Recreationists and Nearby Residents' Perceptions of Water Quality at Utah Lake

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Jordan W. Smith: Methodology, Investigation, Data curation, Formal analysis, Writing – Original Draft, Visualization, Project administration. **Anna B. Miller:** Methodology, Writing – Review & Editing. **Chase C. Lamborn:** Investigation, Writing – Review & Editing.

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Table of Contents

Executive Summary

Utah Lake is integral to the environmental, economic, and social well-being of nearby communities as well as individuals who travel from across the Wasatch Front for the lake's unique recreational opportunities. Recently however, increased occurrences of harmful algal blooms have threatened the valued ecosystem services provided by the lake. Closures of the lake to recreational uses, while essential for public safety, may have already significantly affected the public's perceptions about if, and when, it is safe to recreate in and around the waterbody. This research provides a foundational understanding of recreationists and nearby residents' awareness of, and sensitivity to, varying levels of water quality/clarity. Specifically, the research provides insights into:

- Whether there are thresholds in the aesthetic appearance of lake water (as indicated by different chlorophyll (chl-*a*) concentrations) beyond which current and potential visitors believe Utah Lake becomes undesirable for different recreation activities.
- The extent to which recreationists as well as nearby residents are aware of and concerned about water quality issues at the lake.
- The sociodemographic characteristics and activity preference of Utah Lake recreationists.

The study involved two surveys. The first was administered to recreationists at a variety of recreation settings around the lake in the summer of 2022; this effort yielded a total sample of 290 active recreationists (75.5% response rate). The second was administered via mail (with an option to respond online) to a random sample of households living in Salt Lake and Utah counties; this effort yielded a total of 541 responses (37.4% response rate).

The analysis revealed **slightly more than one-third (35.2%) of visitors, as well as nearly half (48.8%) of nearby residents, *had not* "heard, read about, or experienced" issues related to water quality at Utah Lake.** This finding may be surprising to those individuals who are very familiar with Utah Lake and its water quality issues. It may also signal a need for strategic communication efforts to educate the public about when and how to recreate at the lake.

The survey assumed individuals were aware that harmful algal blooms, excessive bacteria, and water clarity are all water quality issues. This may not always be the case, as some individuals may be aware of these issues, but not associate them with water quality. Consequently, the percentages noted above may be biased downward. If so, there may be a need to inform and educate the recreationists and the public about what "water quality issues" are, and consequently how they may affect their ability to recreate at Utah Lake.

The analysis also revealed no significant relationships between recreationists' desirability for swimming, boating, fishing, or consuming fish from water with different chl-*a* concentrations. There appears to be no relationship between the aesthetic appearance of different chl-*a* concentrations and recreationists' assessments of that water's suitability for recreation. However, the analysis did find turbidity was a significant factor shaping residents' perceptions of whether the water at Utah Lake is suitable for recreation. This finding suggest **many Utah Lake recreationists are likely making decisions about how and when they recreate on the lake based upon how clear it is and not how green it is.**

Collectively, the research suggests there is a need to educate the recreating public about water quality issues at the Lake. State agencies, user groups, and non-profit organizations all can play integral roles in increasing the public's awareness of when, and how, to safely recreate on, or near, Utah Lake. It is essential for resource managers to convey water quality information to the recreating public in as clear, direct, and obvious ways as possible. Finding that recreationists to Utah Lake cannot differentiate between water with extremely variable chl-*a* concentrations places increasing demands on the agencies responsible for resource management and public safety.

The findings highlight a need for more proactive engagement and education efforts as opposed to solely relying on reactionary water quality advisories and warnings. Data from the survey efforts show that of the recreationists who are aware of water quality issues at Utah Lake, the majority (> 50%) receive

their information from local news reports, online, and friends and family members. By comparison, only one-third of visitors sampled at the lake and only 12% of nearby residents who recreate at the lake reported encountering a water quality warning at an access point during any of their visits. The need for more, and more diverse, methods of educating the public about how to safely responsibly is a common need throughout Utah; the data presented here suggest this need is particularly acute at Utah Lake.

Introduction

Utah Lake is integral to the environmental, economic, and social well-being of nearby communities as well as individuals who travel from across the Wasatch Front for the lake's unique recreational opportunities. Recently however, harmful algal blooms have threatened the valued ecosystem services provided by the lake. Increasingly frequent closures of the lake to recreational uses, while essential for public safety, may have already significantly affected the public's perceptions about if, and when, it is safe to recreate in and around the waterbody. While the public may be more knowledgeable about the dangers of cyanobacteria blooms now than they were in the past, it would be inappropriate to characterize the recreating public as a homogenous group that have by and large written off the lake as a place to play. The academic literature on outdoor recreation management is replete with data highlighting the fact that there is no such thing as a typical outdoor recreationist. All recreationists and potential recreationists bring their own experiences, assumptions, biases, and preferences to their decisions about where and how often to recreate at a specific setting. A rigorous and scientifically grounded investigation is needed to better understand preference heterogeneity among the recreationists who currently use, may use, or once visited Utah Lake for outdoor recreation. In this research, we use survey data to develop an understanding of the various preferences for water clarity and quality amongst those who currently do or potentially could recreate on Utah Lake. The specific objectives of the project are to determine:

1. Whether there are thresholds in the aesthetic appearance of lake water (as indicated by different chlorophyll (chl-*a*) concentrations) beyond which current and potential visitors believe Utah Lake becomes undesirable for different recreation activities.

2. Determine the extent to which recreationists as well as nearby residents are aware of and concerned about water quality issues at the lake.

3. Establish a foundational understanding of who the recreationists at Utah Lake are (e.g., their sociodemographic characteristics), and how they recreate on the lake (e.g., their activity preferences, their visit frequency, etc.).

Methods

This work is guided by the Environmental Protection Agency's primer on common practices and insights for developing user perception surveys to protect water quality from nutrient pollution (Environmental Protection Agency, 2021). These practices and insights outline a four-step process for conducting user perception surveys. Specific steps in the process include: scoping, survey design, data collection, and analysis.

Scoping

A user perception study can be used to generate data, information, and knowledge that can guide the management of Utah Lake and how the state, user groups, and non-profit organizations communicate information to the public about changes to water clarity, water quality, and public safety. As such, it is important to gather input on what the most useful information that can be generated through a user perception study would be. This information should be gathered from the agencies, user groups, and non-profit organizations who have and interest in, and influence over, management decisions as well as public engagement/education (Reed et al., 2009). Throughout the winter of 2021-2022, our research team convened five semi-structured interviews with members of the Utah Lake Water Quality Study Steering Committee to develop an in-depth understanding of knowledge that could be generated from user perception surveys focused on water clarity and quality in Utah Lake. In total, 15 Steering Committee members participated in the interviews and provided input for us to consider as we developed the survey instrument. These meetings were designed to help our team better outline the full breadth of the questions which could be addressed through a user perception survey. Importantly, the scoping process also allowed our research team to collaboratively craft and prioritize the research questions that the survey instrument

addressed. The contact email and script for the semi-structured interviews are provided in Appendices A and B, respectively. The scoping interview protocol was approved by the Utah State University Institutional Review Board (#12630). The research team as well as a facilitator from Peak Facilitation Group took notes during each interview. The notes were distilled by the facilitator and revised by the research team in a "key themes" document. The research team subsequently supplemented the key themes document, noting how the points raised by the Steering Committee members would be considered in the development of the survey instrument. The key themes document, with the research team's responses included, is provided in Appendix C. The key themes document was also shared with the Steering Committee after all interviews had been completed in late April 2022. The Steering Committee was asked to review the key themes document, and provide any further input or clarification to the research team if they believe any points within it did not accurately reflect the scoping interview discussions.

Survey Design

We conducted a literature review to identify factors known to influence perceptions of water clarity and quality (Barnett et al., 2018; Brody et al., 2004; Canter et al., 1994; Ditton & Goodale, 1973; Flint et al., 2017; Hu & Morton, 2011). Using this information, in conjunction with information from the scoping interviews, we developed a draft survey instrument that was subsequently reviewed and refined by project managers at the Utah Department of Environmental Quality – Division of Water Quality. The final instrument is provided in Appendix D; it consisted of several distinct sections:

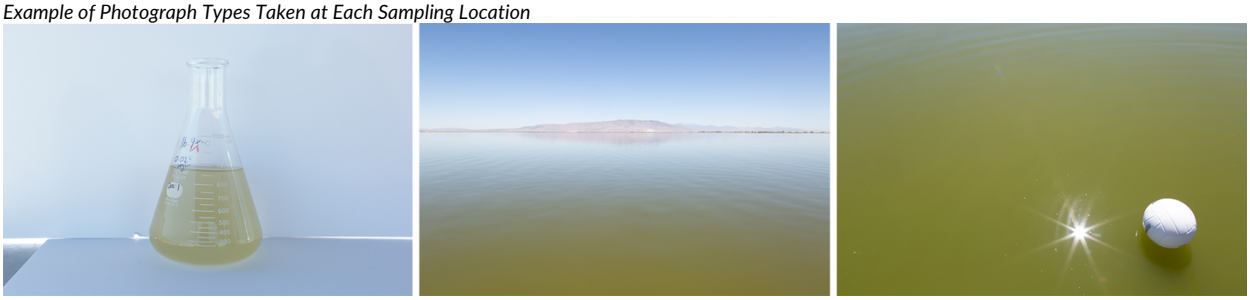
1. **Trip-related characteristics:** Information about the trip during which recreationists were intercepted (e.g., their primary recreational activity, the types of watercraft used, the duration of their trip, their group size, and the importance of different factors affecting their decision to visit the lake.) These questions were only asked of those individuals who were surveyed at Utah Lake as well as nearby residents who had recreated at the lake in the past year.
2. **Desirability:** Designed to ascertain whether there are critical thresholds beyond which recreationists believe chl-*a* concentrations are unacceptable for recreation (more detail provided below).
3. **Perceptions of water quality over time:** Recreationists and residents' perceptions of water quality over long time periods (i.e., changes over the past 5, 10, 20, and 30 years).
4. **Experiences with water quality.** Recreationists and residents' awareness of, and experience with, water quality issues at Utah Lake.
5. **Socio-demographic characteristics.** Information about respondents' socio-demographic characteristics.

Assessing Critical Thresholds of Desireable

To determine whether there are critical thresholds beyond which recreationists believe chl-*a* concentrations are unacceptable for recreation, we presented respondents with a series of photographs of either open water or the shoreline at Utah Lake. Photographs were taken by the Utah Department of Environmental Quality – Division of Water Quality (DEQ-DWQ) in the summer of 2021 (June – September). Photographs were also paired with water quality data (bicarbonate, chl-*a*, DOC, Secchi disk depth, TOC, TSS, TVS, TVS:TSS, turbidity) collected at the same time the photographs were taken. The DEQ-DWQ took several different photographs at each location where water quality/clarity data were collected. Specifically, photographs were taken of an open landscape, an open landscape with a white object (e.g., volleyball), and a photograph of sampled water in a beaker (Figure 1). Pilot testing suggested showing respondents images of sampled water in a beaker could negatively affect the extent to which they indicated the photographed water was desirable for water-based recreation. Even for the lowest chl-*a* concentrations for which photographs were available (chl-*a* < 10 µg/L), individuals in the pilot tests indicated they would not recreate in the water shown. Several respondents indicated that seeing water in a beaker against a white background made the water's clarity/quality look very poor relative to drinking water, which is what they were most familiar with looking at/evaluating. Consequently, we chose to show

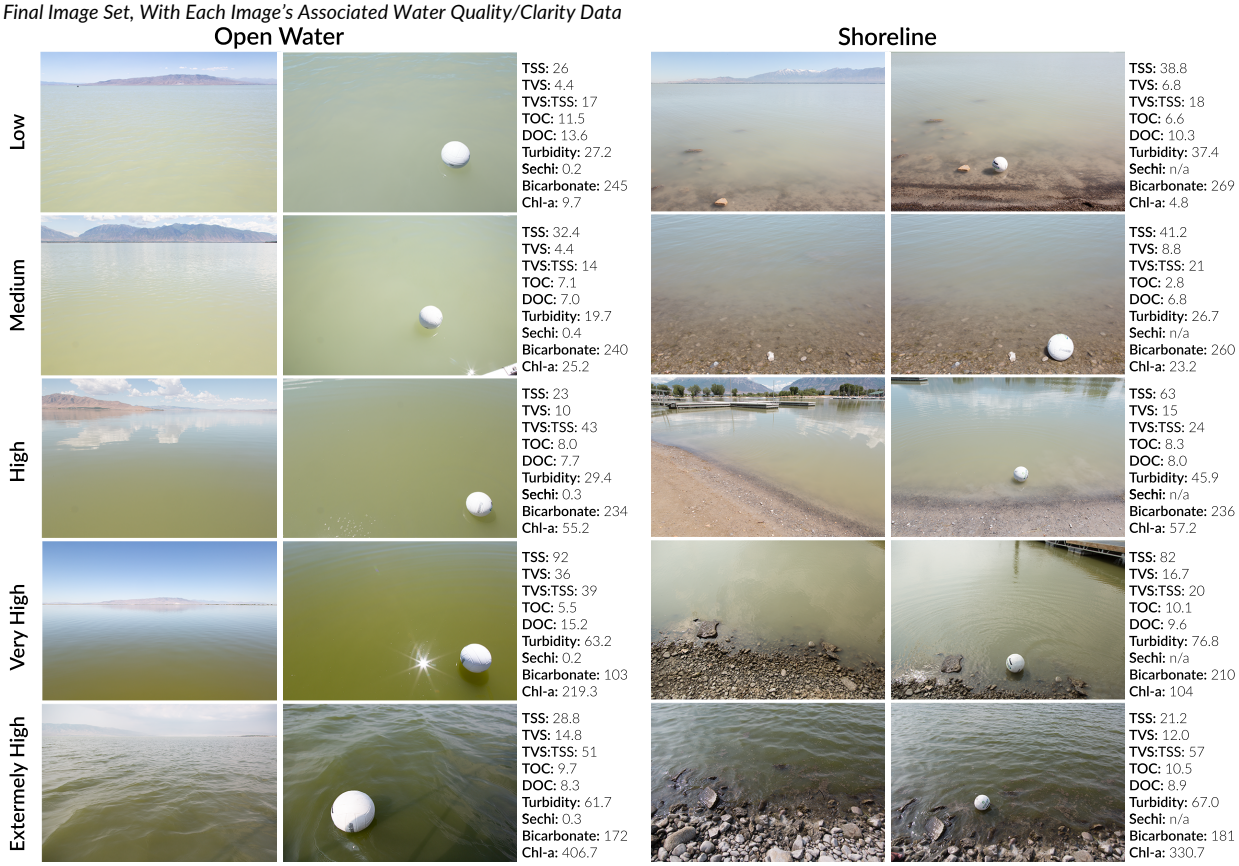
respondents only images of the open landscape and the open landscape with the white object in the foreground; image pairs were presented together. All final images were color corrected in Adobe Lightroom (using pictures of color cards taken at each sampling location) prior to integration into the survey.

Figure 1
Example of Photograph Types Taken at Each Sampling Location



Given chl-*a* is an important indicator of the presence of cyanobacteria blooms, we chose chl-*a* as the primary attribute across which we could select photographs of varying levels. We selected five photographs for which chl-*a* concentrations ranged from low (< 10 µg/L) to extremely high (> 250 µg/L); we did this for photographs of open water as well as photographs of the shoreline resulting in a set of 10 images. The final image set, along with each image's associated water quality/clarity data, is shown in Figure 2. It is important to note that respondents did not see the chl-*a* concentration values when taking the survey, they only saw the paired photographs. Each respondent was presented with three randomly chosen photo-pairs from the final image set. The size of the image pairs was roughly 7.25" (w) × 2.75" (h) for both the on-site and online/mail-back surveys.

Figure 2
Final Image Set, With Each Image's Associated Water Quality/Clarity Data



Data Collection

Data were collected through two parallel survey efforts, one administered to recreationists on-site at a variety of Utah Lake access locations, and the another administered via mail (with an online response option) to a random sample of households within Salt Lake and Utah Counties. The details characterizing our two survey efforts are shown in Table 1.

Table 1
Details Characterizing the Two Survey Efforts

	On-site Intercept Survey	Resident Mail-back/Online Survey
Population	Recreationists visiting Utah lake during the spring/summer of 2022	Residents of Salt Lake and Utah Counties in spring/summer 2022
Sampling method	Randomly sampled recreationists visiting select recreation settings around Utah Lake (as determined through the scoping meetings)	Randomly sampled residents within Salt Lake and Utah Counties
Target sample size	432 (27 survey days at 8 hours each and approximately 2 intercepts made per hour)	300
Expected response rate	75%	33.5% (14.0% via the online option and 19.5% via the mail-back option)
Contacts	**384**	**1,446**
Response rate	**95.6%**	**37.4%**
Final sample size	**367**	**541**

On-site Survey

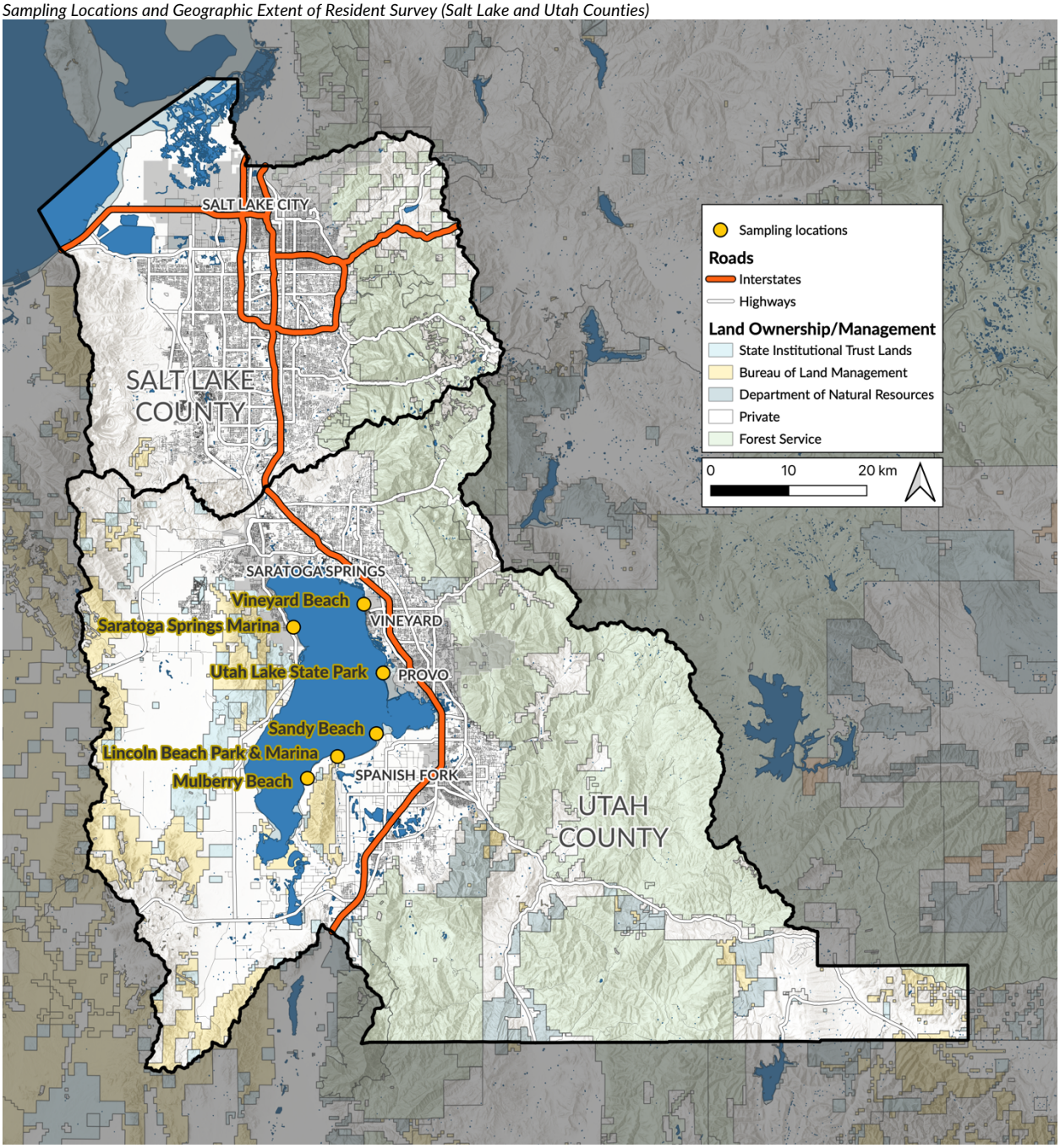
The first survey effort was administered to recreationists in-person at select recreation settings located around the lake. This effort is warranted given previous research within Utah has found participation in water-based recreation is an important factor that affects perceptions of local water quality (Barnett et al., 2018). Data from this survey effort is intended to provide information on why current

recreationists choose to recreate on the lake and what experiences they have had with lake closures in the past.

We intercepted visitors at 6 lake access sites selected by the research team after input from the Steering Committee (Figure 3). Access sites were selected to capture a representative sample of all lake users, ranging from anglers to motorized boaters to those participating in near-shore recreation activities (e.g., picnicking). Site days were concentrated on the weekends (Friday – Sunday) to contact as many recreationists as possible.

Figure 3

Sampling Locations and Geographic Extent of Resident Survey (Salt Lake and Utah Counties)



The survey protocol included one sampling timeframe in the afternoon (12pm – 8pm). Recreationists were approached by a survey technician if the potential respondent appeared to be recreating. The survey technician informed recreationists they were collecting information about recreation experiences at Utah Lake to help inform future recreation and resource management decisions. The survey technician asked for only one visitor from each group, the one with the most recent birthday, to participate in the survey. If potential respondents were amenable to completing the survey, the technician handed them an iPad tablet computer and stood by to answer any questions the respondents might have had as they completed the survey. All surveys were completed using the Qualtrics survey administration application. Again, the full survey instrument is provided in Appendix D.

Resident Survey

The second survey effort was administered to a random sample of 1,500 households within Salt Lake and Utah Counties. Address data were obtained from both counties' official parcel dataset (as of May 2022). Data from this survey effort is intended to provide a better understanding of how the 'general public' views the acceptability of water clarity and water quality at Utah Lake.

Analysis

Descriptive statistics were used to detail all data collected through both the on-site and household surveys following best practices for reporting survey data (Vaske, 2019). A multivariate regression model was used to determine whether chl-*a* concentrations, as well as other covariates, influence individuals' perceptions of desirability. The model involved predicting respondents' perceived desirability for different on- or near-water recreation activities, with not only chl-*a* concentrations, but also a suite of independent factors shown in previous research to affect individuals' perceptions of water quality. These factors included: frequency of recreating at the lake per year, length of time (in years) recreating at the lake, participation in outdoor recreation activities that do and do not involve direct contact with the water, prior experience with warnings and/or closures of the lake, age, education, gender, and income. We also included turbidity (NTU) as well as the ratio of total volatile solids to total suspended solids (TVS:TSS) to test whether desirability is a function of the cloudiness or greenness of the water shown. We used a random effects ordinal probit panel data model, fit using the *xtoprobit* command in Stata 16 (StataCorp LLC, 2019). This approach is similar to previous work using aesthetic characteristics of water bodies to establish numeric nutrient criteria within Utah (Jakus et al., 2017).

Results

On-site Survey Days and Response Rates

Between May 26, 2022, and August 2, 2022, we were able to collect data during 27 site-days at the six sampling locations around the lake. In total, we made 384 contacts with visitors. Of those, 49 (12.8%) refused to complete the survey, 22 (5.7%) could not complete the survey because of a language barrier, and another 45 (11.7%) agreed to complete the survey later via email. 268 recreationists completed the survey on-site and another 22 completed the survey via email, totaling to 290 completed surveys and a 75.5% response rate (Table 2). The overall response rate is more than acceptable for in-person surveys (Dillman et al., 2014). All responses to the on-site survey, regardless of whether the respondent completed the survey on-site or later via email, were analyzed together given respondents were drawn from the same population (current lake users).

Table 2
On-site Survey Effort, Responses, and Response Rate

Method	Site Days	Contacts	Refusals (%)	Prefer Email (%)	Language Barrier (%)	Completed Surveys (%)
On-site survey	27	384	49 (12.8)	45 (11.7)	22 (5.7)	268 (69.8)
On-site contact followed by email		45				22 (48.9)
TOTAL						290 (75.5)

Resident Survey

Of the 1,500 mail surveys sent to a random sample of Salt Lake and Utah County residents, 54 (3.5%) were returned as undeliverable, yielding an effective sample size of 1,446 (Table 3). A total of 237 surveys were completed and returned via mail, while another 304 were completed and returned via the online response option. A total of 541 residents completed the survey (Table 3); this tabulates to a 37.4% response rate which is acceptable for mail-back surveys (Dillman et al., 2014).

The mail-back survey included a lead-in filtering question that asked whether the respondent had recreated at Utah Lake in the past 12-months. If they indicated they had, they were asked questions about their most recent trip to the lake; these questions were identical to those asked of recreationist who were sampled on-site. If they indicated they had not recreated at the lake within the past 12-months they were either prompted to bypass the trip-specific questions (for those choosing to physically fill out the survey and mail it back) or were not shown the trip-specific questions (for those choosing the online response option to the mail survey).

Table 3
Mail-back/Online Survey Effort, Responses, and Response Rate

Method	Contacts	Undeliverable (%)	Effective Sample Size (%)	Completed Surveys (%)
Mail-back survey	1,500	54 (3.6)	1,446	237 (16.4)
Online option included in mail-back survey				304 (21.0)
TOTAL				541 (37.4)

Trip-related Characteristics

Activity Preferences

Respondents were provided a list of different recreation activities offered on and around the lake and asked to indicate all they participated in during their current trip. Of the on-site sample, nearly half (45.3%) of all recreationists indicated they fished during their visit (Table 4). Other less common recreational activities included swimming (16.1%), motorized boating (14.3%), wildlife viewing (14.1%), and picnicking (13.8%). The full list of recreational activities, and associated percentages of recreationists participating in those activities, is reported in Table 4 and Figure 4.

Nearly half (49.0%) of the sample of Salt Lake and Utah County residents had recreated at Utah Lake within the 12-months prior to receiving the survey. This is a notably high proportion, much larger that expected. Of these residents, roughly one-fifth (21.5%) indicated they participated in motorized boating. Slightly fewer residents (18.9%) reported they hiked, walked, or ran near the lake. Other activities that are relatively more common for residents to participate in include picnicking (10.9%), camping (9.1%), and fishing (8.7%). The full list of recreational activities, and associated percentages of residents participating in those activities, is reported in Table 4 and Figure 4.

A comparison of the two survey efforts suggests the on-site survey was more likely to sample nearly all activity types; however, the mail survey was more likely to sample motorized boaters as well as hikers/walkers/runners. It is logical that the on-site survey would capture more individuals participating in outdoor recreation, however because the on-site sampling plan was not exclusively focused on marinas

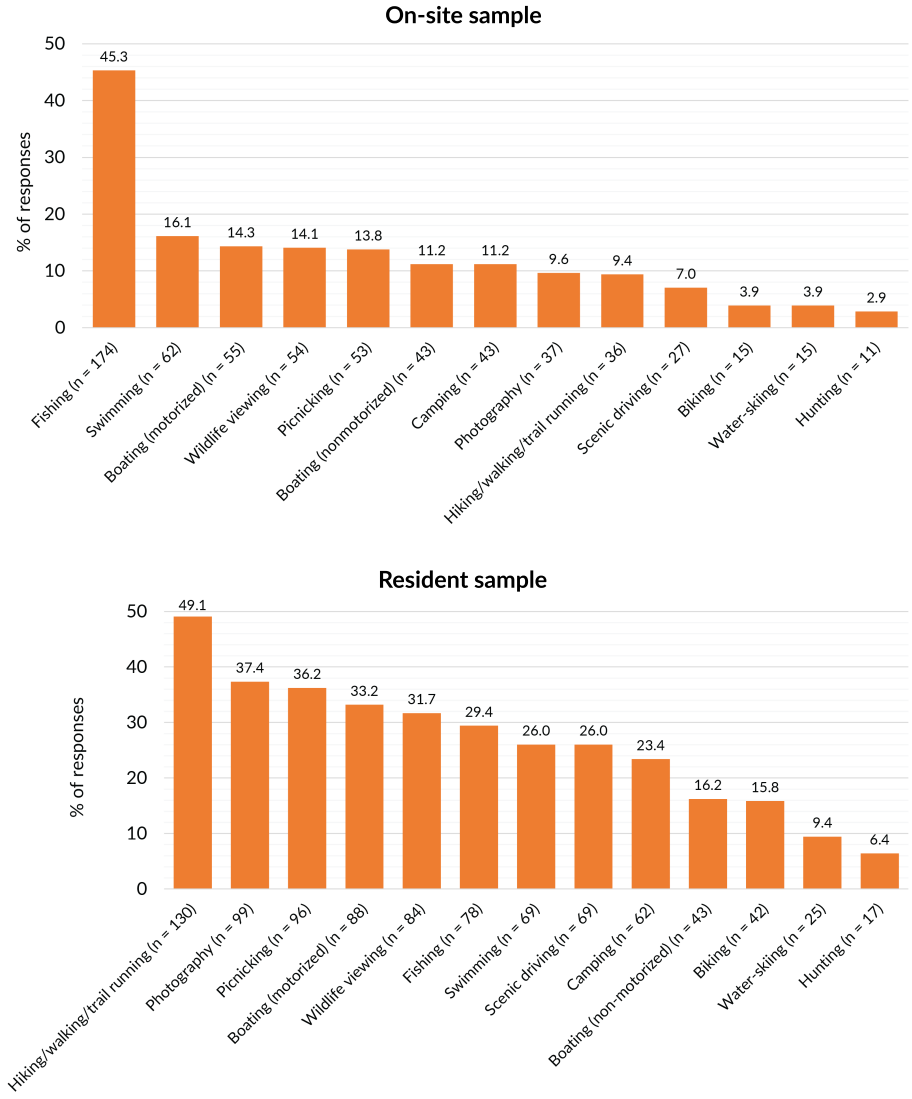
and/or trails, motorized boaters as well as hikers/walkers/runners were underrepresented in the on-site sample. The differences highlight the value for collecting data through both methods.

There are a couple of other studies that offer points of comparison to the breakdown of dominant activity types found at Utah Lake. A 1999 study of boaters at four Utah State Parks (Willard Bay, East Canyon, Jordanelle, and Deer Creek) found roughly half of all boaters also swam during their visit to one of the parks (Reiter et al., 1999). At Utah Lake, only 16.1% of recreationists sampled on-site reported swimming at the lake, the number was notably lower (6.0%) for residents. While not a direct comparison, it appears Utah Lake sees much less swimming use relative to other lakes within the region. All other activities asked about in both this study and in the Utah State Parks study were comparable. Another study of Davis County residents about their use of the Great Salt Lake suggests Utah Lake sees less picnicking, biking, and hunting than the Great Salt Lake, but more boating (Brunson & Nicholson, n.d.).

Table 4
Percent of Respondents Participating in Different Recreational Activities at Utah Lake

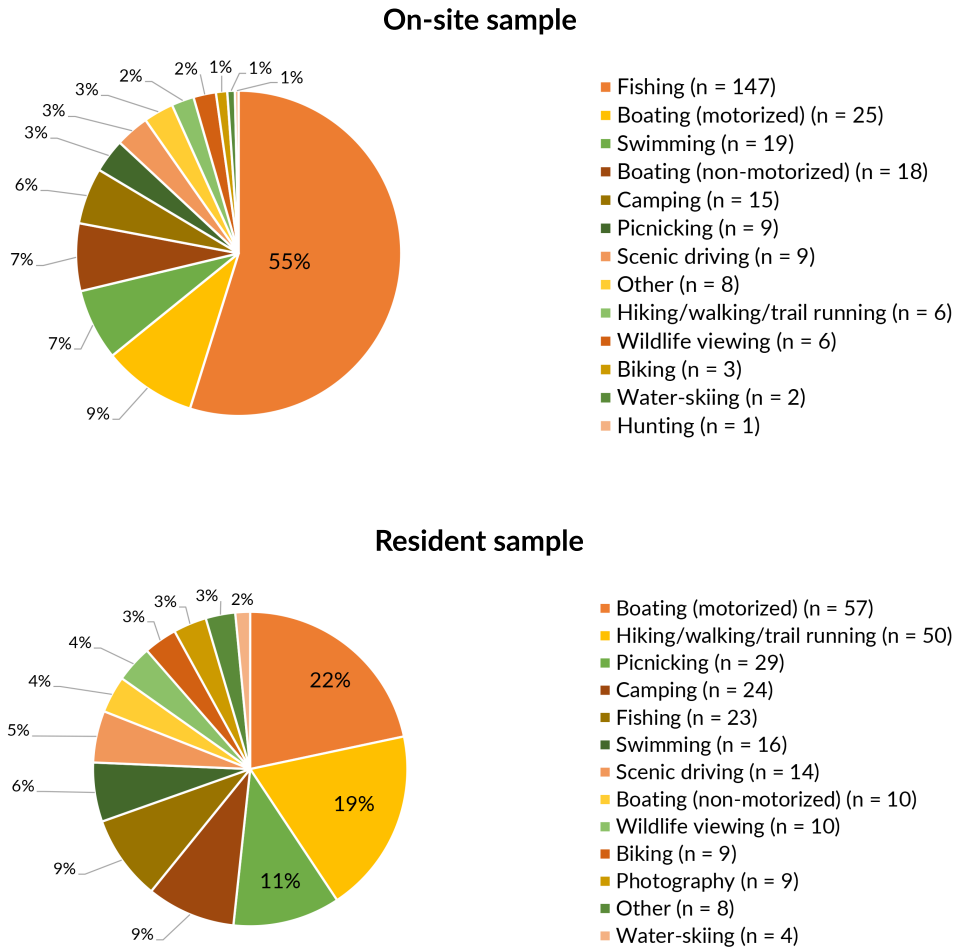
	Percent of Respondents Participating in Each Activity *(n = 384)*		**Percent of Respondents Indicating the Activity was Their *Primary* Activity at Utah Lake** *(n = 265)*	
Activity	**Recreationists Surveyed on the Lake** *(rank)*	**Residents of Salt Lake and Utah Counties who had Recreated at the Lake Within the Past Year** *(rank)*	**Recreationists Surveyed on the Lake** *(rank)*	**Residents of Salt Lake and Utah Counties who had Recreated at the Lake Within the Past Year** *(rank)*
Fishing	45.3 *(1)*	8.7 *(5)*	54.9 *(1)*	29.4 *(6)*
Swimming	16.1 *(2)*	6.0 *(6)*	9.3 *(2)*	26.0 *(7)*
Boating (motorized)	14.3 *(3)*	21.5 *(1)*	7.1 *(3)*	33.2 *(4)*
Wildlife viewing	14.1 *(4)*	3.8 *(8)*	6.7 *(4)*	31.7 *(5)*
Picnicking	13.8 *(5)*	10.9 *(3)*	5.6 *(5)*	36.2 *(3)*
Boating (nonmotorized)	11.2 *(6)*	3.8 *(9)*	3.4 *(6)*	16.2 *(10)*
Camping	11.2 *(6)*	9.1 *(4)*	3.4 *(6)*	23.4 *(9)*
Photography	9.6 *(8)*	3.4 *(10)*	3.0 *(7)*	37.4 *(2)*
Hiking/walking/trail running	9.4 *(9)*	18.9 *(2)*	2.2 *(8)*	49.1 *(1)*
Scenic driving	7.0 *(10)*	5.3 *(7)*	2.2 *(9)*	26.0 *(8)*
Biking	3.9 *(11)*	3.4 *(10)*	1.1 *(10)*	15.8 *(11)*
Water-skiing	3.9 *(11)*	1.5 *(12)*	0.8 *(11)*	9.4 *(12)*
Hunting	2.9 *(13)*	0.8 *(13)*	0.4 *(12)*	6.4 *(13)*

Figure 4
Distribution of Activity Participation Across Respondents



Recreationists were subsequently prompted to indicate which activity was their *primary purpose for visiting the lake*. For the on-site sample, fishing was the most commonly reported purpose for visiting the lake (54.9%), followed by motorized boating (9.3%), swimming (7.1%), and non-motorized boating (6.7%). The full breakdown across all activities is shown in Table 4 and Figure 5. For residents, the most dominant primary purpose for visiting the lake was hiking/walking/running (49.1%) followed by photography (37.4%), picnicking (36.2%), and motorized boating (33.2%). The full breakdown is shown in Table 4 as well as Figure 5. Again, the differences highlight the value for collecting data through both methods.

Figure 5
Primary Purpose for Visiting Utah Lake



Group Size and Trip Length

The mean group size for those sampled on-site was 3.7 individuals (std. dev. = 2.9, min. = 1, max. = 17) (Table 5). Additionally, the vast majority (89.2%) of recreational trips to Utah Lake were day trips. Only 10.8% of respondents indicated they were on an overnight trip to the lake. The mean length of day trips was 3.8 hours, while those who were spending the night on the lake tended to stay an average of 2.7 days. A slightly larger group size was reported by residents who had recreated at the lake in the year preceding the survey (mean = 4.8, std. dev. = 3.4, min. = 1, max. = 23). Additionally, only 13.7% of respondents indicated they had spent longer than one day at the lake on their most recent trip. Trip lengths were slightly higher for residents relative to those surveyed at the lake (Table 5).

Table 5
Time Spent on Utah Lake

	Recreationists on the Lake *(n = 384)*				Residents of Salt Lake and Utah Counties who had Recreated at Utah Lake in the Past Year *(n = 265)*			
			Range				Range	
Trip Type	Mean Trip Length	Std. Dev.	Min.	Max.	Mean Trip Length	Std. Dev.	Min.	Max.
Day trips (hours)	3.8	2.3	0.5	12.0	4.6	2.6	1.0	12.0
Overnight trips (days)	2.7	1.7	1.0	8.0	3.8	2.6	2.0	12.0

Watercraft Used

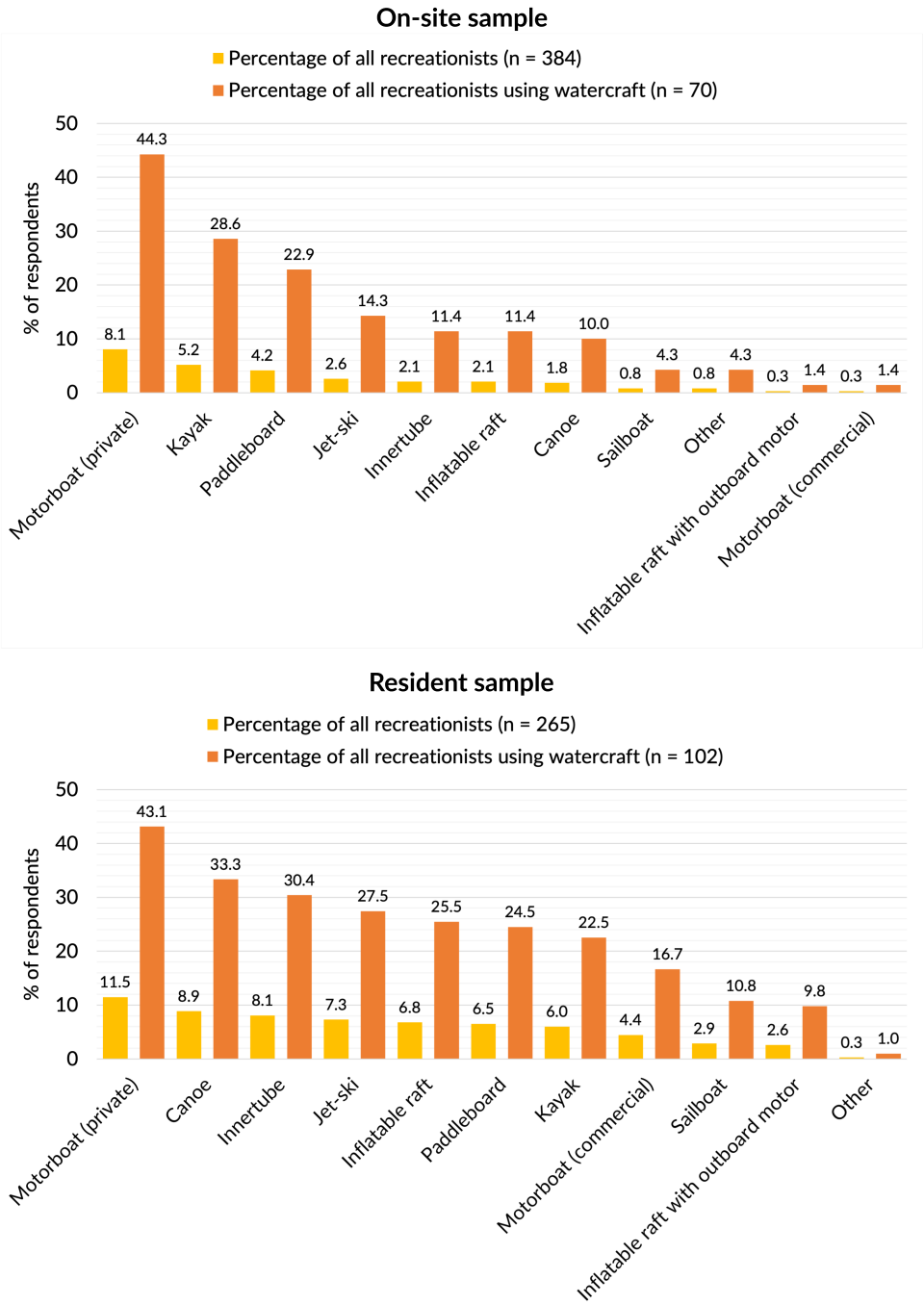
Most (81.8%) visitors the lake who were sampled on-site do not bring a watercraft with them during their recreational trips. Only 8.1% of respondents indicated they had brought a private motorboat with them. Even fewer reported bringing non-motorized watercraft such as kayaks (5.2%) or paddleboards (4.2%). The full breakdown across watercraft types is shown in Table 6 and Figure 6. The table and figure differentiate between watercraft use across all recreationists and just those recreationists who reported bringing at least one watercraft. The mean number of watercraft used, if at least one was used, was 1.5 (std. dev. = 1.1, max. = 6).

The sample of residents who had recreated at the lake within the past year yielded similar proportions of watercraft use as the on-site sample (Table 6). The resident survey suggests (82.2%) do not bring a watercraft with them when recreating at the lake. The proportion of visitors using different types of watercraft was also similar across the on-site and resident survey, with private motorboats being the most common type of watercraft used by visitors (~10% of all visitors and ~44% of visitors bringing at least one watercraft).

Table 6
Type of Watercraft Used

	Percent of All Recreationists *(rank)*		**Percent of All Recreationists *Using Watercraft*** *(rank)*	
Watercraft Type	**Recreationists Surveyed at the Lake** *(n = 384)*	**Residents of Salt Lake and Utah Counties who had Recreated at Utah Lake in the Past Year** *(n = 265)*	**Recreationists Surveyed at the Lake** *(n = 384)*	**Residents of Salt Lake and Utah Counties who had Recreated at Utah Lake in the Past Year** *(n = 265)*
Motorboat (private)	8.1 *(1)*	11.5 *(1)*	44.3 *(1)*	43.1 *(1)*
Kayak	5.2 *(2)*	6.0 *(7)*	28.6 *(2)*	22.5 *(7)*
Paddleboard	4.2 *(3)*	6.5 *(6)*	22.9 *(3)*	24.5 *(6)*
Jet-ski	2.6 *(4)*	7.3 *(4)*	14.3 *(4)*	27.5 *(4)*
Innertube	2.1 *(5)*	8.1 *(3)*	11.4 *(5)*	30.4 *(3)*
Inflatable raft	2.1 *(5)*	6.8 *(5)*	11.4 *(5)*	25.5 *(5)*
Canoe	1.8 *(7)*	8.9 *(2)*	10.0 *(7)*	33.3 *(2)*
Sailboat	0.8 *(8)*	2.9 *(9)*	4.3 *(8)*	10.8 *(9)*
Other	0.8 *(9)*	0.3 *(11)*	4.3 *(8)*	1.0 *(11)*
Inflatable raft with outboard motor	0.3 *(10)*	2.6 *(10)*	1.4 *(10)*	9.8 *(10)*
Motorboat (commercial)	0.3 *(11)*	4.4 *(8)*	1.4 *(10)*	16.7 *(8)*

Figure 6
Watercraft use



Trip Frequency and Use History

We asked respondents how many times they visited Utah Lake for recreation in 2021, the year preceding the survey, as well as how many years they have been visiting the lake for recreation. For the on-site sample, the mean number of recreational trips taken to the lake per year was 19.5 (std. dev. = 55.2, min. = 0, max. = 365). 7.7% of respondents indicated they had visited the lake on a weekly basis (> 52 times per year), with several respondents reporting they visit on a daily or near daily basis (> 300 times a year). The frequency of trips taken to the lake each year was notably less for residents; the mean was only 3.2 trips per year (std. dev. = 6.0, min. = 1, max. = 75). This is likely attributable to the fact the resident

survey was more likely to sample motorized boaters who, on average, visit the lake less than non-motorized recreationists.

On average, visitors surveyed on-site indicated they had been visiting Utah Lake for recreation for over a decade (mean = 13.4, std. dev. = 16.6, min. = < 1, max. = 73). A full 28% of respondents indicated they had been visiting the lake for recreation for at least 20 years. A similar use history was observed for residents (mean = 8.5, std. dev. = 11.2, min. = < 1, max. = 70).

Factors Influencing Trip Taking

Respondents were asked to consider a set of ten factors that might influence their decision to visit the lake and indicate how important each of the factors was to their decision on the day they were surveyed. The ten factors included:

- Air temperature
- Crowds at the lake
- Fishery quality (fish species present or abundant)
- Lake access
- Lake level
- Lake odor
- Travel distance
- Water quality
- Water temperature
- Wind

Responses from the on-site survey are shown in Table 7 and Figure 7. Over three-fourths (77.6%) of respondents indicated lake access was at least "moderately important" in shaping their decision to visit the lake. This was followed by water quality, which 65.3% of respondents indicated was at least "moderately important" to their decision. While the least important factor was water temperature, a full two-fifths (42.9%) of respondents indicated it was at least "moderately important" in affecting their decision to visit.

Responses from the resident survey are also shown in Table 7 and Figure 7. For residents who recreate at the lake, water quality and lake odor are the most important factors shaping their decisions of whether to visit the lake or not. Similar to the on-site sample, lake access was also one of the most important factors.

As shown in Figure 7, the ten factors asked about all play an important role in recreationists' decision-making processes; this was true for both samples. Importantly, there does not appear to be a discernable difference between the importance of physical factors (e.g., lake access, travel distance), environmental factors (e.g., water quality, air temperature), social factors (e.g., crowds), and biological factors (e.g., fishery quality), as the majority of respondents reported each factor asked about as at least "slightly important."

Table 7

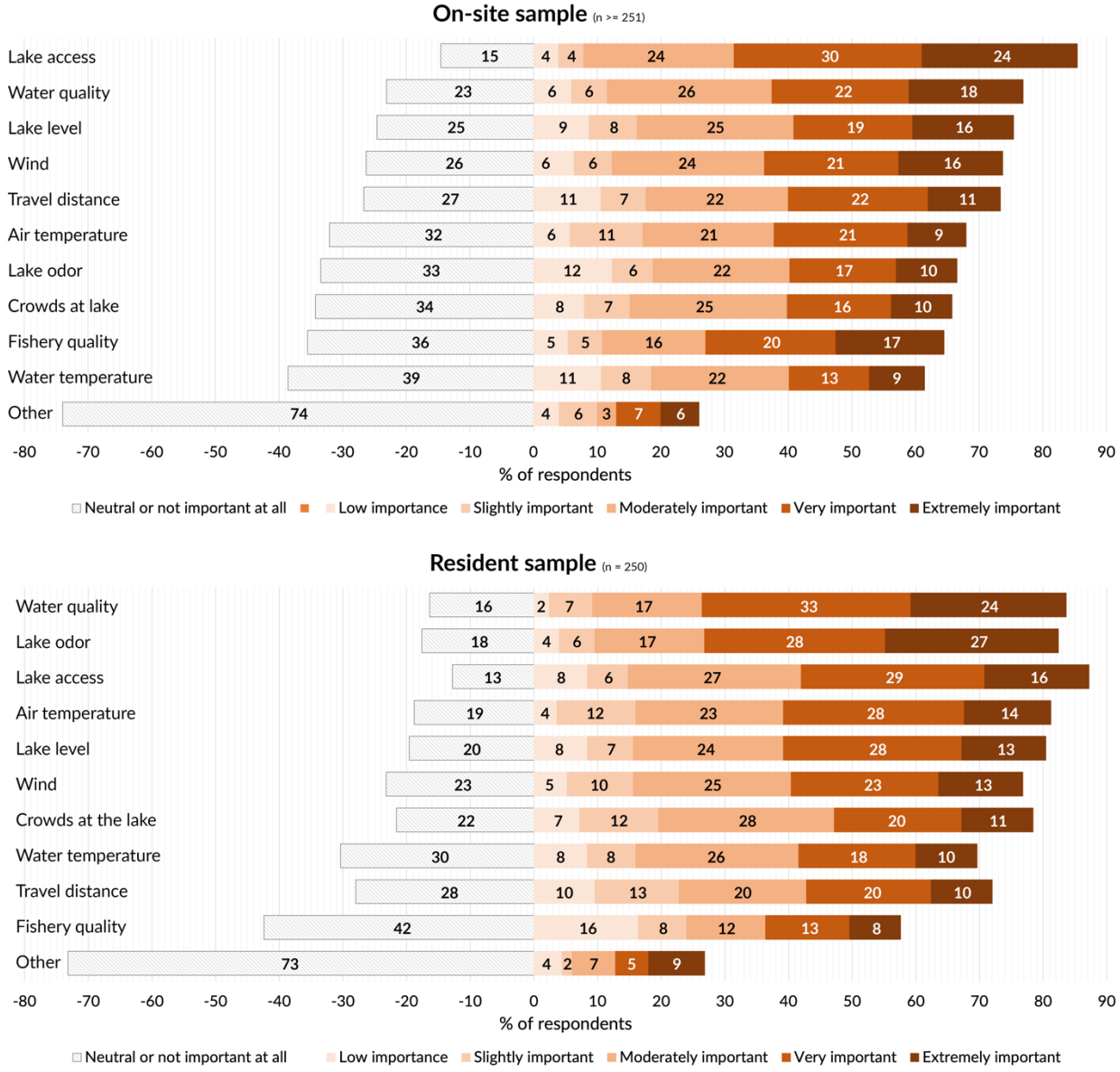
Importance of Different Factors Affecting Trip Taking to Utah Lake for Recreationists Surveyed at the Lake

	Recreationists Surveyed at the Lake						
Factor *(type)*	**Neutral**	**Not Important at All**	**Low Importance**	**Slightly Important**	**Moderately Important**	**Very Important**	**Extremely Important**
Lake access *(physical)*	10.6	3.9	3.9	3.9	23.6	29.5	24.4
Water quality *(environmental)*	18.7	4.4	6.0	5.6	25.9	21.5	17.9
Lake level *(environmental)*	19.4	5.2	8.7	7.5	24.6	18.7	15.9
Wind *(environmental)*	21.9	4.4	6.4	6.0	23.9	21.1	16.3
Travel distance *(physical)*	15.3	11.4	10.6	7.1	22.4	22.0	11.4
Air temperature *(environmental)*	20.2	11.8	5.7	11.5	20.6	21.0	9.2
Lake odor *(environmental)*	22.7	10.8	12.4	6.4	21.5	16.7	9.6
Crowds at the lake *(social)*	21.9	12.4	8.0	7.2	24.7	16.3	9.6
Fishery quality (fish species present or abundant) *(biological)*	13.5	22.0	5.4	5.4	16.2	20.5	17.0
Water temperature *(environmental)*	26.4	12.2	10.6	7.9	21.7	12.6	8.7
Other	65.0	9.0	4.0	6.0	3.0	7.0	6.0

	Residents of Salt Lake and Utah Counties Who Had Recreated At Utah Lake in the Past Year						
Factor *(type)*	**Neutral**	**Not Important at All**	**Low Importance**	**Slightly Important**	**Moderately Important**	**Very Important**	**Extremely Important**
Water quality *(environmental)*	11.6	4.8	2.4	6.8	17.2	32.8	24.4
Lake odor *(environmental)*	14.8	2.8	4.0	5.6	17.2	28.4	27.2
Lake access *(physical)*	8.4	4.4	8.4	6.4	27.2	28.8	16.4
Air temperature *(environmental)*	11.6	7.2	3.6	12.4	23.2	28.4	13.6
Lake level *(environmental)*	15.6	4.0	8.4	7.2	23.6	28.0	13.2
Wind *(environmental)*	20.4	2.8	5.2	10.4	24.8	23.2	13.2
Crowds at the lake *(social)*	17.6	4.0	7.2	12.4	27.6	20.0	11.2
Water temperature *(environmental)*	22.4	8.0	8.4	7.6	25.6	18.4	9.6
Travel distance *(physical)*	21.6	6.4	9.6	13.2	20.0	19.6	9.6
Fishery quality (fish species present or abundant) *(biological)*	16.8	25.6	16.4	7.6	12.4	13.2	8.0
Other	47.2	26.0	4.4	1.6	6.8	5.2	8.8

Note. Factors are listed in descending order of importance *(total percentage of respondents rating the factor as moderately, very, or extremely important.*

Figure 7
Importance of Different Factors Affecting Trip Taking to Utah Lake



Desirability

The heart of the survey were the photo sets depicting images of the lake at areas and times when chl-*a* concentrations varied. We asked respondents to view a randomly selected image pair (Figure 2) and indicate how desirable they believed the water was for five different activities that varied in the extent to which they require individuals to interact with the water. The five different activities were:

- Swimming
- Boating
- Fishing
- Consuming Fish
- Near-water activities

Response options ranged from "vey undesirable" to "very desirable" and did include a "neutral" option. Results for each photo pair are shown in Table 8 and Figure 8.

Table 8
Desirability for Participating in Different Activities Near or in Water with Different Chl-a Concentrations for Recreationists Surveyed at the Lake

Activity	Chl-*a* Level *(value)*	Very Undesirable (%)	Moderately Undesirable (%)	Slightly Undesirable (%)	Neutral (%)	Slightly Desirable (%)	Moderately Desirable (%)	Very Desirable (%)
				Open Water Image Pairs				
Swimming	Low *(9.7)*	18.8	13.0	13.8	28.3	10.9	9.4	5.8
	Medium *(25.2)*	13.9	13.9	8.3	30.6	25.0	2.8	5.6
	High *(55.2)*	24.6	13.8	17.4	21.0	10.1	9.4	3.6
	Very High *(219.3)*	21.3	13.3	16.0	22.0	8.0	11.3	8.0
	Ext. High *(406.7)*	16.8	13.1	14.6	29.2	13.1	9.5	3.7
Boating	Low *(9.7)*	8.1	11.8	8.8	36.8	11.0	12.5	11.0
	Medium *(25.2)*	5.6	5.6	8.3	33.3	16.7	22.2	8.3
	High *(55.2)*	8.8	12.5	12.5	36.8	8.8	12.5	8.1
	Very High *(219.3)*	10.2	12.2	10.2	29.3	10.9	13.6	13.6
	Ext. High *(406.7)*	8.1	7.4	11.0	43.4	14.0	8.8	7.4
Fishing	Low *(9.7)*	8.9	8.9	7.4	37.8	10.4	12.6	14.1
	Medium *(25.2)*	10.8	8.1	0.0	27.0	24.3	13.5	16.2
	High *(55.2)*	8.2	5.9	10.4	42.2	10.4	12.6	10.4
	Very High *(219.3)*	8.8	8.2	11.6	28.6	15.0	10.9	17.0
	Ext. High *(406.7)*	5.1	7.3	5.8	44.5	11.7	14.6	11.0
Consuming fish	Low *(9.7)*	19.1	13.2	12.5	30.9	5.2	9.6	9.6
	Medium *(25.2)*	13.9	16.7	11.1	27.8	16.7	8.3	5.6
	High *(55.2)*	25.4	11.9	11.2	29.9	9.7	8.2	3.7
	Very High *(219.3)*	21.8	12.2	9.5	31.3	4.8	12.2	8.2
	Ext. High *(406.7)*	14.0	14.0	12.5	36.8	11.0	7.4	4.4
Near-water activities	Low *(9.7)*	6.7	11.9	13.4	35.1	10.5	11.9	10.5
	Medium *(25.2)*	2.8	8.3	11.1	36.1	16.7	16.7	8.3
	High *(55.2)*	6.8	8.3	13.6	37.1	12.1	10.6	11.4
	Very High *(219.3)*	8.8	11.5	10.1	33.1	11.5	14.9	10.1
	Ext. High *(406.7)*	6.6	6.6	15.4	39.0	11.0	14.7	6.6
				Shoreline Image Pairs				
Swimming	Low *(4.8)*	13.2	13.2	29.0	10.5	10.5	10.5	13.2
	Medium *(23.2)*	14.7	8.8	14.7	17.7	8.8	29.4	5.9
	High *(57.2)*	19.4	9.7	22.6	12.9	3.2	22.6	9.7
	Very High *(104.0)*	21.9	21.9	9.4	25.0	15.6	0.0	6.3
	Ext. High *(330.7)*	20.0	16.0	20.0	24.0	12.0	4.0	4.0
Boating	Low *(4.8)*	5.3	10.5	15.8	29.0	10.5	15.8	13.2
	Medium *(23.2)*	5.9	8.8	2.9	29.4	8.8	35.3	8.8
	High *(57.2)*	6.5	3.2	9.7	32.3	12.9	22.6	12.9
	Very High *(104.0)*	13.3	13.3	16.7	23.3	16.7	13.3	3.3
	Ext. High *(330.7)*	12.0	4.0	16.0	24.0	16.0	20.0	8.0
Fishing	Low *(4.8)*	8.1	8.1	18.9	24.3	2.7	16.2	21.6
	Medium *(23.2)*	5.9	8.8	8.8	26.5	5.9	32.4	11.8
	High *(57.2)*	0.0	3.1	6.3	37.5	12.5	12.5	28.1
	Very High *(104.0)*	13.3	0.0	23.3	26.7	16.7	13.3	6.7
	Ext. High *(330.7)*	8.0	12.0	0.0	20.0	16.0	28.0	16.0
Consuming fish	Low *(4.8)*	21.1	15.8	13.2	29.0	0.0	15.8	5.3
	Medium *(23.2)*	17.7	17.7	5.9	14.7	2.9	32.4	8.8
	High *(57.2)*	10.0	6.7	13.3	30.0	10.0	16.7	13.3
	Very High *(104.0)*	20.0	10.0	23.3	20.0	16.7	3.3	6.7
	Ext. High *(330.7)*	28.0	8.0	8.0	24.0	16.0	4.0	12.0
Near-water activities	Low *(4.8)*	2.7	5.4	13.5	35.1	10.8	21.6	10.8
	Medium *(23.2)*	2.9	2.9	11.8	26.5	14.7	32.4	8.8
	High *(57.2)*	3.3	3.3	13.3	23.3	16.7	20.0	20.0
	Very High *(104.0)*	9.4	3.1	25.0	37.5	15.6	6.3	3.1
	Ext. High *(330.7)*	16.0	8.0	12.0	36.0	8.0	16.0	4.0

Note. Sample sizes for each open water image pair are: Low (n ≥ 134), Medium, (n ≥ 36), High (n ≥ 132), Very High (n ≥ 147), Ext. High (n ≥ 136). Sample sizes for each shoreline image pair are: Low (n ≥ 37), Medium, (n ≥ 34), High (n ≥ 30), Very High (n ≥ 30), Ext. High (n ≥ 25).

Table 9

Desirability for Participating in Different Activities Near or in Water with Different Chl-a Concentrations for Residents of Salt Lake and Utah Counties Who Had Recreated at the Lake in the Past Year

Activity	Chl-*a* Level (*value*)	Very Undesirable (%)	Moderately Undesirable (%)	Slightly Undesirable (%)	Neutral (%)	Slightly Desirable (%)	Moderately Desirable (%)	Very Desirable (%)
				Open Water Image Pairs				
Swimming	Low *(9.7)*	23.5	14.1	20.1	12.8	11.4	10.1	8.1
	Medium *(25.2)*	35.5	19.4	18.1	8.4	9.7	4.5	4.5
	High *(55.2)*	43.1	19.0	11.1	8.5	5.9	4.6	7.8
	Very High *(219.3)*	48.0	18.5	12.3	8.2	6.9	4.8	1.4
	Ext. High *(406.7)*	29.7	22.5	15.2	15.9	7.3	2.9	6.5
Boating	Low *(9.7)*	7.4	11.4	14.1	20.8	18.8	12.8	14.8
	Medium *(25.2)*	16.1	15.5	12.9	20.0	12.9	13.6	9.0
	High *(55.2)*	18.3	16.3	15.0	12.4	13.1	13.7	11.1
	Very High *(219.3)*	19.2	15.1	20.6	19.2	7.5	12.3	6.2
	Ext. High *(406.7)*	16.7	9.4	14.5	23.2	14.5	14.5	7.3
Fishing	Low *(9.7)*	10.1	12.1	15.4	18.1	13.4	17.5	13.4
	Medium *(25.2)*	18.7	12.9	13.6	19.4	15.5	11.0	9.0
	High *(55.2)*	19.6	14.4	11.1	20.3	11.8	11.1	11.8
	Very High *(219.3)*	24.0	14.4	15.1	26.0	8.2	8.2	4.1
	Ext. High *(406.7)*	18.8	13.0	12.3	25.4	10.1	11.6	8.7
Consuming fish	Low *(9.7)*	29.5	10.7	16.8	16.1	9.4	8.7	8.7
	Medium *(25.2)*	37.4	9.7	11.6	19.4	11.0	4.5	6.5
	High *(55.2)*	38.6	15.7	11.1	11.8	10.5	5.2	7.2
	Very High *(219.3)*	43.8	11.0	15.8	13.7	6.9	5.5	3.4
	Ext. High *(406.7)*	31.2	12.3	15.9	15.9	10.1	7.3	7.3
Near-water activities	Low *(9.7)*	5.4	9.4	17.5	20.1	16.1	20.1	11.4
	Medium *(25.2)*	14.8	11.6	13.6	24.5	12.3	14.2	9.0
	High *(55.2)*	13.7	13.7	13.7	19.0	15.7	10.5	13.7
	Very High *(219.3)*	17.1	17.1	16.4	24.0	8.2	11.0	6.2
	Ext. High *(406.7)*	11.6	10.9	15.9	21.7	16.7	15.2	8.0
				Shoreline Image Pairs				
Swimming	Low *(4.8)*	40.0	22.0	16.7	7.3	3.3	7.3	3.3
	Medium *(23.2)*	20.7	16.3	24.4	13.3	11.1	10.4	3.7
	High *(57.2)*	35.6	19.9	17.1	6.2	11.0	5.5	4.8
	Very High *(104.0)*	52.9	21.0	10.9	9.2	0.8	2.5	2.5
	Ext. High *(330.7)*	26.9	11.9	20.2	11.9	13.4	10.5	5.2
Boating	Low *(4.8)*	22.7	14.0	13.3	15.3	15.3	14.0	5.3
	Medium *(23.2)*	11.9	7.4	9.6	23.0	20.0	15.6	12.6
	High *(57.2)*	13.7	15.1	20.6	13.7	14.4	17.8	4.8
	Very High *(104.0)*	25.2	12.6	14.3	21.0	14.3	4.2	8.4
	Ext. High *(330.7)*	10.5	9.0	11.2	23.1	17.2	15.7	13.4
Fishing	Low *(4.8)*	24.0	13.3	12.0	18.7	12.0	13.3	6.7
	Medium *(23.2)*	13.3	12.6	13.3	21.5	17.0	14.1	8.2
	High *(57.2)*	20.6	11.0	15.1	24.7	11.6	11.6	5.5
	Very High *(104.0)*	24.4	14.3	15.1	20.2	10.9	8.4	6.7
	Ext. High *(330.7)*	15.7	9.7	9.7	21.6	13.4	18.7	11.2
Consuming fish	Low *(4.8)*	38.0	12.7	16.0	14.7	8.0	6.0	4.7
	Medium *(23.2)*	25.2	19.3	14.1	14.1	12.6	9.6	5.2
	High *(57.2)*	39.7	13.7	13.7	13.7	6.9	6.2	6.2
	Very High *(104.0)*	48.7	19.3	9.2	15.1	4.2	3.4	0.0
	Ext. High *(330.7)*	30.6	14.2	6.7	17.9	11.9	10.5	8.2
Near-water activities	Low *(4.8)*	18.7	14.7	8.7	18.0	18.0	12.0	10.0
	Medium *(23.2)*	11.9	5.9	11.1	19.3	19.3	23.0	9.6
	High *(57.2)*	13.7	13.7	13.7	15.8	20.6	17.8	4.8
	Very High *(104.0)*	26.9	15.1	13.5	21.9	8.4	10.9	3.4
	Ext. High *(330.7)*	14.2	4.5	11.2	21.6	19.4	16.4	12.7

Note. Sample sizes for each open water image pair are: Low (n ≥ 149), Medium, (n ≥ 155), High (n ≥ 153), Very High (n ≥ 146), Ext. High (n ≥ 138). Sample sizes for each shoreline image pair are: Low (n ≥ 150), Medium, (n ≥ 135), High (n ≥ 146), Very High (n ≥ 119), Ext. High (n ≥ 134).

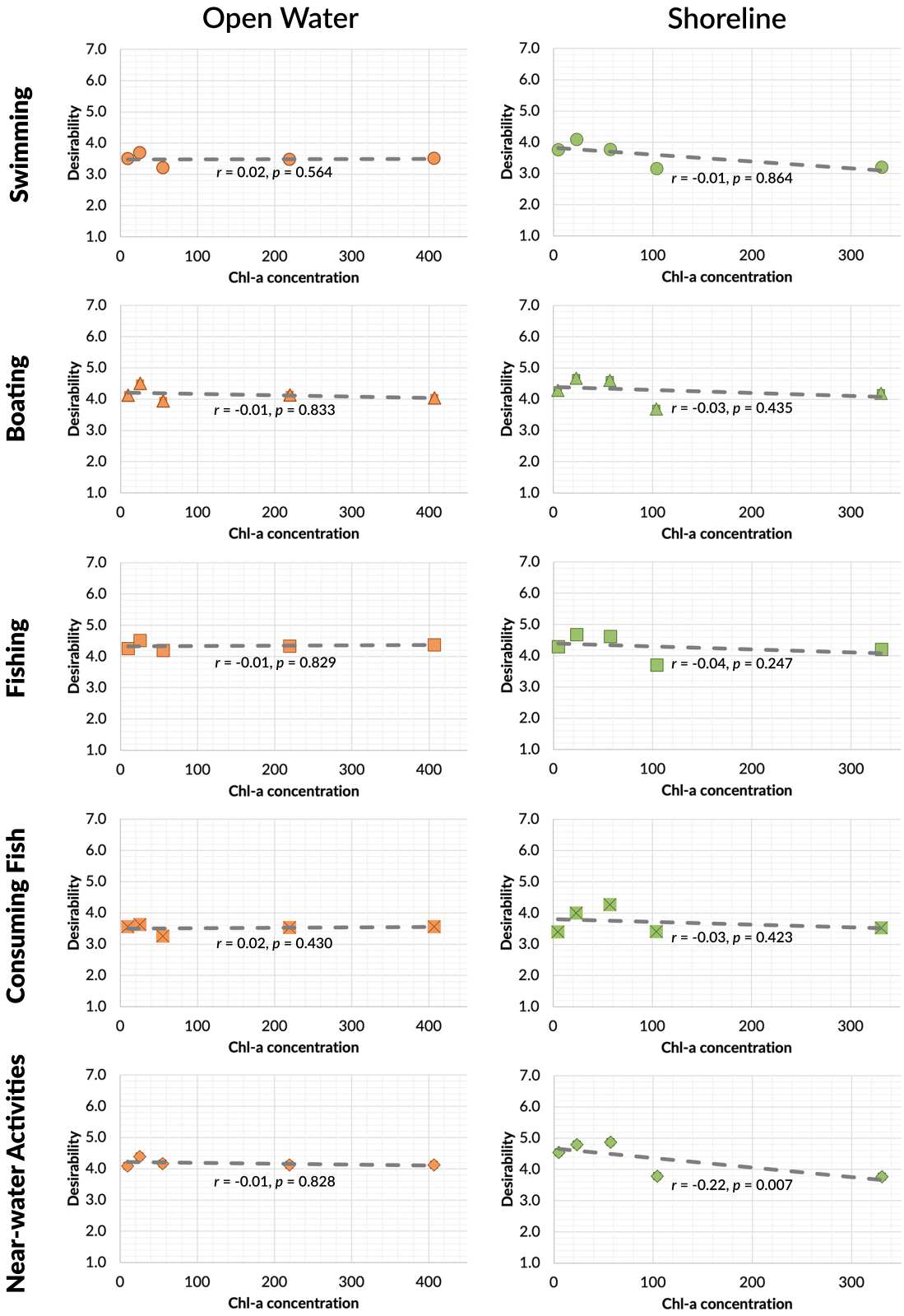
The data show no significant relationships between recreationists' desirability for swimming, boating, fishing, or consuming fish from pictures of water with different chl-*a* concentrations ($p \geq 0.247$) (Figure 8). Similarly, the data show mixed results for the relationship between recreationists' desirability for participating in near-water activities close to water with different chl-*a* concentrations. When viewing images of open-water, there was no significant association ($p = 0.828$), while there was for images of the shoreline ($p = 0.007$). Analysis of data from the resident survey are similar, with no significant and

negative relationships between recreationists' desirability for the different activities asked about and increasing chl-*a* concentrations (Figure 9). Collectively, these data show very weak evidence that recreationists are responsive to highly variable chl-*a* concentrations.

While chl-*a* concentrations are not significantly and negatively associated with chl-*a* concentrations, it is worth noting that respondents appear to believe direct contact activities such as consuming fish and swimming are more sensitive to changes in water quality. Regardless of the chl-*a* of the image shown, roughly 36% of residents of Salt Lake and Utah Counties believed the water shown was "very undesirable" for either consuming fish or swimming. This percentage dropped to roughly 15% for each of the other activities asked about. For those sampled on-site, roughly 20% believed the water shown was "very undesirable" for either consuming fish or swimming. This percentage dropped to between 5 and 10% for each of the other activities asked about.

Figure 8

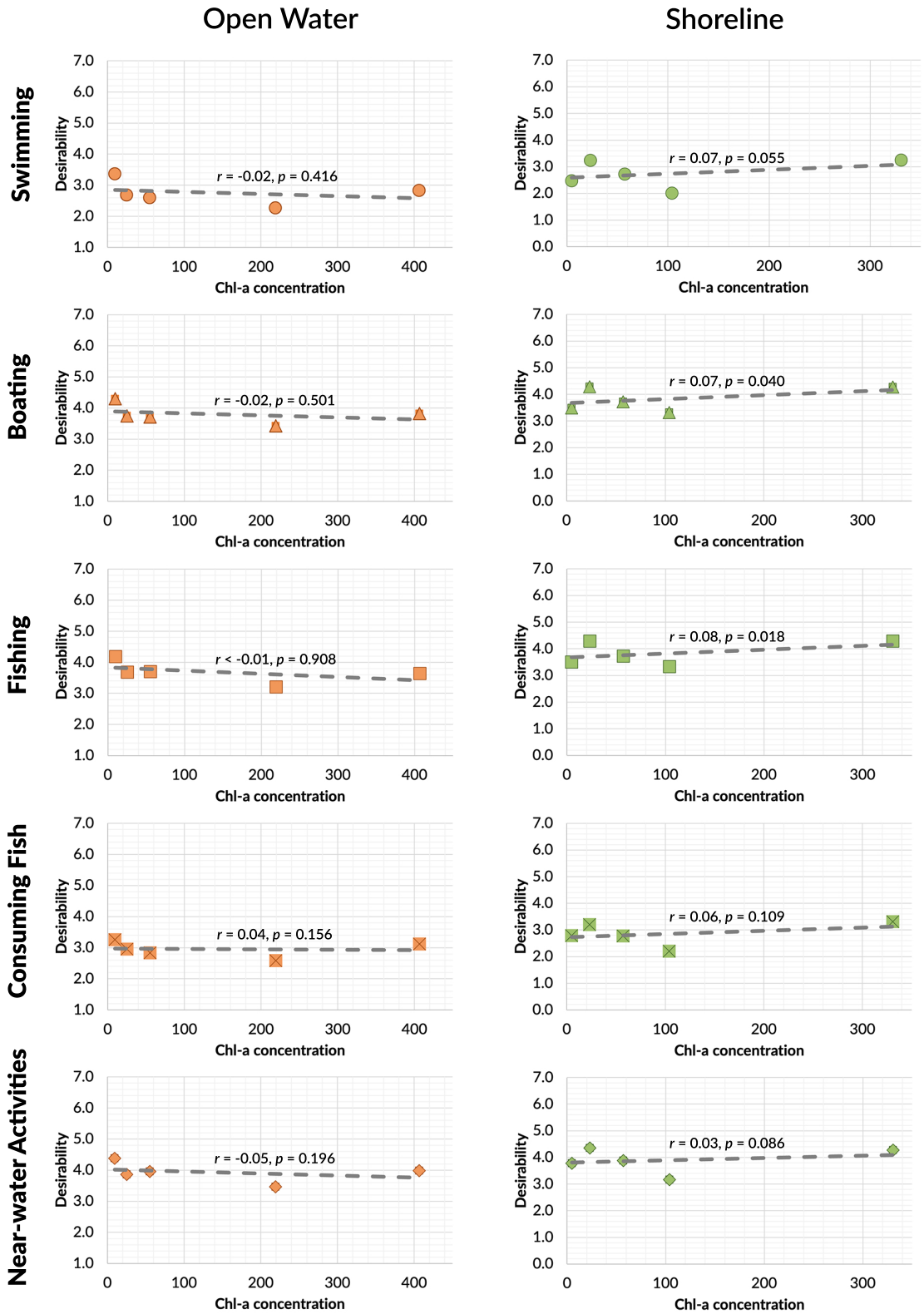
Mean Desirability Scores for Participating in Different Activities with Different Chl-a Concentrations (On-site Sample)



Note. Response scale (y-axis) included 1 = "very undesirable," 2 = "moderately undesirable," 3 = "slightly desirable," 4 = "neutral," 5 = "slightly desirable," 6 = "moderately desirable," and 7 = "very desirable." Sample sizes noted in Table 8.

Figure 9

Mean Desirability Scores for Participating in Different Activities with Different Chl-a Concentrations (Resident Sample)



Note. Response scale (y-axis) included 1 = "very undesirable," 2 = "moderately undesirable," 3 = "slightly desirable," 4 = "neutral," 5 = "slightly desirable," 6 = "moderately desirable," and 7 = "very desirable." Sample sizes noted in Table 9.

Next, we turned our attention to discerning if there were other factors that might be affecting, and possibly moderating, recreationists' assessments of how desirable Utah Lake was for different recreational activities. The results of the random effects ordered probit panel data model fit to data from the on-site sample are summarized in Table 10. Even after controlling for all the other factors known to influence individuals' assessments of water quality, chl-*a* concentrations have no effect on recreationists' assessment of desirability to participate in different recreational activities near or in water with varying chl-*a* concentrations ($p \geq 0.162$). The same can be said for turbidity ($p \geq 0.170$) and the ratio of total volatile solids to total suspended solids (TVS:TSS) ($p \geq 0.193$), which quantifies the proportion of turbidity associated with organic material (primarily algae) and suspended solids (TSS contains both inorganic and algal elements of turbidity). Trip frequency was positively and significantly correlated with three of the five types of activities asked about. Individuals who recreate at the lake more frequently were more likely to rate the water shown as desirable for fishing, consuming fish, and near-water activities. The analysis also revealed individuals who were participating in non-contact activities were more likely to rate the water shown as desirable for swimming, boating, consuming fish, and near-water activities relative to those individuals who were not participating in contact activities. Women also rated the water shown as significantly less desirable for fishing, consuming fish, and near-water activities relative to men ($p \leq 0.001$). Respondent age was positively associated with the desirability of the water shown for consuming fish ($p = 0.006$). Income however, was negatively associated with the desirability of the water shown for consuming fish ($p = 0.015$). As might be expected, photographs of shorelines were rated as more desirable for near-water activities relative to photographs of open water ($p = 0.020$).

Table 10
Results of the Random Effects Ordered Probit Panel Data Model Predicting Desirability for Participating in Different Activities With Different Chl-a Concentrations (On-site Sample)

Independent Variable	Swimming Coef.	Boating Coef.	Fishing Coef.	Consuming Fish Coef.	Near-water Activities Coef.
Water Quality Indicator					
Chl-*a* *(µg/L)*	-0.010	0.042	-0.002	0.017	0.058
Turbidity *(NTU)*	0.000	-0.002	0.002	0.002	-0.006
TVS:TSS *(µg/L)*	-0.002	-0.008	-0.003	-0.006	-0.003
Respondent Characteristics					
Trip frequency	0.000	0.001	0.002*	0.001*	0.002*
Use history	0.001	0.006*	0.003	0.000	0.003
Prior experience with water quality issues at Utah Lake	-0.015	0.042	0.051	0.125	-0.069
Non-contact activities *(0 = no, 1 = yes)*	0.206*	0.222*	0.083	0.160*	0.342*
Contact activities *(0 = no, 1 = yes)*	0.073	0.169*	0.139	0.134	-0.153
Age	-0.003	-0.003	0.001	0.006*	-0.001
Income	0.008	0.014	-0.031	-0.031*	-0.009
Education	-0.028	0.009	0.000	-0.012	0.024
Gender *(0 = male, 1 = female)*	-0.024	-0.080	-0.334*	-0.231*	-0.139*
Photograph Location					
Photograph location *(0 = open water, 1 = shoreline)*	0.115	0.105	0.048	-0.012	0.223*

* Significant at the .05 level.
Note. An alternative model was also fit using

Results of the model fit to data from the resident sample are shown in Table 11. Again, chl-*a* concentrations were not significantly related to desirability ratings ($p \geq 0.270$). However, respondents' ratings were contingent upon the turbidity of the water shown. More turbid water was significantly and negatively associated with desirability ratings specific to swimming, fishing, and consuming fish ($p \leq 0.050$)[1]. Respondents' ratings were not associated with TVS:TSS. Trip frequency was positively and

[1] The activities which are more sensitive to increasing levels of turbidity (swimming, fishing, and consuming fish) are those activities involving direct interaction with the water. This same pattern has been observed in studies of the sensitivity of different activities to chl-*a* concentrations (Kishbaugh, 1994).

significantly correlated with all activities asked about ($p \leq 0.007$). Individuals who recreate at the lake more frequently were more likely to rate the water shown as desirable for all of the activities asked about ($p \leq 0.007$). Individuals who have recreated at the lake for longer were also more likely to rate the water shown as desirable for boating and fishing ($p \leq 0.005$). The analysis also revealed individuals who participated in non-contact activities on their most recent trip to the lake were more likely to rate the water shown as desirable for swimming, consuming fish, and near-water activities relative to those individuals who were not participating in non-contact activities ($p \leq 0.001$). Individuals who participated in contact activities on their most recent trip to the lake were less likely to rate the water shown as desirable for swimming, boating, fishing, and consuming fish relative to those individuals who were not participating in contact activities ($p \leq 0.001$). Women also rated the water shown as significantly less desirable for all activities relative to men ($p \leq 0.014$). Age, education, and gender were associated with desirability ratings for several activities (Table 11). Again, photographs of shorelines were rated as more desirable for near-water activities relative to photographs of open water ($p = 0.045$).

Table 11
Results of the Random Effects Ordered Probit Panel Data Model Predicting Desirability for Participating in Different Activities With Different Chl-a Concentrations (Resident Sample)

Independent variable	Swimming Coef.	Boating Coef.	Fishing Coef.	Consuming Fish Coef.	Near-water Activities Coef.
Water Quality Indicator					
Chl-*a* *(µg/L)*	0.105	0.100	0.114	0.070	0.033
Turbidity *(NTU)*	-0.016*	-0.009	-0.010*	-0.014*	-0.005
TVS:TSS *(µg/L)*	-0.004	-0.011	-0.009	0.001	-0.003
Respondent Characteristics					
Trip frequency	0.021*	0.011*	0.010*	0.017*	0.002*
Use history	-0.003	0.010*	0.011*	0.004	0.004
Prior experience with water quality issues at Utah Lake	-0.069	-0.015	0.038	-0.028	-0.052
Non-contact activities *(0 = no, 1 = yes)*	0.423*	0.135	0.087	0.490*	0.360*
Contact activities *(0 = no, 1 = yes)*	-0.636*	-0.409*	-0.485*	-0.625*	-0.074
Age	-0.005	-0.011*	-0.012*	-0.009*	-0.004
Income	-0.051*	-0.033	0.021	-0.034	-0.001
Education	0.080*	0.036*	0.013	0.062*	0.027*
Gender *(0 = male, 1 = female)*	-0.468*	-0.462*	-0.343*	-0.520*	-0.156*
Photograph Location					
Photo location *(0 = open water, 1 = shoreline)*	0.008	-0.011	-0.046	0.041	0.180*

Note. * Significant at the .05 level.

In summary, the finding of no association between varying chl-*a* concentrations and recreationists' assessment of desirability to participate in different recreational activities near or in water at Utah Lake suggest chl-*a* concentrations alone do not influence recreationists' perceptions. Turbidity appears to be a much better predictor of desirability, at least for nearby residents. For three of the four activities asked about, these individuals' desirability ratings were significantly correlated with the turbidity of water shown. For both samples, the ratio of total volatile solids to total suspended solids was not associated with the desirability of water shown. These findings are discussed in detail below.

Perceptions of Water Quality over Time

We next asked recreationists about their perceptions of how water quality at Utah Lake has changed over time. The question was asked of respondents who indicated they had been recreating at the lake for more than 5 years, more than 10 years, more than 20 years, and more than 30 years. Respondents were only asked the question once, depending upon how long they had been recreating at the lake. If respondents had been visiting Utah Lake for less than 5 years, they were not asked this question.

Data from the on-site sample suggest recreationists who have been recreating at the lake for between 5 and 10 years believe water quality is about the same as it was since they started to visit (Table 12, Figure 10). Over half (52.9%) of respondents indicated water quality was similar to what it was between 5 and 10 years ago. Nearly half (40.7%) of individuals who have been recreating at the lake for between 10 and 20 years believe water quality has declined during that time, slightly more (44.0%) of

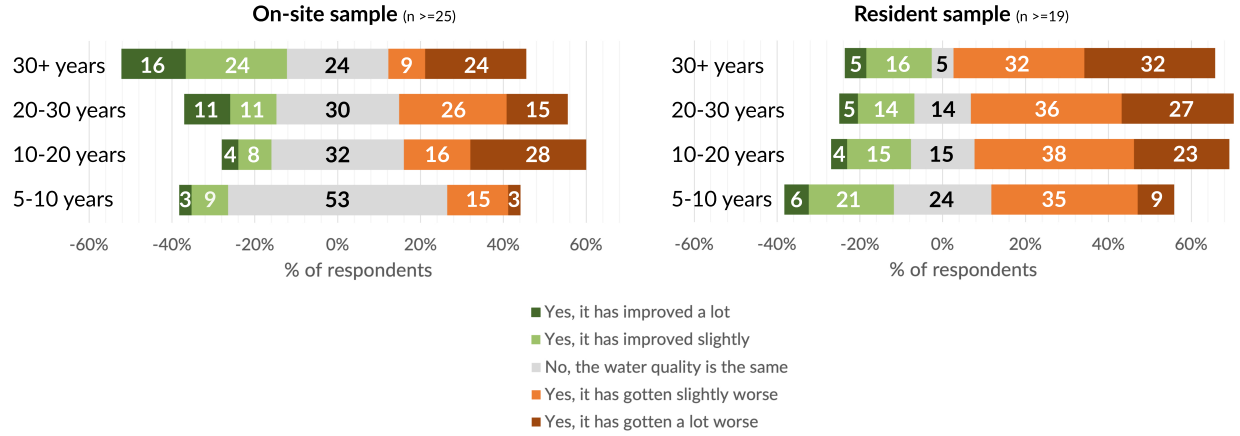
those who have been recreating at the lake for 20 to 30 years hold the same beliefs. Those individuals who have been recreating at the lake for over 30 years tend to hold strong and divergent views with regard to changes in water quality since they started recreating at the lake. Nearly one-quarter (24.4%) of these long-time recreationists believe water quality has "gotten a lot worse" while another 15.6% believe it has "gotten a lot better." These long-time recreationists also held the least ambivalence toward changes in water quality, with only 2.2% indicating they were unsure whether water quality had either improved or worsened since they started recreating at the lake.

Data from the sample of residents show similar trends (Table 13, Figure 10). 44.1% of residents who have recreated at the lake for between 5-10 years believe water quality has worsened over that time. This proportion jumps to ~60% for residents who had been visiting the lake for more than 10 years. Nearly one-third of residents who have been recreating at the lake for more than 30 years believe water quality "has gotten a lot worse" since they started visiting.

Table 12
Recreationists' Perceptions of Changes in Water Quality Over Time

	Recreationists Surveyed at the Lake *(n = 384)*					
Years Recreating at the Lake	**Yes, it has improved a lot**	**Yes, it has improved slightly**	**No, the water is the same as it was**	**Yes, it has gotten slightly worse**	**Yes, it has gotten a lot worse**	**Unsure**
5 to 10 years	2.9	8.8	52.9	14.7	2.9	17.7
10 to 20 years	4.0	8.0	32.0	16.0	28.0	12.0
20 to 30 years	11.1	11.1	29.6	25.9	14.8	7.4
More than 30 years	15.6	24.4	24.4	8.9	24.4	2.2
	Residents of Salt Lake and Utah Counties who had Recreated at the Lake in the Past Year *(n = 265)*					
Years Recreating at the Lake	**Yes, it has improved a lot**	**Yes, it has improved slightly**	**No, the water is the same as it was**	**Yes, it has gotten slightly worse**	**Yes, it has gotten a lot worse**	**Unsure**
5 to 10 years	5.9	20.6	23.5	35.3	8.8	5.9
10 to 20 years	3.9	15.4	15.4	38.5	23.1	3.9
20 to 30 years	4.6	13.6	13.6	36.4	27.3	4.6
More than 30 years	5.3	15.8	5.3	31.6	31.6	10.5

Figure 10
Recreationists' Perceptions of Changes in Water Quality Over Time



Experiences with Water Quality

Awareness of and Types of Experiences with Water Quality Issues

Roughly two-thirds (64.8%) of recreationist sampled on site indicated they had "heard, read about, or experienced" issues related to water quality at Utah Lake. When questioned about how they had either heard, read about, or experienced issues related to water quality at the lake, most respondents indicated they had "heard about them through a local news report" (57.9%), "read about them online" (53.2%), or "heard about them from a friend or family member" (50.9%). Notably fewer recreationists had experienced water quality issues in other ways (Table 13).

Perceptions of Utah Lake

Data from the resident survey suggest only half (51.2%) of residents had "heard, read about, or experienced" issues related to water quality at Utah Lake. Of those who have, the types of experience with water quality issues at the lake mirrored those reported by recreationists sampled on-site (Table 13). The only notable exception was the proportion of residents who reported "seeing signs around the lake." Only 11.8% of residents reported seeing signs related to water quality around the lake, while 34.5% of recreationist sampled at the lake had. This is intuitive, given only half of residents reported ever recreating at the lake within the 12 months preceding the survey.

Table 13
Recreationists' Experience with Water Quality Issues at Utah Lake

	Recreationists Surveyed at the Lake *(n = 384)*		Resident of Salt Lake and Utah Counties *(n = 265)*	
Type of experience	**%**	**Rank**	**%**	**Rank**
Heard about them from a local news report	57.9	1	60.8	1
Read about them online	53.2	2	48.5	3
Heard about them from a friend or family member	50.9	3	53.6	2
Saw signs around the lake	34.5	4	11.8	6
Visited, and was dissatisfied with the water quality	18.1	5	17.3	4
Read about them in a local print magazine or newspaper	9.4	6	13.9	5
Tried to visit, but could not because access point was closed	8.8	7	7.2	8
Heard about them in a podcast	4.7	8	9.3	7

We also asked what types of water quality issues recreationists had heard, read about, or experienced. This question was only asked of the respondents who indicated they had heard, read about, or experienced water quality issues. For those sampled at the lake, the majority had heard, read about, or experienced either Harmful Algal Blooms (84.8%) or poor water clarity (60.2%). Only one-third (33.9%) indicated they had heard, read about, or experienced bacteria-related issues. The proportions were similar for the sample of Salt Lake and Utah county residents. Nearly three-fourths of these respondents (70.9%) had heard, read about, or experienced Harmful Algal Blooms. The proportion dropped to 60.8% for poor water clarity and 43.0% for bacteria-related issues.

Concern About Water Quality Issues

For the recreationists sampled at the lake who had heard, read about, or experienced Harmful Algal Blooms, 53.9% reported being either "moderately concerned" or "extremely concerned" (Table 14, Figure 11). Slightly more concern was expressed by residents who had heard, read about, or experienced Harmful Algal Blooms. Of these individuals, 70.2% reported being either "moderately concerned" or "extremely concerned."

For recreationists sampled at the lake who had heard, read about, or experienced poor water bacteria-related issues, 49.1% indicated they were "moderately" or "extremely concerned" about these issues (Table 14, Figure 11). This proportion jumped to 74.3% for residents who had heard, read about, or experienced bacteria-related issues.

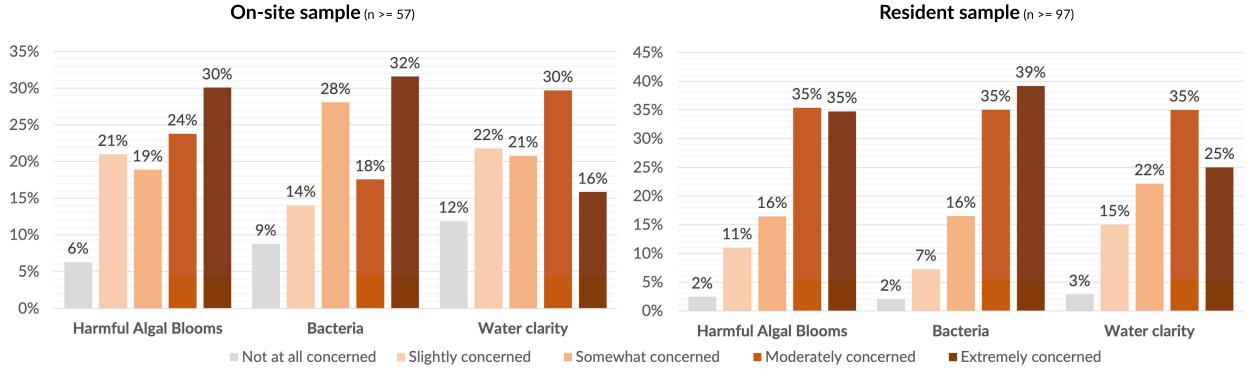
Finally, for recreationists sampled at the lake who had heard, read about, or experienced poor water clarity, 45.5% indicated they were "moderately" or "extremely concerned" about this issue (Table 14, Figure 11). This proportion was slightly higher (60.0%) for residents who had heard, read about, or experienced bacteria-related issues.

Table 14
Recreationists' Concern About Harmful Algal Blooms, Bacteria, and Water Clarity at Utah Lake

	Recreationists Surveyed at the Lake *(n = 384)*				
Type of Water Quality Issue	**Not at All Concerned**	**Slightly Concerned**	**Somewhat Concerned**	**Moderately Concerned**	**Extremely Concerned**
Harmful Algal Blooms	6.3	21.0	18.9	23.8	30.1
Bacteria	8.8	14.0	28.1	17.5	31.6
Water clarity	11.9	21.8	20.8	29.7	15.8

	Residents of Salt Lake and Utah counties who had heard, read about, or experienced each type of water quality issue *(n = 265)*				
Type of Water Quality Issue	**Not at All Concerned**	**Slightly Concerned**	**Somewhat Concerned**	**Moderately Concerned**	**Extremely Concerned**
Harmful Algal Blooms	2.4	11.0	16.5	35.4	34.8
Bacteria	2.1	7.2	16.5	35.1	39.2
Water clarity	2.9	15.0	22.1	35.0	25.0

Figure 11
Concern about Harmful Algal Blooms, Bacteria, and Water Clarity at Utah Lake.



Substitution Behaviors in Response to Water Quality Issues

Recreationists were also asked what they would have done instead if they could not have visited Utah Lake due to concerns about Harmful Algal Blooms, bacteria, or poor water quality. This question was only asked of those recreationists sampled on-site as well as residents who indicated they had recreated at Utah Lake at some point in the 12-months preceding the survey who had heard, read about, or experienced each issue. Separate questions were asked for each issue.

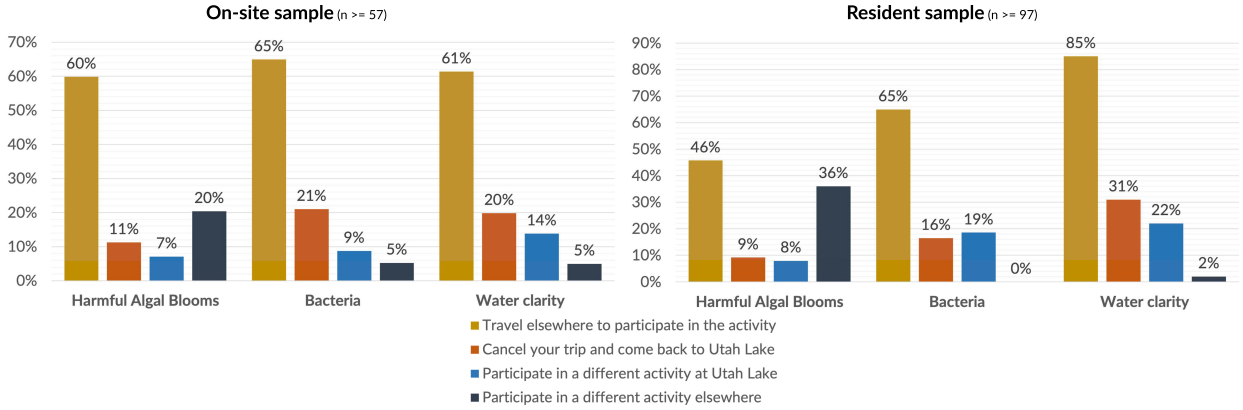
Of those individuals sampled at the lake, most indicated they would "travel elsewhere to participate in their desired activity" if they could not participate in it at Utah Lake due to concerns over Harmful Algal Blooms (59.9%), bacteria (64.9%), or water clarity (61.4%). Other substitution behaviors such as "canceling the trip and coming back to Utah Lake," "participating in a different activity at Utah Lake," or "participating in a different activity elsewhere" were substantially less preferred by recreationists (Table 15; Figure 12). Results were very similar for residents of Salt Lake and Utah counties who had recreated at Utah Lake in the 12-months preceding the survey (Table 15, Figure 12).

Table 15
Substitution Behaviors in Response to Water Quality Issues

Type of Water Quality Issue	Recreationists Surveyed at the Lake *(n = 171)*			
	Travel Elsewhere to Participate in the Activity (%)	Cancel Your Trip and Come Back to Utah Lake at Another Time (%)	Participate in a Different Activity at Utah Lake (%)	Participate in a Different Activity Elsewhere (%)
Harmful Algal Blooms	59.9	11.3	7.0	20.4
Bacteria	64.9	21.1	8.8	5.3
Water clarity	61.4	19.8	13.9	5.0

Type of Water Quality Issue	Residents of Salt Lake and Utah Counties who had Recreated at Utah Lake in the 12-months Preceding the Survey *(n = 237)*			
	Travel Elsewhere to Participate in the Activity (%)	Cancel Your Trip and Come Back to Utah Lake at Another Time (%)	Participate in a Different Activity at Utah Lake (%)	Participate in a Different Activity Elsewhere (%)
Harmful Algal Blooms	45.7	9.2	7.9	36.0
Bacteria	65.0	16.5	18.6	0.0
Water clarity	85.0	31.0	22.0	2.0

Figure 12
Substitution Behaviors in Response to Water Quality Issues



Socio-demographic Characteristics

The sociodemographic characteristics of both samples are reported in Table 16. Respondents sampled at the lake, by and large, were middle age (mean age = 43.7), well-educated (36.5% had at least a bachelor's degree), white (81.4%), and have an annual household incomes between $50,000 - $150,000 per year (52.3% of respondents). The resident sample was similar (mean age = 41.8, 42.8% with a bachelor's degree. 76.7% white, and 52.4% with household incomes between $50,000 - $150,000 per year). One notable difference between the samples was in the gender of respondents. Only 31.0% of those sampled on site were women, while the proportion of female respondents to the resident survey was 51.0%. It is likely the on-site survey oversampled men because of their more frequent trips to the lake.

Table 16
Sociodemographic Characteristics of Utah Lake Users

	Recreationists Surveyed at the Lake (n = 384)					Residents of Salt Lake and Utah Counties (n = 541)				
				Range					Range	
Sociodemographic Characteristic	%	Mean	Std. Dev.	Min.	Max.	%	Mean	Std. Dev.	Min.	Max.
Age		40.0	14.7	18	74		41.8	16.3	18	91
Education (%)										
Less than high school	3.1					0.4				
Some high school	3.5					2.9				
High school graduate	23.6					20.6				
Vocational/trade school	3.9					3.3				
Some college	19.4					20.6				
Associate degree	10.1					9.5				
Bachelor's degree	26.7					30.1				
Master's degree	7.0					9.5				
Professional degree	1.6					1.6				
Doctoral degree	1.2					1.6				
Gender (%)										
Male	65.5					48.5				
Female	31.0					51.1				
Prefer not to answer	3.5					0.4				
Hispanic (%)										
Yes	14.0					14.0				
Ethnicity (%)										
American Indian	1.9					6.1				
Asian	6.2					4.3				
Black	1.9					15.0				
Hawaiian or other Pacific Islander	3.9					2.2				
White	81.4					76.7				
Income (%)										
Less than $25,000	14.3					13.8				
$25,000 to $34,999	9.0					12.2				
$35,000 to $49,999	10.2					10.9				
$50,000 to $74,999	19.6					18.0				
$75,000 to $99,000	13.1					18.4				
$100,000 to $149,000	19.6					16.0				
$150,000 to $199,999	5.3					6.4				
$200,000 to $249,999	3.7					2.0				
$250,000 to $299,999	2.5					1.3				
$300,000 or more	2.9					1.1				
Residency										
USA	96.2					97.6				
Other than the USA	3.8					2.4				

Discussion

We set out on this investigation to develop a better understanding of the various preferences for water clarity and quality amongst those who currently do or potentially could recreate on Utah Lake. Our survey effort was guided by three research objectives and informed by input from members of the Utah Lake Water Quality Study Steering Committee. The specific objectives of the project were to determine:

1. Whether there are thresholds in the aesthetic appearance of lake water (as indicated by different chl-*a* concentrations) beyond which current and potential visitors believe Utah Lake becomes undesirable for different recreation activities.

2. Determine the extent to which recreationists as well as nearby residents are aware of and concerned about water quality issues at the lake.

3. Establish a foundational understanding of who the recreationists at Utah Lake are (e.g., their sociodemographic characteristics), and how they recreate on the lake (e.g., their activity preferences, their visit frequency, etc.).

Critical Thresholds Beyond Which Water Quality is Unacceptable for Recreation

No critical thresholds of chl-*a* were observed that notably affected the desirability of participating in recreation at Utah Lake; this is true for both recreationists surveyed at the lake as well as those surveyed via mail. It appears both recreationist who are actively using the lake, as well as residents who had recreated at the lake in the recent past, are not capable of discerning differences in water quality as indicated in images of the water with varying chl-*a* concentrations. The analysis did show however, that turbidity was a dominant indicator driving residents' perceptions of whether the water at Utah Lake is suitable for recreation. It appears from the analysis and data presented here that there are a large proportion of Utah Lake users (primarily those sampled through the on-site survey) who tend to be indifferent in their assessments of how water of varying quality and clarity affects the desirability to participate in different recreational activities. These individuals appear to unresponsive to changes in water quality/clarity.

It is not entirely surprising to find no critical thresholds of chl-*a* beyond which recreationists believe water quality at Utah Lake is unacceptable for recreation. The development of user perception surveys to inform numeric nutrient criteria for lakes dates back to the late 1980s and early 1990s (Heiskary & Walker, 1988). Reviews of this early work point out user perception surveys are most useful when lake users can substantively identify an individual change in the aesthetic characteristics of lake water (Kishbaugh, 1994). Most applications of user perception surveys have focused on the growth of benthic algae, finding lake user thresholds between 15-20 µg/L (Heiskary & Walker, 1988; Hoyer et al., 2004; Smeltzer & Heiskary, 1990; A. J. Smith et al., 2015)[2]. Even the "medium" chl-*a* image-pairs presented to respondents in this study had chl-*a* values in the mid 20's, so we were very surprised that recreationists and residents did not rate the "very poor" water quality as undesirable. Again, the mean desirability ratings are shown in Figure 8 and 9. When viewing these ratings, it is important to note that the midpoint on the response scale (neutral) was 4 and that values above this midpoint represent desirable perceptions. Even for the images where chl-*a* concentrations were exceptionally high (> 250 µg/L), recreationists do not tend to rate the water as undesirable.

Another logical explanation for why we were unable to discern critical thresholds of chl-*a* beyond which recreationists believe water quality is undesirable comes from the presence of coincident water clarity indices. Water clarity in Utah Lake is diminished by both increases in algal density and suspension of lake bed particulate matter during wind events. Attempts were made to isolate these factors when sampling, but isolation of these two mechanisms was not always possible. We presented images to individuals that systematically varied in chl-*a*, however they also had some natural variation in a variety of other covariates (e.g., turbidity, TVS:TSS, etc.). This coincidence of clarity indicators is likely to have made it more difficult for respondents to evaluate desirability. It is worth noting that early nutrient monitoring efforts purposefully chose not to use user perception surveys on dystrophic and calcareous lakes (Kishbaugh, 1994). Both dystrophic and calcareous lakes exhibit "brownness" and "yellowness" in addition to the "greenness" caused by benthic algae. In New York, even the coincidence of nuisance macrophytes (with algae) was found to impair lake users' ability to discern aesthetic differences in lake conditions (Kishbaugh, 1994)

Within the context of similar research conducted within Utah, previous survey-based analysis has found a clear threshold for benthic algae beyond which river water becomes undesirable for recreation (Jakus et al., 2017) The images shown to survey respondents in that study did not include water clarity

[2] It is important to acknowledge an analogous literature focused on users' perceptions of rivers with varying nutrient pollution levels. In this literature, there has been a noted threshold of ~ 150 µg/m^2 beyond which river water becomes undesirable for recreation. Even though this trend has been observed in surveys of residents of both Utah (Jakus et al., 2017) and Montana (Suplee et al., 2009), it does not appear the threshold translates to lakes. This chl-a threshold is an order of magnitude higher than those commonly reported for lakes (Angradi et al., 2018). Lakes and rivers differ notably in the biophysical processes affecting water clarity (e.g., wind, sediment movement, etc.), and it appears users' perceptions of acceptability vary notably across they two water body types as well.

indicators (e.g., turbidity) that could have covaried with the presence of benthic algae. This is similar to previous lake-based studies outside the state (Heiskary & Walker, 1988; Hoyer et al., 2004; Smeltzer & Heiskary, 1990; A. J. Smith et al., 2015). It appears the absence of water clarity covariates may be a very important factor in identifying thresholds of acceptability.

In lakes for which clarity is not driven by nutrient concentrations, there has been very little research. Even when previous research has identified a trend in desirability relative to quality/clarity, the analysis is often limited to simple frequency distributions and perhaps bivariate analysis. This research is one of the first efforts to disentangle whether lake users are more (or less) responsive to different measures of water quality/clarity. The analysis revealed turbidity was consistently and negatively correlated with the desirability of Utah Lake water for swimming, fishing, and consuming fish. This suggests many recreationists are assessing water quality/clarity based primarily on turbidity as opposed to the "greenness" of the lake, as would be expected if either chl-*a* or TVS:TSS were significantly and consistently associated with desirability ratings. However, recent research utilizing social media data and water quality/clarity metrics suggests negative sentiments are positively and non-linearly related to both turbidity *and* chl-*a* (Do et al., 2021). This finding, taken in conjunction with those reported from our analysis, suggest Utah Lake recreationists likely can perceive differences in both turbidity and chl-*a*, but that much of their ability to make these differentiations comes from stimuli that were not present in our survey (e.g., more extensive visual cues, odors, the opinions of others, etc.). Put simply, the survey format employed in this research appears to have obfuscated some of the important contextual factors that likely influence individuals' ability to assess the desirability of water quality/clarity at Utah Lake. While the Environmental Protection Agency's primer on common practices and insights for developing user perception surveys to protect water quality from nutrient pollution make no mention of the difficulties in conducting user perception surveys on lakes experiencing both "brownness" and "greenness," the results of this work (in addition to early nutrient monitoring efforts) suggest a cautionary note is warranted. Further work using alternative methods, such as on-site interviews at randomly sampled days, are warranted for lakes and perhaps other types of waterbodies that have water quality/clarity indicators which do not covary.

Recreationists and Residents' Awareness of, and Concern for, Water Quality Issues at Utah Lake

This study provides some new insights into recreationists and residents' awareness of, and concern for, water quality issues at Utah Lake. We expected the proportion of both recreationist and residents who were aware of water quality issues at Utah Lake to be much higher than it was. Of those "regulars" who recreate at the lake an average of 20 times a year, only two-thirds (64.8%) said they had "hear, read about, or experienced" issues related to water quality at Utah Lake. This proportion dropped to 57.2% for residents of Salt Lake and Utah counties who recreate at the lake and 44.6% for residents who do not recreate at the lake. While water quality (and related) issues seem to be common knowledge for some, the data here suggest that is not the case. This finding highlights an opportunity to educate the recreating public about aesthetic expectations and water quality issues at the lake. State agencies, user groups, and non-profit organizations all can play integral roles in increasing the public's awareness of when, and how, to safely recreate on, or near, Utah Lake.

The survey did assume individuals were aware that harmful algal blooms, excessive bacteria, and water clarity all water quality issues. This may not always be the case, as some individuals may be aware of these issues, but not associate them with water quality. Consequently, the percentages noted above may be biased downward. If so, there may be an additional need to inform and educate the recreationists and the public about what "water quality issues" are, and consequently how they may affect their ability to recreate safely at Utah Lake.

Currently, large proportions of the public are unaware that any issues even exist. It is essential for resource managers to convey water quality information to the recreating public in as clear, direct, and obvious ways as possible. Finding that many recreationists to Utah Lake cannot differentiate, or do not care, about water with extremely variable chl-*a* concentrations places increasing demands on the agencies responsible for resource management and public safety.

This suggestion points to a need for more proactive engagement and education efforts as opposed to solely relying on reactionary water quality advisories and warnings. Data from the survey efforts show that of the recreationists who are aware of water quality issues at Utah Lake, the majority (> 50%) receive their information from local news reports, online, and friends and family members. By comparison, only one-third of lake visitors reported encountering a water quality warning at an access point during any of their visits to the Lake. The need for more, and more diverse, methods of educating the public about how to recreate responsibly is a common need throughout Utah (J. W. Smith & Trout, 2023); the data presented here suggest this need is particularly acute at Utah Lake. It is important to note that when water quality warnings are in effect, they are more likely to be encountered by individuals participating in certain types of outdoor recreation activities. For example, individuals who participate in activities that are less proximate to water (e.g., wildlife viewing, picnicking, walking/running, etc.) are less likely to be encounter water quality warnings if they are present. This fact reinforces the need for more diverse methods of educating the public about how to recreate in a safe and responsible way around Utah Lake.

A Foundational Understanding of Who the Recreationists at Utah Lake Are

While only a tertiary focus of this research, we were able to develop a broad understanding of who Utah Lake recreationists are, information that has been elusive in the past given the lake's access points are managed by a variety of different agencies and municipalities. This information can guide the management of Utah Lake and how the state, user groups, and non-profit organizations communicate information to the public about changes to water clarity, water quality, and public safety. Notable findings include:

- The lake supports a variety of terrestrial and water-based recreation activities. Nearly half (45.3%) of recreationists sampled at the lake participated in fishing. Of the Salt Lake and Utah County residents who recreate at the lake, nearly half (49.1%) said they hike/walk/run at the lake while roughly two-thirds engage in either photography, picnicking, or motorized boating at the lake.
- Relatively few of either recreationists sampled on-site or residents of Salt Lake and Utah County reported participating in activities involving direct contact with the water at Utah Lake. This may indicate those individuals who do participate in these activities have altered their trip-taking behavior by choosing to recreate at another lake or reservoir that has fewer water quality concerns.
- Most (~82%) visitors do not bring a watercraft with them during their recreational trips.
- On average, Utah Lake recreationists have been visiting the lake for approximately a decade.
- Of those sampled at the lake, lake access was the most important factor shaping recreationists' decisions to visit the lake, this is followed by water quality and the level of the lake. Of residents of Salt Lake and Utah county who recreate at the lake, the most important factors (in order) were water quality, lake odor, and lake access.
- Only two-thirds (64.8%) of recreationists sampled at the lake indicated they had "heard, read about, or experienced" issues related to water quality at Utah Lake. This proportion dropped to 57.2% for Salt Lake and Utah county residents who recreate at the lake and 44.6% for residents who do not recreate at the lake. These proportions may be lower than what those familiar with the lake believe, given the frequent news coverage of lake-related issues. This may be very likely, as the survey revealed that if recreationists could not recreate at Utah Lake because of water quality issues, they indicated a highly likelihood of traveling elsewhere to participate in their preferred activity.
- For those individuals who had heard, read about, or experienced water quality related issues, the majority had heard, read about, or experienced either Harmful Algal Blooms (~80%) or poor water clarity (~60%); only one-third (~40%) indicated they had heard, read about, or experienced bacteria-related issues.

A particularly noteworthy finding comes from identifying significantly different use patterns amongst those surveyed on-site and those surveyed via mail. Those surveyed on-site appear to be "the regulars," those committed to recreating at Utah Lake regardless of any water quality issues it might have[3]. On average, a recreationist sampled as part of the on-site survey recreates at Utah Lake nearly 20 times a year; this compares with the roughly three trips per year taken by the random sample of Salt Lake and Utah County residents. Given the frequency of their use, it is unsurprising these individuals are not responsive to varying levels of water clarity. It is highly likely they have seen Utah Lake at not only it's clearest, but also at its most turbid, its most green, and its most "scummy," and they keep coming back. Data from both survey efforts reinforce this point, as we found more frequent use of the lake to be positively associated with perceptions of the desirability for different on- or near-water recreation activities. More frequent recreators are clearly deriving a lot of personal utility from the lake, and its surrounding recreational amenities, in their current condition. We highlight this point to emphasize the fact that all recreation at Utah Lake is not contingent upon water quality/clarity. Fishing, for example, was by far the most common activity those sampled on-site were participating in. This activity, as well as several others that were more common amongst the on-site sample (e.g., wildlife viewing, picnicking, etc.) are not dependent upon water quality/clarity. The number one factor affecting the on-site sample's decisions to visit the lake was "ease of access;" more important than any of the negative factors believed to deter visitation. Frequent visitors are, and will likely continue to be, an important user group that the municipalities, counties, and state agencies who provide outdoor recreation on, or around, the lake need to provide opportunities for long into the future.

Conclusion

Collectively, the research suggests there is a need to educate the recreating public about water quality issues at the Lake. Recreationists to the lake either cannot differentiate between water with exceptionally high levels of chl-*a or* the do not care about water quality. Results from the survey efforts suggest the former is more likely than the latter as nearly two-thirds of those surveyed at the lake (65.3%) and nearly three-quarters of nearby residents (74.4%) indicated that water quality was a "moderate," "very," or "extremely" important factor in their decisions to recreate at Utah Lake. The findings of the study do suggest, however, that nearby residents who recreate at the lake are responsive to water with varying turbidity levels. Knowing that recreationists' aesthetic preferences are not contingent upon the visual appearance of water with high chl-*a* concentrations points to the need for more proactive engagement and education efforts. This need is amplified if one considers only two-thirds (64.8%) of recreationists sampled at the lake indicated they had "heard, read about, or experienced" issues related to water quality at Utah Lake. This proportion dropped to 57.2% for Salt Lake and Utah county residents who recreate at the lake and 44.6% for residents who do not recreate at the lake. Proactive engagement and education efforts may increase the public's awareness of when, and how, to safely recreate on, or near. The need for more, and more diverse, methods of educating the public about how to recreate responsibly is a common need throughout Utah; the data presented here suggest this need is particularly acute at Utah Lake.

[3] The on-site survey is more likely to sample frequent visitors, a process known as endogenous stratification in the recreation management and resource economics literatures (Shaw, 1988).

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Appendices

Appendix A: Contact email for stakeholder interviews

Dear [NAME OF STAKEHOLDER],

Later this spring, researchers from the Institute of Outdoor Recreation and Tourism at Utah State University will be conducting surveys to assess perceptions of water quality in Utah Lake. The survey efforts are being funded by the Utah Department of Water Quality. The surveys are being designed specifically to identify thresholds at which the users of Utah Lake cyanobacterial blooms and turbidity to be unacceptable for recreation. Beyond this purpose, the surveys can also be used to generate data, information, and knowledge that can be used to guide the management of Utah Lake and how the state, user groups, and organizations communicate information to the public about changes to water clarity, water quality, and public safety. The research team at Utah State University would like to schedule a time with you to provide input into the development of the survey. If you are interested in providing input into the effort, please provide us with your availability on this poll [POLL LINK]. If you have any questions about the survey effort, please feel free to reach out to both Dr. Jordan W. Smith, who is leading the development of the survey, and Scott Daly, the Utah Lake Watershed Coordinator for the Department of Environmental Quality.

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Appendix B: Semi-structured Interview Guide

Later this spring, we will be conducting surveys to assess perceptions of water quality in Utah Lake. The surveys are being designed specifically to identify thresholds at which the users of Utah Lake cyanobacterial blooms and turbidity to be unacceptable for recreation. The target populations that will receive the surveys include a sample of households living in Salt Lake and Utah Counties as well as a sample of recreationists who are actively using the lake. The households will be contacted and asked to respond through a mail-back survey while the recreationists will be contacted through an in-person survey administered on-site at select access points to the lake.

We want to use this time today to make sure we are collecting as much information as possible through the two survey efforts. Our goal is to develop surveys that can generate data, information, and knowledge which can be used to guide the management of Utah Lake and how the state, user groups, and organizations communicate information to the public about changes to water clarity, water quality, and public safety.

First, can you tell us about yourself and how your organization is related to issues of recreation on Utah Lake?

From your perspective, how does poor water quality, such as the presence of algal blooms or high levels of turbidity, affect recreation on Utah Lake?

Are there any specific types of recreationists that are particularly affected by poor water quality at Utah Lake? We want to know so that we can include them in these early discussions.

[FOLLOW-UP] How are these recreationists affected?

[FOLLOW-UP] Are these recreationists affected at a particular time of the year?

[FOLLOW-UP] Do you have a good contact for someone who represents each of the groups you mentioned?

We will be delivering one of our surveys to recreationists who are at the lake. What access points/areas do you think should be the biggest priority for reaching recreationists affected by poor water quality?

What other pieces of information do you think should be asked about in the survey to help guide how the state, user groups, and organizations communicate information to the public about changes to water clarity, water quality, and public safety?

Thanks for your time and input. Is there anything else that we didn't ask about, or you didn't mention, that you think would be helpful to us as we develop the surveys?

Finally, is there anyone who you feel we need to talk to about the development of the survey?

Thanks again. We will be following up in the next several weeks with more information about the draft survey.

Appendix C: Key themes from the interviews (with responses from the research team)

Utah Lake Water Quality Study (ULWQS)
Recreation User Survey Small Group Discussion Themes
Updated on April 27, 2022

Overview
In March and April 2022, ULWQS Steering Committee members met in small groups to discuss and provide feedback on the ULWQS recreation user survey. The objective of the Utah Lake recreation user perception survey is to identify how users respond to different levels of water aesthetics and how they perceive water quality in Utah Lake. The vision for the project is to use well-established methods from the field of survey research and recreation economics to develop an empirically grounded and scientifically defensible understanding of the various preferences for water clarity and quality amongst those who currently do or potentially could recreate on Utah Lake. In total, 15 Steering Committee members participated in five small group discussions to provide input on the survey. The key themes from the discussions are summarized below by question.

1. CAN YOU TELL US ABOUT YOURSELF AND HOW YOUR ORGANIZATION IS RELATED TO ISSUES OF RECREATION ON UTAH LAKE?

Key Theme –Interests
- Agriculture
- Academia
- Residents using Utah Lake as a recreation destination
- Water users and irrigators
- June Sucker recovery
- Providing clean water for irrigation and drinking water
- Vegetation management along Utah Lake
- Balancing recreation use and migratory bird habitat conservation

Key Theme – Personal Experience
- Grew up recreating on Utah Lake
- Regular user of Utah Lake

2. FROM YOUR PERSPECTIVE, HOW DOES POOR WATER QUALITY, SUCH AS THE PRESENCE OF ALGAL BLOOMS OR HIGH LEVELS OF TURBIDITY, AFFECT RECREATION ON UTAH LAKE?

Key Theme – General Use Patterns and Perceptions
- Some people will not recreate on Utah Lake due to historical perceptions that Utah Lake is dirty, regardless of the actual water quality conditions on the lake.
- Utah Lake is warmer and offers a different atmosphere and recreational experience than high-elevation lakes. Most people tend to go to high-elevation lakes.
- People who tend to recreate on Utah Lake were raised recreating on Utah Lake. Those who have historical experience with Utah Lake will likely continue to recreate on the lake regardless of water quality.
- Most people do not evaluate water quality when determining whether they choose to recreate on Utah Lake. They use signs that warn of harmful algal blooms (HABs) to determine whether to

recreate. Signs will likely change where a person recreates on Utah Lake, but they do not stop recreators from recreating on the lake altogether.

- People may choose not to recreate on Utah Lake due to toxins and HABs more than color and clarity. The survey should distinguish whether recreators are not using the lake due to toxins or the color of the water.
- Most people who do not regularly recreate on Utah Lake or have never visited will likely say that water clarity or greenness affects their recreation use. It is important to determine whether someone's perception is driven by on-the-ground experience or different messaging campaigns (e.g., tv advertisements, billboards, etc.).
- Other factors other than water quality can drive recreation use patterns. Water clarity is not the only component of water quality; other water quality metrics, such as E. coli presence, may impact recreation use.
- Foul odors may discourage people from recreating on or near Utah Lake.
- People who regularly recreate on Utah Lake expect turbidity and greenness.
- Different factors impact different recreational user groups. Birders and hunters may care less about the color of Utah Lake than those interacting with the water directly, like boaters and swimmers.
- The survey can be used as an opportunity to increase the awareness and understanding of Utah Lake as a natural system among recreators.

Key Theme – Other Environmental Conditions That Affect Decisions to Recreate on Utah Lake

- Other environmental conditions affect recreational use on Utah Lake, such as lake level and water depth. In particular, people with boats do not want to recreate on Utah Lake when it is too shallow to avoid damaging their boats.
- For anglers, water temperature is a driving factor for recreation use.
- High winds may prevent recreation users from going onto Utah Lake.
- The presence and overgrowth of phragmites may impact shoreline recreators (e.g., birders, hunters, anglers) because their presence prevents users from getting to the lake.

Key Theme – Access and Amenity Concerns Affecting Decisions to Recreate on Utah Lake

- One reason people do not use Utah Lake is that there are very few beach areas on Utah Lake. The beach areas on Utah Lake have trash and are not attractive places for people to recreate.
- Due to limited access points, people do not recreate in some parts of Utah Lake, such as Provo Bay.
- People who recreate on Utah Lake may do so because of its proximity and convenience. In these cases, water quality would likely have a minimal impact on whether someone chooses to recreate on Utah Lake.

Responses to this section:

- The survey collects background information on respondent's including their use history (i.e., how long they have been recreating on Utah Lake) which will allow the research team to address questions raised here.
- The survey includes a question asking where people get their information on water quality, including signs located around the lake.
- Respondents are asked to rate the acceptability of water quality based on photos as well as their concern for different water quality issues based on the information they have heard or read and their experience. This will allow the research team to address questions raised here regarding how recreationists evaluate water quality at Utah Lake.
- Water quality perceptions in the survey are based on several key indicators, including presence of Harmful Algal Blooms, presence of harmful bacteria (e.g., E. coli), and water clarity.

- The survey does not address the effects of foul odors on recreation behaviors, as this would be difficult to objectively measure through a survey.
- To avoid biasing survey responses, and to create a concise survey that addresses the research objectives, we have chosen not to add materials to educate the public about Utah Lake water quality issues and expectations.

3. ARE THERE ANY SPECIFIC TYPES OF RECREATIONISTS THAT ARE PARTICULARLY AFFECTED BY POOR WATER QUALITY AT UTAH LAKE?

Key Theme – Impacts of Water Quality on Specific Recreation User Groups

- The people who water ski on Utah Lake will water ski regardless of the conditions. Some people prefer when Utah Lake has some small pockets of HABs as it will result in fewer people using Utah Lake and create more space for their recreational activities.
- Experienced boaters will avoid areas with algal blooms, but algal blooms on part of the lake will not prevent them from using the lake.
- Poor water quality may discourage recreators who are walking their dogs from recreating near the lake.
- Poor water quality and displeasing aesthetics may affect whether anglers and hunters choose to eat their catch.
- Poor water quality conditions impact those who have direct contact with the lake, like boaters and swimmers. Local triathlon groups that train on Utah Lake are particularly aware of, and susceptible to, poor water quality.

Key Theme – Algal Blooms

- A large portion of water skiers will avoid using the lake if there are algae bloom warnings. A smaller portion of water skiers will avoid the area that a warning applies to but find a different part of the lake to recreate on.
- Cladophora is a type of algae that can pile up along the shoreline of Utah Lake as the lake depth drops. Cladophora is a visual problem, but it is not a problem that the ULWQS Steering Committee can fix, as it is found in many of the tributaries to Utah Lake. The recreation user survey team should not use Cladophora to measure water quality in the survey.

Key Theme – Lake Levels and Depth

- Boaters and water skiers will avoid using the lake later in the season when the lake's depth is lower.
- Boaters may choose to recreate on Utah Lake more during a wet year than during a dry year.
- Lake levels will affect bank anglers and waterfowl and upland game hunters.
- Lake levels impact other environmental conditions, including water quality and water temperatures, that affect recreation use patterns.
- Lower lake levels will expose mudflats that are critical to migratory birds, which will drive bird-watching recreators.

Key Theme – Seasonal Impacts

- Different recreation user groups will use the lake at different times and seasons. The recreational user groups that use Utah Lake in the spring may be different from those that use it in the summer.
- Some recreation user groups may be more exposed to harmful algal blooms, particularly those that use the lake in July, than other recreation user groups.

Response to this section:

- The survey includes questions regarding the respondent's recreational activities on Utah Lake, and length of time they've visited the lake, which will help the research team investigate these ideas.
- The survey does ask about the importance of several factors in affecting recreationists' decision to visit the lake (e.g., distance to the lake, air temperature, water temperature, etc.). Water quality is included in this list, allowing the research team to understand the relative importance of water quality on recreationists' decisions.
- In general, the information gathered through scoping group discussions regarding this question will prove useful in the interpretation of results. We have not added questions to gather all of this information empirically through the survey, as they do not directly address the objectives of this survey.

4. THE SURVEY TEAM WILL BE DELIVERING ONE OF THEIR SURVEYS TO RECREATIONISTS WHO ARE AT THE LAKE. WHAT ACCESS POINTS/AREAS DO YOU THINK SHOULD BE THE BIGGEST PRIORITY FOR REACHING RECREATIONISTS AFFECTED BY POOR WATER QUALITY?

Key Theme – General Comments

- The locations where the survey team distributes surveys should be random to include perspectives from multiple recreation user groups. For example, only surveying at marinas would capture only boaters' perspectives.
- The survey team will likely not connect with any waterfowl hunters until the fall, so the survey team should consider alternative methods to connect with recreation user groups that recreate outside the spring/summer timeframe.
- The survey team should put QR codes at different points around the lake to passively capture recreators.

Key Theme – Boating Access Points

- Lindon Marina
- Lincoln Beach Marina
- Provo Bay boating dock
- Saratoga Springs City Marina

Key Theme – Birding, Pedestrian, Fishing, and Hunting Access Points

- There are maps of the different sediment types on the Utah Lake shoreline. This map may help the recreation survey team identify suitable places for fishing and beach users. Dennis Shiozawa, Brigham Young University (BYU), has access to these maps.
- Anglers often fish at Lincoln Point and the mouth of the Provo River.
- Hunters and anglers access Utah Lake at the mouth of Mill Race.
- Bird watchers frequent Utah Lake at Swede's Lane, the Hobble Creek Wildlife Management Area, and around Goshen Bay.
- Pheasant and waterfowl hunters recreate in areas on the south and southwest sides of the lake.
- The survey team should deliver surveys on the pedestrian walkways, particularly on the north side of the lake around Saratoga Springs, Lehi, and American Fork.
- Surveying at Sandy Beach would capture a variety of recreational uses, including paramotoring, bird watching, and kayaking.
- On the west side of Utah Lake, recreators will access Utah Lake via the Knolls at mile marker 19.
- Many people spend time at the shoreline and beaches around West Mountain.

- The Utah Lake eBird website will identify the hotspots for birding.
- The survey team should survey recreation user groups at the state parks on Utah Lake.
- There are hot springs ("hot pots") that feed into the south part of Utah Lake. The survey team should consider surveying those who use those hot springs.
- There is a private recreational vehicle park by the American Fork boat harbor.

Responses for this section:

- We selected a range of survey delivery locations based on participants' responses to this question. These sites are intended to capture different recreationist activity groups, sampling at marinas, parks, beach areas and other lake access points, targeting boat ramps, campgrounds, beaches, and parking lots at different zones around Utah Lake.
- Sampling sites do not target access points used by hunters, as hunting does not occur during the survey period. Furthermore, in accordance with the objectives of the survey, sampling sites focus on water-based recreationists rather than land-based recreationists, and thus do not specifically include areas along the shoreline trail; however, trail based recreationists will not be excluded if encountered in the sampling locations.
- QR codes: we have chosen not to use QR codes as the literature shows that QR codes result in very low survey response rates. Additionally, it is difficult to quantify if QR code respondents contain a representative sample of the survey population, as we are not able to collect non-response bias data on from those who choose not to respond to the survey.
- While not every site mentioned below is included in the survey, we believe the sites selected are representative of the range of recreational activity groups of interest, particularly focusing on those who come into contact with the water in Utah Lake.

5. DO YOU HAVE A SENSE OF HOW FAR PEOPLE GENERALLY TRAVEL TO UTAH LAKE FOR RECREATION? WHERE SHOULD THE SURVEY TEAM FOCUS THEIR MAIL SURVEYS?

Key Theme – Geographic Extent

- It is unlikely that there is a correlation between proximity to the lake and use. Use of Utah Lake is distributed across Utah Valley.
- The recreation team should survey people who live within a mile of Utah Lake.
- Respondents in Salt Lake County may have different opinions than those in Utah County. The survey team should survey both and see how perceptions may differ among residents in each county.
- Recreation user groups in Salt Lake County will likely be different from those in Utah County. People coming from Salt Lake County to Utah Lake will likely have a more specific purpose (e.g., looking for a certain bird species) than those coming from Utah County.
- The vast majority of recreators on Utah Lake may be from Utah County. The geographic extent of the survey should include Utah and Salt Lake County.

Key Theme – Targeted Interests

- People with boats will be more likely to use the lake. The recreation survey team should sample licensed boaters in Utah and Salt Lake County.
- The state park may have visitor data that indicate where people are coming from to recreate on Utah Lake. If available, the recreation survey team should consider using that information to determine where to send surveys.
- The recreation survey team should reach out to people in Utah and Salt Lake Counties that have a fishing license.

- The recreation survey team should consider having someone hand out surveys at sporting goods stores, fishing equipment shops, and local boat shops in Utah Valley.
- The recreation user survey team should solicit feedback from special interest groups. Potential interest groups include:
    - Duck and waterfowl hunting and conservation non-profits (particularly on the south and southwestern part of Utah Lake)
    - Audubon Society (to contact bird watchers) – Great Salt Lake chapter
    - Great Salt Lake and Utah Waterfowl Associations
    - Utah Lake Water Ski Club
    - T3 Triathlon Club

Key Theme – Distribution Methods

- Cities have reverse 911 systems. It may be possible to send a text message with a link to the survey through those systems.
- City councils will have a good understanding of how to reach their constituents. The survey team should reach out to city councils to distribute the survey.

Responses for this section:

- We will conduct off-site surveys via mail-back and/or email surveys. While the "reverse 911" type text messaging system is useful for broadcasting information to a large audience, we expect it will result in a very low response rate for a survey, with a sample that is not representative of the full population. Thus, we have chosen not to distribute the survey through this text messaging system.

6. WHAT OTHER PIECES OF INFORMATION DO YOU THINK SHOULD BE ASKED ABOUT IN THE SURVEY TO HELP GUIDE HOW THE STATE, USER GROUPS, AND ORGANIZATIONS COMMUNICATE INFORMATION TO THE PUBLIC ABOUT CHANGES TO WATER CLARITY, WATER QUALITY, AND PUBLIC SAFETY?

Responses to this section are addressed for each consideration or group of similar considerations, below.

Key Theme – Additional Considerations

- Utah Lake has certain physical properties and characteristics that impact water quality. The phrasing of survey questions should not set false expectations on what water quality conditions are attainable in Utah Lake.
    - **Response:** We were careful to avoid using language that would bias survey respondents. In doing this, we chose not to provide background information about the water quality dynamics of the lake.

- There are water quality concerns in Utah Lake beyond turbidity and algal blooms. Some concerns, such as E. coli, are not visible. The survey team should consider incorporating these water quality issues into the survey.
    - **Response:** We have incorporated this point into the survey, asking about respondents' experiences with three water quality issues: HABs, bacteria (e.g., E. coli), and water clarity. Based on their response to an initial question, they will be asked to indicate their level of concern for and behavioral response to each issue that they have heard about, read about, or experienced.

Perceptions of Utah Lake

- The survey should distinguish whether someone's perception of Utah Lake is driven by messaging campaigns or on-the-ground experience. There should be questions to detect whether people use media campaign messages to inform their responses.
    - **Response:** We included a question for respondents to report categories of information sources where they have heard, read about, or experienced issues related to water quality at Utah Lake. Given a set of options, they may select all that apply. This will allow the research team to determine if certain categories of information correspond with respondent's awareness of the three primary water quality issues at Utah Lake, as well as respondents' level of concern or predicted behavioral response to those water quality issues.

- The survey should ask respondents whether they perceive that the lake's water quality has improved or degraded over the past couple of years and over the past couple of decades to understand their near-term and long-term perceptions of water quality in Utah Lake. If the user responds that the water quality conditions have degraded, it may suggest that media campaigns have impacted their perception of Utah Lake.
    - **Response:** We have integrated this idea into the survey. For respondents who have recreated at Utah Lake for at least 5 years, we ask a question about their perceptions of whether water quality has changed since they began recreating on the lake, and if that change is improvement of worsening of the water quality.

- The survey should ask people about their historical experience recreating on Utah Lake. Those who grew up recreating on Utah Lake may have a different experience than those who do not.
    - **Response:** We have added a question capturing the length of time that the respondent has recreated on Utah Lake and can combine that information with the individual's age to carry out this type of analysis.

- The phrasing of survey questions should be as neutral as possible.
    - **Response:** We have taken this into consideration and avoid biasing the respondent through the phrasing of the questions.

- In addition to identifying reasons why people do not use Utah Lake, the survey should identify why people who recreate in Utah Lake choose to do so
- The survey should not assume that water quality is the main driver for why people do and do not recreate on Utah Lake. The questions should ask what other factors and considerations people take into account when deciding whether to recreate on Utah Lake.
    - **Response:** In response to the two points above: This is an excellent point. However, to stay within the scope of the objectives of this survey, we have chosen to focus on how water quality attributes affect respondents' predicted visitation patterns at Utah Lake. Adequately addressing other drivers of visitation would increase the length of the survey substantially and would be outside the scope of the project objectives.

- In the questions that use images from Utah Lake, the recreation team should be mindful to ask the question in a way that does not lead to a foregone conclusion. For example, when comparing images, people will always choose to recreate in the clearer water.
    - **Response:** The survey will provide photos of three different chlorophyll-a levels in a randomized order rather than "anchoring" the survey (i.e., having water quality representations grow increasingly better or worse through the course of the survey), to avoid biased responses. The wording of these questions also avoids bias and allows

respondents to indicate their perception of water quality on a 7-point scale ranging from "totally unacceptable" to "perfectly acceptable", with a "neutral" option in between.

- The survey should ask how respondents would prefer to receive information on Utah Lake to inform future educational campaigns.
  - **Response:** This question is outside the scope of the survey objectives, and we have left it out.

- The survey questions should inform further evaluations and allow researchers to monitor trends in people's perceptions and understanding of Utah Lake over time. The survey should be replicable.
  - **Response:** We have kept this in mind in building the survey. This survey will be replicable at desired intervals.

- The survey should ask respondents about their primary occupation.
  - **Response:** We included this question.

- The survey should ask how much people are aware of the different habitat types around Utah Lake.
  - **Response:** We chose not to include this question as it is not within the scope of the survey objectives. Answers would likely be highly varied and would not contribute substantially to interpretation of the survey results.

- Anglers sometimes like to fish near the Timpanogos Special Service District's (TSSD) outfall. The survey should ask if recreators choose to recreate or not recreate in specific parts of Utah Lake due to water quality concerns.
- The survey should ask what type of information would change the mind of respondents. For example, the survey could ask if respondents would be willing to recreate on Utah Lake if they learned that water quality conditions were within an acceptable range according to water quality standards.
  - **Response:** Addressing the two points above, a section of the survey asks respondents to indicate their predicted behavior based on photographic representations of three different levels of water quality.

- The survey should ask questions to better understand how posted warnings affect people's perception of water quality in Utah Lake in the long term. This question may expose certain long-term perception biases people have due to hearing about warnings and closures on Utah Lake.
  - **Response:** The survey asks respondents from which types of sources they have obtained information regarding Utah Lake water quality, including posted warnings at the lake. Based on this information we will be able to analyze how those who obtain information from posted warnings respond to other questions (e.g., perceptions of if water quality has improved/worsened over the time period that they've been recreating on Utah Lake), given a large enough sample size.

- It may be useful to ask about perceptions of macroinvertebrates, as they serve a useful function for improving water quality but may be seen as a nuisance.
  - **Response:** We don't expect enough survey respondents would have strong opinions or perceptions on macroinvertebrates to create results that would be useful for analysis, so we have left this question out.

Key Theme – Additional Questions to Consider

Perceptions of Utah Lake

- How much are people willing to spend to improve water quality in Utah Lake within the constraints of what is attainable given Utah Lake's baseline conditions?
- Are recreation users interested in having access to an education center to teach about the geography and history of Utah Lake?
- What type of facilities would attract recreation users to Utah Lake?
- How far away do you live from Utah Lake?
- What recreation activities do you engage in? What frequency do you engage in those recreation activities?
- How familiar are you with recent media campaigns on Utah Lake?
- Please rank these factors in the degree that they impact your decision to recreate on Utah Lake (e.g., water levels, aesthetics, access to amenities, quality of beaches, toxins, etc.).
- What conditions/amenities would increase your likelihood to recreate on Utah Lake?
- How do you interact with Utah Lake?
- Do you understand cyanotoxin levels in Utah Lake, and if so, do those cyanotoxin levels concern you?
    - **Responses:** Some of these are addressed within the existing survey draft (e.g., how far away do you live from Utah Lake?; What recreation activities do you engage in?). Others are interesting questions that are outside the scope of the present study, but could be pursued in a follow-up study.

Appendix D: Survey instrument

Start of Block: Note: The field technician will fill out this section.

FT1 Site:

- American Fork Marina (American Fork)
- Eagle Park (Saratoga Springs)
- Lincoln Beach Marina (Spanish Fork)
- Lindon Marina (Vineyard)
- Mosida Lake Access (Mosida)
- Mulberry Beach (Spanish Fork)
- Sandy Beach (Spanish Fork)
- Saratoga Springs Marina (Saratoga Springs)
- Shoreline Park (Saratoga Springs)
- Utah Lake State Park (Provo)
- Vineyard Beach (Vineyard)
- Other (please specify): _____

FT2 Survey Location:

- Boat Ramp
- Campground
- Beach
- Parking Lot
- Other (please specify): _____

FT3 **Recreation Perception Surveys to Establish Water Quality Objectives for Utah Lake** You are invited to participate in a research study by Dr. Jordan Smith, Director, and Dr. Anna Miller, Assistant Director of the Institute of Outdoor Recreation and Tourism at Utah State University.

The purpose of this research is to understand the preferences for water clarity and quality amongst those who currently do or potentially could recreate on Utah Lake. Specifically, we are interested in learning about the types and frequency of recreation activity of recreationists who use Utah Lake and their perceived changes in water quality at Utah Lake in recent years. You are being asked to participate in this research because you are recreating at Utah Lake, have recreated at Utah Lake, or are a resident of Utah County.

Your participation in this study is voluntary and you may withdraw your participation at any time and for any reason by telling the research assistant of your desire to do so, or by closing out your web browser. If you take part in this study, you will be asked to participate in a survey which should take approximately 10-minutes to complete.

The possible risks of participating in this study include loss of confidentiality. We cannot guarantee that you will directly benefit from this study, but it has been designed to learn more about perceptions of those who are recreating, have recreated, or could recreate at Utah Lake.

Risks associated with contracting COVID-19 cannot be eliminated. Please carefully consider whether you are comfortable participating in person, particularly if you or someone in your home is at higher risk of serious illness from COVID-19. COVID-19 vaccination is strongly encouraged, but not required, for Utah State University employees and students. This means that we cannot guarantee that the people you interact with in this research project are vaccinated. Masking or using other face coverings is strongly encouraged, but not required, for Utah State University employees and students. This means that we cannot guarantee that the people you interact with in this research project will wear a face covering. Researchers and fellow participants are not required to share vaccination information with you or to wear a facial covering. **Research participation is always completely voluntary, and you can decline or stop participating at any time.**

We will make every effort to ensure the information you provide remains confidential. We will not reveal your identity in any publications, presentations, or reports resulting from this research study.

We will collect your information through Qualtrics, an online survey application, or a hard copy of the survey which you can return to us in a postage paid envelope. If you choose to respond online, online activities always carry a risk of a data breach, but we will use systems and processes that minimize breach opportunities. This survey data will be securely stored in a restricted-access folder on Box.com, an encrypted,

cloud-based storage system and/or a locked drawer in a restricted-access office. If you offer your email address to take the survey online or mail the survey back, email addresses and mailing addresses will be removed from the data files, separating them from responses, prior to being saved to the internal network drive. We will never ask for participants' names, so your identity will never be associated with your response.

You can decline to participate in any part of this study for any reason and can end your participation at any time. If you have any questions about this study, you can contact and member of our research team: Dr. Jordan Smith (jordan.smith@usu.edu) or Dr. Anna Miller (anna.miller@usu.edu). Thank you again for your time and consideration. If you have any concerns about this study, please contact Utah State University's Human Research Protection Office at (435) 797-0567 or irb@usu.edu.

By continuing to and completing the survey, you agree that you are 18 years of age or older, and wish to participate. You agree that you understand the risks and benefits of participation, and that you know what you are being asked to do. You also agree that if you have contacted the research team with any questions about your participation, and are clear on how to stop your participation in this study if you choose to do so. Please be sure to retain a copy of this form for your records.

FT4 Acceptance:

- **YES**, I am over 18 years of age and agree to participate.
- **NO**, I am over 18 years of age and I refuse to participate.
- **LATER**, I am over 18 years of age and I will participate later via email.
- **LANGUAGE BARRIER**, not proficient enough in English to participate.

Skip To: FT6 If FT4 = NO, I am over 18 years of age and I refuse to participate.

Skip To: End of Block If FT4 = YES, I am over 18 years of age and agree to participate.

Skip To: End of Survey If FT4 = LANGUAGE BARRIER, not proficient enough in English to participate.

Display This Question:

If FT4 = LATER, I am over 18 years of age and I will participate later via email.

FT5 What is your email address?

_____

Skip To: End of Survey If Condition: What is your email address? Is Not Empty. Skip To: End of Survey.

Display This Question:

If FT4 = NO, I am over 18 years of age and I refuse to participate.

FT6 Are you willing to answer six quick questions?
Refusal Type:

- NO (**Hard Refusal** -> Ends the survey.)
- YES (**Soft Refusal** -> 6 non-response bias check questions.)

Skip To: End of Survey If FT6 = NO (Hard Refusal -> Ends the survey.)

Page Break

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

NR1 How many people are in your group today?

_____

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

NR2 Are you a permanent resident of the United States?

- Yes
- No

Display This Question:

If NR2 = Yes

NR 2a What is your primary zip code?

_____

Display This Question:

If NR2 = No

NR 2b What is your country of origin?

_____

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

NR 3 What is your age?

_____

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

NR 4 Is this a day trip or overnight trip?

- Day Trip
- Overnight Trip

Display This Question:

If NR 4 = Day Trip

NR 4a How many hours do you plan to spend at Utah Lake today?

_____

Display This Question:

If NR 4 = Overnight Trip

NR 4b How many days do you plan to spend at Utah Lake in total during your trip?

_____

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

NR 5 Watercraft observed to be in use by group: *(Check all that apply.)*

- canoe
- inner-tube
- inflatable raft
- inflatable raft with outboard motor
- jet-ski
- kayak
- motorboat (commercial)
- motorboat (private)
- paddle-board
- sailboat
- other (please specify): _____
- No watercraft observed.

Display This Question:

If FT6 = YES (Soft Refusal -> 6 non-response bias check questions.)

Tech For a soft refusal, please select the option below to skip to the end of the survey.

- The non-response bias checks have been answered. Skip to the end of the survey.

Skip To: End of Survey If Tech = The non-response bias checks have been answered. Skip to the end of the survey.

End of Block: Note: The field technician will fill out this section.

Start of Block: ABOUT YOUR TRIP

TC 1 How many people are in your group on this trip, including yourself?

_____

TC 2 Is this trip a day trip or overnight trip?

- Day Trip
- Overnight Trip

Skip To: TC 2a If TC 2 = Day Trip

Skip To: TC 2b If TC 2 = Overnight Trip

Display This Question:

If TC 2 = Day Trip

TC 2a How many hours do you plan to spend at Utah Lake today?

_____

Display This Question:

If TC 2 = Overnight Trip

TC 2b How many days do you plan to spend at Utah Lake in total during your trip?

_____

TC 3 What was your **primary** activity for visiting Utah Lake on this trip?

- boating (motorized)
- boating (non-motorized)
- biking
- camping
- fishing
- hunting
- hiking/walking/trail running
- photography
- picnicking
- scenic driving
- swimming
- water-skiing
- wildlife viewing
- other (please specify): _____

Carry Forward Unselected Choices from "TC 3"

Perceptions of Utah Lake

TC 4 What other activities have you done, or do you plan to do, while visiting Utah Lake on this trip?

- boating (motorized)
- boating (non-motorized)
- biking
- camping
- fishing
- hunting
- hiking/walking/trail running
- photography
- picnicking
- scenic driving
- swimming
- water-skiing
- wildlife viewing
- other (please specify): _____

Display This Question:

If TC 3 = boating (motorized)

Or TC 3 = boating (non-motorized)

Or Or Trip Characteristics (Other Activities) boating (motorized) Is Selected

Or Or Trip Characteristics (Other Activities) boating (non-motorized) Is Selected

TC 4a Did you use any of the following types of watercraft during your trip to Utah Lake? *(Check all that apply.)*

- canoe
- inner-tube
- inflatable raft
- inflatable raft with outboard motor
- jet-ski
- kayak
- motorboat (commercial)
- motorboat (private)
- paddle-board
- sailboat
- other (please specify): _____

TC 5 How many trips did you take to Utah Lake to participate in ${TC 3/ChoiceGroup/SelectedChoices} last year (2021)?

_____

TC 6 How long have you been visiting Utah Lake to participate in ${TC 3/ChoiceGroup/SelectedChoices}? *(Enter "1" if this is your first year visiting the lake.)*

_____

Perceptions of Utah Lake

TC 8 How important were each of the following factors in your decision to visit Utah Lake today?

	not at all important	low importance	slightly important	neutral	moderately important	very important	extremely important
air temperature	●	●	●	●	●	●	●
crowds at the lake	●	●	●	●	●	●	●
travel distance	●	●	●	●	●	●	●
fishery quality (fish species present or abundant)	●	●	●	●	●	●	●
lake access	●	●	●	●	●	●	●
lake level	●	●	●	●	●	●	●
lake odor	●	●	●	●	●	●	●
water temperature	●	●	●	●	●	●	●
water quality	●	●	●	●	●	●	●
wind	●	●	●	●	●	●	●
other (specify below)	●	●	●	●	●	●	●

Display This Question:

If TC 8 = other (specify below) [low importance]

And TC 8 = other (specify below) [slightly important]

And TC 8 = other (specify below) [moderately important]

And TC 8 = other (specify below) [very important]

And TC 8 = other (specify below) [extremely important]

TC 8a Please specify the other factor you selected.

_____

End of Block: ABOUT YOUR TRIP

Start of Block: PERCEPTIONS OF UTAH LAKE RANDOMIZED

AP 0 The Utah Division of Water Quality is interested in recreationists' perceptions of water clarity and quality at Utah Lake. In the next few questions, we would like you to view several sets of pictures of the lake that were taken on the same date and at the same location. We would like you to let us know how acceptable each set of pictures are for a variety of recreational activities.

End of Block: PERCEPTIONS OF UTAH LAKE RANDOMIZED

Start of Block: AP1

Perceptions of Utah Lake

AP 1

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

AP 1a RANDOM 1

If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP1

Start of Block: AP2

AP 2

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Perceptions of Utah Lake

AP 2a If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP2

Start of Block: AP3

AP 3

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

AP 3a If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP3

Start of Block: AP4

Perceptions of Utah Lake

AP 4

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	○	○	○	○	○	○	○
boating	○	○	○	○	○	○	○
fishing (catch-and-release)	○	○	○	○	○	○	○
consuming fish caught in the water	○	○	○	○	○	○	○
near water activities (e.g. picnicking, hiking, etc.)	○	○	○	○	○	○	○

AP 4a If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP4

Start of Block: AP5

Q130

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	○	○	○	○	○	○	○
boating	○	○	○	○	○	○	○
fishing (catch-and-release)	○	○	○	○	○	○	○
consuming fish caught in the water	○	○	○	○	○	○	○
near water activities (e.g. picnicking, hiking, etc.)	○	○	○	○	○	○	○

Perceptions of Utah Lake

Q131 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP5

Start of Block: AP6

Q132

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Q133 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP6

Start of Block: AP7

Perceptions of Utah Lake

Q134

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Q135 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP7

Start of Block: AP8

Q136

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Perceptions of Utah Lake

Q137 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP8

Start of Block: AP9

Q138

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Q139 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP9

Start of Block: AP10

Perceptions of Utah Lake

Q140

How desirable is the water shown above for each of the following recreational activities?

	very undesirable	moderately undesirable	slightly undesirable	neutral	slightly desirable	moderately desirable	very desirable
swimming	●	●	●	●	●	●	●
boating	●	●	●	●	●	●	●
fishing (catch-and-release)	●	●	●	●	●	●	●
consuming fish caught in the water	●	●	●	●	●	●	●
near water activities (e.g. picnicking, hiking, etc.)	●	●	●	●	●	●	●

Q141 If the water at Utah Lake **always** looked like it does in the images above, approximately how many trips would you take to the lake to participate in ${FT3 /ChoiceGroup/SelectedChoices} each year? *Enter '0' if you would not visit the lake if the water always looked like it does in the images above.*

_____

End of Block: AP10

Start of Block: PERCEPTIONS OF WATER QUALITY OVER TIME BASED ON USE HISTORY

Display This Question:

If If Trip Characteristics (Use History) Text Response Is Greater Than 4

And And Trip Characteristics (Use History) Text Response Is Less Than 10

AP 4 Do you believe that water quality has changed over the past 5 years?

- Yes, it has improved a lot.
- Yes, it has improved slightly.
- No, the water quality is the same as it was 5 years ago.
- Yes, it has gotten slightly worse.
- Yes, it has gotten a lot worse.
- I'm unsure.

Display This Question:

If If Trip Characteristics (Use History) Text Response Is Greater Than 9

And And Trip Characteristics (Use History) Text Response Is Less Than 20

Perceptions of Utah Lake

AP 5 Do you believe that water quality has changed over the past 10 years?

- Yes, it has improved a lot.
- Yes, it has improved slightly.
- No, the water quality is the same as it was 10 years ago.
- Yes, it has gotten slightly worse.
- Yes, it has gotten a lot worse.
- I'm unsure.

Display This Question:

If If Trip Characteristics (Use History) Text Response Is Greater Than 19

And And Trip Characteristics (Use History) Text Response Is Less Than or Equal to 30

AP 6 Do you believe that water quality has changed over the past 20 years?

- Yes, it has improved a lot.
- Yes, it has improved slightly.
- No, the water quality is the same as it was 20 years ago.
- Yes, it has gotten slightly worse.
- Yes, it has gotten a lot worse.
- I'm unsure.

Display This Question:

If If Trip Characteristics (Use History) Text Response Is Greater Than 29

AP 7 Do you believe that water quality has changed over the past 30 years?

- Yes, it has improved a lot.
- Yes, it has improved slightly.
- No, the water quality is the same as it was 30 years ago.
- Yes, it has gotten slightly worse.
- Yes, it has gotten a lot worse.
- I'm unsure.

End of Block: PERCEPTIONS OF WATER QUALITY OVER TIME BASED ON USE HISTORY

Start of Block: EXPERIENCES WITH WATER QUALITY ISSUES AT UTAH LAKE

AE 1 Have you heard, read about, or experienced any issues related to water quality at Utah Lake?

- Yes
- No

Skip To: End of Block If AE 1 = No

Perceptions of Utah Lake

AE 2 How did you hear, read about, or experience issues related to water quality at Utah Lake? *(Check all that apply.)*

- I heard about them from a friend or family member.
- I heard about them from a local news report.
- I heard about them on a podcast.
- I read about them online.
- I read about them in a local print magazine or newspaper.
- I tried to visit the lake, but could not, because the access point was closed.
- I visited the lake, but was dissatisfied with the water quality during my visit.
- I saw signs around the lake.

AE 3 What types of water quality issues at Utah Lake have you heard, read about, or experienced? *(Check all that apply.)*

- Harmful Algal Blooms
- Bacteria (E. *coli*)
- Poor Water Clarity
- Other (please specify): _____

Display This Question:

If AE 3 = Harmful Algal Blooms

AE 4 How concerned are you that harmful algal blooms will negatively impact your recreational activities at Utah Lake in the future?

- not at all concerned
- slightly concerned
- somewhat concerned
- moderately concerned
- extremely concerned

Display This Question:

If AE 3 = Harmful Algal Blooms

AE 5 If you could not have visited Utah Lake today due to concerns over harmful algal blooms, what would you have done instead?

- Travel elsewhere to participate in the same recreational activities
- Cancel your trip and come back to Utah Lake at a different time
- Participate in a different activity at Utah Lake
- Participate in a different activity elsewhere
- Other (please specify): _____

Display This Question:

If AE 3 = Bacteria (E. coli)

AE 6 How concerned are you that harmful bacteria (e.g., E. *coli*) will negatively impact your recreational activities at Utah Lake in the future?

- not at all concerned
- slightly concerned
- somewhat concerned
- moderately concerned
- extremely concerned

Display This Question:

If AE 3 = Bacteria (E. coli)

AE 7 If you could not have visited Utah Lake today due to concerns over harmful bacteria, what would you have done instead?

- Travel elsewhere to participate in the same recreational activities
- Cancel your trip and come back to Utah Lake at a different time
- Participate in a different activity at Utah Lake
- Other (please specify): _____

Display This Question:

If AE 3 = Poor Water Clarity

AE 8 How concerned are you that poor water clarity will negatively impact your recreational activities at Utah Lake in the future?

- not at all concerned
- slightly concerned
- somewhat concerned
- moderately concerned
- extremely concerned

Display This Question:

If AE 3 = Poor Water Clarity

AE 9 If you could not have visited Utah Lake today due to concerns over poor water clarity, what would you have done instead?

- Travel elsewhere to participate in the same recreational activities
- Cancel your trip and come back to Utah Lake at a different time
- Participate in a different activity at Utah Lake
- Other (please specify): _____

End of Block: EXPERIENCES WITH WATER QUALITY ISSUES AT UTAH LAKE

Start of Block: ABOUT YOU

Q1 Are you a permanent resident or citizen of the United States?

- Yes
- No

Skip To: Q2 If Q1 = Yes

Skip To: Q4 If Q1 = No

Display This Question:

If Q1 = Yes

Q2 What is your primary zip code?

_____

Display This Question:

If Q1 = Yes

Q3 How many years have you lived within this zip code?

_____

Display This Question:

If Q1 = No

Q4 What is your country of origin?

_____

Q5 What is your age?

_____

Q6 What is the highest level of formal education you have completed?

- Less than high school
- Some high school
- High school graduate
- Vocational/trade school certificate
- Some college
- Associate degree (AA, AS, etc.)
- Bachelor's degree (BA, AB, BS, etc.)
- Master's degree (MA, MS, Med, MSW, MBA, etc.)
- Professional degree (MD, DDS, DVM, LLB, JD, etc.)
- Doctorate degree (PhD, EdD, etc.)

Q7 What is your gender?

- Male
- Female
- I prefer to self-identify: _____
- I prefer to not answer.

Q8 Are you Hispanic or Latino(a)? *(Answer only for yourself.)*

- Yes
- No

Q9 Which of these categories best indicates your race? *(Answer only for yourself. Check all that apply.)*

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White

Q10 If you are currently employed, what industries do you work in? *(Check all that apply.)*

- I am not currently employed (unemployed, retired, etc.).
- Agriculture
- Mining or oil and gas extraction
- Utilities
- Construction
- Manufacturing
- Wholesale trade
- Retail trade
- Transportation and warehousing
- Information Technology
- Finance and Insurance
- Real estate
- Professional, scientific, or technical services
- Education
- Health care
- Arts, entertainment, or recreation
- Accommodation and food services
- Public administration
- Other (please specify): _____

Q11 Which category best represents your annual household income in 2021?

- Less than $25,000
- $25,000 to $34,999
- $35,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- $150,000 to $199,999
- $200,000 to $249,999
- $250,000 to $299,999
- $300,000 or more

End of Block: ABOUT YOU