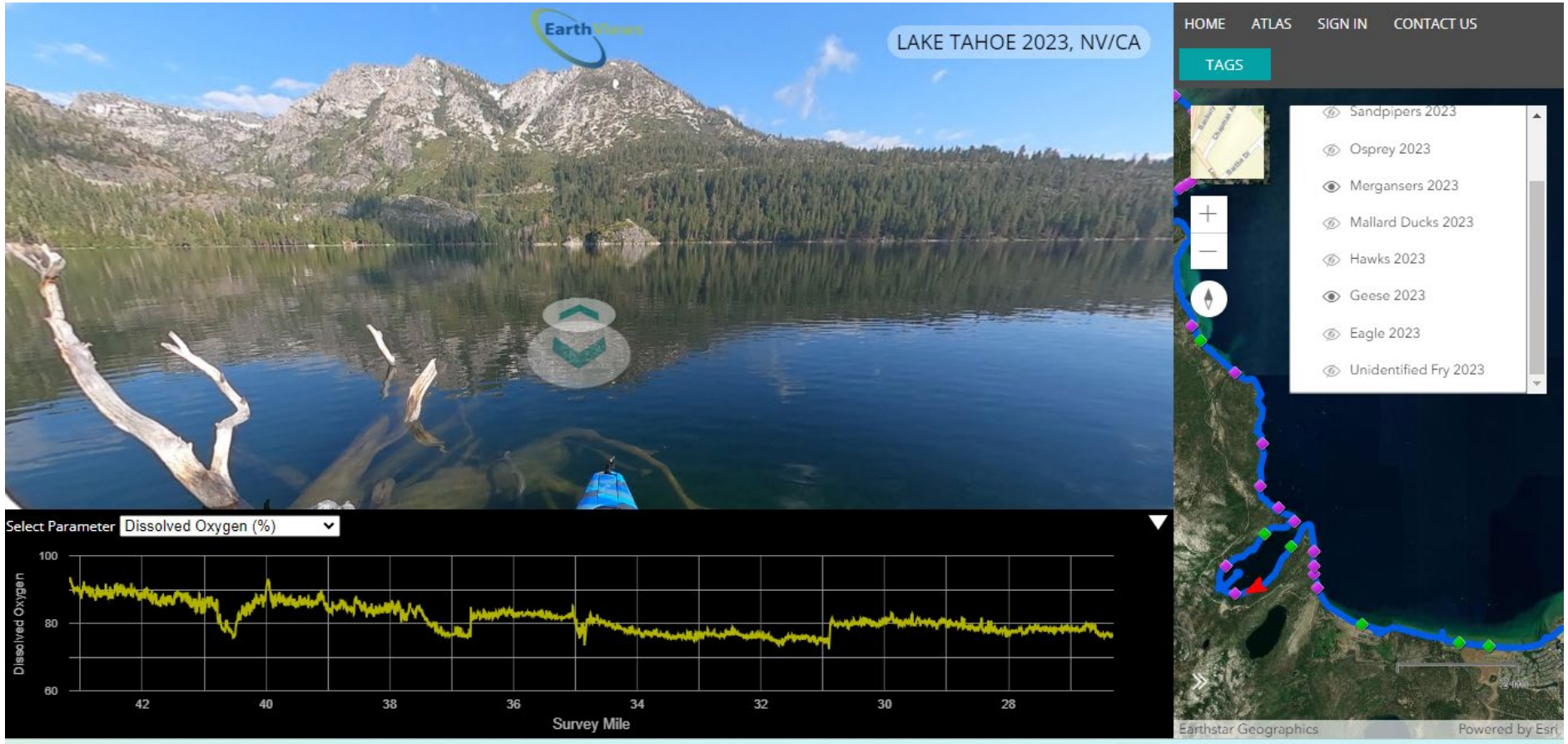
An increase in the count of eagles, mergansers, and osprey was observed in 2023. A decline was noted in the geese counts in 2023. Over 8,000 unidentified fry were observed in 2023, which weren't observed in 2022. Two sandpipers were spotted in 2023, but none in 2022. In contrast, two terns were seen in 2022, but none were observed in the following year. Note: The counts recorded during these surveys were opportunistic encounters and were not conducted systematically. As such, these numbers represent the species observed during the specific survey period and not the actual population or population trends of the species in the area.

Species	2022	2023
Eagles	4	6
Geese	507	386
Mergansers	128	203
Osprey	0	2
Unidentified Fry	-	8,000+
Sandpipers	-	2
Terns	2	0

Discussion

Benefits of ShoreView Mapping:

The introduction of ShoreView Image Mapping has paved the way for a detailed understanding of Lake Tahoe's nearshore conditions. When augmented with the comprehensive dataset from the nearshore, this visual tool grants us an enhanced, contextual insight into the intricate ecological dynamics of the lake's periphery. The ability to visualize and correlate data on the same platform holds significant value for future investigations and decision-making.



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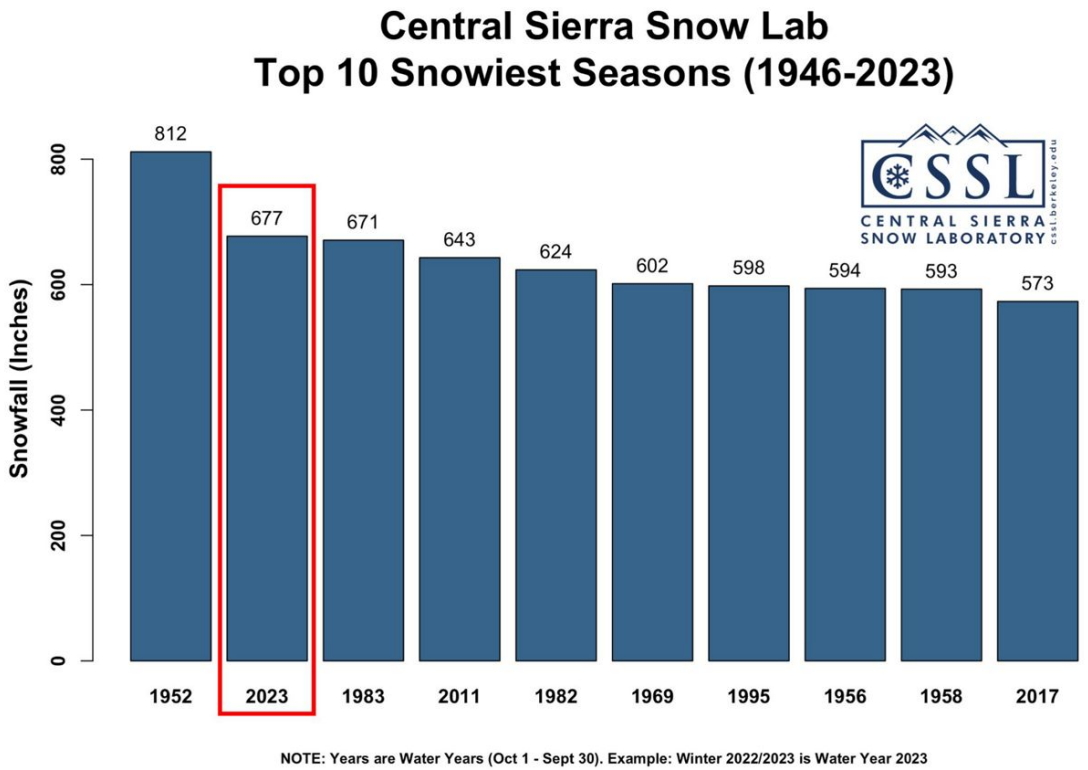
Survey and Weather Conditions:

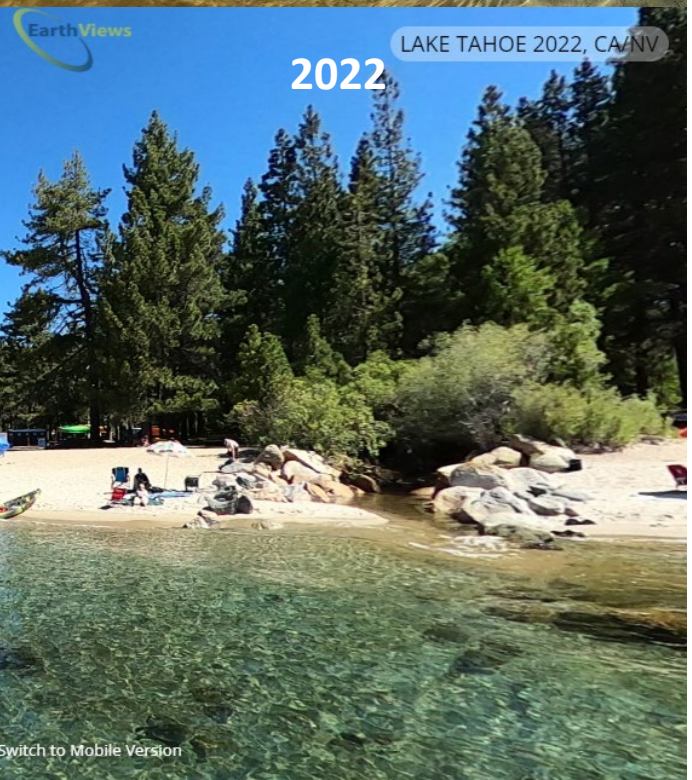
Ensuring consistency in survey periods and comparable weather conditions between years eliminates variables that could introduce bias in our data interpretations. The similarities in weather and survey conditions between 2022 and 2023 were conducive to a qualitative data collection process, with neither factor having a discernible impact on the data's quality. Any differences observed can be confidently attributed to natural or anthropogenic factors, rather than variations in the surveying weather conditions.

Impact of Lake Elevation:

The variation in lake elevation between 2022 and 2023 highlighted its influence on both imagery and data measurements. Elevated water levels in 2023 facilitated the survey of previously inaccessible shorelines, streams, and coves, shedding light on regions that could have otherwise been overlooked. This change in elevation may also have implications on the observed differences in measurements, particularly turbidity and dissolved oxygen.



The second highest snowpack on record had an impact on the differences seen between the two survey years.

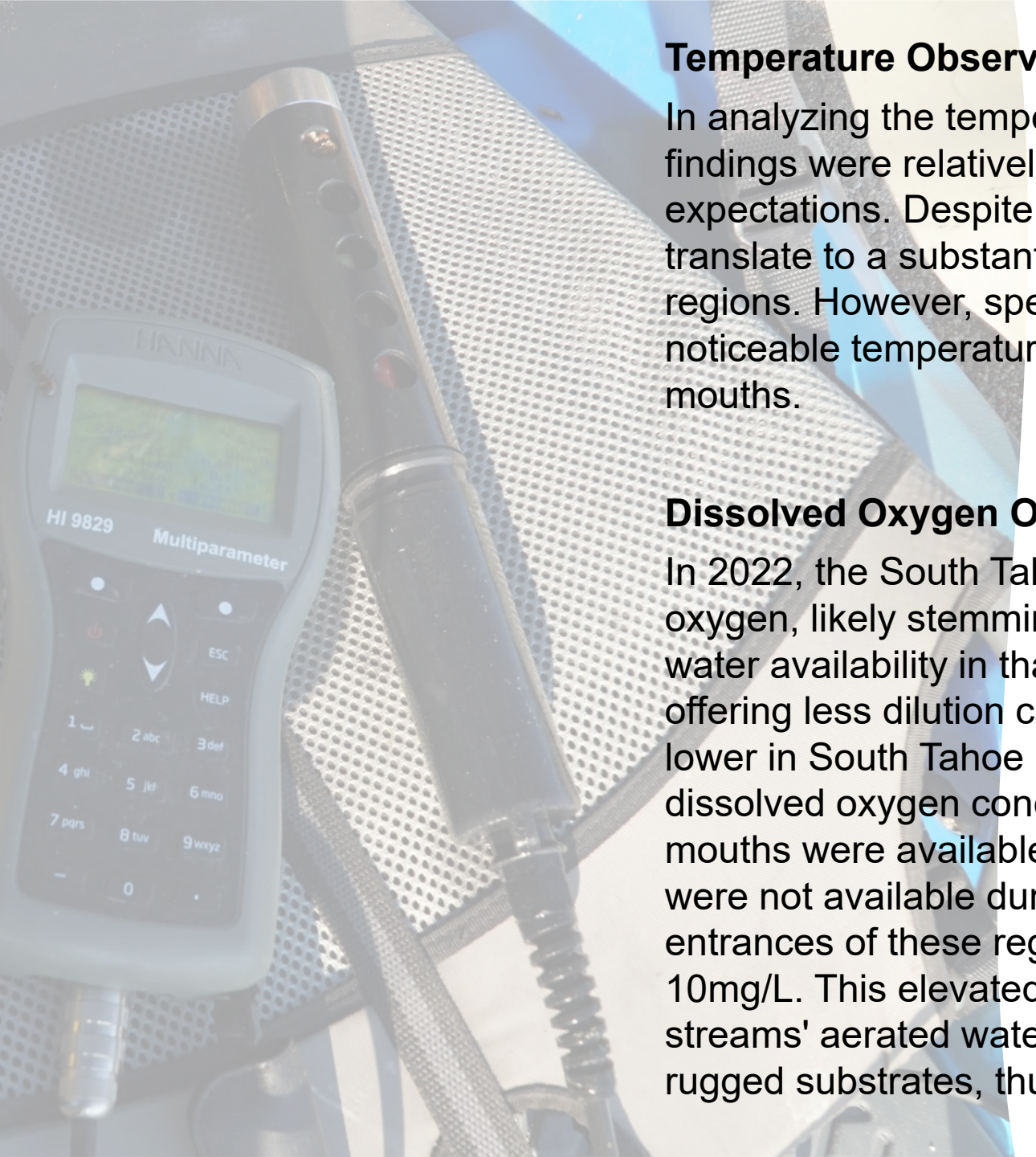


Turbidity Observations:

A significant disparity in turbidity measurements between the two years, especially in the South Tahoe region in 2022, underscores the regional effects on this parameter. As shown here high flows from Incline Creek in 2023 resulted in more turbid waters than those of the lower flows from the stream in 2022. While Incline Creek flowing into Crystal Bay indicated a potential turbidity increase due to runoff in 2023, the dramatic spike in turbidity during 2022 in South Tahoe's nearshore remains enigmatic. Wave actions and their interaction with the lakebed in shallower water during drought conditions in 2022, combined with the dilution of these effects in the higher water during 2023 might explain this difference, though conclusive evidence requires a longer trending data set. As our dataset expands over the years, understanding the correlation between lake surface elevation and nearshore turbidity will become clearer, prompting a deeper exploration into the causative factors.

2023 - https://arcgis.earthviews.com/public/lake-tahoe-0723#5168

2022 - https://arcgis.earthviews.com/public/lake-tahoe-east-0722#5515



Temperature Observations:

In analyzing the temperature dynamics between 2022 and 2023, the findings were relatively consistent across both years, contrary to the initial expectations. Despite the significant snowmelt in 2023, this did not translate to a substantial temperature reduction in the lake's nearshore regions. However, specific regional anomalies were identified, with noticeable temperature decreases being observed proximate to tributary mouths.

Dissolved Oxygen Observations:

In 2022, the South Tahoe region exhibited reduced levels of dissolved oxygen, likely stemming from anthropogenic impacts. The decreased water availability in that year could have compounded these effects, offering less dilution capacity for such disturbances. Although DO was lower in South Tahoe region during 2023 as well, areas of heightened dissolved oxygen concentrations, particularly proximate to tributary mouths were available for measurement and contributing to the lake that were not available during the low water year in 2022. Notably, at the entrances of these regions, readings occasionally reached between 8 and 10mg/L. This elevated oxygenation can be attributed to the mountain streams' aerated waters, which become oxygenated from cascading over rugged substrates, thus infusing the lake with oxygen-rich inflows.

Wildlife Observations:

The consistency in animal counts between the two years indicates a stable ecological environment for the observed species. However, the observation of possibly sockeye fry in 2023 when there were none observed in 2022, warrants further study and any potential link to changes in water quality or lake surface elevation.

Conclusion:

Findings from the two survey years illuminate the multifaceted relationship between lake surface elevation and the various biophysical parameters of the nearshore ecosystem. Observations point towards the benefits of maintaining lake levels akin to those of 2023, especially when considering the favorable conditions of decreased turbidity and enhanced dissolved oxygen levels, both indicative of a thriving aquatic environment. Nevertheless, advocating for specific lake levels requires a broader dataset over multiple years. As more data becomes available, we can refine our understanding of the lake’s nearshore ecology and better advocate for its optimal health.

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