Paradise Lake Association: Lake Quality and Best Practices Survey

September 1st, 2024

Tip of the Mitt Watershed Council

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Acknowledgements

Tip of the Mitt Watershed Council (TOMWC, hereafter referred to as the Watershed Council) would like to offer our special thanks to the Paradise Lake Association (PLA) for their sincere interest in the protection of Northern Michigan's waters and for contracting with us to compose, mail, and collect responses for a 'Lake Quality and Best Practices Survey' for lakefront property owners. The following report is intended to be a comprehensive overview of the results from the contract made between TOMWC and PLA.

Introduction

Paradise Lake, formerly known as Carp Lake, is a large, shallow drainage lake located partially in northern Emmet County and partially in Cheboygan County (Figure 1). Paradise Lake is part of the larger Carp River Watershed (sometimes referred to as the Coastal/Other Watershed in Watershed Council reports) and has a surface area of 1,947 acres. Paradise Lake has a shoreline of 9.7 miles and reaches a maximum depth of 18 feet. The lake is approximately 3 miles in length and has two prominent points known as Stony Point and Ashbaugh Point. The area to the west of Ashbaugh Point is known as Carlton Cove. Paradise Lake is fed by Mud Creek (extending for about 8 miles) to the east and flows into the Carp River (Carp Lake River) to the west. The Carp River eventually empties into Lake Michigan at Cecil Bay, which is just east of Wilderness State Park.

While the majority of the lake is less than 10 feet deep, the deepest spot (18 feet) is located in a long, narrow trough that runs east to west along the lake's northern half. A small, shallow plateau, reaching no deeper than 5 feet, is found at the center of Paradise Lake. The lake supports a thriving fishery, most notably providing habitat for large, predatory pike. While the waters of Paradise Lake are considered high in quality, it suffers from aquatic invasive species presence (e.g. Eurasian Watermilfoil).

Paradise Lake is a popular spot for recreation and outdoor activities. The lake hosts paddlers, fishermen, boaters, and swimmers. The town of Carp Lake (found on US-31) holds only about 400 residents as of the 2022 census. There are multiple preserves, protected by the Little Traverse Conservancy, along the shore of Paradise Lake.

Figure 1. A map of Paradise Lake.

Paradise Lake Water Quality

Paradise Lake has been monitored every three years from 1987-2022 through the Watershed Council's Comprehensive Water Quality Monitoring (CWQM) Program for dissolved oxygen, specific conductivity, pH, total nitrogen, total phosphorus, and chloride levels.

Aquatic nutrients, such as total phosphorus and total nitrogen, are important chemical parameters that form the foundation of all freshwater ecosystems. Total phosphorus is an essential aquatic nutrient required by algae and rooted aquatic plants to facilitate their growth and reproduction. Total phosphorus predicts both biological productivity and current trophic states of freshwater bodies. It can be used to determine whether nutrient pollution is occurring, and to what extent. Nutrient pollution can not only cause increased aquatic plant and algal growth, but can contribute to decreased water clarity, depleted levels of dissolved oxygen, mucky lake bottoms, unstable food chains, hypoxic zone formation, and death of benthic organisms.

Total nitrogen is another essential nutrient found in aquatic ecosystems. Nitrogen contributes to the growth of algae and plants, which provide wildlife habitat. Similar to total phosphorus, excess levels of nitrogen are indicative of a eutrophic ecosystem. Nitrogen-heavy waters may reflect environmental disturbances or anthropogenic activities, such as fertilizer use, stormwater runoff, or wastewater leakage from malfunctioning septic systems.

Chloride is the third and final nutrient measured through the CWQM program. Chloride occurs naturally in freshwater, and is needed by aquatic organisms to carry out basic life functions. However, excess levels of chloride (whether from road salting, brining, drilling of gas and oil wells, or runoff) can pollute freshwater in many ways. For example, chloride can contaminate drinking water, can destabilize aquatic plant community structure, and can be toxic to amphibians and fish. Furthermore, chloride may cause soil to be more sensitive to erosion by affecting its ability to retain water, can corrode infrastructure, and may even cause death if ingested by wildlife.

Below are the assessment criteria used for nutrient parameters sampled through the Watershed Council's CWQM program (Table 1). The assessment criteria are derived from the United States Environmental Protection Agency's (EPA) ambient water quality recommendations. Standard parameter values vary based on classification of waterbodies (i.e. lake or stream), type of parameter (i.e. type of nutrient, type of physical parameter, etc.), and EPA ecoregions and subecoregions. An ecoregion refers to specific areas where ecosystems are generally similar. A subecoregion refers to an ecoregion, but on a smaller geographic scale. Paradise Lake falls into subecoregion 50.

Table 1. Aquatic parameters measured as part of the Watershed Council's CWQM program.

Total Phosphorus (micrograms per liter, or ug/L)	**Subecoregion 50:** 12 ug/L streams, 9.7 ug/L lakes
Total Nitrogen (micrograms per liter, or ug/L)	**Subecoregion 50:** Streams: 440 ug/L streams, 400 ug/L lakes

Total Chloride (milligrams per liter, or mg/L)	Aquatic Maximum Value: 320 mg/L

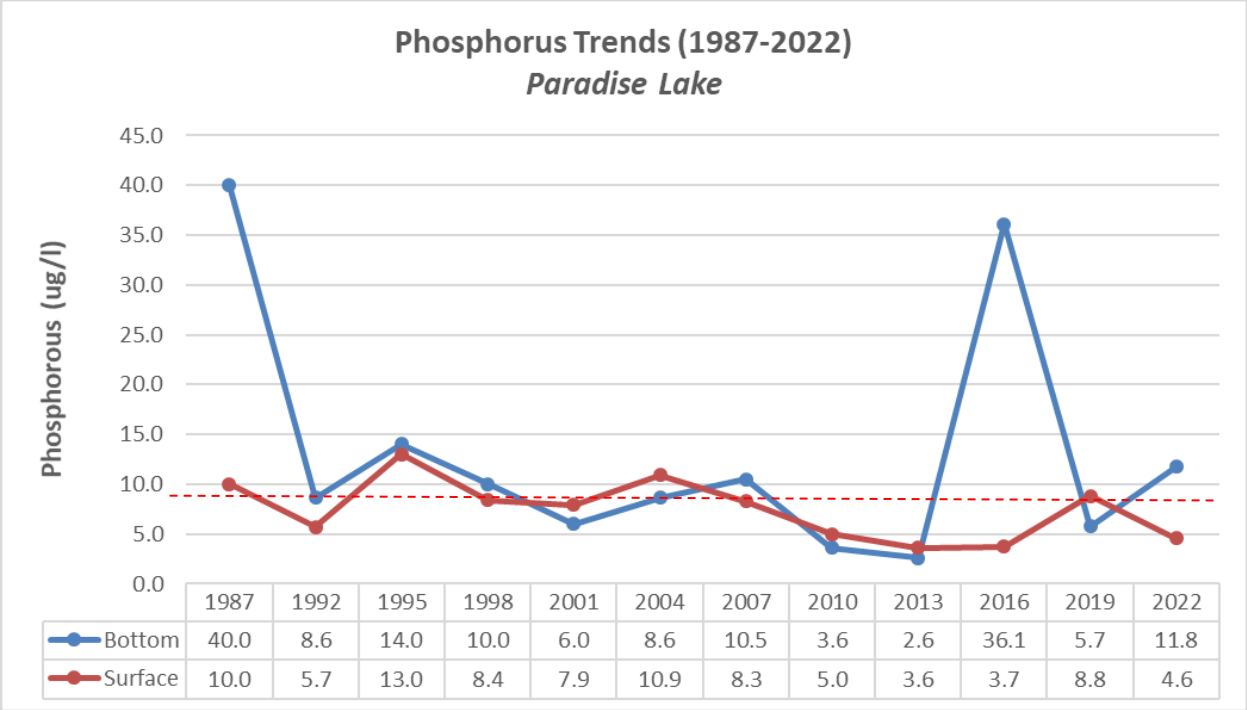
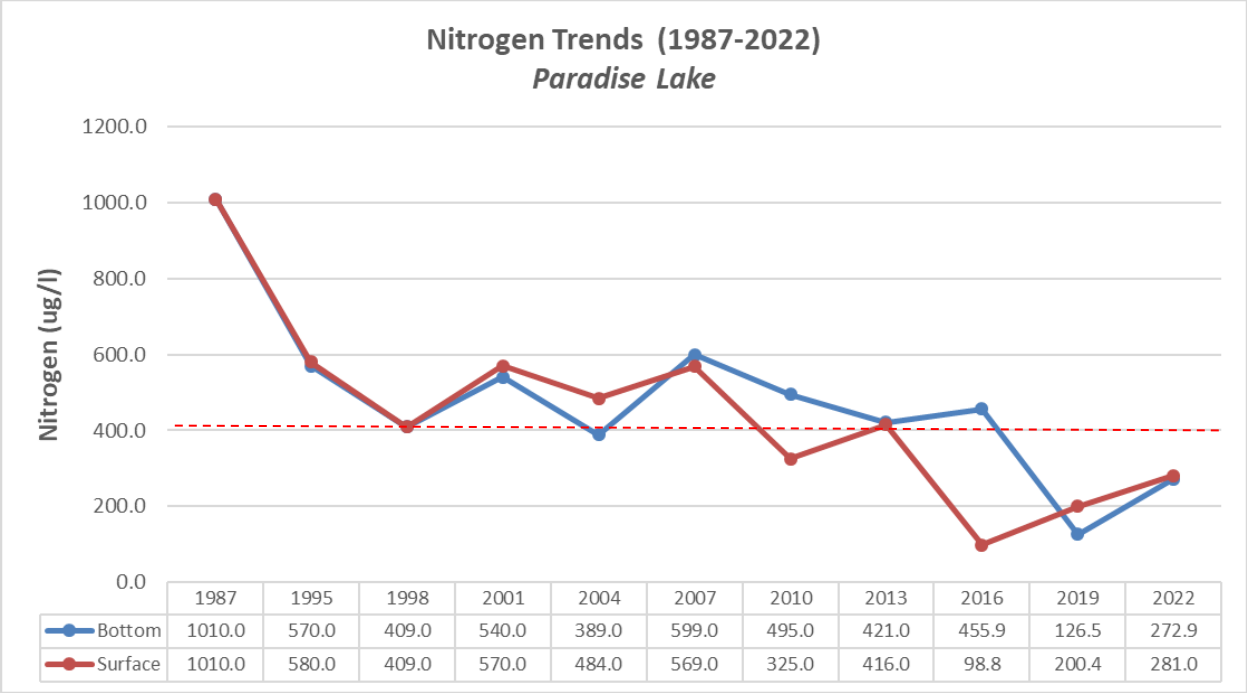
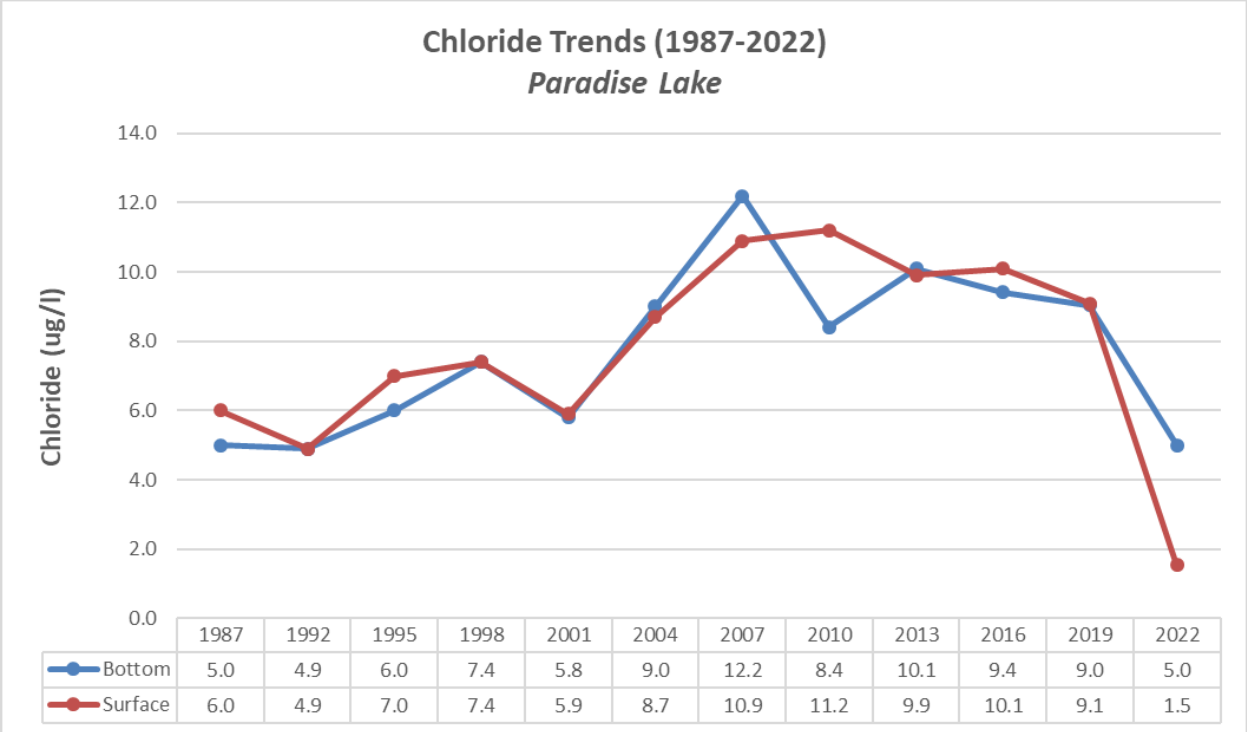


Figure 2. Phosphorus trends in Paradise Lake, from 1987 - 2022, collected through the Comprehensive Water Quality Monitoring Program. Note: Red dashed line indicates EPA recommended maximum value (9.7 ug/L).



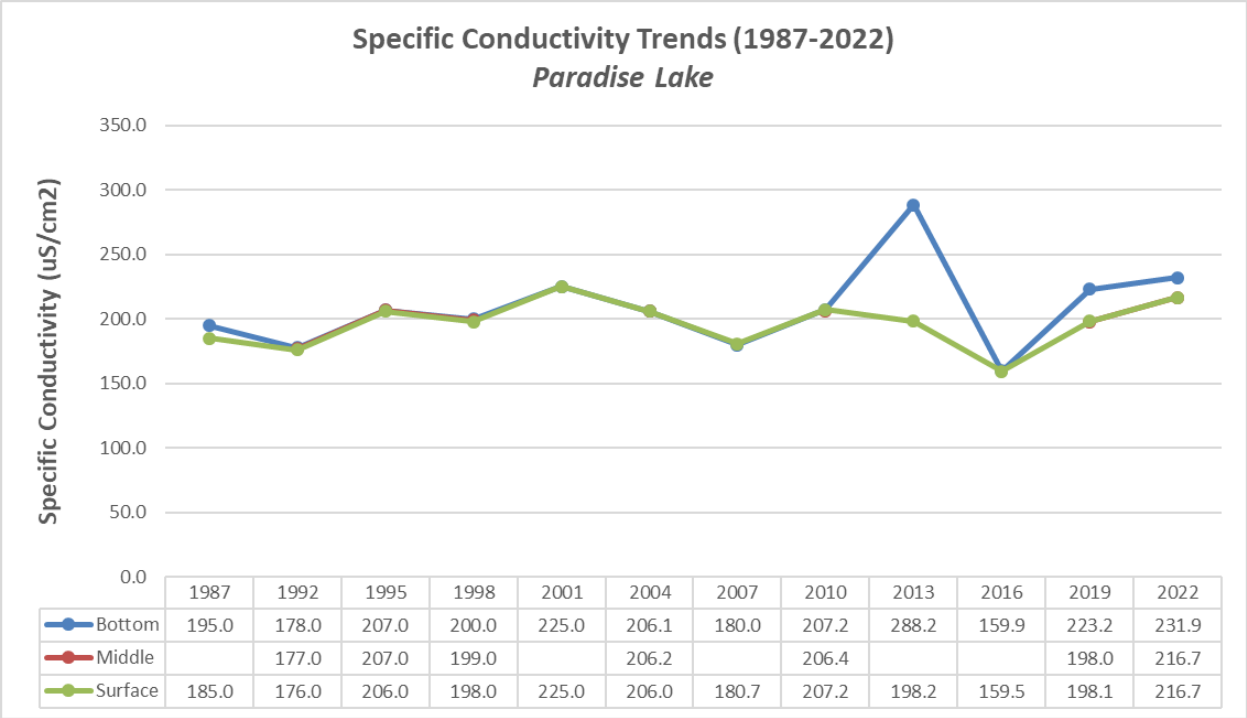
	1987	1995	1998	2001	2004	2007	2010	2013	2016	2019	2022
Bottom	1010.0	570.0	409.0	540.0	389.0	599.0	495.0	421.0	455.9	126.5	272.9
Surface	1010.0	580.0	409.0	570.0	484.0	569.0	325.0	416.0	98.8	200.4	281.0

Figure 3. Nitrogen trends in Paradise Lake, from 1987 - 2022, collected through the Comprehensive Water Quality Monitoring Program. Note: Red dashed line indicates EPA recommended maximum value (400 ug/L).



	1987	1992	1995	1998	2001	2004	2007	2010	2013	2016	2019	2022
Bottom	5.0	4.9	6.0	7.4	5.8	9.0	12.2	8.4	10.1	9.4	9.0	5.0
Surface	6.0	4.9	7.0	7.4	5.9	8.7	10.9	11.2	9.9	10.1	9.1	1.5

Figure 4. Chloride trends in Paradise Lake, from 1987 - 2022, collected through the Comprehensive Water Quality Monitoring Program. Note: Not noted by red line as levels are nowhere near the maximum (320 mg/L).



	1987	1992	1995	1998	2001	2004	2007	2010	2013	2016	2019	2022
Bottom	195.0	178.0	207.0	200.0	225.0	206.1	180.0	207.2	288.2	159.9	223.2	231.9
Middle		177.0	207.0	199.0		206.2		206.4			198.0	216.7
Surface	185.0	176.0	206.0	198.0	225.0	206.0	180.7	207.2	198.2	159.5	198.1	216.7

Figure 5. Conductivity trends in Paradise Lake, from 1987 - 2022, collected through the Comprehensive Water Quality Monitoring Program. Note: A suitable conductivity range to support freshwater fish populations is 150 - 800 uS/cm^2. Note that some years have missing data for middle-level conductivity readings.

Based on the above nutrient data, we see relatively stable phosphorus levels throughout the years of data collection in Paradise Lake. However, there are a few notable instances where phosphorus data exceeds the EPA recommended limit, both near the beginning of data collection (around 1987) and in later years (from 2013 - 2016). Interestingly, nitrogen levels on Paradise Lake show a general decline throughout the span of data collection. Levels consistently breached the EPA recommended maximum until around 2016. Chloride readings show no concrete trend from 1987 – 2022 and levels do not approach the recommended maximum. Conductivity readings are within a suitable range to support healthy freshwater fish populations and do not exhibit a concrete trend throughout the span of data collection. There is a noticeable jump, however, in bottom-level conductivity in the year 2013, where levels reach almost 300 uS/cm^2. However, this value is well within range for a healthy freshwater ecosystem, and does not suggest anything atypical.

Paradise Lake is also monitored on an annual basis for water clarity (Secchi) and chlorophyll-*a* data through the Watershed Council's Volunteer Lake Monitoring (VLM) Program. Secchi disks are used to measure water clarity, or transparency, of a lake. Water clarity relates to overall nutrient levels and biological productivity (i.e. the clearer the water, the more nutrient-poor), and thus, Secchi disks are used for general assessment of lakes worldwide. For example, clear, nutrient-poor lakes may have Secchi disk depths reaching up to 50 feet or more, and nutrient-heavy lakes with excess algal blooms may be invisible just a few feet below the water's surface.

Chlorophyll-*a* is a photosynthetic pigment found in all green plants, including algae. Chlorophyll-*a* concentrations can be used as a measure of algal biomass in freshwater ecosystems, and can provide an estimate of overall biological productivity, and thus, trophic state. Trophic state essentially refers to the level of biological productivity, and overall nutrient levels, observed in waterbodies. Trophic state is commonly classified into four distinct categories: oligotrophic (nutrient-poor), mesotrophic (moderate nutrient levels), eutrophic (nutrient-enriched), and hypereutrophic (extreme nutrient enrichment). The median value of the summer chlorophyll-*a* monitoring results is used to calculate the Carlson Trophic Status Index (TSI) value for the lake, which is compared with the Secchi disk and total phosphorus TSI values for trophic status determination. The Carlson TSI uses an equation to calculate overall biological productivity and trophic state for any given waterbody (Table 3). Below are the assessment criteria used for all aquatic parameters sampled through the Watershed Council's VLM program (Table 3).

Table 2. Aquatic parameters measured as part of the Watershed Council's VLM program.

Parameter	Standard Value(s)
Chlorophyll-*a* (maximum value reported, in ug/L)	Oligotrophic = < 2.2 ug/L Mesotrophic = 2.2 - 6.0 ug/L Eutrophic = 6.0 - 22.0 ug/L Hypereutrophic = >22.0 ug/L
Water Clarity (Carlson Trophic Status Index (TSI))	Oligotrophic = ● Secchi disc depth: > 15.0 ft ● Chlorophyll-*a*: < 2.2 ug/L Mesotrophic = ● Secchi disc depth: 7.5 - 15.0 ft ● Chlorophyll-*a*: 2.2 - 6.0 ug/L Eutrophic = ● Secchi disc depth: 3.0 - 7.5 ft ● Chlorophyll-*a*: 6.0 - 22.0 ug/L Hypereutrophic: = ● Secchi disc depth: < 3.0 ft ● Chlorophyll-*a*: > 22.0 ug/L

Table 3. Trophic State and Corresponding Carlson TSI Values.

Trophic State	Carlson TSI
Oligotrophic	<38
Mesotrophic	38-48
Eutrophic	48-61
Hypereutrophic	>61

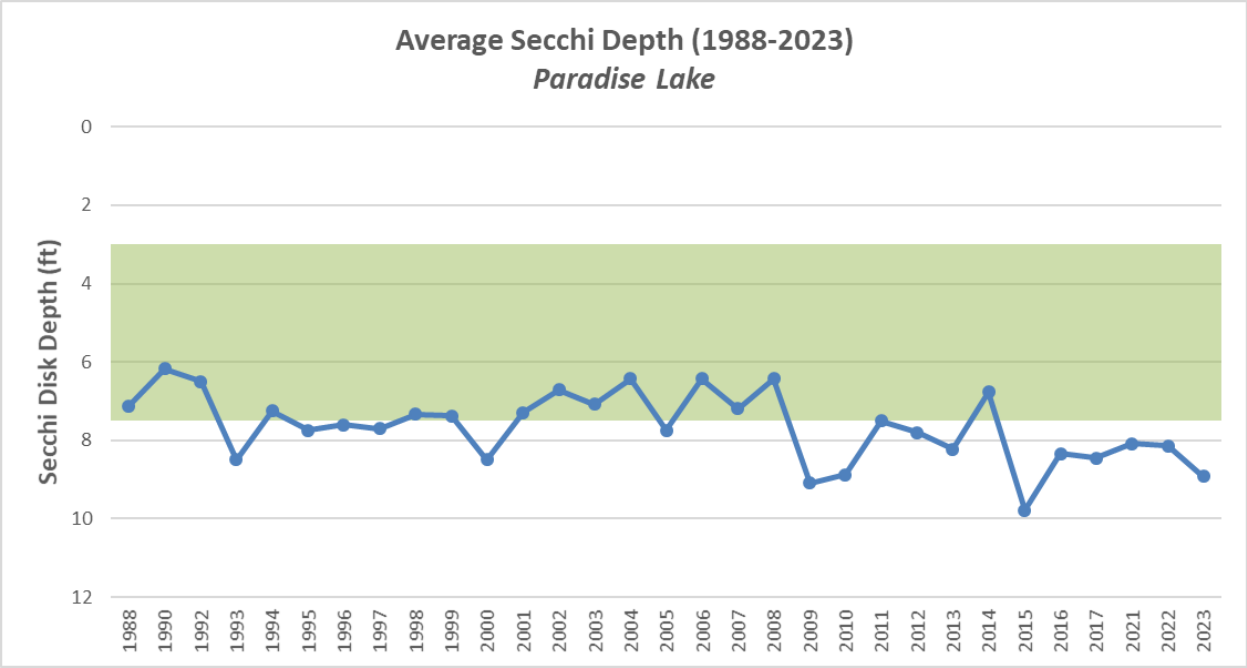


Figure 6. Secchi disk depth trends in Paradise Lake, from 1988 - 2023, collected through the Volunteer Lake Monitoring Program. Note: Green shaded region indicates a eutrophic ecosystem (Secchi depth readings of 3.0 feet to 7.5 feet). Readings less than 3.0 feet are indicative of a hypereutrophic ecosystem.

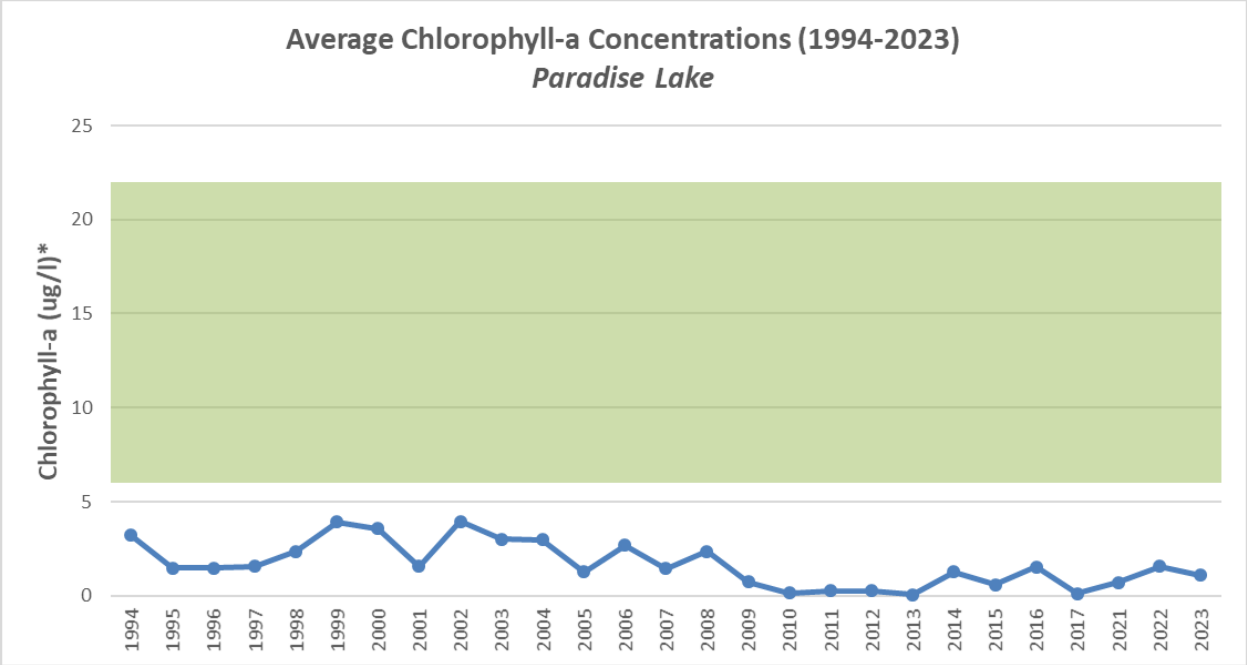


Figure 7. Chlorophyll-a trends in Paradise Lake, from 1994 - 2023, collected through the Volunteer Lake Monitoring Program. Note: Eutrophic conditions are indicative of chlorophyll-a concentrations at 6.0 ug/L and above. Levels do not exceed this threshold for this lake in the data reflected above.

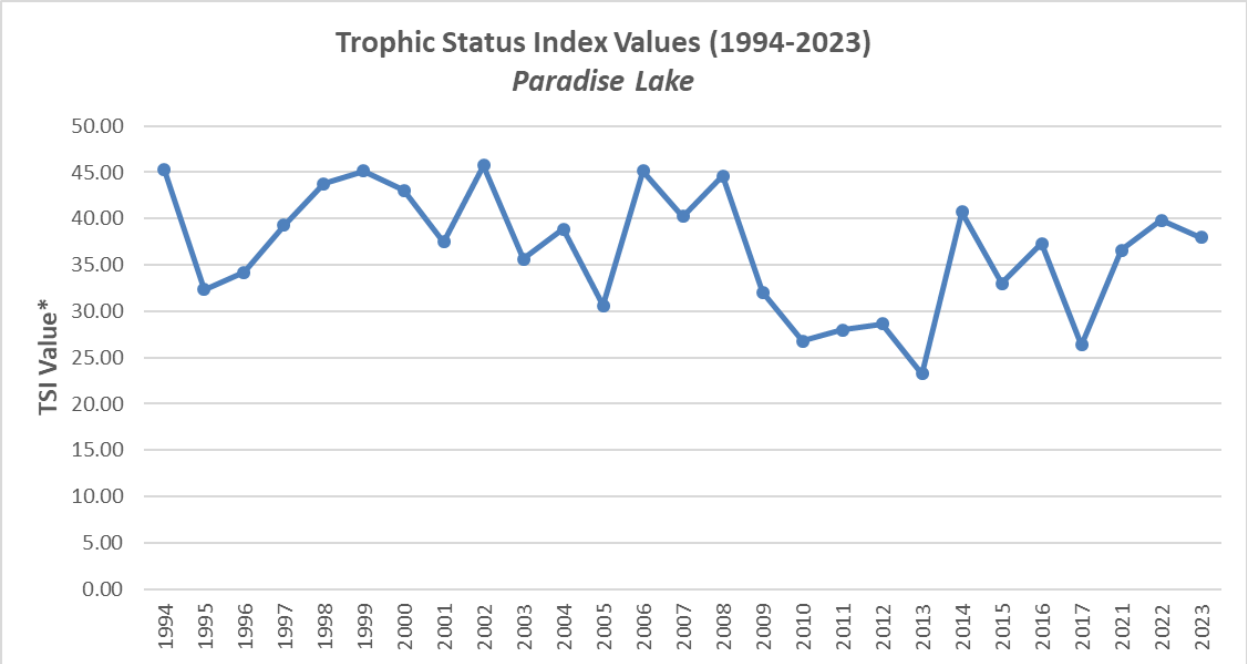


Figure 8. Trophic status index trends in Paradise Lake, from 1994 - 2023, collected through the Volunteer Lake Monitoring Program. Note: Eutrophic conditions are associated with a Trophic Status Index value of 48 or higher. Levels do not exceed this threshold for this lake in the data reflected above.

Based on the above data, we see that water clarity data collected via Secchi disk demonstrates that Paradise Lake has exhibited eutrophic conditions over time, most notably in 1990 and 2008, where

water clarity barely surpasses 6 feet. Interestingly, water clarity has increased beginning in 2015, and has remained under the eutrophic 'threshold' since then, with Secchi depth extending to about 8 feet. In comparison to this, chlorophyll-*a* data is not indicative of eutrophic conditions based on previous data, where levels stayed under 5 ug/L, and concentrations begins to level out around 2009 onwards. Trophic Status Index values for Paradise Lake approached eutrophic conditions (maximum TSI value of 46), but do not reach 48 (TSI reference point for eutrophication).

While Paradise Lake generally has high-quality waters, Paradise Lake Association had previously expressed interest in conducting a septic study to better understand if septic systems, or improper septic system maintenance, was contributing to water quality issues in the lake. Watershed Council staff reached out to Paradise Lake Association in fall of 2023 to ask about their interest in conducting a septic survey. A septic survey, re-named as a 'Lake Quality and Best Practices Survey' for this particular project, is intended to characterize lakefront property owner information related to shoreline health, septic system maintenance, and general homeowner practices that may impact water quality. The methodology of the 'Lake Quality and Best Practices Survey' is described in the next section of this report.

Methodology

The methodology for the 'Lake Quality and Best Practices Survey' was straightforward. First, Watershed Council staff composed a 36-question survey intended to be received and filled out by Paradise Lake lakefront property owners. The survey question content largely consisted of three primary categories: 1) general homeowner information/practices, 2) septic system knowledge/maintenance, and 3) overall property 'health' as it relates to both the shoreline and the water quality of Paradise Lake. Questions included, but are not limited to, the following:

<u>Category 1: General Homeowner Information/Practices</u>

1. Is your property developed?
2. When are people typically at your house (i.e. summer, year-round, etc.)?
3. How much lakefront footage do you own?
4. Have any additions been added to the home's original structure?

<u>Category 2: Septic System Knowledge/Maintenance</u>

1. What is your septic tank made of?
2. How often is the septic tank pumped?
3. How many years old is your septic system?
4. How many bathrooms does your house have?

<u>Category 3: Shoreline and Water Quality</u>

1. What shoreline type best describes your lakefront? (Examples include sand beach, steel seawall, greenbelt or vegetation strip, natural, rock and boulder, other).
2. Is erosion occurring at your shoreline?
3. Do filamentous green algae ever grow at your shoreline?

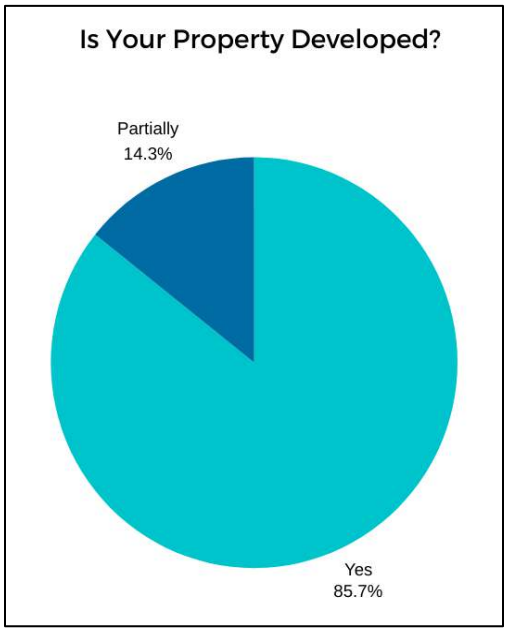
Images were included alongside certain questions to better provide survey respondents with what they should be looking for at their property (i.e. erosion, greenbelts, seawalls, etc.). For a full list of survey questions, along with the survey layout/images itself, please visit the following link: Paradise Lake Association Survey - Tip of the Mitt Watershed Council. Please note that the survey closed for responses on August 15th, 2024.

After the survey was composed, letters notifying lakefront property owners about the availability of the survey were sent to all 337 parcels on Paradise Lake, regardless of which county the lakefront property owner resided in. Letters were sent to summer home addresses and provided the property owner with a full description of the survey, along with a brief description of associated water quality issues that can arise from shoreline hardening, excess fertilizer usage, and improper septic system maintenance. Survey letters were sent in early July of 2024, and lakefront property owners were given until August 15th, 2024, to respond.

Results

A total of 19 survey responses were received (5.6%). However, it is important to make note of a few issues that may have interfered with receiving a higher survey response. For example, a large portion of survey letters came back to the Watershed Council office due to issues such as 'No Mail Receptacle' on the property, or 'Not Deliverable as Addressed'. Additionally, survey response rates are typically low, even with motivational incentives. To boost the number of survey responses, PLA sent out the survey link to their mailing listserv, instructing recipients that only lakefront property owners should respond to the survey. A few more responses were received due to this effort. Below are the results from the 'Lake Quality and Best Practices Survey':

Category 1 Results: General Homeowner Information/Practices



Primarily, 85.7% of respondents (from available data*) said their property was classified as 'developed', meaning an existing structure (house, barn, etc.) has been constructed (Figure 9). Only 14.3% of respondents indicated that their property was partially developed (meaning a shed, paved road, trailer, boat launch, etc. was present).

To ascertain more about housing structure and use, we asked how many people lived in the household. The majority of respondents (63%) said that 2 people lived at the property, while 16% of respondents said 1 person lived at the property, and 21% of respondents said that 2+ people (i.e. 2-5 people, depending on time of year/family visiting) lived at the property.

Figure 9. Property development on Paradise Lake (from survey respondents).

In addition to asking about the number of people at the household, we asked when residents typically were in their homes (i.e. summer only or year-round, etc.). The responses received and saved (2) indicated that residents only stayed at the properties during summer**.

**A small amount of data was lost due to technical difficulties with the survey. Respondents were accidentally editing the survey questions themselves, and this resulted in a small portion of data loss.*
***Due to the same technical issue involving inadvertent data loss due to respondents accidentally deleting questions, 16 responses were lost for the question involving length of stay.*

The survey asked about appliances and additions to the home's structure. 63% of respondents indicated that no additions had been added to the home's original structure, with 36% indicating that additions had been added, either by the current property owners or previous ones. The most common type of addition was a bathroom, but other additions included bedrooms, sunrooms, garages, kitchens, living rooms, and porches. Appliances that may impact wastewater levels, septic system effluent, and water quality are shown below (Figure 10).

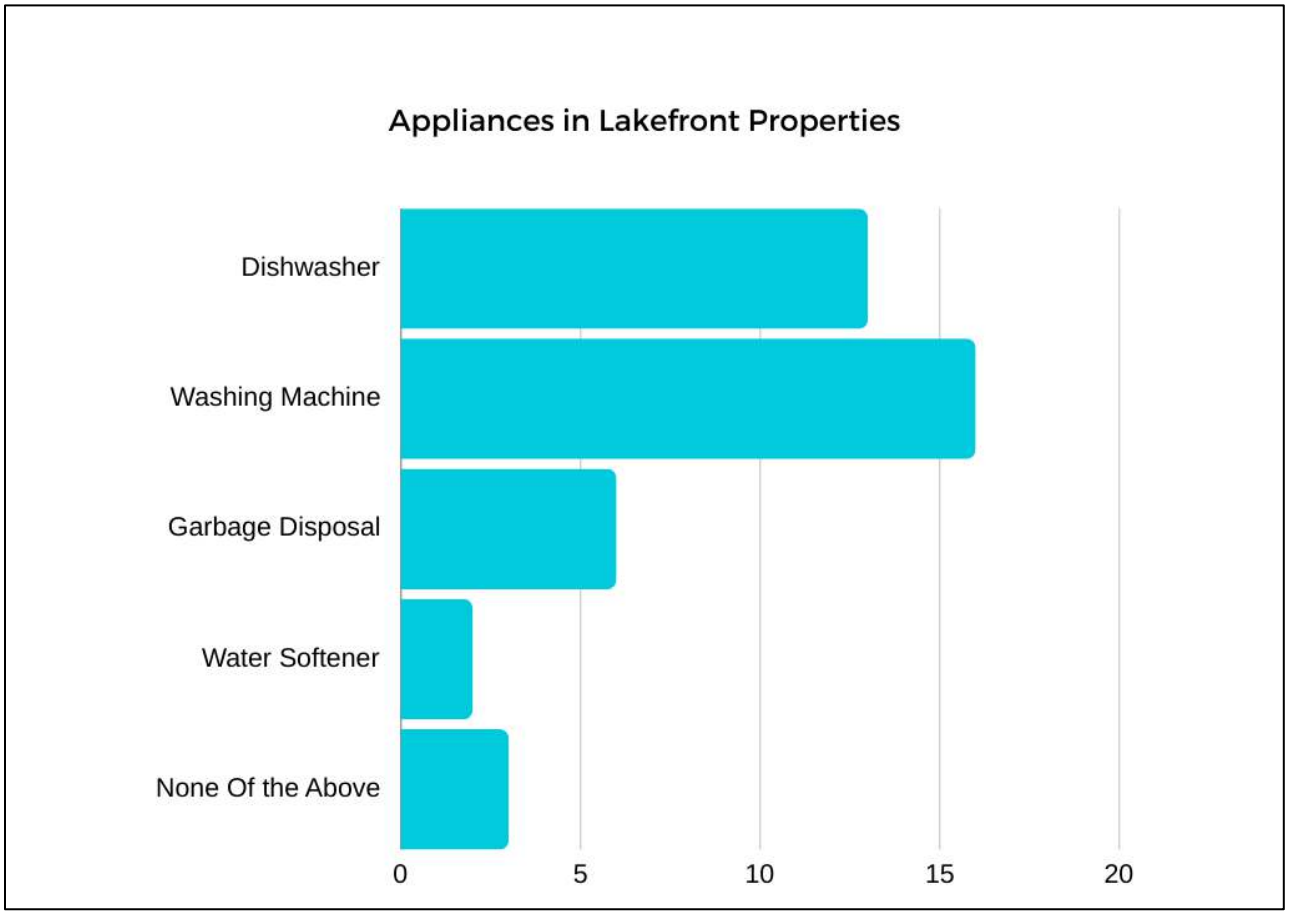


Figure 10. Appliances in lakefront properties on Paradise Lake. Washing machines and dishwashers are the most popular appliances.

The survey asked about presence of footing drains and where, if present, the footing drains discharge to. 89% of respondents did not have footing drains on their property. Of the 11% that did, respondents said

that their footing drains discharged to 'land', 'the side yard', and one respondent said that their sump pump drains to the lake. Finally, respondents were asked about how much lakefront footage they owned. 63% of respondents owned between 100 – 200 feet of lakefront property, 26% of respondents owned less than 100, and one respondent indicated that they owned 1,800 feet. One response was not usable as it did not directly address the question.

Category 2 Results: Septic System Knowledge and Maintenance

Lakefront property owners were first asked what type of septic system they had (Figure 11). They were also asked about the dimensions of the tank (in gallons). 5 respondents indicated that the tanks were 1000 gallons, 2 had tanks above 1000 gallons, and 2 indicated a 500 gallon tank. 10 of the respondents either stated they did not know the dimensions of the tank, or did not provide usable data.

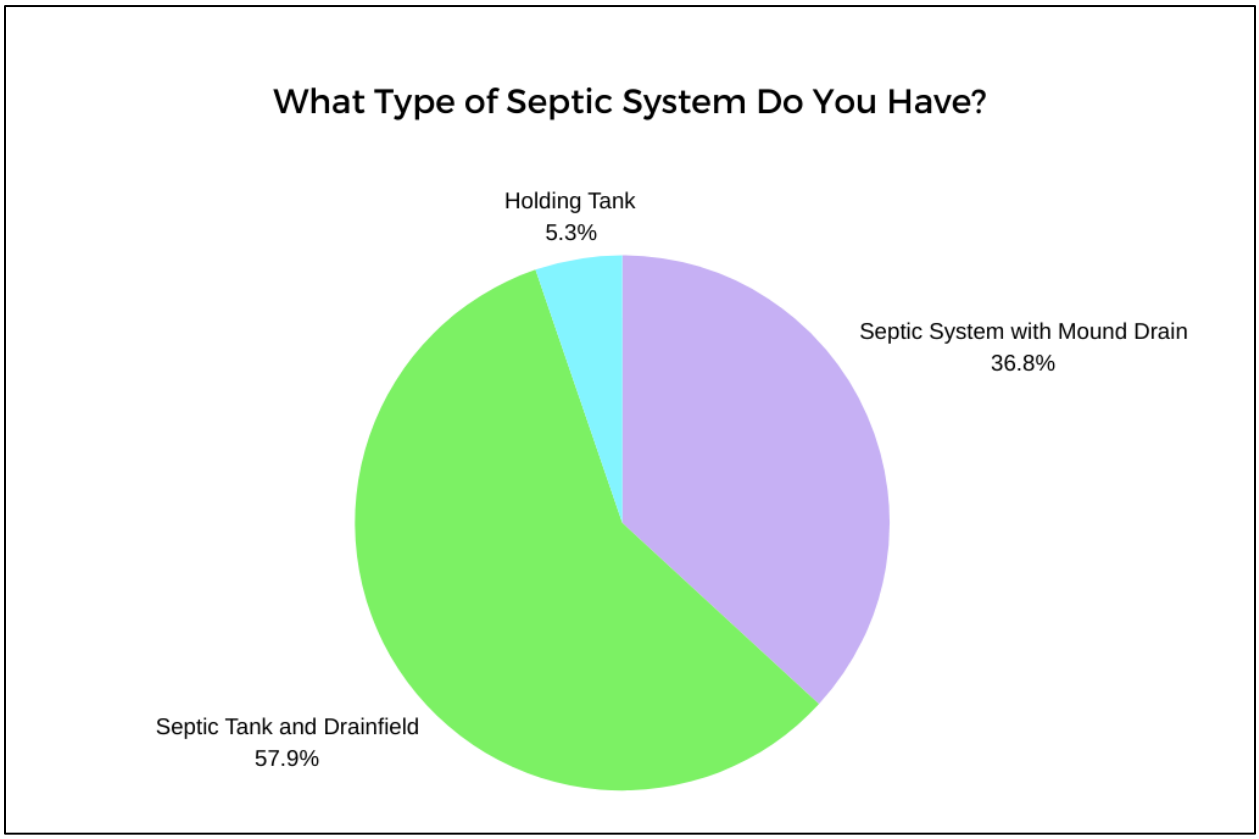


Figure 11. Types of septic systems on lakefront properties for Paradise Lake. A septic tank with an accompanying drainfield is what the majority of homeowners utilize.

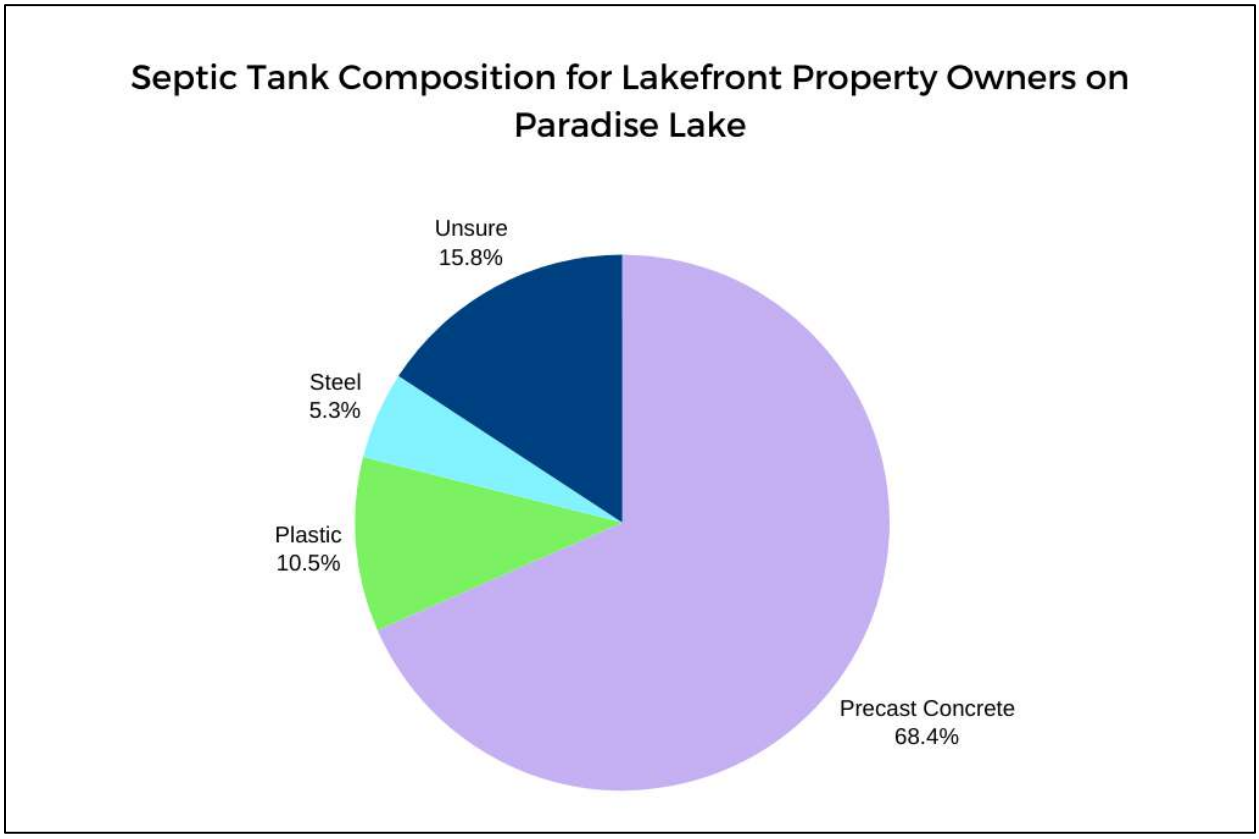


Figure 12. Various septic tank compositions for lakefront property owners. Precast concrete is the most common material.

Respondents were asked about how often they pump their septic tanks: whether every 3-5 years (the recommended amount of time), or a longer/shorter time period. Encouragingly, 74% of respondents indicated that they currently pump or plan to pump every 3-5 years (with one response being 5-10 years, however). 11% waited longer than 5 years before pumping, one respondent said they pump 1-2x per summer, one was not sure, and one response was invalid. 84% of respondents had never had a problem with their septic system, whereas 16% experienced one of the following: tank or drainfield failure, replacement part was needed, or new septic system was needed. In regards to the location of their septic system in relation to Paradise Lake, all respondents (with the exception of 3) indicated that their system was far removed from the shoreline. 3 of the responses indicated that their septic systems were within 25-50 feet of the lakefront.

Finally, respondents were asked how many bathrooms were in the household, how old their septic system was, and when the tank was last pumped. Number of bathrooms ranged from 1-4, with 1 bathroom and 3 bathrooms as the most typical options. Septic system ages ranged from 3 years old to 60+ years of age, with 58% of septic systems being 25+ years old. Septic tank previous pumping ranged from as early as this year (2024) to 5 years ago, with some respondents saying that they were unsure/the information was unknown (Figure 13).

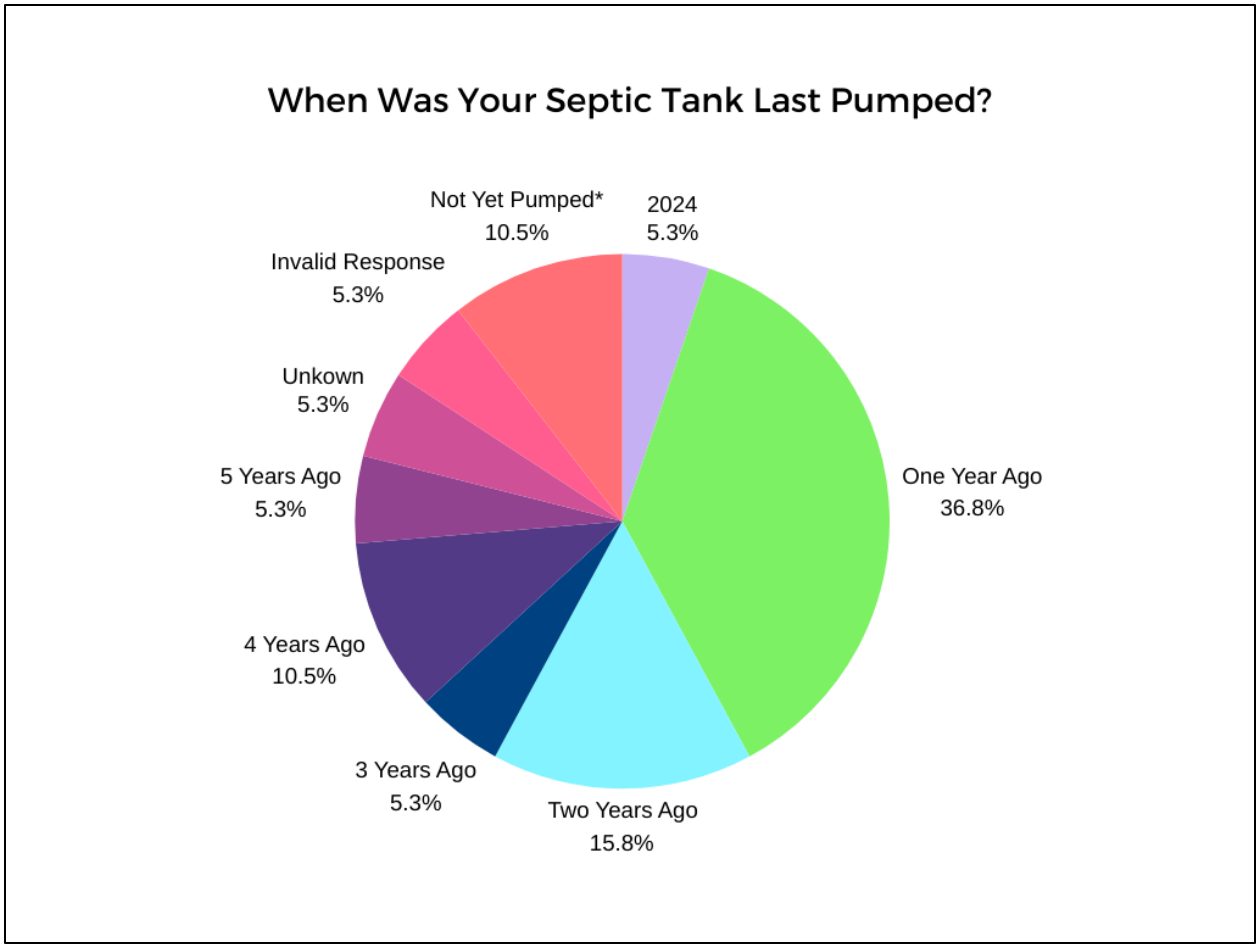


*Figure 13. Categories (by years) for when respondents' septic tanks were last pumped. 36.8% of septic tanks were pumped in 2023. *10.5% of respondents indicated their septic tanks had not yet undergone routine pumping due to a new tank recently being installed, or the occupancy being low to the point that the tank was not in use.*

Category 3 Results: Shoreline and Water Quality

Respondents were asked about issues that may be directly impacting the water quality and shoreline health of Paradise Lake.

Erosion was recorded at only 16% of shorelines according to respondents. 95% of respondents indicated that filamentous green algae were not present in the lake water in front of their property. 63% of respondents indicated that they had aquatic plants growing in the shallow water of their lakefront property, but 74% indicated that the plants were not increasing in abundance.

84% of respondents indicated they do not apply fertilizer to their lawn. Of the respondents that indicated they do apply fertilizer, they stated that they do so either bi-annually or annually. For the N-P-K formulas used by residents applying fertilizer, 2 respondents did not know the formula, whereas 1 respondent indicated they use a 12-12-12 formula but do not apply the fertilizer near the lake. All respondents indicated that they do not have their soil tested for nutrients***.

****There is no data for 1 respondent.*

Respondents were asked to characterize their shoreline (Figure 14). If their shoreline did not fit within one of the provided categories, they provided their own explanation and selected 'other'.

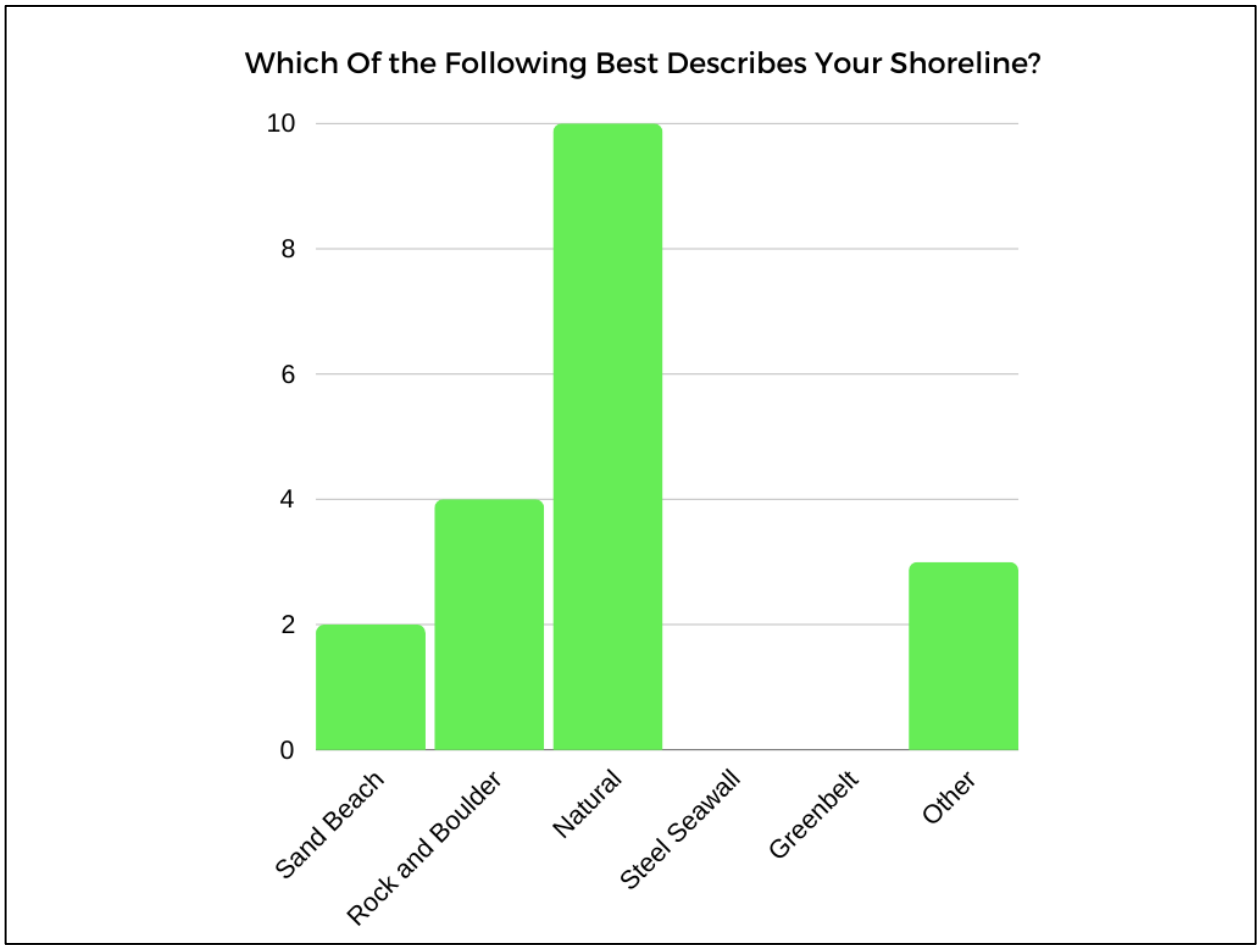


Figure 14. Characterization of shorelines on Paradise Lake. The most common shoreline type was 'natural', indicating that little to no disturbances or changes had occurred.

While the majority of respondents selected 'natural' as their shoreline type, many respondents (>3, as shown in the above graph) chose to describe their shoreline as 'other'. For example, respondents included descriptions such as 'concrete seawall with rip-rap', 'mix of rocks and vegetation', and a few respondents that listed a mixture of sand, rocks, and vegetation.

53% of respondents indicated that their lawn does not extend to the water's edge, but 47% of respondents said that their property did extend this far. Only 32% of respondents indicated that they have a greenbelt (minimum of 50 feet deep) consisting of shrubs, bushes, trees, and native plants along their lakefront property shoreline. Finally, all respondents indicated that their lawns are not drained by a subsurface tile system, and all respondents with the exception of 1 did not have a creek/ditch passing through their yard.

Discussion

The 'Lake Quality and Best Practices Survey' provided helpful insight to Watershed Council staff about the status of septic systems, shoreline health, water quality, and more. Below, we break the discussion down by category of survey questions.

Homeowner Information/Practices

One of the most critical aspects of lake and shoreline health is the degree of property development and how the lakefront property is being used or maintained. Unsurprisingly, 85.7% of respondents indicated that their property was developed (Figure 9). Upon comparison to the Paradise Lake Shoreline Survey, conducted in 2002, this is a greater percentage of development compared to a previous 77% of development (by parcel). While this survey did not directly look for total-lake parcel development, it is still a notable increase in developed properties.

It was evident from survey responses that property usage varied based on number of residents, property additions, and number/type of in-home appliances. With a high number of residents, which is especially common in the summer months, there is a greater need for proper septic system maintenance to prevent backup or failure. The number/type of in-home appliances provides context to greywater discharge from items like washing machines, which were the most commonly used household appliance (Figure 10). Utilization of greywater discharge from in-home appliances can be a way to reduce liquid waste, prevent septic system overflow, and maintain a healthier and more vibrant property by using the greywater to irrigate or water a rain garden or greenbelt.

Drainage from in-home appliances was just one aspect of water usage that respondents were asked about. While an encouraging 89% of respondents indicated that they did not have footing drains, the small portion of respondents that do have footing drains explained that their drains and/or sump pumps drain directly to the property's lawn or lakefront. While a footing drain is meant to collect and discharge excess water so that the foundation of the house/property structure is not damaged by moisture, the disposal of the water can be problematic. For example, excess stormwater and precipitation can carry nutrients such as nitrogen, phosphorus, or even chloride from surrounding urban runoff. Footing drains are not typically designed to handle intense storm events (Behm Enterprises, Inc.), and drain discharge points that are either adjacent to or directly into Paradise Lake may exacerbate nutrient influx and subsequent algal growth.

Septic System Knowledge and Maintenance

Proper septic system usage and maintenance is a critical issue facing not only Paradise Lake, but all of Northern Michigan's water resources. Michigan is the only state in the nation without a uniform statewide septic code, meaning there are no existing regulations for how to build, install, or maintain septic systems. Poorly functioning and failing septic systems may introduce excess nutrients and bacteria to ground and surface waters that can be harmful to human health (via pathogen exposure)

and to ecosystems (via contribution to cultural eutrophication), which can produce harmful algal blooms (HABs) and unsightly algal growth (*Cladophora*). *Cladophora* is a green, non-toxic, filamentous algae that proliferates in response to excess nutrient concentrations (Image 1). While not harmful to human health, *Cladophora* can clog pipes, interfere with boating and recreation, decay and produce rotting masses, and is generally unsightly.

Image 1. Cladophora, a green, filamentous algae.

The majority of respondents (57.9%) indicated that they have a septic system with an accompanying drainfield, with septic systems with a mound drain being the second-most common type of system (36.8%, Figure 11). Unfortunately, tank failure and drainfield failure were cited by some respondents as problems they experienced with their system(s). Failing septic tanks or drainfields present with sewage backup, standing water or lush grasses over the drainfield, lakefront algal blooms, or bacterial contamination of recreational waters (United States Environmental Protection Agency). In fact, the Paradise Lake Shoreline Survey (2002) states that many *Cladophora* blooms were associated with fertilized lawns and/or septic system drainfields.

Years Between Pumping Based on Number in Household*

Tank size (Gallons)	Number of people in the household					
	1	2	3	4	5	6
500	5.5	2.5	1.5	1.0	0.5	0.5
1,000	12.0	5.5	3.5	2.5	2.0	1.5
1,500	18.5	9.0	5.5	4.0	3.0	2.5
2,000	25.0	12.0	8.0	5.5	4.5	3.5

*Estimate only - other factors may impact the recommended amount of time between the pumping of the tank.

Interestingly, when respondents were surveyed regarding the size (in gallons) of their septic tanks, data was limited. Many homeowners were unaware of the size of their septic tank and how that related to the number of bedrooms/bathrooms and occupancy limits of the property. The minimum requirement is a 500 gallon tank for a 1 bedroom house (Gibb 2012, Image 2). It is important for property owners to be aware of their septic system capacity in relation to frequency of usage and household occupancy to

Image 2. General guidelines for septic tank pumping schedule based on tank size and household occupancy (Gibb 2012).

prevent excess wastewater discharge, nutrient pollution, and pathogen exposure via recreational activities.

The majority of respondents indicated that their septic systems were made out of precast concrete (Figure 12), with 74% of residents pumping/planning to pump their septic tanks every 3-5 years. This is the recommended pumping schedule and increases the longevity of the system. Though only a small portion of respondents (16%) confirmed that they had experienced issues with their systems, both tank and drainfield failure were recorded, which, if left untreated, can lead to a plethora of water quality issues. Fortunately, many of the respondents described their septic tank as further than 100 feet from the lake, lowering the chances of effluent reaching the surface water.

With septic systems ranging in age (3-60+ years), number of bathrooms varying by household, and pumping times extending beyond 5+ years, it is an excellent idea for Paradise Lake residents to consider proper septic system maintenance practices. These include:

1) Never disposing of anything besides human waste and toilet paper when flushing toilets.
2) Never putting chemical drain openers, cooking oils, or toxic cleaners down the sink.
3) Never parking or driving over septic systems with drainfields.
4) Planting trees away from drainfields to avoid root encroachment.
5) Using water efficiently by investing in energy-efficient appliances or spreading out usage of the washing machine.
6) Regularly have your septic system pumped every 3-5 years, inspect the drainfield for standing water or lush grasses, and watching for sewage backup into toilets.

<u>Shoreline and Water Quality</u>

Many of the potential shoreline and water quality issues addressed in the 'Lake Quality and Best Practices Survey' directly tie into septic system maintenance.

Image 3. A greenbelt in action. Greenbelts prevent erosion and uptake/filter nutrients.

While responses demonstrated that erosion and algal growth were quite low, fertilizer use was limited, and that any aquatic plants present were not increasing in abundance, only 32% of respondents stated that they have a greenbelt (a strip of native vegetation consisting of shrubs, bushes, trees, and native plants) with a depth of 50+ feet. However, the most popular shoreline characterization was 'natural', indicating that many property owners likely have a built-in greenbelt due to the lack of alterations made to the property. Greenbelts stabilize shorelines, prevent erosion, filter excess sediment and nutrients before they can reach the lake, and provide wildlife and pollinator habitat (Image 1). Greenbelt installation is a recommended way

to prevent septic effluent from contaminating freshwater resources.

Though most of the shoreline types of lakefront owners were described as 'natural', there was a sizable component that consisted of mixed shoreline types (i.e. rip-rap and vegetation, sand and vegetation, etc.). This is not uncommon, and even a small amount of native vegetation can reduce nutrient pollution.

Finally, previous water quality data collected through the Watershed Council's CWQM and VLM programs (see 'Water Quality in Paradise Lake') shows both total phosphorus and total nitrogen exceedances. Furthermore, water clarity (Secchi depth) has dipped into a range that suggests eutrophic (high nutrient, low-oxygen, high levels of algae) conditions. While much of this nutrient pollution is non-point source, there is undeniably a percentage linked to septic system effluent, shoreline hardening, and lake development. Actions to address these issues can be found in the 'Recommendations' section.

Recommendations

(1) **Conduct an updated Shoreline Survey for Paradise Lake.** The Watershed Council recommends conducting new Shoreline and Aquatic Plant surveys every 5-10 years. A new survey will provide our experts with a great degree of understanding of shoreline hardening, nutrient pollution, erosion severity, and parcel development.

(2) **Pursue additional research and monitoring to determine sources of nutrient influx.** This may take the form of collection and subsequent analysis of tributary samples that may be contributing excess nutrients (phosphorus, nitrogen, or even chloride from road salting/brining) to Paradise Lake.

(3) **Pursue a septic study in which properties that exhibit high conductivity readings and/or excessive *Cladophora* growth are sampled for *E. coli*.** *E. coli* samples can be analyzed via microbial source tracking (MST) to understand if the source of *E. coli* in a waterbody is from an animal or human source. *E. coli* from a human source would suggest malfunctioning or failing septic systems are contributing to water quality issues.

(4) **Education should be provided to lakefront property owners regarding proper septic system maintenance and high-quality shorelines.** This report should be distributed to PLA members, lakefront property owners, and any interested individuals. Additionally, the Watershed Council has publications on septic system maintenance, permit guides, rain gardens, and resources for maintaining healthy shorelines.

(5) **Outreach should be provided to property owners and prospective buyers around the lake by providing educational materials.** Distribution of signage, Watershed Council publications, or in-house posters/stickers can remind residents about proper septic maintenance, lake health and water quality, and can inform out-of-town visitors about how to protect septic systems.

(6) **Property owners should review the results of the 'Lake Quality and Best Practices Survey' and act accordingly.** While survey responses were anonymous, respondents can read this report and understand if their lakefront property complies with principles of proper septic system usage and healthy shorelines. To learn more, see these additional resources:

    a. EPA SepticSmart Program website at SepticSmart | US EPA.
    b. The Watershed Council's website at www.watershedcouncil.org.

c. Residents may request an inspection from the Health Department of Northwest Michigan for $346.00 as a routine preventative measure at HDNW - Permits (nwhealth.org).
d. Michigan State University Extension has a helpful table for pumping schedules based on tank capacity and usage: https://www.canr.msu.edu/news/household_septic_system_-_part_two
e. Michigan Shoreline Stewards is a helpful step for property owners to take in terms of receiving recognition for their protection efforts and practicing best management practices on their shoreline properties: Be a Shoreland Steward - Michigan Shoreland Stewards (mishorelandstewards.org)

(7) Continue to monitor Paradise Lake through the Volunteer Lake Monitoring (VLM), and Comprehensive Water Quality Monitoring (CWQM) Programs. Long-term trend data is extremely useful when it comes to interpreting environmental changes.

(8) Implement Best Management Practices (BMPs) when it comes to fertilizer usage. Numerous efforts can be taken to limit nutrient runoff from lakefront properties.

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