Preferences and willingness to pay to restore Elk/Beaver Lake

Report provided to the municipalities of the Capital Regional District on Vancouver Island, B.C.
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Executive Summary

Elk/Beaver Lake has been experiencing worsening water quality issues, including harmful algal blooms (HABs) and the spread of non-native fish and lake weeds, that ultimately affect how people use and enjoy the lake. In response to these water quality issues, the Capital Regional District (CRD), in collaboration with community members and other shared responsibility-holders, produced the Elk/Beaver Lake Watershed Management Plan and an in-lake remediation plan (here, we refer to these collectively as the lake restoration plan). This work resulted in the installation of a hypolimnetic oxygenation system in Elk Lake in the summer of 2023 and initiation of this system in late fall of 2023. Costs of implementing an oxygenation system in Elk/Beaver Lake have been estimated, however, the benefits the community would receive from alleviating these issues and restoring Elk/Beaver Lake have not yet been investigated. Additionally, the community's preferred restoration goals (i.e., which issues they prefer to be addressed) have not been articulated. Understanding which water quality issues are a priority for the community and how much the community would be willing to pay to alleviate these issues is important to determine whether the costs of planned restoration activities are outweighed by the benefits and where to focus management efforts.

Therefore, the purpose of this research was to better understand:

(i) Water quality issues in Elk/Beaver Lake,
(ii) How these issues impact community use and enjoyment of the lake, and
(iii) The community's preferences and willingness to pay for planned lake restoration activities.

Through interviews and discussions with locals, as well as an extensive review of lake monitoring data and reports, we found that the key issues the community was concerned about in Elk/Beaver Lake were:

- Increased frequency and duration of HAB events,
- Moderately poor water quality, as measured by the Canadian Water Quality Index,
- Greater proportion of non-native to native fish species, and
- Extensive growth of the invasive lake weed, Eurasian milfoil.

Insights from interviews suggested that these impacts affect the ways that people use and enjoy Elk/Beaver Lake. For example, extensive weed growth in Elk/Beaver Lake interferes with the aesthetical appeal and ability to paddle or row in the lake, and safety concerns related to HAB events has caused some groups to shift their lake use to activities that do not involve contact with the lake water. Interview and focus group participants were additionally concerned about the biodiversity in Elk/Beaver Lake, which has been affected by an increasingly large proportion of non-native fish species, as well as moderately poor water quality as measured by the Canadian Water Quality Index.

To understand the community's preferences for, as well as the benefits the community would receive from, alleviating these issues and restoring Elk/Beaver Lake, we used an economic tool known as a choice experiment survey, developed in collaboration with the

community and administered in the Capital Regional District. A choice experiment is a survey that is designed to gauge people's preferences and willingness to pay for improvements in the environment. This survey was largely informed by interviews and discussions with members of the community and the local governments. In the survey, people were informed about the ongoing issues at Elk/Beaver Lake and were asked to choose between the current situation at Elk/Beaver Lake and possible outcomes of lake restoration plans. Each improvement scenario was assigned a cost. Through choosing between leaving the lake as is and paying for various possible outcomes of restoration in Elk/Beaver Lake, survey respondents informed us of their preferences and willingness to pay for restoring Elk/Beaver Lake.

The survey revealed that more than half of the survey respondents:

- Felt their use and enjoyment of Elk/Beaver Lake has been affected by water quality issues,
- Agreed that they are concerned about current and future water quality and the ability of Elk/Beaver Lake to support wildlife, and
- Disagreed that they felt safe using the lake.

Given the impacts of lake degradation on this community, it is perhaps unsurprising that the willingness to pay to restore Elk/Beaver Lake and reduce the frequency of HABs is high, ranging from $141–$292 per household per year. The high willingness to pay to restore Elk/Beaver Lake indicates that in general, the community is in favour of implementing lake restoration plans.

To determine whether the benefits outweigh the costs of restoring Elk/Beaver Lake, we compare the estimated willingness to pay with estimated costs of the oxygenation system and the goals laid out in the watershed management plan. The costs of oxygenation put forward from the CRD ($750,000 in capital for the oxygenation system, with the provincial government matching this amount) equates to ~$4.00 per household, plus an estimated $0.80 per household in annual costs of operation and maintenance of the oxygenation system (estimated at ~$150,000 annually). These annual costs are substantially less than the average annual willingness to pay of $141–$272 per household for possible improvements in Elk/Beaver Lake resulting from oxygenation. Additionally, through a review of cases of watershed management, we estimate that watershed management and the management of non-native fish and weed species could cost upwards of $4.5 million plus at least $103,000 in annual maintenance costs (a total of $24 per household plus $0.55 annually). Again, this is substantially less than the estimated average annual willingness to pay of $142–$292 per household for attaining the goals set out in the watershed management plan.

Aggregating the economic benefits over the number of households in the CRD (estimated 188,841 households in 2010), we find that the aggregate annual benefits of oxygenating Elk/Beaver Lake ranges from $27–$51 million per year, whereas the aggregate annual benefits of implementing goals laid out in the Watershed Management Plan range from $27–$55 million. As mentioned, the estimated costs of implementing these restoration plans were around $5.9 million plus ~$253,000 in annual maintenance costs, depending on the level of watershed management. Clearly, the aggregate annual benefits of restoring Elk/Beaver Lake (between $27–$55 million per year) is substantially greater than estimated costs of restoration (around $5.9 million plus ~$253,000 annually). Thus, this research demonstrates that the estimated benefits are greater than the costs of restoring Elk/Beaver Lake.

Additionally, we find that the community has strong preferences for increasing the Canadian Water Quality Index score and reducing the duration of HABs, the proportion of non-native fish species, and the extent of Eurasian milfoil coverage. We found heterogenous preferences relating to the recreational fish catch rate per trip, meaning that while some respondents prefer increases in the number of fish caught each fishing trip, others either oppose or are indifferent to increases in this attribute. These results indicate that management actions should prioritize mitigating HABs, improving the water quality in Elk/Beaver Lake, and managing non-native fish and macrophyte species.

The actual impacts of lake restoration efforts, as well as when improvements will occur, are challenging to predict. Therefore, given that economic benefits are greater than the costs of lake restoration, we suggest that should additional interventions be required to achieve the goals of restoring Elk/Beaver Lake in a timely manner, this may be justifiable following community engagement. Additionally, as other lakes in the region (e.g., Thetis Lake) are suffering more frequent and longer-lasting harmful algal blooms events, our results showing that households within the CRD have high willingness to pay for lake restoration programs may provide justification for launching a collaborative effort to creating additional lake restoration plans, building off the wealth of investigations and work that went into the Elk/Beaver Lake Watershed Management Plan. Finally, we suggest the use of other tools (e.g., participatory ecosystem service mapping, gameplay) to understand sources of value related to Elk/Beaver Lake, other than economic.

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List of acronyms

Acronym	**Definition**
CEs	Choice experiments
CRD	Capital Regional District
CWQI	Canadian Water Quality Index
EBL	Elk/Beaver Lake
ES	Ecosystem services
HABs	Harmful algal blooms
N	Nitrogen
P	Phosphorus
TN	Total nitrogen
TP	Total phosphorus
WMP	Watershed management plan
WTP	Willingness to pay

1. Introduction

Elk/Beaver Lake is one of the most visited recreational parks on Vancouver Island (Capital Regional District [CRD], 2020). Yet, this lake experiences harmful algal blooms (HABs) year-round, affecting biodiversity and people's enjoyment of the lake. Additional issues in the lake include the spread of non-native fish (e.g., carp) and lake weeds (Eurasian milfoil). Many of these issues in Elk/Beaver Lake are related to cultural eutrophication—defined as the pollution of water bodies including lakes with excess nutrients, mainly phosphorus (P) and nitrogen (N), from human activities such as agricultural land use and sewage treatment (Schindler et al., 2016; Vollenweider, 1968). Cultural eutrophication often leads to excessive growth (or blooms) of algae and cyanobacteria. These impacts have attracted the attention of the public and the provincial and regional governments, leading to a collaborative, community-wide effort to produce the Elk/Beaver Lake Watershed Management Plan (WMP) (Capital Regional District [CRD], 2020). Additionally, an in-lake remediation plan has been produced, with plans to install oxygenation systems in both Elk and Beaver Lakes, both estimated to cost $1.4 million total to install, plus $100,000–$150,000 for annual maintenance costs (CRD, n.d.). Funding for the installation of oxygenation systems in Elk Lake has recently been approved by the provincial government. However, it is unknown how the costs of oxygenating Elk Lake, as well as implementing the actions laid out in the WMP, compare to the benefits that the community would receive from restoring Elk/Beaver Lake.

Informed by the community's needs, the purpose of this research was to better understand the benefits to the community of restoring Elk/Beaver Lake (EBL), and how these benefits compare to the costs of lake restoration. To quantify the benefits the residents of the CRD would receive from restoring EBL, this research employed an economic tool known as a discrete choice experiment. Choice experiments (CEs) are an economic tool designed to estimate people's preferences and willingness to pay for environmental improvements/restoration. A choice experiment is administered to people in the form of a survey. In this survey, people are presented with several 'choice tasks' (Johnston et al., 2017), often presented as a series of tables within the survey. Each choice task typically presents three scenarios—the current condition (or status quo) of the lake and two hypothetical improvement scenarios, all described using lake characteristics or attributes (e.g., average number of fish caught each fishing trip, number of days with harmful algal blooms each year, etc.). In the environmental improvement scenarios, the levels of attributes (e.g., number of fish caught) change from the current conditions. The improvement scenarios are assigned a cost, whereas the status quo ('do nothing') scenario is free because no management action is being taken. Survey respondents are asked to choose their preferred option in each choice task, revealing which attributes of EBL are most valued, and how much people would be willing to pay to improve these attributes.

The application of the choice experiment in EBL allows us to (i) assess preferences for restoration in EBL, (ii) inform decision makers of key management areas (e.g., management of HABs, the recovery of native fish species), (iii) gauge the community's support for plans for restoring EBL, and (iv) estimate the community's willingness to pay for restoring EBL.

This report is structured as follows: we first present the objectives of this research, then provide background information on trends in water quality in EBL. We then provide more information on choice experiments and how they were applied in EBL, followed by the presentation and discussion of results. We discuss the implications of the findings for the restoration of EBL and conclude with key insights and recommendations.

2. Research objectives

1. Assess preferences and willingness to pay for restoring Elk/Beaver Lake
    i. Inform decision makers and lake managers of preferences for restoration
    ii. Provide pragmatic recommendations on key management areas based on preferences and willingness to pay for restoring Elk/Beaver Lake
2. Investigate the characteristics driving people's preferences for improved water quality
3. Gauge public support for restoring Elk/Beaver Lake

To achieve these objectives, we first needed to identify the relevant water quality attributes (e.g., the average number of fish caught per trip, number of harmful algal bloom advisory days per year, etc.) and ecosystem services (e.g., ability to fish, swim, etc.) that were important to the community surrounding Elk/Beaver Lake. We also needed to determine possible outcomes of restoring Elk/Beaver Lake, based on current science and historic/background conditions at Elk/Beaver Lake. The next section provides a summary of water quality issues in Elk/Beaver Lake—in addition to interviews with community members, this literature review helped to identify the relevant water quality attributes, as well as define possible outcomes of restoring Elk/Beaver Lake.

3. Water quality issues in Elk/Beaver Lake

Prior to European settlement, the EBL watershed was primarily forested. Following settlement, the key anthropogenic activities that have impacted EBL are: i) the conversion of a portion of the watershed from forest to agricultural lands; ii) the construction of the Victoria waterworks between 1873–1879, which included the construction of a dam and filter beds at the outflow of EBL; and iii) the construction of the Patricia Bay Highway alongside the lake in the 1950s (Das et al., 2008a). In response to these disturbances, key changes in Elk Lake include: increased export of organic matter and nutrients to the lake following disturbance periods (Das et al., 2008a) and a shift in the dominant species of phytoplankton (algae) towards more harmful species of cyanobacteria (Das et al., 2008b). Although development in the watershed has slowed since 1970, between 2005-2015, anthropogenic activities increased the loading of total nitrogen (TN) and total phosphorus (TP) in the EBL watershed by 60% and 38%, respectively (Rodgers, 2015). The sources contributing to the external P in the EBL watershed include residential lawn care, septic tanks and fields on most properties to the north and west of the lake, stormwater runoff, excrement from pets and abundant, non-migratory Canada geese, and agricultural practices (CRD, 2020). Despite these recent increases in external loads, the key driving factor impacting lake health and recreational use has been consistently identified as the depletion of dissolved oxygen in the deeper regions of Elk Lake during summer months, leading to the release of substantial amounts of phosphorus (P) that has accumulated over time in the sediments of Elk Lake (McKean, 1992; Nordin, 1981; Nürnberg & Lazerte, 2016; Rodgers, 2015)—this process is commonly referred to as internal (or sediment) P loading.

Internal P loading typically occurs in the hypolimnion (the deepest layer of the lake) as the lake thermally stratifies into distinct layers in summer. As the lake cools and mixes in the fall, the P that has been released from lake sediments becomes available to the rest of the lake, likely contributing to blooms in the fall and winter (Nordin, 2015; Nürnberg & Lazerte, 2016). Internal P loading and concentrations of TP in the hypolimnion of Elk Lake have approximately doubled between 1988–2014 (Nordin, 2015; Nürnberg & Lazerte, 2016). In this system, P has consistently been identified as the nutrient limiting phytoplankton growth (Nordin, 1981, 2015)—correspondingly, during this same period where internal P loading doubled, seasonal mean chlorophyll *a* concentrations (the indicator measuring algal biomass) has more than doubled (McKean, 1992; Ministry of Environment and Climate Change Strategy, 1996; Nordin, 2015). Concerningly, much of this algal biomass is dominated by cyanobacteria throughout most of the year (Davies et al., 2010; McKean, 1992; Nordin, 2015), with cyanobacterial blooms occurring in Elk Lake during January and February since 2011 (Rodgers, 2015). Cyanobacterial species capable of producing toxins that are harmful to human and animal health have been identified in Elk Lake, including species that are capable of producing saxitoxin, anatoxin-a, and microcystins (Davies et al., 2010)—all which have been listed as priority toxins by the US EPA (2015).

As a result of cyanobacterial blooms in 2014 and 2015, the Polar Bear Swim that was traditionally held at Elk Lake was moved to Thetis Lake due to the presence of a cyanobacterial bloom and high concentrations of anatoxin, a neurotoxin produced by several genera of cyanobacteria (Nordin, 2015). However, aside from the relocation of this popular winter activity, winter blooms do not majorly impact public use of the lake (CRD Parks and Environmental Services, 2018). Additionally, blooms in Elk Lake did not exceed toxin detection limits (were less than 5ppb) between 2015–2017 (CRD Parks and Environmental Services, 2018). In Beaver Lake, blooms are more frequent in the summer and impact recreational use, with a toxic bloom with high levels of microcystin forming in August 2016. In 2017, a bloom consisting of 100% potentially toxin-producing cyanobacteria resulted in a summer-long advisory against contact with water at Beaver Lake, despite toxins being below detection limits (CRD Parks and Environmental Services, 2018). Additionally, the invasive aquatic weed, Eurasian milfoil, covers nearly 100% of Beaver Lake and Beaver Channel by the end of summer (CRD Parks and Environmental Services, 2018). If left unmanaged, Beaver Lake could be closed to swimmers every year between June–September as result of these issues (CRD Parks and Environmental Services, 2018). Despite these issues, use of the Elk/Beaver Regional Park has continued to increase. Park visitation has increased from 250,000 visits in 1989 (McKean, 1992) to nearly 2 million 2021 (CRD, 2022).

The impacts of degraded water quality have cascaded throughout the food web in EBL. Although no fish kills have occurred as a direct result of cyanobacterial blooms in EBL (Environmental Services CRD, 2018), prolonged periods of dissolved oxygen depletion have degraded the habitat suitability of the deeper regions of the lake. For example, recent surveys of

Elk and Beaver Lakes identified no native fish species in either Elk or Beaver Lake, compared to surveys conducted in 1970 which caught several native species including cutthroat trout and prickly sculpins (Hemmera Envirochem Inc., 2017). The most abundant fish species identified in the 2017 fish inventory were species that had been introduced to the lake, such as yellow perch, which withstand warmer water temperature and lower DO concentrations (Hemmera Envirochem Inc., 2017). Increased pressure from recreational angling could also be contributing to a shift in the fish community; estimates of angler days have increased from 8995 days in 1986 to between 14,000–16,000 days in 2011 (Hemmera Envirochem Inc., 2017; Nordin, 2014). Potentially as a result of shifts in the fish community, there are low numbers of crustacean zooplankton in EBL, potentially due to predation by introduced perch and sunfish, or because of the dominance of largely inedible cyanobacteria (Nordin, 2015). Similarly, there are relatively low numbers of benthic organisms, also potentially related to predation or frequent and prolonged periods of anoxia (Nordin, 2015). These observations provide evidence that prolonged anoxia in Elk/Beaver Lake has affected the suitability of the habitat for many species, thus affecting the biodiversity of EBL.

Because internal P loading can delay the recovery of a lake following reductions in external nutrient loading for decades or longer (Lürling et al., 2016; Schindler, 2012), in-lake interventions such as oxygenation or sediment capping techniques are often used to speed recovery. Interestingly, the reports published in the 1990s recommended watershed management and oxygenation for EBL (McKean, 1992). Increased public concern over the safety of the lake and the impediment of recreational use have contributed to the recent collaborative, community-wide effort to produce the Elk/Beaver Lake Watershed Management Plan (WMP) and the in-lake remediation plan. In this report, we collectively refer to the EBL WMP and in-lake remediation plans as the lake restoration plan.

4. Choice experiment survey

Numerous steps were employed in this research. We provide a summary of the methods to give a general overview of steps taken. Several methodological steps have been omitted in this report for conciseness. These details are available, however, in the manuscript of this research that has been published and is freely accessible (Spence et al., 2023). These details will also be made available in the published dissertation, when complete. Details that were omitted here but can be found in the submitted manuscript include: details on how attribute levels (both the status quo and improvement levels under each lake restoration policy) were determined, the use of debriefing questions and screening for response anomalies to assess the validity of the survey instrument, and a detailed description of the theory behind data analysis.

4.1. Attribute selection

In the early stages of this research, we worked with the CRD and members of the community to understand the issues related to water quality in EBL, whether and how these issues had affected the community and their enjoyment of the lake, and the goals of planned restoration activities. Specifically, we interviewed several local lake users and members of the municipal governments (the CRD and the District of Saanich) (n=7). In these interviews, we asked about the interviewees' use of EBL, whether they had observed changes in the water quality in EBL, and their concerns related to water quality in EBL. When interviewing government employees, we also asked about the process of creating, and progress towards implementing, the watershed management plan. These interviews informed the list of lake attributes used in the choice experiment survey and assisted with interpretation of results. We also took steps to ensure we included the key community concerns related to EBL and that the representation of these issues in the survey was clear and accurate. These steps included sending the survey to members of the community and the regional government for feedback and testing the survey in a focus group with a random selection of residents living in the CRD (n=5).

Following our work with the CRD and community members, we had a list of 5 different lake attributes representing key community concerns related to the water quality in EBL. These attributes included: i) the number of days that blue-green algae advisories are posted for EBL in a year, warning of the presence and risks of cyanobacteria blooms in EBL; (ii) the recreational fish catch rate per fishing trip; (iii) the proportion of non-native to native fish species, (iv) the extent of lake weed cover (specifically, Eurasian milfoil, which is invasive to EBL), and (v) a modification of the Canadian Water Quality Index (CQWI) measuring the frequency and amplitude of excursions from water quality objectives set for the protection of aquatic life.

We used a variety of reports and monitoring data for EBL to determine the status quo or current levels for each attribute. See Spence et al. (2023) for more details on each of the attributes and the types of information used to determine the status quo levels for each attribute. Table 1 provides a summary of the finalized list of attributes, definitions, attribute levels, the aspects of the lake use or enjoyment these issues affect, and tools to achieve restoration of these attributes.

Table 1: Attributes included in the choice experiment, the levels used in the choice sets with **bolded levels** indicating status quo (current) level, the biophysical indicators used to measure changes in attributes, and the mechanisms for ES improvement. Modified from Spence et al. (2023).

Attribute	Description	Levels	Use or enjoyment affected	Restoration tools
Days of blue-green algae advisories	Average number of days blue-green algae advisories are posted per year in EBL.	(40, 75, **115**, 150 advisory days)	Swimming, biodiversity	Watershed management, oxygenation
Recreational fish catch rate	Average number of fish caught per fishing trip.	(1, **2**, 3, 4 fish per trip)	Fishing	Selective catch and removal, stocking, oxygenation
Water Quality Index score for the protection of aquatic life	The frequency and amplitude of excursions from water quality objectives[1] set for the protection of aquatic life	(Aquatic life is … almost always (score of 30%), **frequently (score 47%)**, rarely (score 85%), almost never (score 95%) … threatened)	Biodiversity	Oxygenation, watershed management
Proportion of non-native to native fish species	The percentage of non-native relative to native fish species.	(45%, 65%, **85%**, 100% non-native species)	Biodiversity	Invasive removal, stocking native species
Weed extent	The percentage of EBL that is covered by Eurasian milfoil by the end of each summer.	(10%, 20%, **30%**, 50% of the lake covered by milfoil)	Boating, paddling, aesthetics, and swimming	Weed harvester, targeted removal
Cost	The amount of money that your household will have to pay each year for 10 years.	(**$0**, $20, $70, $135, $230, $350)	-	-

[1](Davies, 2006)

4.2. Survey structure

The first section of the survey asked respondents about their use of EBL, as well as other local lakes. Then, the current water quality conditions (status quo) in EBL and how these conditions could be improved were described to respondents. The attributes were then described. To encourage survey respondents to answer in a way that reflects their true preferences, the survey respondents were given budgetary reminders (i.e., "remember, paying for environmental improvement means you would have less money available to buy other things") and informed respondents that the results of the survey would be used to inform local decision makers about preferences for restoring EBL.

In the choice experiment section of the survey, respondents were given a series of voting questions where they were asked to choose between the status quo and two alternative restoration scenarios, all described using different attribute levels. The survey presented each respondent with 6 choice tasks (see example choice task in Table 2). All choice tasks were designed using NGENE software to create an efficient experimental design for the choice task attribute levels. A total of 96 different choice tasks were included in the design, blocked into 16 different survey versions and randomized in their presentation to respondents.

Table 2: Example choice task used in the Elk/Beaver Lake survey.

Question 1 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year	**40** days per year	**60** days per year	**115** days per year
Recreational fish catch rate per trip	**3** fish per trip	**1** fish per trip	**2** fish per trip
Water Quality Index score for aquatic life	**85%** (rarely threatened)	**65%** (occasionally threatened)	**47%** (frequently threatened)
Proportion of non-native to native fish species	**65%** non-native	**75%** non-native	**85%** non-native
Weed extent	**50%** of lake area	**20%** of lake area	**30%** of lake area
Cost to your household per year for 10 years	**$300**	**$55**	**$0**
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

After completing the choice tasks, respondents were asked a series of debriefing questions. These debriefing questions were asked to test the validity of the survey instrument (see Spence et al. (2023) for more details). Then, respondents were asked to rate the impacts of water quality issues on their use and enjoyment of EBL, as well as questions regarding their awareness of and satisfaction with lake restoration plans. The final section collected information on respondent demographics. See Appendix V for the full survey instrument.

4.3. Survey testing and administration

The survey instrument underwent several rounds of testing to ensure that the information presented in the survey was relevant and clear, as well as to test and improve the experimental design. First, a focus group was conducted online with 5 participants recruited through random probability sampling methods by telephone from the target population (individuals aged 18+ living in the CRD). The focus group participants were tasked with completing the survey. Upon completion, the participants engaged in discussions about each individual section of the survey, and finally, were asked a series of questions about the survey. The survey then underwent pilot testing, meaning it was administered to a small sample of the target population (n=31 responses) who were members of an opt-in internet panel. Responses from the pilot test were used to improve the experimental design of the choice sets for the final survey distribution. Following survey testing and revision, the survey was administered to an opt-in internet panel (AskingCanadians) of individuals aged 18 and older living in the CRD (postal codes were used to screen for respondents living within the CRD). A total sample of n=841 survey responses was obtained.

4.4. Data preparation and analysis

Prior to analyzing data, we used the responses to the debriefing questions that followed the choice experiment portion of the survey to identify and remove any response anomalies (i.e., responses from individuals who completed the survey in a manner that did not reflect their true preferences—see Spence et al. (2023) for more details). Additionally, because the survey was administered to an online panel (and thus, a non-probability-based sampling strategy was used to administer the survey), we applied survey weights to the data to correct for overrepresentation of observable respondent characteristics, including gender, age, and income using the procedures outlined by Pasek et al. (2014) and the R package *anesrake* (Pasek, 2018). For a comparison of the sample demographics to those of the target population, see Table 2.1 in Appendix II.

Analysis of the data involved using the survey responses to estimate choice models. Choice experiments are rooted in the theory of random utility, which states that individuals will make choices based on the utility they would gain from the option they choose (Louviere et al., 2010) and assumes that individuals will choose the option (also called an alternative) that would provide them with the greatest utility (Hensher et al., 2005)—in simple terms, random utility theory assumes that when presented with a set of alternatives (which is called a choice task in a choice experiment survey), people will choose what they consider to be the ‘best’ option. Choice modelling uses the choices made in each choice task to determine the probability that one alternative will be chosen over another (Louviere et al., 2010). By associating a price with each alternative (except for the status quo alternative, which is the ‘do nothing’ scenario), economic welfare measures (or benefits) associated with each alternative can be assessed (Holmes et al., 2017). The outputs of choice models reveal which environmental attributes (e.g., days of blue-green algae advisories) were most preferred by survey respondents and can be used to calculate the economic benefits associated with different environmental improvement programs.

The type of choice model we used is called a mixed logit (MIXL) model. The mixed logit model is flexible and can incorporate heterogenous preferences (Holmes et al., 2017; Kosenius, 2010). We estimate two different MIXL specifications; one where utility is linear (which assumes that marginal utility changes proportionally with attribute level changes), and one where a log transformation is applied to all environmental attributes (thus allowing for marginal utility to decrease as water quality increases). Under the linear model specification, the benefits of lake restoration will continue to increase linearly for additional improvements in lake attributes. Under the log specification, however, the benefits of lake restoration follow a logarithmic distribution—meaning that as lake attributes improve, the willingness to pay for additional improvements declines (because the lake reaches a state where the water quality might be considered ‘good’ and further improvements would not be of great benefit)—this is referred to as diminishing returns or diminishing marginal utility of improvements. For more details on choice models and how they are estimated, see Spence et al. (2023).

To determine whether preferences and willingness to pay for improvements in lake attributes differ based on the types of activities respondents typically participate in, we separated the survey data according to the types of activities respondents participated in. Out of the 739 respondents who identified as having used EBL at least once, 208 indicated they participate in water-based activities (swimming, fishing, rowing, kayaking, boating), whereas 531 indicated they did not participate in water-based activities and instead, participated in other activities (e.g., beach activities, picnicking, walking/jogging, nature enjoyment, birdwatching, artistic purposes, cultural purposes, horseback riding, or bicycling).[1]

Choice models were estimated using the *apollo* package in R (Hess & Palma, 2019). All code used for data analyses are available here: https://github.com/daniellespence/elkbeaver.

4.5. Policy analysis

Policy analysis uses choice model parameter estimates to calculate the economic benefits of lake restoration scenarios in EBL. The mixed logit model produces model outputs (parameters) that are used to calculate welfare measures (economic benefits) for lake restoration. Using the model outputs, we calculated the economic benefits of the possible outcomes of two lake restoration plans—the implementation of oxygenation systems in EBL and the actions laid out in the in the EBL Watershed Management Plan (WMP). Under these plans, we developed four future scenarios, or outcomes, of lake restoration: one conservative and one best-case scenario of lake restoration in response to oxygenation, and the shorter- and longer-term goals

[1]It was originally planned to compare responses from survey respondents who identified as users of EBL to respondents who did not identify as EBL users/visitors; however, due to the small sample size of non-users, meaningful comparisons could not be made.

set out in the WMP.[2] Note that the conservative scenario and shorter-term goals are considered more realistic/achievable scenarios. Table 3 summarizes each of the four restoration scenarios developed for policy analysis.

Table 3: Summary of lake restoration scenarios defined for use in policy analysis of restoration plans for Elk/Beaver Lake. In Spence et al., (2023).

Plan	Scenario	Attribute levels
Oxygenation	Conservative scenario	• 78 advisory days • 72% CWQI
	Best-case scenario	• 66 advisory days, • 100% CWQI
Elk/Beaver Lake Watershed Management Plan	Short-term goals for lake restoration	• 82% non-native fish species • 15% coverage of Eurasian milfoil • 58 advisory days
	Longer-term goals for lake restoration	• 67% non-native fish species • 6% coverage of Eurasian milfoil • 29 advisory days

The economic benefits of each of these policies were estimated using the *apollo* package in R (Hess & Palma, 2019). See Spence et al. (2023) for more information on calculating the economic benefits of lake restoration and for further details on how the future scenarios under oxygenation were developed.

5. Results and discussion

This section begins with a presentation and discussion of interview and survey responses to questions regarding the impacts of degraded water quality on the use and enjoyment of EBL. Then, we present the economic benefits of lake restoration plans. Finally, we compare the economic benefits to estimated costs of lake restoration to assess whether the benefits outweigh the costs.

5.1. Water quality impacts on EBL use and enjoyment

To understand whether and how water quality issues in EBL impact the ways people use and enjoy the lake, we first asked interview participants and survey respondents about their use of Elk/Beaver Lake, and then asked about their experiences with and perceptions of water quality issues in EBL. In interviews, participants were asked about their use of EBL (e.g., how long since they first started visiting, how often they visit, what type of activities they typically

[2]Note that because of the difficulty involved in translating water quality improvements into changes in fish communities, we do not specify a best-case scenario involving fish catch rates in EBL. In addition to water quality improvements, targeted action such as stocking of fish would be required to increase recreational fish catch rates.

participate in), as well as questions related to the water quality in the lake (e.g., if they had noticed any changes in the lake since they first started visting, whether their intended use of the lake had been impaired by a blue-green algae bloom).

Several interviewees indicated that in the past, they enjoyed swimming and picnicking at Elk and Beaver Lakes, but in recent years, water quality issues including blooms and overgrowth of lake weeds have shifted their use to primarily non-water contact activities, such as walking and running. Some had indicated that Beaver Lake had deteriorated more so than Elk Lake, likely because Beaver Lake was originally a swamp prior to the damming and conjoining of Elk and Beaver Lakes. According to one interviewee, about 20 years ago, Beaver Beach was full of people—but as HABs became more frequent, many lake users stopped visiting Beaver Beach, and those who continue to visit Beaver Beach typically use the picnic benches and do not enter the lake. Additional issues brought up in interviews include that EBL is one of the only lakes in the region that allows the use of motorized boats on the lake which could interfere with people's swimming or non-motorized boating activities, the proximity of the lake to the highway, and concerns over large geese populations contributing fecal matter into the lake.

To support interviewees' notion that water quality issues have been impacting lake use, we included several questions in the survey regarding respondent use of EBL and other local lakes, as well as the extent to which water quality issues impact respondent use. We asked about participation in the same activities at EBL and at other local lakes to explore whether differences in lake uses exist and whether these differences could potentially be attributed to water quality issues. Figure 1 compares the types of activities respondents reported participating in at EBL compared to other local lakes. The activities included in the survey have been combined into categories in Figure 1 and include spending time at the beach (including picnicking), boating activities (motorized and non-motorized), fishing, enjoying nature (including nature viewing, bird watching, artistic purposes, and cultural, traditional, and/or sacred reasons), swimming, and the use of trails (for running, walking, jogging, bicycling, and horseback riding). A breakdown of all activities included in the survey is presented in Table 3.1 in Appendix III. Figure 1 shows that the largest differences in participation when comparing EBL to other local lakes are in beach activities and swimming. Respondents reported engaging in beach activities, swimming, fishing, and boating more often at other local lakes than at EBL, perhaps due, at least in part, to water quality issues.

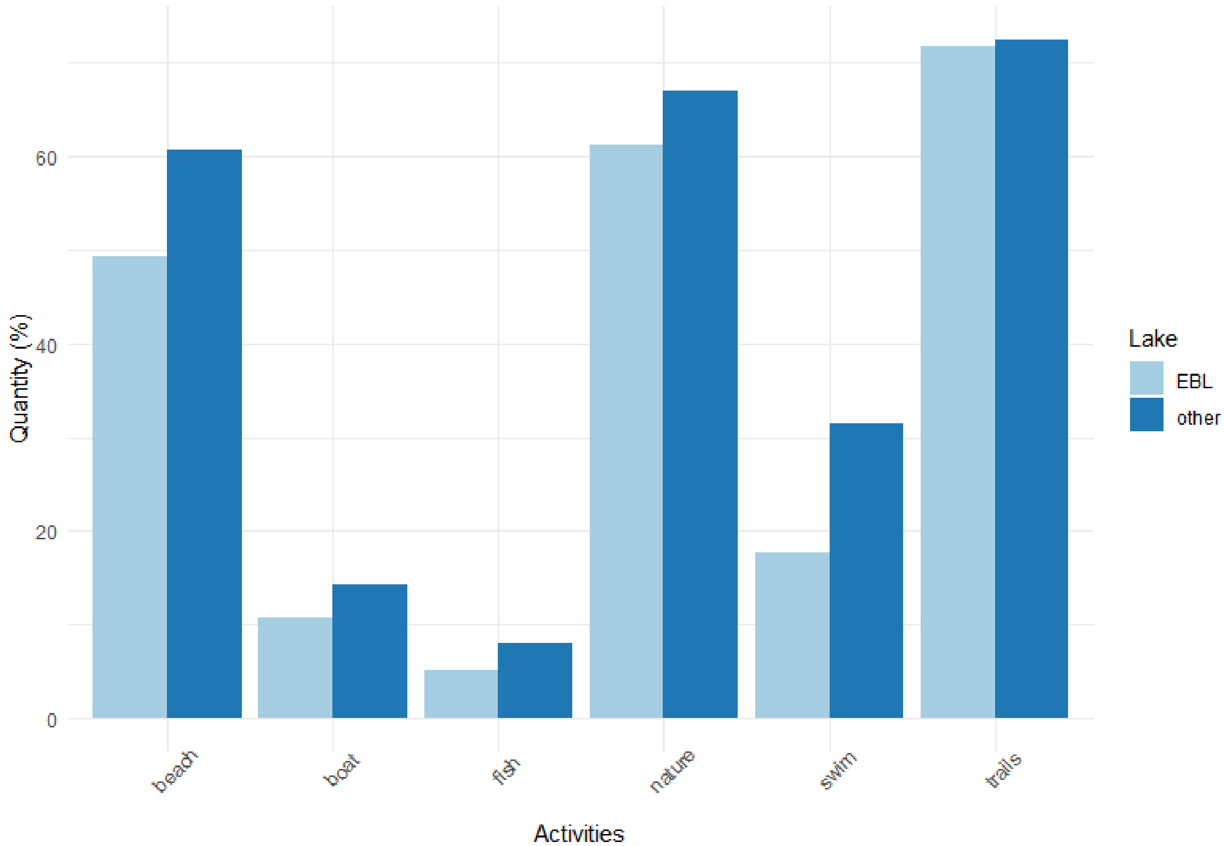

Figure 1: A comparison of respondent participation in activities at Elk/Beaver Lake (EBL) compared to other local lakes. Quantity represents the percentage of respondents (n=807) that indicated they typically participate in that activity.

Indeed, respondents indicated their use of EBL was somewhat (25%), moderately (23%), or very much (18%) impacted by water quality issues. Only 20% of respondents indicated their use was unimpacted. Figure 2 demonstrates that many respondents (52%) disagreed to some extent (i.e., slightly disagreed, disagreed, or strongly disagreed) with the statement that they feel safe swimming in EBL. Most disagreed to some extent that they felt safe allowing their pets to drink from EBL (63%), indicating that the level of awareness of risks to animals is relatively high. Similarly, many disagreed (49%) that they felt safe consuming fish caught from EBL. Boating was not viewed as high risk as swimming, with most neither agreeing nor disagreeing (31%) or agreeing to some extent (55%) that they feel safe boating in EBL. Figure 2 also shows that most respondents agreed to some extent that they were concerned about the current (86%) and future (89%) water quality in EBL, as well as the ability of EBL to support wildlife, including native and endangered species (85%). These results suggest that water quality issues in EBL are impacting people's use and enjoyment of EBL, particularly when it comes to water-based activities.

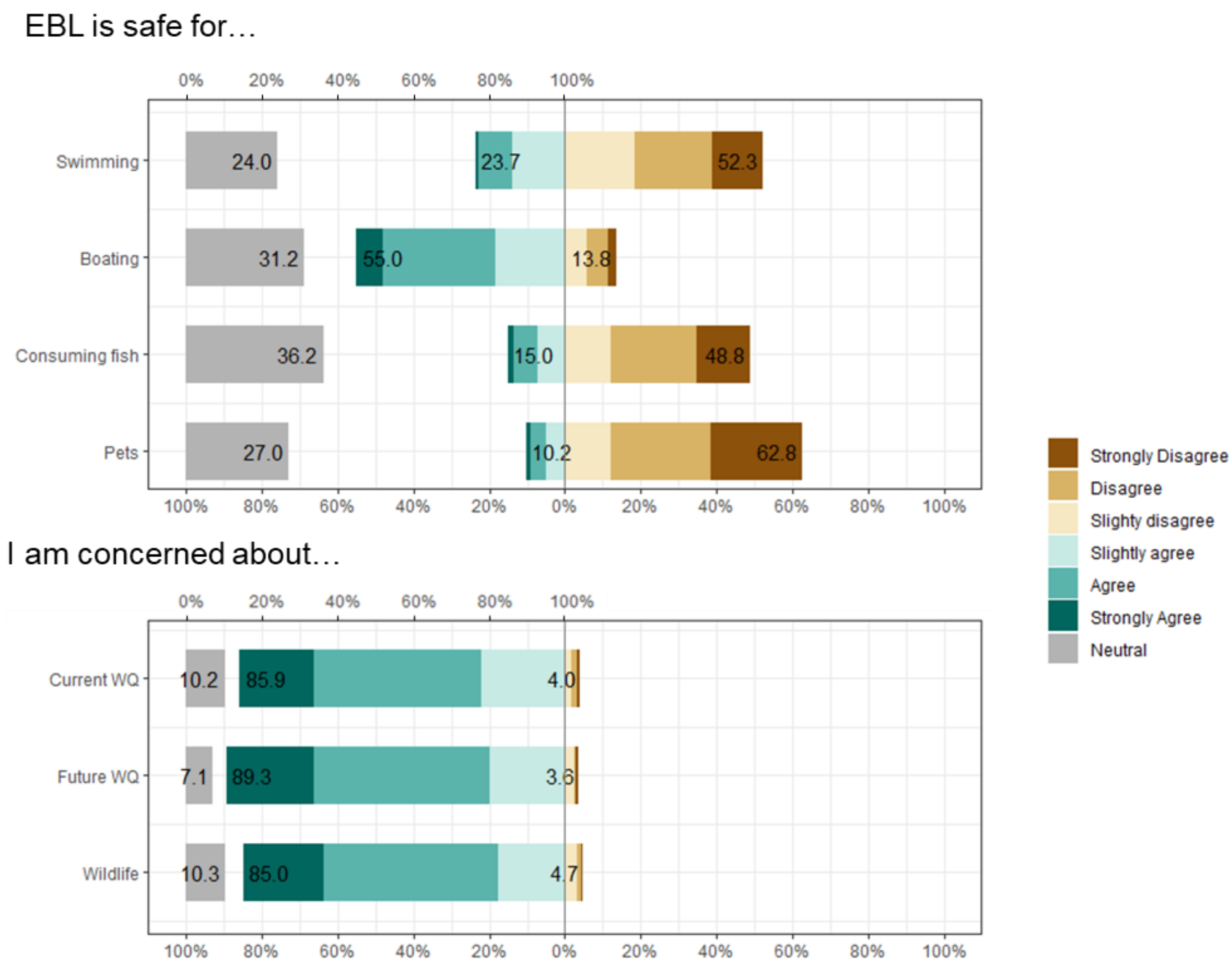

Figure 2: Likert responses to value-based statements, including the extent to which respondents agreed or disagreed that they feel safe swimming and boating in EBL, consuming fish caught from EBL, and letting pets drink from EBL, as well as the extent to which they are concerned about current and future water quality (WQ) in EBL and the ability of EBL to support wildlife. Note that 'neutral' responses ('neither agree nor disagree') are shown separately in grey. In Spence et al. (2023).

To probe deeper into respondents' awareness and perceptions of water quality improvement programs at EBL, we asked respondents if they were aware of any actions planned or taken to improve water quality at EBL, and if so, whether they were satisfied with the actions taken. Only 18% of respondents were aware of any action taken to improve water quality at EBL. Interview participants also noted that despite interest groups posting about issues and blue-green algae advisories on social media, and communication by the CRD about blue-green algae advisories through the radio, newspapers, and the CRD website, most members of the public (those that aren't affiliated with interest groups or have a long history with the lake) are seemingly unaware of the issues at EBL. Nonetheless, of the 18% of survey respondents that were aware of actions being planned or taken to improve EBL, 55% were satisfied with the actions being taken. Some who were not satisfied provided comments, including that not enough action was being taken and that the government needs to do more, improvements and/or implementation of water quality improvement plans (i.e., oxygenation) were happening too slow, more effort needed to be directed at reducing populations of non-native species and improving populations of native species, concerns that the problem is recurring and solutions are only temporary fixes, and a lack of awareness about specific plans or action being taken to improve water quality in EBL.

In addition to asking about their awareness of water quality improvement programs, we asked survey respondents about their perceptions of responsibility over lake protection and improvement programs (Figure 3). Most respondents agreed to some extent (slightly agreed, agreed, or strongly agreed) (94%) that the regional government was responsible for protecting water quality (Figure 2). Similarly, most agreed that the provincial government (92%), park visitors (83%), landowners (80%), the respondents themselves (70%), and non-governmental organizations (NGOs) (65%) were responsible for protecting water quality. These results suggest that although the jurisdiction over the lake itself lies with the provincial government, locals look to the regional government for environmental protection and improvement. This observation was confirmed in interviews with locals and representatives of the regional government, who suggested that differing levels of jurisdiction can be confusing, and despite the community often looking to the CRD to take action, the CRD often does not have jurisdiction and requires permission from the Provincial and/or Federal governments before implementing any proposed actions. See Table 4.1 in Appendix IV for more details on the Likert responses.

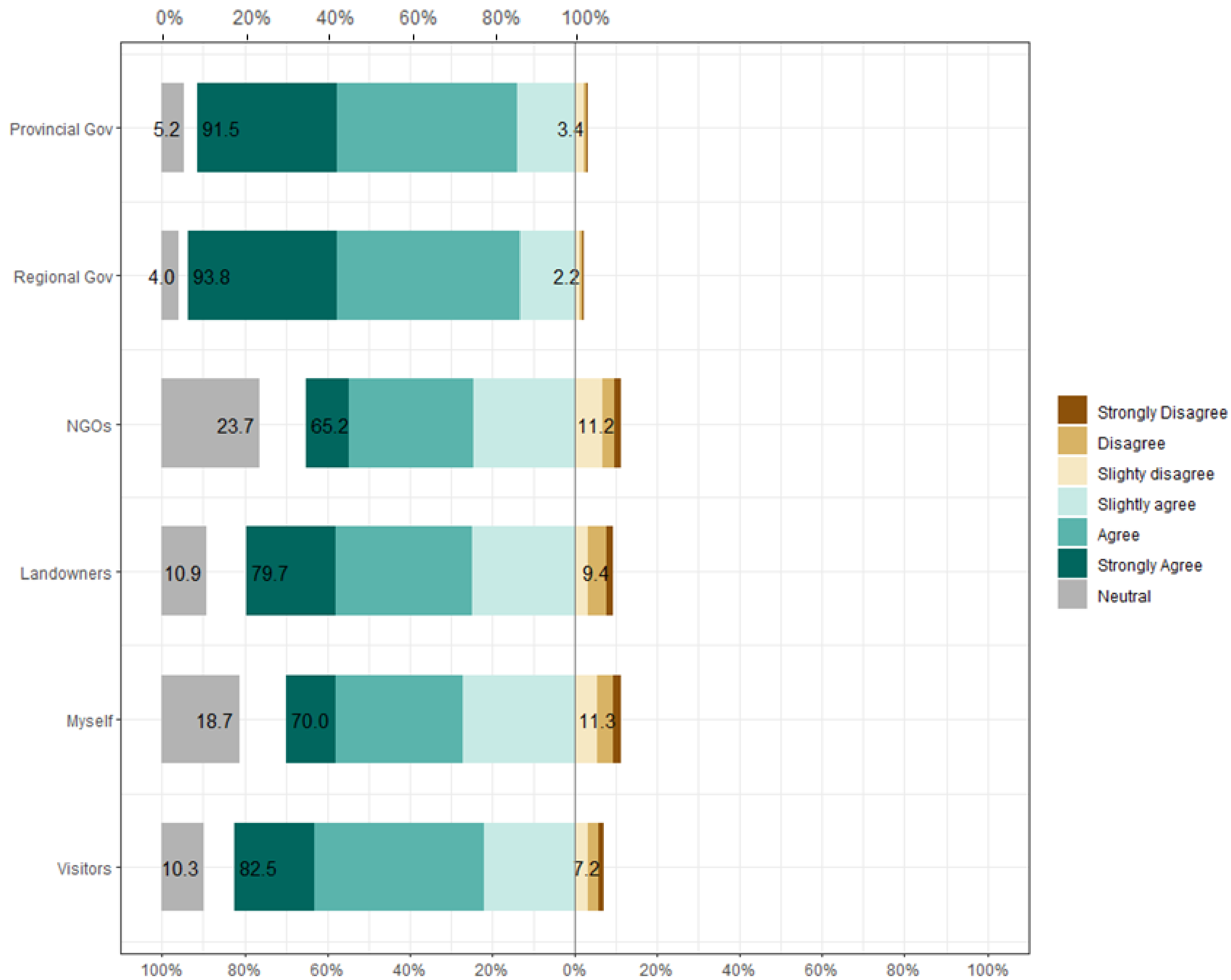

Figure 3: Likert responses to statements asking who, in respondents' perception, is responsible for protecting water quality in Elk/Beaver Lake, including the provincial and regional governments, non-governmental organizations (NGOs)m landowners, respondents themselves, and visitors to the park. Note that 'neutral' responses ('neither agree nor disagree') are shown separately in grey.

5.2. Preferences for lake restoration program attributes

Choice models confirmed that respondents have significant preferences for each environmental attribute, except for the recreational fish catch rate. Our results indicate that although some respondents have strong preferences for the increasing the catch rate, others are strongly opposed to or indifferent to increases in fish catch rates. In interviews, it was suggested that many anglers were satisfied with the fish catch rate. Although anglers were mainly catching non-native fish (e.g., carp) and were aware of and concerned about the proportion of non-native to native fish species, it was suggested that anglers typically enjoy the fishing experience at EBL. This offers one potential explanation why, in general, survey respondents did not have significant preferences for increasing the fish catch rate. Additionally, we found that people have strong preferences for lake restoration programs in comparison to the status quo or 'do nothing' scenario—indicating that most respondents support action to restore EBL. We also found that the log MIXL model specification fit the data better than the linear MIXL, providing evidence for that as water quality improves in EBL, the community will be willing to pay less for additional improvements. See Table 4.2 in Appendix IV for the choice model parameter estimates.

5.3. Benefits of lake restoration programs

The two lake restoration plans that are assessed here—the implementation of oxygenation systems in EBL and the actions laid out in the in the EBL Watershed Management Plan (WMP)—address different concerns for this community, including the increased frequency and duration of HABs, the impacts of degraded water quality, and the spread of non-native species and subsequent decreases in biodiversity. Looking at the benefits estimated for the oxygenation plan, the benefits of reducing the prevalence of HABs and improving the Canadian Water Quality Index score were $141–$358 per household per year. In comparison, the benefits of implementing the WMP to manage HABs as well as invasive fish and macrophyte species were $142–$389 per household per year (Table 4 and Figure 4).

Table 4: Economic benefits of two lake restoration policies (oxygenation and watershed and non-native species management). Estimates generated using trimmed weighted dataset (n=807) and MIXL model with utility specified as linear in all attributes (Linear MIXL) and the MIXL model with a log transformation applied to all non-monetary attributes.

	MIXL – Linear	MIXL – Log
	Compensating surplus ($CAD per household per year)	
Oxygenation		
Conservative scenario	$154 (132, 177)	$141 (119, 163)
Best-case scenario	$272 (231, 313)	$232 (196, 268)
EBL Watershed Management Plan		
Short-term goals	$169 (142, 195)	$142 (117, 166)
Longer-term goals	$292 (247, 336)	$227 (189, 264)

Figure 4 below illustrates the range of benefits associated with lake restoration policies, with the economic benefits of the longer-term goals under the WMP being greatest, followed closely by the best-case scenario under oxygenation. The estimates generated using the log model that incorporates diminishing returns are less than the estimates generated under the linear model, and therefore serve as the more conservative estimates. Although the WTP increases as the ambition of the lake restoration plans increase, the better fit of the log MIXL model suggests that the marginal willingness to pay decreases (diminishes) as the attribute levels increase. This means that as the conditions in EBL improve, people will be willing to pay less for additional improvements, compared to their willingness to pay for improvements from the current conditions in EBL.

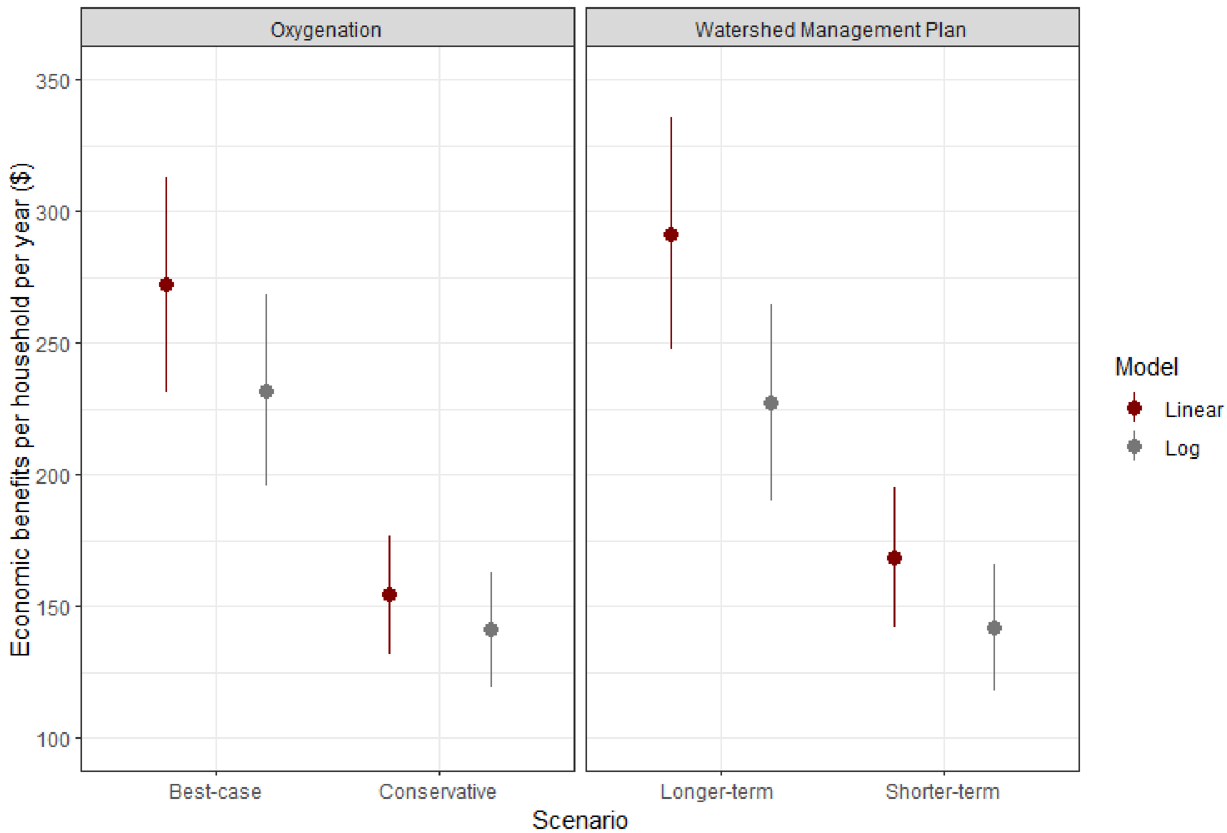

Figure 4: A comparison of economic benefits ($CAD per household per year) of scenarios of lake restoration Elk/Beaver Lake under two restoration plans: oxygenation and the watershed management plan (WMP). Scenarios include conservative and best-case scenarios under oxygenation of Elk Lake, as well as short-term and longer-term goals of the Elk/Beaver Lake Watershed Management Plan. Benefits are generated using one model that specifies utility as linear and another that applies a log transformation to all non-monetary attributes (log). The error bars represent 95% confidence intervals. In Spence et al., (2023).

Importantly, these results research align well with similar studies. For example, a similar study in Shawnigan Lake, British Columbia (<50km away from Elk/Beaver Lake) found that the community was willing to pay between $90.84–$400.38 CAD per household per year to slow eutrophication of Shawnigan Lake (Renzetti et al., 2021). Additionally, community members were willing to pay $353 CAD per household per year to reduce the frequency of HABs in Missisquoi Bay, Quebec (L'Ecuyer-Sauvageau et al., 2019). The results of these similar studies help to validate the results found here—meaning that economic benefits we have estimated for restoring EBL are within a reasonable range.

To add to this analysis, we further comapre economic benefits across activity types (Table 5). This comparison shows that those who engage in water-based activities have a greater willingness to pay for lake restoration compared to users who participate in activities that do not involve contact with the lake water. This is perhaps unsurprising given the nature of the impacts of degraded water quality on water-based activities, including potential health risks associated with participating in water-based activities during potentially toxic blue-green algae bloom events.

Table 5: Economic benefits of two lake restoration policies (oxygenation and watershed and non-native species management). Estimates generated using survey responses from respondents that identified as a user of EBL, divided into whether respondents identified as engaging in water-based activities (n=208) or activities that do not involve contact with water (n=531).

	MIXL – Water-based activities	MIXL – Non-water-based activities
	Compensating surplus ($CAD per household per year)	
Oxygenation		
Conservative scenario	$206 (148, 265)	$138 (114, 162)
Best-case scenario	$358 (252, 463)	$245 (201, 289)
EBL Watershed Management Plan		
Short-term goals	$228 (164, 291)	$148 (119, 177)
Longer-term goals	$389 (280, 494)	$258 (209, 306)

As shown in Figure 5, there is less confidence (greater uncertainty) in the estimated economic benefits of the lake restoration plans for individuals who identify as participating in water-based activities at EBL. The 95% confidence intervals are much larger for the water-based activity users than those of the EBL users who do not participate in water-based activities. The large confidence intervals could be related, at least in part, to the smaller sample size of those who identified as participating in water-based activities (n=208). The purpose of this comparison of economic benefits across users participating in water-based activities to users participating in land-based activities is to provide a preliminary exploration of how preferences and willingness to pay differ based on respondent characteristics (e.g., the activities they prefer). However, for the remainder of this report, we discuss the benefits generated using the full dataset and the log and linear model specifications.

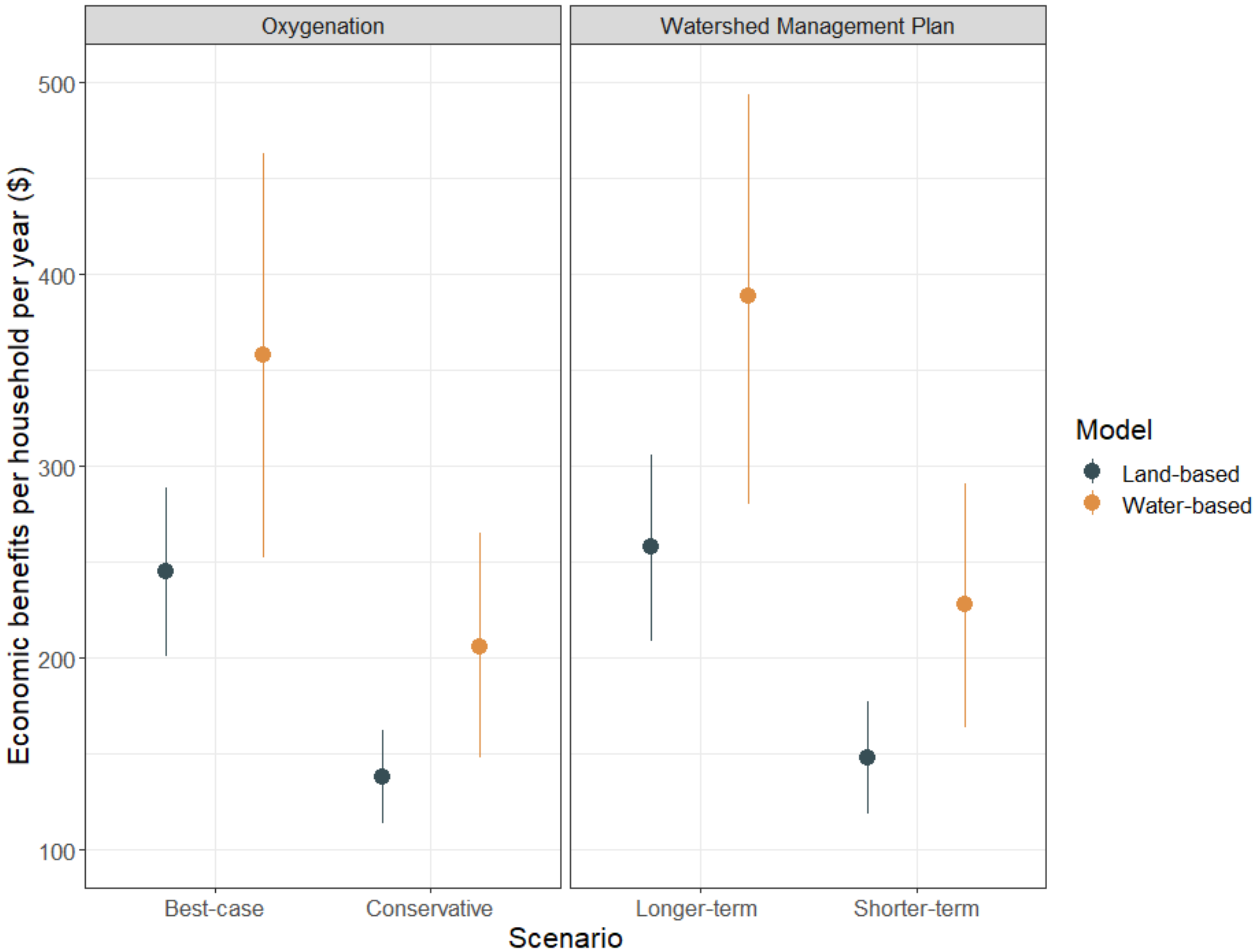

Figure 5: A comparison of economic benefits ($CAD per household per year) of scenarios of lake restoration Elk/Beaver Lake under two restoration plans: oxygenation and the watershed management plan (WMP). Scenarios include conservative and best-case scenarios under oxygenation of Elk Lake, as well as short-term and longer-term goals of the Elk/Beaver Lake Watershed Management Plan. Benefits are generated using one model uses responses from respondents who engage in water-based activities and another with responses from respondents who engage in activities that do not involve contact with water (land-based). The error bars represent 95% confidence intervals.

5.4. Comparing benefits to costs of lake restoration

To determine whether the benefits outweigh the estimated costs of restoring EBL, we (i) calculated the total economic benefits for lake restoration programs and (ii) performed a literature review to estimate the potential costs of watershed management, in addition to the estimated costs of oxygenation in EBL (see Appendix V for the review of watershed management costs that informed these estimated costs). Specifically, we multiplied the household benefits for each scenario by the number of households in the CRD (188,841).[3] Using the outputs from the log and linear models, the aggregate annual benefits of oxygenation range

[3] In 2021, the average household size was 2.2 people and the total population of individuals aged 18+ living in the CRD was 415,451.

from $27–29 million under the conservative scenario and $44–51 million under the best-case scenario. The CRD estimates that the installation of oxygenation system in Elk Lake will cost $1.4 million plus $100,000–$150,000 in annual maintenance costs (Environmental Services CRD, 2018). The CRD contributed half of the capital required to purchase the oxygenation system ($750,000) and will fund the annual operation and maintenance of the system—this equates to ~$4.00 per household to purchase the system plus an estimated $0.80 per household annually (with the provincial government contributing $750,000 towards the purchase of the oxygenator). Comparing the benefits of both the conservative and best-case scenarios for possible improvement of Elk Lake under oxygenation ($141–$272 per household or $27–51 million total annually), we see the benefits are far greater than the costs of purchasing, installing, and maintaining this system.

Similarly, the benefits of shorter- and longer-term goals in the WMP are far greater than estimated costs of implementing these goals. Again, using the outputs from the log and linear models, the aggregate annual benefits for the shorter- and longer-term goals of the WMP range from $27–32 million and $43–55 million, respectively. We estimate that watershed management and the management of non-native fish and weed species could cost upwards of $4.5 million plus at least $103,000 in annual maintenance costs (a total of $24 per household plus $0.55 annually). Therefore, the costs are far exceeded by the estimated benefits of watershed management.

As we see from the comparisons above, even at the conservative end of the estimated range of benefits, the economic benefits of restoring EBL are substantially greater than the costs of implementing these plans, suggesting that these restoration plans are economically efficient. In addition to insights gained from interviews and the focus group, the magnitude of benefits compared to the costs of restoring EBL suggest that the community supports the restoration of EBL. Furthermore, given that the benefits are substantially greater than the costs of restoring EBL, additional efforts to restore EBL may be justifiable to the community, should they be required.

6. Conclusion and key insights

In Elk/Beaver Lake (EBL), we found that key community concerns regarding water quality issues in EBL were increased frequency and duration of harmful algal bloom (HAB) events; moderately low scores on the Canadian Water Quality Index; greater proportion of non-native to native fish species; and extensive growth of the invasive macrophyte, Eurasian milfoil. These impacts affect the ways that people use and enjoy the ecosystem services provided by Elk/Beaver Lake—HABs endanger the health of humans and pets, affecting the safe use of the lake for swimming and for pets and other animals, low water quality index scores and non-native fish species affect the biodiversity of the lake, and extensive weed growth interferes with the aesthetical appeal and ability to paddle or row in the lake. Most interviewees, focus group participants, and survey respondents felt they had been affected by these issues in EBL and disagreed that they felt safe using the lake, given these issues. Indeed, several interviewees had shifted their use from water-based activities to primarily land-based activities at EBL, related to the risks that HABs pose to their health and the health of their pets. Furthermore, most survey respondents agreed that they are concerned about the current and future water quality of EBL, as well as the ability of EBL to support wildlife. In the words of several interviewees, it would be a "real shame", "tragedy", or "huge injustice" for this community to lose this "important, beautiful lake".

Given how impacted many in the community feel about the water quality issues in EBL, it is understandable that the willingness to pay to restore EBL and reduce the frequency of HABs is high, ranging from $141–$292 per household per year—suggesting that the community supports the implementation of lake restoration plans in EBL. Aggregating these economic benefits over the number of households in the CRD, we find that the aggregate annual benefits of oxygenating Elk/Beaver Lake ranges from $27–$51 million per year, whereas the aggregate annual benefits of implementing goals laid out in the Elk/Beaver Lake Watershed Management Plan range from $27–$55 million. These values substantially exceed the estimated costs of oxygenation and watershed management ($5.9 million plus ~$253,000 in annual maintenance costs). Additionally, we found that the community has strong preferences for increasing the Canadian Water Quality Index score and reducing the frequency and duration of HABs, the proportion of non-native fish species, and the extent of Eurasian milfoil coverage. We found heterogenous preferences relating to the recreational fish catch rate per trip, meaning that while some would prefer increases in the number of fish caught each fishing trip, others either oppose or are indifferent to increases in this attribute. These results indicate that management actions should prioritize mitigating HABs, improving the water quality in EBL, and managing non-native fish and macrophyte species.

Should the implementation of oxygenation and the watershed management plan not achieve desired outcomes in a reasonable timeframe, additional interventions may be considered. For example, although oxygenation can improve the deep-water habitat for cold-water fish (if thermal stratification in the lake is not disrupted), the long-term improvements via oxygenation alone is questionable (Nygrén et al., 2017), and a review of case studies suggested that hypolimnetic oxygenation typically only achieves a 30–50% reduction in hypolimnetic P (Lewtas et al., 2015). To achieve the desired level of restoration in EBL, it is possible that additional in-lake remediation options may merit consideration and community consultation. Furthermore, although the effectiveness of reducing external nutrient loading via beneficial land management practices is variable (Baulch et al., 2019; Osgood, 2017; Osmond et al., 2019), reducing external nutrient loading is critical for long-term improvements, and therefore watershed management should remain a priority.

Additionally, within the Capital Regional District, there are other high-use lakes that have also been experiencing worsening HABs. For example, Lower Thetis and Prior Lakes, which are also popular for swimming, paddling (e.g., kayaking, paddleboarding), and for walking dogs, had an active blue-green algae alert from May 26, 2022–November 21, 2022, for Prior Lake, and May 26, 2022–January 20th, 2023, for Lower Thetis Lake.[4] Prior Lake experienced another long-lasting bloom from August 15th–October 6th, 2023. Given the similar uses and proximity of these lakes to EBL, our results showing households within the CRD have high WTP for lake restoration programs may provide justification for launching a collaborative effort to creating

[4]https://www.crd.bc.ca/about/alerts-notices/blue-green-algae-bloom-at-prior-lake

additional lake restoration plans, building off the wealth of investigations and work that went into the Elk/Beaver Lake Watershed Management Plan.

As mentioned, heterogenous preferences were observed in the choice model parameter estimates. One source of heterogeneity that was explored here was between individuals who identified as participating in primarily water-based activities to those who participate primarily in land-based activities. Individuals who participated in water-based activities had a greater willingness to pay to restore Elk/Beaver Lake, perhaps related to potential health risks associated with using the lake during potentially toxic blue-green algae bloom events. Additional sources of heterogeneity could include characteristics of the respondents, such as income, age, level of education, cultural background, etc. Therefore, we recommend taking the more conservative estimates of economic benefits as the best estimates of the economic benefits of lake restoration in EBL. Future research projects could include non-monetary valuation of ecosystem services provided by EBL, including gameplay (e.g., Daw et al., 2015) or participatory mapping of ecosystem services (e.g., Pert et al., 2015) with a representative selection of members in the community—this may provide additional information on the ecosystem services that are cherished for reasons other than recreation (e.g., spiritual, cultural, artistic purposes, etc.) and inform future projects related to the protection and restoration of Elk/Beaver Lake.

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Appendix I—Review of historical conditions in Elk/Beaver Lake

This section will provide a chronological detail of changes in water quality, primarily in Elk Lake, from pre-European settlement to current. The purpose of this section is to understand what conditions may be considered 'natural' for the lake, to better understand what could be possible in terms of water quality improvements. Note that to improve a lake beyond what is considered its 'natural' condition is extremely difficult and costly and generally not recommended.

Prior to European settlement, the Elk/Beaver Lake watershed was primarily forested. Following settlement, the key anthropogenic activities that have impacted Elk Lake were: i) the conversion of a portion of the watershed from forest to agricultural lands; ii) the construction of the Victoria waterworks between 1873–1879, which included the construction of a dam and filter beds at the outflow of Elk/Beaver Lake; and iii) the construction of the Patricia Bay Highway alongside the lake in the 1950s (Das et al., 2008a). These anthropogenic disturbances were evident in core samples extracted from Elk Lake in 2008, showing increases in export of organic matter and nutrients to the lake following disturbance periods (Das et al., 2008a). The sources that have largely contributed to the increase in organic matter in the lake were catchment soils and particulate organic matter, which also likely contributed to the increased nutrient accumulation in lake sediments (Das et al., 2008a).

Sediment cores taken from Elk Lake showed that prior to European settlement, species richness and productivity followed natural variability, but since settlement and subsequent disturbance in the watershed, primary productivity and phytoplankton diversity have changed (Das et al., 2008b). The most notable changes have included an increase in primary production by Bacillariophyceae (diatoms) and Chrysophyceae (golden algae), and a shift in the dominant species of cyanobacteria towards more harmful species of the Order Nostocales (Das et al., 2008b). Examples of species under this Order include *Anabaena, Aphanizomenon, Cylindrospermopsis, Nodularia, Oscillatoria,* and *Planktothrix*. Both *A. flos-aquae* and *Anabaena* spp. have been identified in blooms in Elk and Beaver Lakes (Davies et al., 2010). These species have been produce the neurotoxin anatoxin-a, the cytotoxin cylindrospermopsin, and the hepatotoxin microcystin (US EPA, 2014; Lyon-Colbert et al., 2018). Additionally, *A. flos-aquae* may produce saxitoxin, a neurotoxin (Lyon-Colbert et al., 2018). Saxitoxin, anatoxin-a, and microcystins are listed as priority toxins by the US EPA (2015).

The impacts of anthropogenic activities in the watershed on the quality of water in Elk/Beaver Lake have been a concern for residents of the Greater Victoria region and lake users since at least the late 1960s (e.g., Nordin, 1981, McKean, 1982). For example, in 1969, a newspaper article outlined a proposal to make scuba gear available to lifeguards at Elk/Beaver Lake after lifeguards were unable to locate a drowning swimmer in Elk Lake due to murky water, resulting in the death of the swimmer (Nordin, 1981). At this time, the dominant species of weeds that were impeding recreational use of Elk and Beaver Lake were *Elodea* and *Ceratophyllum,* both which are endemic to the region (Nordin, 1981). Cyanobacteria were identified as the dominant phytoplankton, with an objective set in 1992 to have cyanophytes comprise less than 50% of the phytoplankton community (Table 1; Mckean, 1992); this objective was not met in subsequent water quality monitoring at Elk/Beaver Lake in 1994 (Ministry of Environment and Climate Change Strategy, 1996). An additional water quality objective set in 1992 was to maintain a concentration of dissolved oxygen greater than 5 mg/L one meter above the bottom of the lake; this objective was not met in 1993–1995 (Ministry of Environment and Climate Change Strategy, 1996), nor has it been met since (e.g., Environmental Services CRD, 2018; Nordin, 2015; Nürnberg & Lazerte, 2016). The key driving factors underlying degraded lake health and recreational use at this time were identified as hypolimnetic oxygen depletion and the contribution of internal P loading to primary productivity in Elk Lake, with P being the nutrient limiting growth (Nordin, 1981).

Table 1.1: Water quality objectives set in 1992 for Elk and Beaver Lakes for the protection of aquatic life and recreational use. In (Mckean, 1992).

Sampling Sites	Elk Lake Centre 1100844	Beaver Lake Centre E207470
Designated Water Uses	Primary Contact Recreation, Aquatic Life	Primary Contact Recreation, Aquatic Life
Temperature Hypolimnion Maximum	15°C	15°C
Dissolved Oxygen Summer Minimum	5 mg/L (1 m above sediment)	5 mg/L (1 m above sediment)
Chlorophyll-a	1.5 - 2.5 µg/L	1.5 - 2.5 µg/L
Secchi Disc Depth	1.9 m	1.9 m
Phytoplankton Community	No dominance (< 50% cells/mL) by Cyanophytes	No dominance (< 50% cells/mL) by Cyanophytes

Although development in the watershed has slowed since 1970, between 2005-2015, anthropogenic activities increased the loading of TN and TP in the Elk/Beaver Lake watershed by 60% and 38%, respectively (Rodgers, 2015). The sources contributing to the external P in the Elk/Beaver Lake watershed include residential lawn care, septic tanks and fields on most properties to the north and west of the lake, stormwater runoff, excrement from pets and abundant, non-migratory Canada geese, and agricultural practices (CRD, 2020). Despite these recent increases in external loads, the key driving factors impacting lake health and recreational use have been consistently identified as hypolimnetic oxygen depletion and the contribution of internal P loading to primary productivity in Elk Lake, with P being the nutrient limiting growth (McKean, 1992; Nordin, 1981; Nürnberg & Lazerte, 2016; Rodgers, 2015).

Despite reports published throughout 1980–2018 calling for intervention, no action has yet been taken to improve water quality in Elk Lake and as such, hypolimnetic TP concentration has significantly increased since 1986 (Nordin, 2015; Rodgers, 2015). The hypolimnetic TP concentration more than doubled from 890 µg/L in mid October 1988 to 1500 µg/L in Fall 2014 (Nordin, 2015), and the internal P load has increased from 950 kg/year in 1988 to 1752 kg/year in 2014 (Nürnberg & Lazerte, 2016). This internal loading of P contributes 6-8 times more P than external sources, or about 86-89% of TP inputs (Nürnberg & Lazerte, 2016). Internal loading has likely increased due to an increasingly long period of DO depletion in Elk Lake, with the anoxic factor increasing from 60 days per year in 1988 to 86 days per year (Nürnberg & Lazerte, 2016). This increased duration of anoxia could be related to prolonged periods of stratification, with stratification in Elk Lake beginning as early as February in recent years and fully stratifying by June (Environmental Services CRD, 2018; Nordin, 2015). Hypolimnetic increases in TP have also coincided with increased hypolimnetic manganese and iron concentrations, indicative of the redox conditions that permit the release of sediment-bound P (Nordin, 2014; Nürnberg & Lazerte, 2016).

Because phosphorus has consistently been identified as the nutrient limiting phytoplankton growth this system, with TN:TP ratios of 18:1 and 14:1 measured at spring overturn in Elk Lake in 2014 and 2015, respectively (Nordin, 2015), increased internal loading has translated into greater amounts of P available for primary producers. Correspondingly, seasonal mean chlorophyll *a* concentrations have increased from 1.72–3.73 µg/L between 1988–1994 (McKean, 1992; Ministry of Environment and Climate Change Strategy, 1996) to 8.0 µg/L in 2014 (Nordin, 2015). The highest concentrations of chlorophyll *a* in Elk Lake typically occur between November and February (Nordin, 2015). Although chlorophyll *a* is commonly used as a proxy for total phytoplankton biomass and does not speak to species assemblages, samples taken from Elk and Beaver Lake show that cyanobacteria are dominant for most of the year, and the objective of <50% cyanobacteria in the phytoplankton community has consistently not been met (McKean, 1992; Nordin, 2015). Sampling between 2014–2015 revealed that cyanobacteria comprised anywhere from 10–99% of the phytoplankton community (Nordin, 2015). An increasing trend in chlorophyll *a* is therefore concerning so long as cyanobacteria remain dominant, as this confirms recent observations that blooms are becoming more of an issue in Elk and Beaver Lakes. Table 2 compares measurements taken from Elk Lake between 1980–1990 and 2013–2015.

Table 1.2: Comparison of characteristics of Elk Lake between 1980–1990, 2013–2015, and 2019–2022.

Spring overturn TP	Autumn hypolimnetic TP	Internal P load	Mean chlorophyll *a*	AF	Period of stratification	Depth of layers at stratification	Mixing period	Water temperature
1980–1990								
13–30μg/L [1,2]	890μg/L [1]	950kg/year [3]	1.7μg/L (1988) [1] 3.7μg/L (1993) [4] 2.9μg/L (1994) [4]	60 days/year [3]	March/April–November [2,4]	Epilimnion: 3–7 m Metalimnion: 6–9m Hypolimnion: 9 to ~18m [2]	November–end of April [4]	Winter: 5–8ºC [2] Summer: 22ºC (surface), 9ºC (hypolimnion) [1]
2013–2015								
33–44μg/L [5]	1500μg/L [5]	1752kg/year [3]	8 μg/L [5]	86 days/year (May–Nov) [3]	February–November [5]	Epilimnion 5m Metalimnion 5–10m Hypolimnion <9–10m	November–January [5]	Winter: 4–6ºC Summer: 23-25ºC (surface), 7–8ºC (hypolimnion) [5]
2019–2020								
17–44μg/L [6] (years 2019–2022)	1200–1400 μg/L [7]	--	10 μg/L [6] (2019–2022)	--	March/April–October/ November	--	--	Winter: ~7ºC Summer: 21-24ºC (surface), 7–9ºC (hypolimnion) [7]

[1] (McKean, 1992); [2] (Nordin, 1981); [3] (Nürnberg & Lazerte, 2016); [4] (Ministry of Environment and Climate Change Strategy, 1996); [5] (Nordin, 2015); [6] Data from British Columbia Environmental Monitoring System; [7] Data provided by the CRD.

Table 2.4: CWQI ratings, values, and interpretations. Modified from Table 1 in (Davies, 2006).

Rating	CWQI value	Interpretation
Excellent	95–100	Aquatic life virtually never threatened
Good	80–94	Aquatic life rarely threatened
Fair	60–79	Aquatic life occasionally threatened
Marginal	45–59	Aquatic life frequently threatened
Poor	0–44	Aquatic life almost always threatened

Appendix II—Demographics

Table 2.1 presents a comparison of the target population demographics (individuals aged 18+ living in the CRD) in 2021 to the sample demographics.

Table 2.1: A comparison of target population (CRD) (n= 415,451) in 2021 and sample (n= 807) demographics. Demographics are reported as percentages of the total population or survey sample.

Demographic	CRD	Survey
Gender		
Man	48	50
Woman	52	49
Non-binary		0.5
Prefer to self-identify		0.0
Prefer not to say		0.6
Age		
18-39*	30	12
40–54	22	15
55–64	17	27
65+	24	46
Prefer not to say		0.6
Income of private households (pre-tax)		
<$29,000	12	7.3
$30,000-$49,999	16	15
$50,000-$69,999	16	14
$70,000-$99,999	20	22
$100,000-$149,999	22	18
$150,000+	22	8.6
Prefer not to say		15

*CRD census data has age categories of 15–19, 20–24. To calculate the percentage of people 18 & 19 years of age in the target population for comparison to survey respondents, the 15–19-year category was assumed to be homogenous in distribution (an assumption we recognize is false, but sufficient for our purposes). These ages were added to the 20-24 age group and the 25–39 age group, given small sample size of both these categories.

Appendix III—Use types

In the beginning of the choice experiment survey, respondents were asked about their participation in activities at EBL as well as other local lakes. Activities included artistic purposes, beach activities, bicycling, bird watching, cultural purposes, fishing, horseback riding, kayaking/canoeing, motorboating, nature viewing, none, other (comments including camping, dog walking, foraging, geocaching, paddleboarding, photography, etc.), picnicking, rowing, swimming, and walking/jogging. These activities were combined into categories, as shown in Table 6.1, to assess differences in use types.

Table 3.1: Categories of lake uses included in Figure 1 (Section 4.1) and the types of activities included in those categories.

Category	**Activities**
Beach	Spending time at the beach Picnicking
Boat	Motorboating Kayaking/canoeing Rowing
Fish	Fishing
Nature	Enjoying nature Birdwatching Artistic purposes Cultural, traditional, and/or sacred reasons
Swim	Swimming
Trails	Hiking, walking, or running Horseback riding Biking

Appendix IV—Additional results

To understand respondent beliefs and concerns related to water quality issues in and the responsibility of managing these issues in Elk/Beaver Lake, we presented survey respondents with a series of Likert scale questions following the debriefing questions (Table 4.1).

Table 4.1: Responses to value-based questions presented in the choice experiment survey administered in the CRD (n=807).

	Strongly disagree			Neither agree nor disagree			Strongly agree
	1	2	3	4	5	6	7
I feel safe…							
Swimming in EBL	14%	20%	18%	24%	14%	9%	1%
Boating, rowing, kayaking in EBL	2%	6%	6%	31%	18%	30%	7%
Consuming fish caught from EBL	14%	23%	12%	36%	7%	6%	2%
Allowing pets to drink from EBL	37%	27%	12%	27%	5%	4%	1%
I am concerned about…							
The current water quality in EBL	1%	1%	2%	10%	22%	44%	20%
The future water quality of EBL	1%	1%	27%	7%	20%	46%	23%
The ability of EBL to support to support wildlife, including native and endangered species	1%	1%	3%	10%	18%	46%	21%
Who is responsible for protecting water quality…							
Provincial Government	1%	1%	2%	5%	14%	44%	34%
Regional Government	0%	1%	1%	4%	13%	44%	49%
Non-Government Groups	1%	3%	7%	24%	25%	30%	11%
Landowners	2%	5%	3%	11%	25%	33%	22%
Yourself	2%	4%	6%	19%	27%	31%	12%
Park visitors	2%	3%	3%	10%	22%	41%	19%

Choice model parameter estimates

Table 4.2 presents the parameter estimates for four choice models. The first and second models use the full dataset (n=807). The first model specifies utility as linear in all attributes (linear MIXL) while the second model applies a log transformation to all non-monetary attributes (log MIXL). The third and fourth models also specify utility as linear but use responses from survey respondents to those who indicated they only participate in water-based activities (n=208) or only participate in land-based activities (n=678), respectively. The mean parameter estimates generally have the expected signs and the parameters are significantly different from zero except for the recreational fish catch rate. The standard deviation parameter estimates confirm substantial unobserved preference heterogeneity across the attributes including the recreational fish catch rate. The status quo parameter is negative and significant indicating people prefer a lake restoration program to the status quo. Model fit criteria (AIC, BIC, and log likelihood) suggest that the log MIXL specification fits the data better than the linear MIXL, providing evidence for diminishing marginal utility as attribute levels increase.

Table 4.2: Preference parameter estimates for lake restoration program attributes using four different mixed logit model specifications.

	Linear MIXL		Log MIXL		MIXL – Water-based activities		MIXL – Non-water-contact activities	
Utility parameter	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Status quo scenario	-3.63*** (0.20)	2.38*** (0.16)	-1.10*** (0.14)	2.71*** (0.15)	-3.81*** (0.05)	2.57*** (0.30)	-3.61*** (0.22)	2.16*** (0.28)
Cost ($00s)	-0.62*** (0.03)	(fixed)	-0.69*** (0.03)	(fixed)	-0.52*** (0.44)	(fixed)	-0.63*** (0.03)	(fixed)
Days of blue-green algae advisory (100s of days)	-1.20*** (0.08)	1.02*** (0.08)	-0.93*** (0.07)	0.95*** (0.09)	-1.44*** (0.17)	1.23*** (0.18)	-1.16*** (0.09)	-0.92*** (0.10)
Fish catch rate per trip	0.04 (0.02)	0.29*** (0.03)	0.099 (0.06)	0.77*** (0.07)	0.03 (0.04)	0.39*** (0.06)	0.05* (0.02)	0.31*** (0.03)
Water Quality Index (0 to 100%)	2.07*** (0.15)	2.02*** (0.15)	1.41*** (0.01)	1.43*** (0.10)	2.20*** (0.29)	1.72*** (0.23)	2.07*** (0.16)	2.19*** (0.17)
Proportion of non-native to native fish species (0 to 100%)	-1.74*** (0.15)	1.80*** (0.16)	-1.03*** (0.11)	1.53*** (0.15)	-1.71*** (0.33)	2.01*** (0.37)	-1.68*** (0.17)	1.85*** (0.25)
Aerial extent of non-native weeds (0 to 100%)	-1.73*** (0.22)	3.02*** (0.24)	-0.35*** (0.06)	0.87*** (0.07)	-1.86*** (0.44)	3.11*** (0.43)	-1.60*** (0.22)	2.72*** (0.28)
Log likelihood	-3901		-3873		-1072		-3274	
AIC	7829		7772		2171		6573	
BIC	7914		7857		2238		6655	
Number of choice tasks	4842		4842		1248		4068	
Number of Respondents	807		807		208		678	
Estimated parameters	13		13		13		13	

Notes: from MIXL model, log MIXL incorporates diminishing returns into parameter estimates
Some variables have been scaled. Interpretations of scaling indicated in brackets. Robust standard errors reported in parentheses.
*** indicates 99% confidence level; ** indicates 95% confidence level

Appendix V—Review of costs of watershed management

Although cost estimates for the in-lake remediation plan for EBL are available, the costs of watershed management, invasive species removal, and macrophyte control have not been directly estimated in the EBL Watershed Management Plan (WMP). Here, we use a literature review and secondary estimates to determine potential costs of watershed management. For watershed management, the costs of restoring shorelines, inflow streams, and watershed function are difficult to estimate, as it depends on the goals and extent of restoration. Installation of buffer strips along the lake shoreline can cost between $30–$50 (2015 USD) per lineal foot (approximately $46–$77 in 2022 CAD), and landscaping homes in the watershed to reduce nutrient export costs anywhere from $5000–$40,000 per home in 2015 USD ($7682–61,460 in 2022 CAD) (Lewtas et al., 2015). Restoration of 2.4 km of Alderson Creek in Spallumcheen Township, British Columbia, was estimated to cost ~$93,000 to stabilize the banks, plant riparian vegetation, and reconfigure sections of the channel to restore natural habitats and water flow (Carvajal & Janmaat, 2016)—all similar goals as laid out for the restoration of the three inflow streams in the WMP.

Reductions in non-native fish populations will rely on voluntary and provincial catch and removal efforts, and reductions in the extent of Eurasian milfoil growth will rely on weed harvesting and more aggressive, targeted weed removal (Capital Regional District, 2020). The eradication of invasive species is typically viewed as unattainable (Dodds & Whiles, 2020); therefore, catch-and-removal programs may help to control populations of invasive fish, but are unlikely to eradicate the species. More aggressive invasive fish eradication programs, such as the program recently implemented in Miramichi Lake, New Brunswick, are costly and often require temporary removal of native species and application of the chemical rotenone—this program is estimated to cost upwards of $1.5 million CAD (van den Heuvel et al., 2017). Indeed, the goals for EBL are not to eradicate invasive fish species, but to reduce biomass and prevent new introductions (Capital Regional District, 2020); harvesting and removing invasive fish species has been estimated to cost $0.66 per pound removed (Lyder et al., 2015). Although biomass estimates or specific removal plans are not available for EBL, a study assessing the cost-effectiveness of invasive fish removal in Swan Lake, Montana, estimated that an investment of about $1.5 million in 2013 USD (2.7 million in 2022 CAD) could lead to the collapse of invasive lake trout by using gill nets to harvest juvenile and adult lake trout (Syslo et al., 2013). To control the extensive growth of macrophytes in Elk/Beaver Lake, a weed harvester was purchased in 2016 for $200,000 and removes 300–450 tons of macrophytes each year (Capital Regional District, 2020). Operating weed harvesters has been estimated to cost between $650–1000 in 2015 USD ($998.73–1,536.49 in 2022 CAD) per hectare of lake harvested (Lewtas et al., 2015). Elk/Beaver Lake is approximately 224 hectares, and Eurasian milfoil is estimated to cover approximately 30% of the lake area in summer—therefore, to harvest weeds from the entire affected area would cost approximately $67,000–$103,000 each time the area is harvested. See Table V.1 for a summary of these costs.

Table V.1: Description of potential costs of lake restoration. In (Spence et al., 2023).

Restoration tool	Description	Estimated cost
Oxygenation systems	Hypolimnetic oxygenation system in Elk Lake and a destratification system in Beaver Lake estimated to cost $1.4 million total to install, plus annual maintenance costs. [1]	$1.4 million $100,000–$150,000 in maintenance annual costs
Riparian buffer strips	$14–$23 per meter to install riparian buffer strips. [2] Goal to restore 60% of shallow water habitat. [3]	$1.5 million
Stream habitat restoration	Three tributary streams, 60% of stream area planned to be restored. [3] ~$95,000 to restore 2.4 km of stream habitat. [4]	$95,000 x 3 streams $285,000 total
Non-native fish removal	Invasive removal program in Miramichi, New Brunswick estimated to cost $1.5 million.[5] Invasive removal economic efficiency study estimated $2.7 million.[6]	$1.5–$2.7 million
Weed harvesting	Operating weed harvesters estimated to cost $998.73–1,536.49 per hectare of lake harvested. [2]	$103,000 per year
Estimated total		$5.9 million plus $253,000 in annual costs

[1](CRD, n.d.); [2](Lewtas et al., 2015); [3](CRD, 2020); [4](Carvajal & Janmaat, 2016); [5](van den Heuvel et al., 2017); [6](Syslo et al., 2013)

Appendix VI—Survey instrument

To ensure you are eligible to participate in the survey, please provide the first 3 digits of your postal code:

_____ *[display list]*

[FSAs for study area include:

V0N
V0S
V8K
V8L
V8M
V8N
V8P
V8R
V8S
V8T
V8V
V8W
V8X
V8Y
V8Z
V9A
V9B
V9C
V9E
V9Z
Other - My postal code is not in this list --→ Screen out
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UNIVERSITY OF SASKATCHEWAN

Participant Consent Form

You are invited to participate in an independent University of Saskatchewan research study entitled: Public preferences for local water quality management.

Researcher(s):
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Purpose and Objective of the Research: The goal of this research is to learn about public preferences for management of water in the Capital Regional District.

Procedures: You have been selected to take part in a survey and the estimated time to complete this is about 20 minutes.

Funded by: The study is being funded by the Global Water Futures research program at the University of Saskatchewan.

Potential Risks: There are no known or foreseen risks associated with participation in this study.

Potential Benefits: Survey participants will help provide decision makers with a better understanding of preferences and priorities for water management in their community.

Confidentiality: All information you provide is considered confidential and grouped with responses from other participants. Names will not be associated with survey responses. Access to the data will be restricted to the investigators. The survey is being collected using Voxco, a Canadian-owned and managed company whose data is securely stored in Canada. Information on Voxco's privacy policy is available here https://www.voxco.com/privacy-policy/.

Storage of Data: Electronic survey data will be stored by the Principal Investigator on a password-protected research-dedicated computer, with access restricted to the researchers. Anonymous survey response data will be stored for at least 5 years post-publication.

Right to Withdraw: Participation in this survey is voluntary. You can decide not to participate at any time by closing your browser. Survey responses will remain confidential. Once the survey has been completed you cannot withdraw the information you provided.

Publication of Results: The outcomes of this research will be shared with Capital Regional District officials, presented at academic and professional conferences, and published in a doctoral thesis and academic journals.

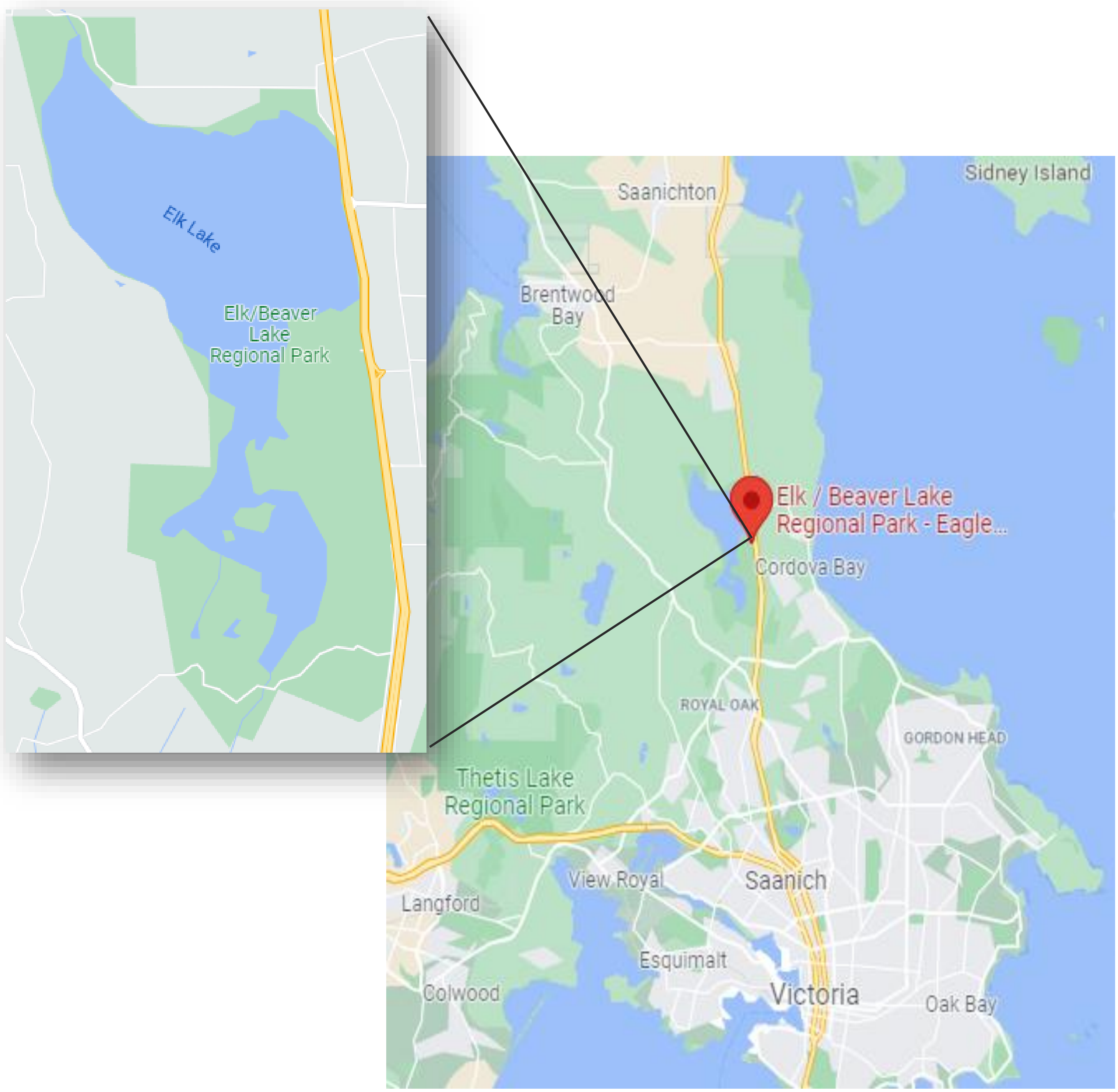
Questions or Concerns: Contact the researcher(s) using the information at the top of page. This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office: ethics.office@usask.ca; 306-966-2975; out of town participants may call toll free 1-888-966-2975.

By completing and submitting this questionnaire, **your free and informed consent is implied** and indicates that you understand the above conditions of participation in this study.
Thank you for your assistance in this research project.

Thank you for participating in this survey. A representative group of local citizens in your area has been randomly selected to answer the questionnaire, including you. Your answers are important, whether or not you are interested in the topic. This survey will help local decision makers know what you would like to see happen in Elk and Beaver Lakes (often also written as Elk/Beaver Lake and referred to as Elk or Beaver Lake).

Elk/Beaver Lake is located alongside the Patricia Bay Highway, about 15km north of the city of Victoria. The lake is surrounded by Elk/Beaver Lake Regional Park. A map showing the location of the lakes is provided below.

Note that the lakes will be collectively referred to as Elk/Beaver Lake throughout this survey.



1. **Before** starting this survey, had you heard of Elk/Beaver Lake?
   ___Yes
   ___No -> Skip to Section 2 Alt
   ___Don’t know -> Skip to Section 2 Alt

We would like to begin by asking about your connection to Elk and Beaver Lakes.

1. Have you ever visited Elk/Beaver Lake?

Yes
No
Don't know

[PROGRAMMER'S NOTE: if Yes, include the following question, if no, Skip ahead to Q. 4]

2. In the last 12 months, approximately how many times have you visited Elk/Beaver Lake?

- Never
- 1–2 times
- 3–4 times
- 5–9 times
- 10–19 times
- 20+ times

[PROGRAMMER'S NOTE: if Yes, include the following question,]

3. What activities do you typically participate in at Elk/Beaver Lake?

- None – not applicable
- Rowing
- Motor boating
- Fishing
- Swimming
- Kayaking/canoeing
- Hiking/walking/running
- Horseback riding
- Biking
- Spending time at the beach
- Picnicking
- Enjoying nature
- Birdwatching
- Artistry
- Cultural, traditional, and/or sacred reasons
- Other (please specify):

4. What activities do you typically participate in when visiting other local lakes (i.e., any local lake other than Elk/Beaver Lake, such as Thetis Lake, Durrance Lake)?

- None – not applicable
- Rowing
- Motor boating
- Fishing
- Swimming
- Kayaking/canoeing

- Hiking/walking/running
- Horseback riding
- Biking
- Spending time at the beach
- Picnicking
- Enjoying nature
- Birdwatching
- Artistry
- Cultural, traditional, and/or sacred reasons
- Other (please specify):

Before today, have you ever seen, heard, or read about water quality issues in Elk/Beaver Lake?

Yes

No

Don’t know

[show if “no” or “don’t know” to having heard of Elk/Beaver Lake]

Section 2 Alt:

What activities do you typically participate in when visiting your local lakes (such as Thetis Lake, Durrance Lake, etc.)?

- None – not applicable
- Rowing
- Motor boating
- Fishing
- Swimming
- Kayaking/canoeing
- Hiking/walking/running
- Horseback riding
- Biking
- Spending time at the beach
- Picnicking
- Enjoying nature
- Birdwatching
- Artistry
- Cultural, traditional, and/or sacred reasons
- Other (please specify):

Status of Elk and Beaver Lake

For many years, the **water quality** in Elk/Beaver Lake **has been worsening**, mainly because of increased levels of nutrients such as **nitrogen** and **phosphorus** in the lake.

Although nutrients are naturally occurring substances, **excess nutrients** in Elk/Beaver Lake have led to **a number of water quality issues**. These excess nutrients come from human activities, such as fertilizing agricultural crops and lawns, as well as leakage from septic systems.

The image below summarizes several of these water quality issues in Elk/Beaver Lake.

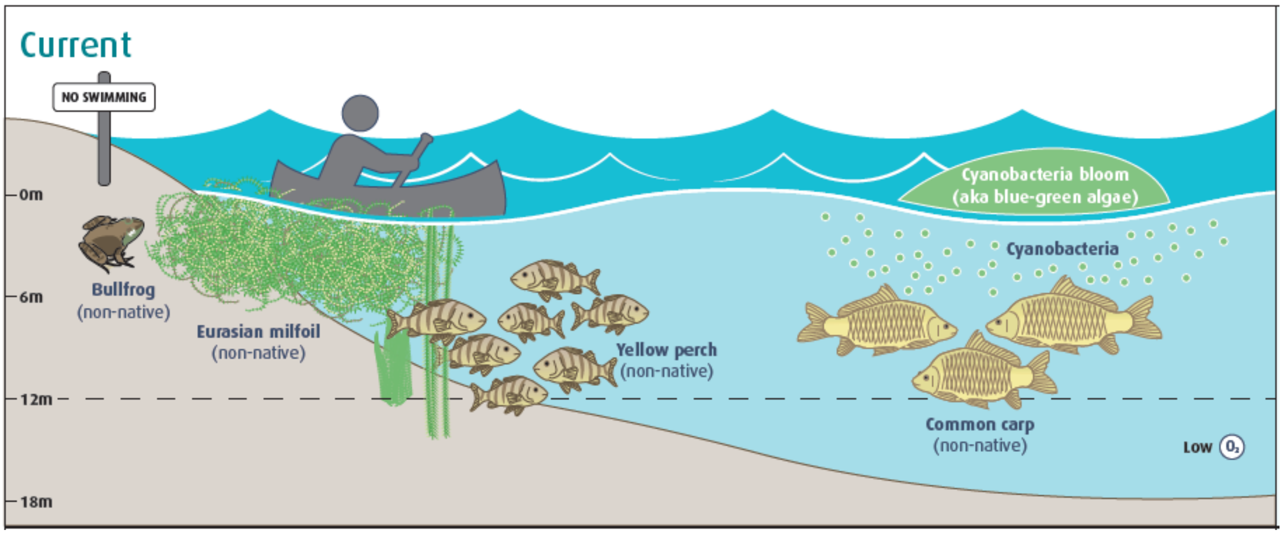


Image adapted from Capital Regional District, Elk/Beaver Lake Initiative (EBLI) webpage

The following water quality issues are present in Elk/Beaver Lake:

- **The spread of non-native lake weeds** (Eurasian milfoil) and **non-native fish species** (e.g., carp)
- **Low oxygen** in the deep parts of the lake
- **The lake habitat has become unsuitable for many species**, especially **native fish** that were once present in Elk/Beaver Lake (e.g., cutthroat trout, prickly sculpins)
- Frequent blooms of cyanobacteria, also known as **blue-green algae**

New lake improvement programs for Elk/Beaver Lake

Local governments are considering several actions and tools to **improve water quality** at Elk/Beaver Lake. One vision for the future of Elk/Beaver Lake with improved water quality is shown in the image below.

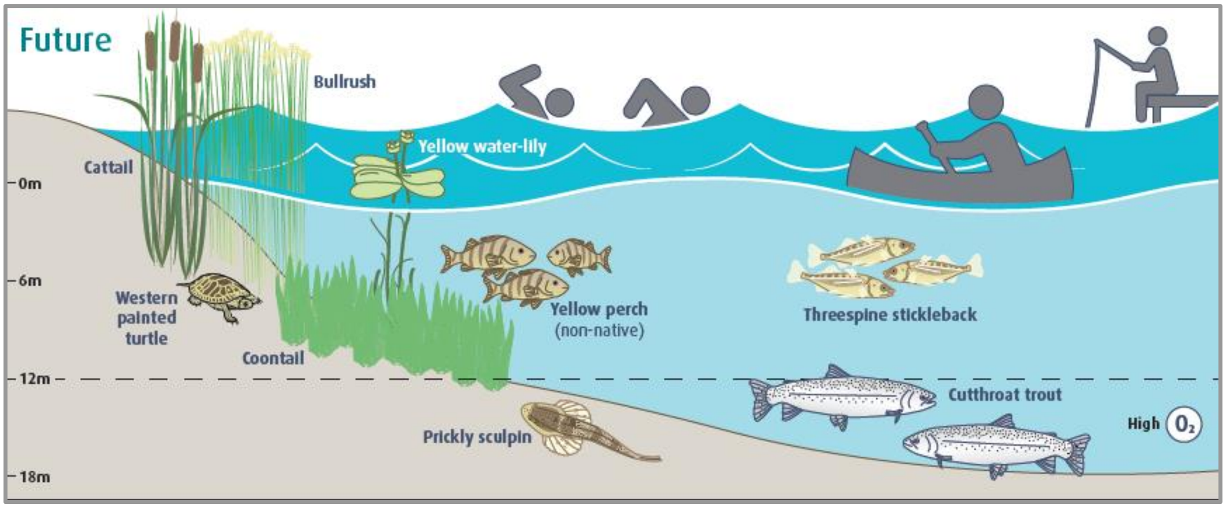


Image adapted from Capital Regional District, Elk/Beaver Lake Initiative (EBLI) webpage

Improvements in water quality could mean:

- **Fewer non-native species** in the lake
- **More oxygen** in the deep parts of the lake
- **Better habitat** for many species, **especially native fish** species such as cutthroat trout
- **Fewer blooms of blue-green algae**

The tools available for improving water quality are:

Oxygenation is the use of machines to add oxygen to the lake. Adding oxygen improves the habitat for fish and other aquatic life, so that fish such as trout can survive and grow in the lake. Additionally, this will reduce the amount of nutrients in the lake water.

Water pollution control: These are various practices that target the source of nutrients to prevent more nutrients from entering the lake. Thus, these tools help address the causes of nutrient pollution.

- For example, proper maintenance of septic systems and using less fertilizer on lawns and crops in areas that flow into the lake will help reduce the amount of nutrients entering the lake.

Geo-engineering methods: this approach encompasses materials that are added to the surface of a lake. As they sink to the lake bottom, they collect and trap nutrients, reducing the amount of nutrients in the lake water.

Native fish stocking and wildlife habitat restoration: lake managers can stock the lake with native fish. Restoring the lake habitat (making it more suitable for native fish) helps the native fish to grow, survive, and successfully reproduce.

Mechanical weed harvesters: can be used to physically cut down the lake weeds (akin to using a giant lawn mower on the lake).

Cost of tools: The use of these tools comes with costs, which include the following:

- **Purchase of equipment and/or materials** (e.g., oxygenation systems, geo-engineering materials)
- **Money for active restoration** (e.g., costs to run the mechanical weed harvester each summer)

These tools can be used separately or can be combined to improve water quality in Elk/Beaver Lake.

Before today, had you ever heard of any of these tools for improving water quality?
__ Yes
__ No
__ Don’t know

People are interested in taking action to improve water quality at Elk/Beaver Lake for a variety of reasons that may include:

- the benefits of having a healthier lake for all to enjoy is worth the money.
- a healthy lake ecosystem should not be endangered by human actions.
- a healthy lake is a source of recreation, enjoyment and learning for people now and in the future.

People are concerned about taking action to improve water quality at Elk/Beaver Lake for a variety of reasons that may include:

- The cost to improve the lake's water quality is too expensive given the benefits.
- Improving lake water quality diverts government funding away from other important uses.
- There may be restrictions placed on what people can do, including limits on land development and agricultural activities.

Environmental Outcomes in Elk/Beaver Lake

Depending on which actions are taken to improve water quality, there can be different outcomes in Elk/Beaver Lake.

The following 5 environmental outcomes are of interest to this survey:

- Blue-green algae advisories
- Recreational fishing
- Water Quality Index score for aquatic life
- Non-native fish
- Non-native lake weeds

Please read the following information carefully to answer the questions in the survey.

Blue-green algae advisories

Did you know that…

- There are times that using Elk/Beaver Lake poses a risk to health of lake users and their pets?

__Yes, I did know
__No, I did not know
__Not sure

One of the most direct impacts of the excess nutrients in Elk/Beaver Lake is the growth of **blue-green algae**, also known as cyanobacteria.

When blue-green algae are present in large numbers, they form blooms**.**

The growth of blue-green algae in Elk/Beaver Lake is a concern because they threaten the **safe recreational use of the lake.** This is because blue-green algae can produce **toxins** that are **harmful to the health of humans and animals**.

Exposure to water that contains blue-green algae toxins can result in:

- minor skin irritations,
- illness including vomiting and diarrhea, and
- in extreme cases, can result in the death of humans and animals

When blue-green algae bloom in Elk/Beaver Lake, the CRD posts **advisories. These advisories warn people** that using the lake (e.g., for swimming, rowing, kayaking, etc.) or allowing their pets to drink from the lake may result in **adverse health effects**.

The number of days in a year that blue-green algae advisories have been posted reflects how many days per year blue-green algae are potentially threatening the safe recreational use of Elk/Beaver Lake.

Currently, blue-green algae advisories are posted for an average of 115 days per year. Between June–September, the period in which people use the lake most, there is an average of 40 days of blue-green algae advisories.

A blue-green algae advisory posted at Elk/Beaver Lake is shown below:

Image cropped from CTV News Victoria.

Recreational Fishing

Did you know that…

- Elk/Beaver Lake is one of the most popular freshwater fishing locations on Vancouver Island?

__Yes, I did know
__No, I did not know
__Not sure

Elk/Beaver Lake is a popular fishing spot. In fact, Elk Lake is the most fished lake on Vancouver Island. The next most popular lake for fishing, Prospect Lake, is fished just under half as much as Elk Lake.

The productivity of fisheries is often measured using expected catch rates, which measure **how many fish are caught per fishing trip.** This number represents what an average angler will catch on a typical trip, though the actual number of fish caught will vary by the time spent fishing, the skill of the angler, and the techniques and equipment used.

Although Elk Lake is stocked with rainbow trout each year, the catch rates of preferred species, including trout, have been declining in Elk/Beaver Lake, in part due to water quality issues.

The average catch rate of recreational fish in Elk/Beaver Lake is currently 2 fish per trip.

Water Quality Index score for aquatic life

Did you know that…

- Poor water quality is a risk to aquatic life including fish?

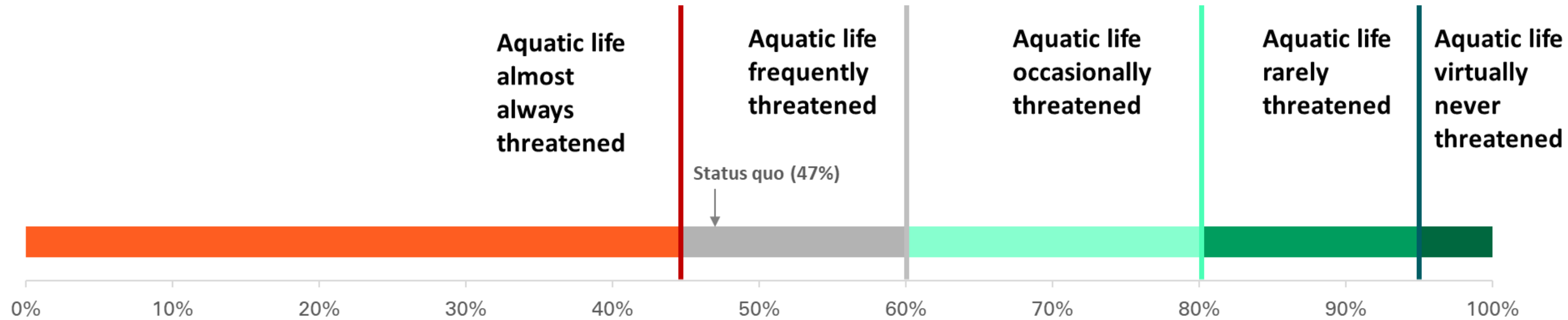
__Yes, I did know
__No, I did not know
__Not sure

The conditions of a lake, including the lake's quality of water, can sometimes threaten the health and survival of aquatic life. For example, if the water in a lake is frequently very low in oxygen, then it is **difficult for some types of aquatic life, such as fish, to survive in the lake**.

To measure **how often a lake's conditions threatens the aquatic life** within it, scientists and lake managers use a **Water Quality Index**. The Water Quality Index looks at the water quality conditions in the lake (e.g., how much oxygen is in the lake water) and compares it to the water quality conditions required to support aquatic life.

Lower scores on the Water Quality Index means that water quality conditions in the lake are more frequently threatening aquatic life, whereas higher scores mean that water quality conditions are rarely threatening aquatic life.

Currently, Elk/Beaver Lake has a score of 47/100 (47%) on the WQI. This means that the water quality in the lake is **frequently threatening aquatic life**. The graph below shows how WQI scores indicate how often aquatic life is threatened.



Water Quality Index scores representing how frequently water quality affects aquatic life.

Proportion of non-native species to native species

Did you know that…

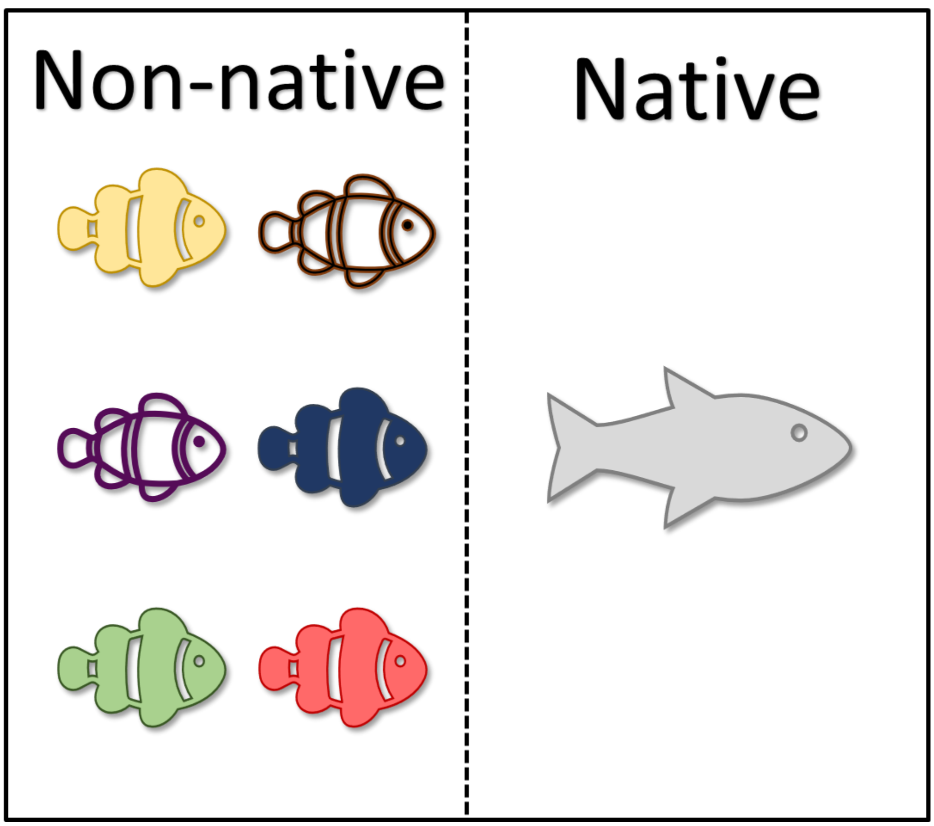
- Native fish species such as cutthroat trout are currently rare, and in many cases absent, from Elk/Beaver Lake?

__Yes, I did know
__No, I did not know
__Not sure

Instead, **non-native fish species such as carp are common**. Importantly, these non-native fish species often contribute to water quality issues in the lake and prevent the return of native fish species.

Water quality issues at Elk/Beaver Lake have created a habitat that is **difficult for native species to live in** and enables **non-native (human-introduced) species to thrive**.

Currently, about **85% of fish species in Elk/Beaver Lake are non-native**.



Non-native lake weeds

Did you know that…

- Thick lake weeds can be difficult to paddle or row through, and many people do not like the look of lake weeds or having to swim through the weeds?
- __Yes, I did know
- __No, I did not know
- __Not sure

The spread of non-native lake weeds is not necessarily linked to nutrients in the lake, but can result from human activities (e.g., neglecting to clean, drain, and dry boats before transferring boat from one lake to another).

However, when these weeds die, they decompose and release more nutrients into the lake, therefore, they can **contribute to the oversupply of nutrients** in Elk/Beaver Lake.

The **extent of non-native lake weeds** covering the lake is measured as a **percentage of the total lake area**.

In Elk/Beaver Lake, the **non-native lake weed known as Eurasian milfoil** covers up to **30% of the entire lake** by the end of summer each year. The image below shows Eurasian milfoil.

Image source: CRD Presentation on Elk/Beaver Lake

The image below illustrates the extent of Eurasian milfoil in Elk/Beaver Lake. Green areas denote medium density, beige is high density, and yellow is ultra high density of weeds.

Image source: CRD Watershed Management Plan.

This is just a fun quiz to see how much you already know about Elk/Beaver Lake. The answers will be provided on the next screen.

Please select whether you feel the following statements are true or false.

When blue-green algae advisories are in place for Elk/Beaver Lake, using the lake poses a risk to health of lake users and their pets.

T/F

Elk/Beaver Lake is one of the most popular freshwater fishing locations on Vancouver Island.

T/F

A Water Quality Index (WQI) can be used to determine how frequently the water quality conditions at Elk/Beaver Lake threaten aquatic life, such as fish.

T/F

Native fish species such as cutthroat trout are currently rare, and in many cases absent, from Elk/Beaver Lake.

T/F

Lake weeds such as Eurasian Milfoil cover up to 70% of Elk/Beaver Lake.

T/F

We asked you how much you already knew about Elk/Beaver Lake. The correct answers to the quiz are below:

	True	**False**
When blue-green algae advisories are in place for Elk/Beaver Lake, using the lake poses a risk to health of lake users and their pets.	✓	
Elk/Beaver Lake is one of the most popular freshwater fishing locations on Vancouver Island.	✓	
A Water Quality Index (WQI) can be used to determine how frequently the water quality conditions at Elk/Beaver Lake threaten aquatic life, such as fish.	✓	
Native fish species such as cutthroat trout are currently rare, and in many cases absent, from Elk/Beaver Lake.	✓	
Lake weeds such as Eurasian Milfoil cover up to 70% of Elk/Beaver Lake. Correct answer: Lake weeds such as Eurasian Milfoil cover up to **30%** of Elk/Beaver Lake		✓

Which Elk/Beaver Lake Future Do You Prefer?

Your opinions are important to understand what Elk/Beaver Lake future outcomes the public prefers. The survey will inform decision-makers on the opinions and preferences of the community regarding the future state of Elk/Beaver Lake.

Next, we will ask you to make **6 choices** to indicate which option you prefer between different Elk/Beaver Lake future scenarios. In each question, you are asked to choose between:

- **The Status Quo Alternative (leave as is),** which represents the **current conditions** at Elk/Beaver Lake, and
- **Alternative A and B,** which represent the expected outcomes over the next 10 years under two of the many potential future scenarios that do more and cost more to **improve water quality** at Elk/Beaver Lake. The added cost to your household each year for 10 years is shown for each alternative.

Please **choose the option you most prefer** and indicate how certain you are about the choice you have made.

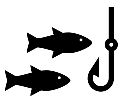
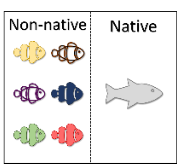
Note that changes in individual lake outcomes may not occur to the same extent and it is possible that some may worsen while others improve.

For each question, ask yourself whether you believe the Elk/Beaver Lake improvements offered under Alternatives A or B are worth the additional costs each year to your household over 10 years.

The fee will be paid into a fund earmarked for undertaking the activities described above to improve water quality in Elk/Beaver Lake. Assume that your household will **pay this fee each year for the next 10 years**.

For homeowners, this would mean the **annual costs to your household could increase**, and this would translate into **increased rent for renters**.

The effects of each possible scenario will be described using the following characteristics:

Lake Outcome	What it Means
Blue-green algae advisories 	The number of days per year when blue-green algae advisories are posted at Elk/Beaver Lake. Without management changes, **the number of days with blue-green algae advisories will be 115 per year.**
Recreational fishing 	The expected daily catch rate of recreational fish species. Without management changes, **the catch rate will be 2 fish per trip.**
Water Quality Index score for aquatic life %	A score between 0 and 100 percent showing how frequently the water quality conditions in Elk/Beaver Lake threatens aquatic life. A score of 100 means that aquatic life is virtually never threatened; 0 means almost always threatened. Without management changes, **the score in the Elk/Beaver Lake will be 47% (frequently threatened).**
Proportion of non-native to native species 	The percentage of non-native fish species relative to native fish species. A low percentage (e.g., 0%) means no non-native fish species are present in the lake; a high percentage (100%) means all fish in the lake are non-native. Without management changes, **the proportion of non-native to native fish species will be 85%.**
Non-native lake weeds 	The percentage of the total lake area that non-native lake weeds cover. Without management changes, **non-native lake weeds will cover 30% of the total lake area.**
Cost to your household per year for 10 years $	The amount of money that your household will have to pay each year for 10 years while the remediation activities take place.

Ready, set, choose.

Remember

- Paying for environmental improvement means you would have less money available to buy other things.
- Please answer these questions truthfully and to the best of your ability, keeping in mind your budgetary constraints.
- Please treat each of the following questions individually as a separate choice.

You may use the back button below to review previous instructions.
[Back buttons available up until “Which Elk/Beaver Lake Future Do You Prefer?” text]

[] I am ready to make choices between potential futures for Elk/Beaver Lake

EXAMPLE CHOICE TASK
[Programmer Note: randomize order of Alt A and Alt B]

Question 1 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year	**40** days per year	**60** days per year	**115** days per year
Recreational fish catch rate per trip	**3** fish per trip	**1** fish per trip	**2** fish per trip
Water Quality Index score for aquatic life	**85%** (rarely threatened)	**65%** (occasionally threatened)	**47%** (frequently threatened)
Proportion of non-native to native fish species	**65%** non-native	**75%** non-native	**85%** non-native
Weed extent	**50%** of lake area	**20%** of lake area	**30%** of lake area
Cost to your household per year for 10 years	**$300**	**$55**	**$0**
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Question 2 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year			
Recreational fish catch rate per trip			
Water Quality Index score for aquatic life			
Proportion of non-native to native fish species			
Weed extent			
Cost to your household per year for 10 years			
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Question 3 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year			
Recreational fish catch rate per trip			
Water Quality Index score for aquatic life			
Proportion of non-native to native fish species			
Weed extent			
Cost to your household per year for 10 years			
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Question 4 of 6:

Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year			
Recreational fish catch rate per trip			
Water Quality Index score for aquatic life			
Proportion of non-native to native fish species			
Weed extent			
Cost to your household per year for 10 years			
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Question 5 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year			
Recreational fish catch rate per trip			
Water Quality Index score for aquatic life			
Proportion of non-native to native fish species			
Weed extent			
Cost to your household per year for 10 years			
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Question 6 of 6:
Alternatives A and B are scenarios of potential futures for Elk/Beaver Lake if action is taken to improve the lake. The Status Quo alternative means no new lake improvement action occurs. Given the choice between these three alternatives, how would you vote?

	Result in 10 years		
	Alternative A	**Alternative B**	**Status Quo**
Days of blue-green algae advisories per year			
Recreational fish catch rate per trip			
Water Quality Index score for aquatic life			
Proportion of non-native to native fish species			
Weed extent			
Cost to your household per year for 10 years			
I would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

Considering the alternatives outlined above, what do you think a typical person in your neighbourhood would choose if the following options were put to vote in a real referendum?

A typical neighbour of mine would vote for…	☐ Alternative A	☐ Alternative B	☐ Status Quo

How would you rate the difficulty in answering the previous lake improvement questions?

Very difficult to answer	Difficult to answer	Slightly difficult to answer	Neither easy nor difficult to answer	Slightly easy to answer	Easy to answer	Very easy to answer
○	○	○	○	○	○	○

To what degree are you certain about your votes on the previous lake improvement questions?

Very uncertain	Uncertain	Slightly uncertain	Neither certain nor uncertain	Slightly certain	Certain	Very certain
○	○	○	○	○	○	○

When decision-makers decide whether to implement the proposed lake improvement plan you just voted on, how likely do you think it is that they will take into account your vote and that of the other respondents to this study in their decision-making?

Very unlikely	**Unlikely**	**Slightly unlikely**	**Neither likely nor unlikely**	**Slightly likely**	**Likely**	**Very likely**
○	○	○	○	○	○	○

Please indicate to what extent you agree with each of the following statements:

[PROGRAMMERS NOTE: Randomize statement order]

I voted as if my household would actually face the costs shown
I voted as if the lake improvement programs would actually achieve the results shown
I am against any more government spending
It is important to improve water quality at Elk/Beaver Lake no matter how high the cost
I should not have to pay to protect the environment

Did you believe that if one of the alternative scenarios is implemented, you and your family would be charged the annual fee shown for the next 10 years, more than annual fee shown, or less than annual fee shown?

- ☐ Charged annual fee shown
- ☐ Charged more
- ☐ Charged less

Section 6

Uses and enjoyment of Elk/Beaver Lake

[show only if S2Q1_A = 1 (if they've ever visited Elk/Beaver Lake)]

1. To what extent do you feel that blue-green algae affects your use and/or enjoyment of Elk/Beaver Lake? [*Programmer note: if respondent selects 'not at all', please skip next question]*
   - Not at all
   - Somewhat
   - Moderately
   - Very much so
   - Completely

2. Have you ever looked on the CRD's Alerts and Advisories page to determine whether a blue-green algae advisory was active at Elk/Beaver Lake, prior to visiting the lake?
   - Yes
   - No

3. Have you ever visited Elk/Beaver Lake but had to change your plans because of advisories for blue-green algae at Elk/Beaver Lake?
   - Yes
   - No

[show if changed plans due to advisories]

4. What did you do in response to not being able to use Elk/Beaver Lake as planned?
   - Went home
   - Went to a different lake
   - Went to the lake, but did not go in the water
   - Went to the lake and used it anyway
   - Other (please specify):

[show if changed plans due to advisories]

5. How many times over the 12 months have your plans for going to Elk/Beaver Lake been affected by blue-green algae advisories?
   - Never-I have not had to change my plans in the past 12 months
   - Once
   - Twice
   - Three times or more

6. To what extent do you agree or disagree with the following statements?
   [randomize order]

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree … Agree….Strongly agree
I feel safe swimming in Elk/Beaver Lake.	☐	☐	☐	☐	☐

I feel safe boating, rowing, or canoeing/kayaking in Elk/Beaver Lake.	☐	☐	☐	☐	☐
I feel safe consuming fish that I catch from Elk/Beaver Lake.	☐	☐	☐	☐	☐
I feel safe allowing my pet to drink from the lake.	☐	☐	☐	☐	☐
I am concerned about the current water quality in Elk/Beaver Lake.	☐	☐	☐	☐	☐
I am concerned about the future state of water quality in Elk/Beaver Lake.	☐	☐	☐	☐	☐
I am concerned about the ability of Elk/Beaver Lake to support wildlife, including native and endangered species.	☐	☐	☐	☐	☐

7. To what extent do you feel the following groups/organizations should be responsible for protecting the water quality at Elk/Beaver Lake?

[randomize order]

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree … Agree….Strongly agree
Provincial Government	☐	☐	☐	☐	☐
Regional Government	☐	☐	☐	☐	☐
Non-Government Groups	☐	☐	☐	☐	☐
Landowners	☐	☐	☐	☐	☐
Yourself	☐	☐	☐	☐	☐
Park visitors	☐	☐	☐	☐	☐

Are there any **other** groups/organizations that you feel should be responsible for protecting the water quality at Elk/Beaver Lake? (please specify) [*programmer note: do not force response]*:

8. Are you aware of any actions taken by the government to improve the water quality at Elk/Beaver Lake? [*Programmer note: if no, skip to question 12*]

   ☐ Yes
   ☐ No

9. Do you feel satisfied with the steps the government is taking to improve water quality at Elk/Beaver Lake? [*Programmer note: if yes, skip to question 12*]
   ☐ Yes
   ☐ No

10. Please indicate why and provide any suggestions for what you would like to see the government do to improve water quality at Elk/Beaver Lake:

11. Please think back about everything you read during this survey. Overall, do you think it tried to push you to choose one way or the other, or let you make up your own mind about how to choose?

- ☐ Tried to push you to choose the Status Quo option
- ☐ Tried to push you to choose the Alternative A or B options
- ☐ Let me make up my own mind

Demographics

This information is for statistical purposes only – to help us better understand your answers. Remember that responses are confidential.

1. Are you a member of any non-governmental or community organizations, such as the Victoria Golden Rods and Reels Society, the Elk/Beaver Lake Equestrian Society, the Victoria Rowing Society, Beaver Elk Lake Environmental Stewards (BEES), etc.?
   ___Yes (please specify which):

   ___No

2. Which gender do you identify with?

___Man
___Woman
___ Non-binary
___ Prefer to self-identify: [textbox]
____Prefer not to answer

3. Which age category do you fall under?

___18–24 years
___25–39 years
___40–54 years
___55–64 years
___65+ years
Prefer not to say

4. Which of the following do you identify with? Please select all that apply.

____North American Indigenous
____First Nations
____Inuit
____Métis
____Canadian
____American
____Latin, Central, or South American (e.g., Argentinian, Brazilian, Mexican)
____African
____South Asian (e.g., East Indian, Pakistani, Sri Lankan)
____East and Southeast Asian (e.g., Chinese, Filipino, Japanese, Korean, Vietnamese)
____West Asian (e.g., Iranian, Afghan)
____Caribbean origins
____Oceania
____British Isles origin (e.g., English, Irish, Scottish, Welsh)
____Northern European (e.g., Iceland, Finland, Denmark)
____Western European (e.g., Austrian, Belgian, Dutch)

____Eastern European (e.g., Bulgarian, Latvian, Polish)
____Southern European (e.g., Albanian, Bosnian, Catalan)
____Other European
____(dis)ability
____LGBTQ2S+
____ Other (please specify)……
____Prefer not to answer

5. How would you describe your living situation? Do you live:
 ____With parents
 ____With roommate(s)
 ____By yourself
 ____Alone with a child or children
 ____With a significant other
 ____With a significant other and one or more children
 ____Other (please specify):
Prefer not to say

6. How many people live in your household (including yourself)?

Prefer not to say

7. Do you have grandchildren?

 ___Yes
 ___No
 ___Prefer not to say

8. What is the highest level of education that you have completed?

 ____Less than high school
 ____High school graduate
 ____Vocational/Trade/Technical School
 ____Some University/College
 ____Bachelor's degree
 ____Advanced degree
Prefer not to say

9. What is your employment status?

 ___Unemployed
 ___Employed part-time
 ___Employed full-time
 ___Student

___Retired
___Full-time homemaker
Prefer not to say

10. To the best of your knowledge, please indicate the total annual income of your **household** before taxes.

___Less than $29,999
___Between $30,000 and $49,999
___Between $50,000 and $69,999
___Between $70,000 and $99,999
___Between $100,000 and $149,999
___$150,000 or greater
Prefer not to say

Please provide your postal code:

When entering your postal code, please include a space between the first three and last three characters (e.g., V9B 3P3).

[textbox: restricted format (A9A 9A9)]
Prefer not to say

Have you previously completed this survey as part of a focus group?
1,Yes
2,No
3,Don't know

Thank you very much for taking the time to answer the questionnaire.

Please enter any additional comments you may have about this survey in the space provided.

____

Survey completion message

Thank you for your participation.

The purpose of this survey was to determine how the public benefits from Elk/Beaver Lake, and what improvements they would like to see in the water quality at Elk/Beaver Lake, if any. This information may be used to inform the water quality management activities at Elk/Beaver Lake and in other lakes across Canada.

If you have any questions or concerns regarding this survey, or would like a summary of the results upon completion of this research (by the end of 2022), please contact:

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