



# The Beaver Lake Monitor

A publication of the Beaver Lake Management District Advisory Board

In 1995 the residents in the Beaver Lake watershed voted to form the Beaver Lake Management District (LMD). The LMD was formed to implement a monitoring program and provide information on water quality issues to the Beaver Lake community. The monitoring program was designed to detect water quality issues related to the land development within the basin.

Since the original formation of the District in 1995, the residents have voted to extend the District three more times (2001, 2006, 2017). The most recent extension of the LMD is scheduled to run from 2017-2026. While the intent of the District is still to detect water quality impacts related to development, several changes to the program have been enacted. Two additional monitoring stations were added in 2014 to account for new developments within the watershed and the management of aquatic noxious weeds were included in the District scope.

Beaver Lake residents have expressed concerns about the invasive aquatic plants that were present in all three lake basins. The non-native plant *Nymphaea odorata* (also known as fragrant water lily) appears to be increasing around the lake. Fragrant water lily is native to the northeastern United States but has become a common invader in many parts of the country, including the Pacific Northwest. When densities are high, the plant can have negative impacts on water quality and recreation including: increased temperature, lower dissolved oxygen, reduced habitat for native species, reduced access to the lake, as well as pose a potential entanglement risk for swimmers. Because of these concerns the most recent extension of the district included the management of aquatic invasive plants to the District scope of work. Work on this topic will begin over the next few years.

The following articles provide information on the water quality of Beaver Lake and its tributaries. Water quality data collected for the District is funded through voter-approved District taxes as well as funding provided by the City of Sammamish. Lake water samples tested for water quality were collected by both volunteers and King County Water and Land Resources Division Staff.



*Non-native plant Nymphaea odorata (also known as fragrant water lily)*



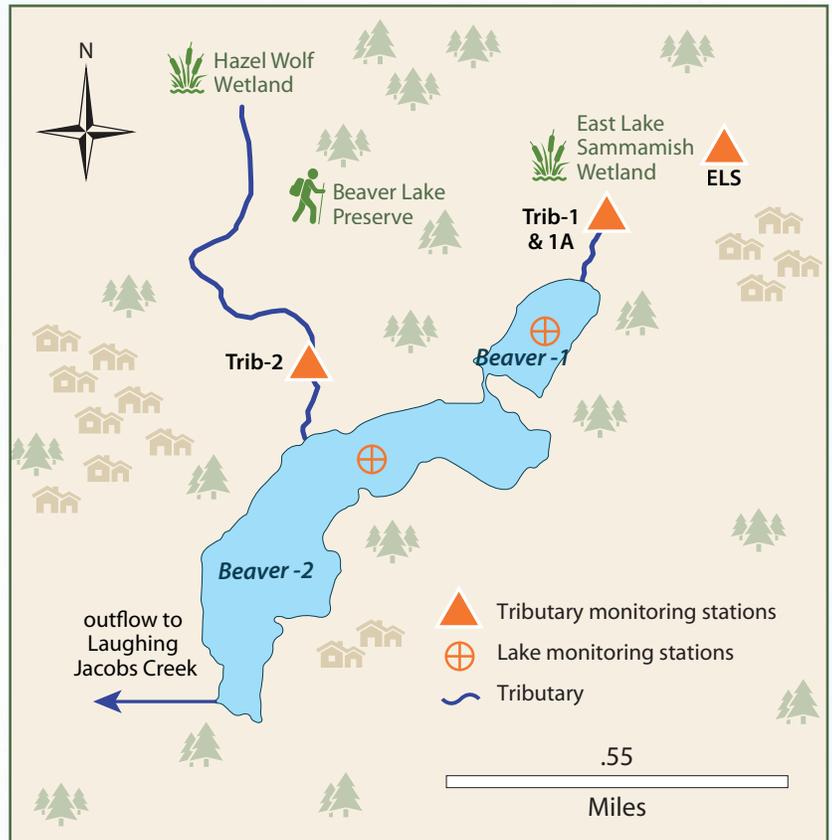
*Entanglement risk – Nymphaea odorata*

# Beaver Lake Watershed Overview

Beaver Lake has two basins connected by a short channel. The smaller, northeastern basin is referred to as Beaver-1, and the main basin as Beaver-2. Water level in both basins is about the same height, and evens out quickly after rainstorms. As a result, there is usually very little flow through the channel.

Each basin has one small stream flowing into the lake, known as a tributary. Trib-1 flows into the northeast side of Beaver-1, carrying water from the East Lake Sammamish Wetland. Trib-2 flows into the north side of Beaver-2, carrying water from the Hazel Wolf Wetland and the Beaver Lake Preserve. These tributaries typically flow during the wet season, and then dry out during the summer.

Water flows out of the southwest corner of Beaver Lake into Laughing Jacobs Creek, which flows through Beaver Lake Park and eventually into Lake Sammamish.



## Stormwater

Rain falling on the landscape around Beaver Lake can take different paths into the tributaries or the lake. Rain that falls on forests and other vegetated areas mostly soaks into the ground and becomes groundwater. Shallow groundwater is an important natural supply of water to bogs, streams, and lakes. Unlike in forested areas, rain falling on roads, driveways, roofs, and other hard surfaces cannot soak into the ground. Instead, it flows over the surface as stormwater (also called runoff). When people build roads and houses, they replace soft vegetated surfaces with hard surfaces. More hard surfaces means more stormwater – and unfortunately, stormwater can cause problems for Beaver Lake.

When stormwater flows over the landscape, it picks up materials and washes them into roadside ditches and eventually into Beaver Lake. Leaves and soil particles are the most visible examples, but stormwater can also carry fertilizer, pet waste, and pollutants (like oil or metals) that have deposited on roads and other hard surfaces. In many areas around Beaver Lake, stormwater carries these materials into the lake with no treatment. In some areas, newer approaches to stormwater management help to reduce the amount of pollutants entering the lake. Settling ponds and detention basins let particles settle out instead of entering the lake. For example, the stormwater facility on 267th PI SE uses two ponds plus a sandfilter that helps remove more pollutants.

## Monitoring

Beaver Lake gets regular check-ups to track its health and water quality. Beaver Lake residents volunteer with King County's Lake Stewardship Program to measure rainfall, lake level, water clarity (Secchi depth), and water temperature year-round. From May through October, volunteer stewards also collect water samples that are tested (at the King County Environmental Lab) for nutrients (nitrogen and phosphorus), chlorophyll (a measure of algal growth), and other water-quality indicators.

Every five years, King County staff take more detailed measurements of water quality in Beaver Lake every month over the course of a year. Measurements and water samples are taken throughout the water column, from the surface to the lake bottom. Water temperature, dissolved oxygen, conductivity, and pH are measured every meter throughout the water column, and water samples are collected from six depths (tested for the same water-quality indicators as the volunteer-collected samples described above).

During the winter, King County staff monitor the tributaries into Beaver Lake. Trib-1 and Trib-2 have been monitored since 1997. Two additional monitoring points on Trib-1 were added in November 2014: Trib-1A is slightly upstream of Trib-1, at the outlet from the wetland and upstream of any road runoff. ELS is at the outlet from the stormwater detention facility along the eastern side of the wetland (on 267th PI SE), and flows into the buffer of the wetland.



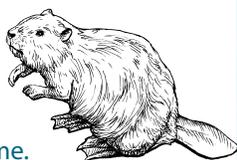
## Keeping Beaver Lake Healthy

All of the water-quality data tell a consistent story: Beaver Lake has held up well over the last twenty years, even as the watershed around it has changed. Keeping Beaver Lake healthy for future decades depends on everybody in the watershed. The most important thing you can do to maintain good water quality is to prevent excess nitrogen and phosphorus from running off into storm drains, streams, and Beaver Lake.

Simple, everyday actions can be a big help in reducing nutrient runoff. Scoop pet waste, bag it, and place it in the trash. If you fertilize your lawn, make sure you give it only as much as it needs (a free soil test from the King Conservation District can help you figure out the right amount). Setting your lawnmower blades high and irrigating wisely both help grass develop strong root systems that retain nutrients in the soil. And finally, make sure to keep grass clippings and leaves off of sidewalks, driveways, and roads so they don't wash into the lake.

If you're feeling ambitious, King County's Natural Yard Care program has more ideas and information for sustainable landscaping projects. Consider replacing some of your lawn with native vegetation, including trees and shrubs. Learn about building healthy soils in gardens and lawns. These projects and more are at: [kingcounty.gov/naturallyard](http://kingcounty.gov/naturallyard)

The Beaver Lake monitoring program will continue to keep an eye on water quality to detect any changes that may happen and guide management decisions. With your help, we hope to find Beaver Lake staying healthy for many decades to come.



# Beaver Lake Water Quality Trends

During the last twenty years, there has been new development and other environmental changes around Beaver Lake. But how has the lake itself changed? The Beaver Lake Management District, the City of Sammamish, King County, and local residents have all contributed to a water-quality monitoring program that provides a valuable window into Beaver Lake's recent history. The monitoring data show that Beaver Lake has held up well over the past two decades, with little change in water quality despite the changes happening around it.

Keeping Beaver Lake healthy depends on everybody in the watershed. You can take simple, everyday actions at home to reduce nutrient runoff and protect Beaver Lake. The water-quality monitoring program will continue to keep an eye on Beaver Lake, watching for the first signs of any future changes. And with your help, we hope to find Beaver Lake staying healthy for decades to come.

## Trophic state

We describe a lake's overall water quality using one of three categories known as trophic states. Determining a lake's trophic state uses data on water clarity (Secchi-disk depth), algal growth, and nutrients. **Oligotrophic** lakes are very clear, with low nutrient concentrations and low algal growth. These are often mountain lakes, or lakes in undisturbed forests. **Mesotrophic** lakes are in the middle, with fairly clear water, and moderate nutrient concentrations and algal growth. Mesotrophic lakes are common in lowland western Washington, especially in areas with some development along the shoreline and in the watershed. **Eutrophic** lakes have less-clear water, with high nutrient concentrations and high algal growth. These eutrophic lakes often have highly altered watersheds, high nutrient inputs, and/or long residence times (little water flows through to flush them out), and may have frequent algal blooms.

The main basin of Beaver Lake (designated Beaver-2) is described as mesotrophic. The smaller, northeast basin (designated Beaver-1) is described as eutrophic. Beaver-1 has higher nutrient concentrations than Beaver-2, with correspondingly higher algal growth and less-clear water. Each basin has generally stayed within the same trophic state over the past two decades.

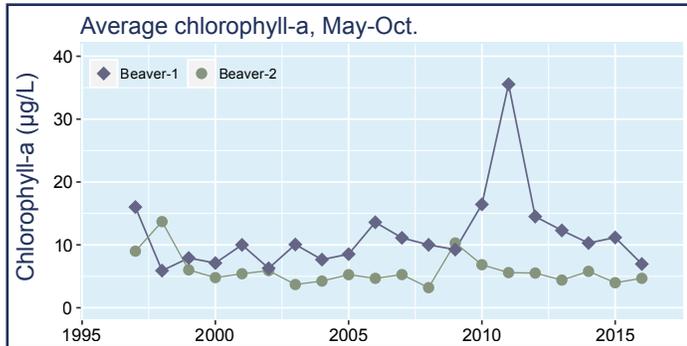
In the following sections, we'll take a look at water-quality data since 1997. Most of the data shown here are average values for each year's May-October sampling season. Water samples were collected twice per month in the middle of the lake, one meter below the surface. The tributaries have been monitored since 1997 at the Trib-1 and Trib-2 sampling stations; the Trib-1A and ELS stations were added in November 2014. Data for the tributaries are December-March averages.

## Algal growth

Algae are small, microscopic organisms that photosynthesize like plants do, getting their energy from sunlight. Algae are the base of the lake's food web, eaten by zooplankton (microscopic animals) that in turn are eaten by fish. Bog-fed lakes like Beaver Lake have fairly high natural amounts of algae, but too much algal growth can cause problems for a lake. Algal blooms reduce water clarity and dissolved-oxygen concentrations, and large blooms can be unsightly or smelly. In addition, large algal blooms can drive out some of the plant or fish species. Certain type of algae such as cyanobacteria (aka blue-green algae) can produce toxins that are dangerous for people, pets, and wildlife. Fortunately, toxic algal blooms have not been a problem to date in Beaver Lake.

## Beaver Lake Data Trends continued

The amount of algae in a lake is measured by the concentration of chlorophyll-a in a water sample. Chlorophyll-a is the main green pigment that algae (and plants) use in photosynthesis to capture sunlight and manufacture sugars.



*Average algal growth has stayed fairly constant, except for 2011 when a large algal bloom occurred in Beaver-1.*

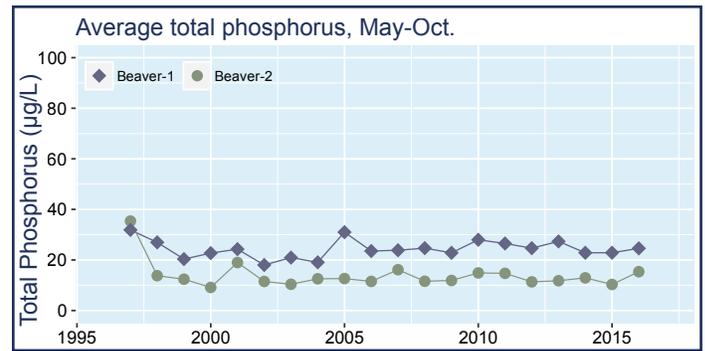
Beaver-1 has generally had higher average chlorophyll-a concentrations than Beaver-2, with larger variation from year to year. Beaver-1 had a large spike in chlorophyll-a concentrations in 2011. Beaver-2, in contrast, has had relatively stable chlorophyll-a concentrations from year to year. There is no sign of a long-term trend in chlorophyll-a concentrations in either basin.

## Nutrients: Phosphorus and nitrogen

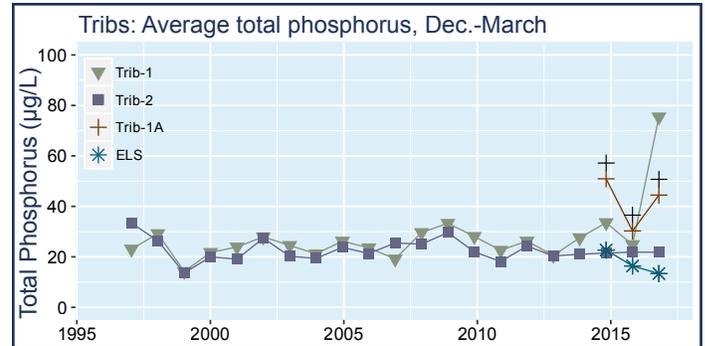
Algae get their energy from sunlight, but like all living things they also need nutrients such as phosphorus and nitrogen. The more nutrients are available in the lake, the more algae can grow. Excess nutrients – too much of a good thing – is a recipe for more frequent and dense algal blooms.

Although new development often increases nutrient runoff into a lake, this has not been the case for Beaver Lake. Average phosphorus and nitrogen concentrations in Beaver Lake have not increased since 1997. This probably reflects the good stewardship actions that residents have taken to manage their yards and help prevent nutrient runoff.

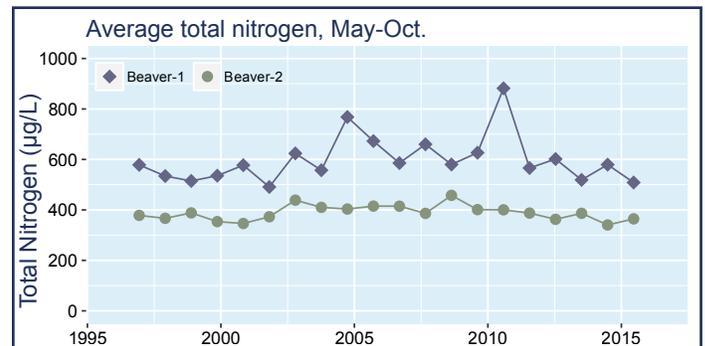
Throughout the past two decades, nutrient concentrations have been higher in Beaver-1 than in Beaver-2 – which is why Beaver-1 has had more algal growth. Average phosphorus concentrations have been generally stable from year to year in both basins, as have average nitrogen concentrations in Beaver-2. Nitrogen concentrations in Beaver-1 have been more variable, with peaks in 2005 and 2011. The 2011 algal bloom in Beaver-1 was likely caused by high nitrogen concentrations that year. (Total nitrogen concentrations were not measured in the tributaries.)



*Average phosphorus concentrations have been higher in Beaver-1 than Beaver-2.*



*Average phosphorus concentrations in the tributaries have been fairly constant except 2017, when Trib-1 had substantially higher phosphorus concentrations than normal.*



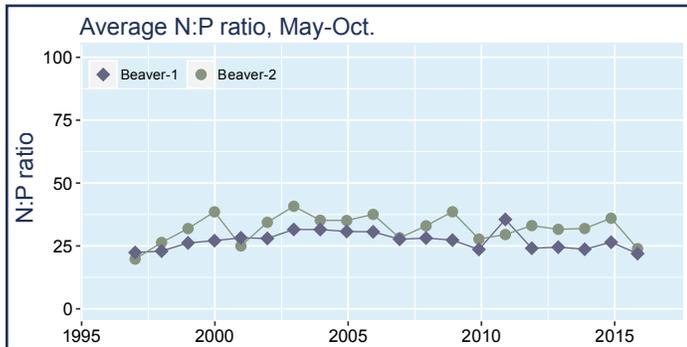
*Average nitrogen concentrations have been higher and more variable in Beaver-1 than Beaver-2.*

In 2017, Trib-1 phosphorus concentrations were much higher than any previous year on record. It is too soon to tell whether this was one isolated high year, or whether this is part of a longer-term trend. Stormwater runoff from developed areas can be a source of excess phosphorus, but that does not appear to be the source for Trib-1. Phosphorus concentrations entering the wetland from the stormwater facility, at the ELS monitoring station, were lower than concentrations at Trib-1 or Trib-1A. The high phosphorus in Trib-1 may be due to changes in nutrient cycling in the East Lake Sammamish Wetland (possibly due to changing pH; see page 6).

## Cyanobacteria and harmful algal toxins

Not all algal blooms are the same: some are filamentous green algae that look like strands or mats, while others are cyanobacteria (blue-green algae) that look more like pea soup or a paint spill. Cyanobacteria have a unique ability to produce harmful algal toxins (microcystin, anatoxin-a, and others) that could harm people, pets, or wildlife.

The overall amount of algal growth in a lake is controlled by total nitrogen and phosphorus concentrations, but the dominant type of algae is affected by the ratio of nitrogen to phosphorus (N:P ratio). Cyanobacteria are more likely to dominate algal blooms when the N:P ratio is at or below 25.



*In recent years, Beaver-1's nitrogen-to-phosphorus (N:P) ratios have been around 25. N:P ratios at or below 25 mean that it is more likely to have potentially toxic algal blooms.*

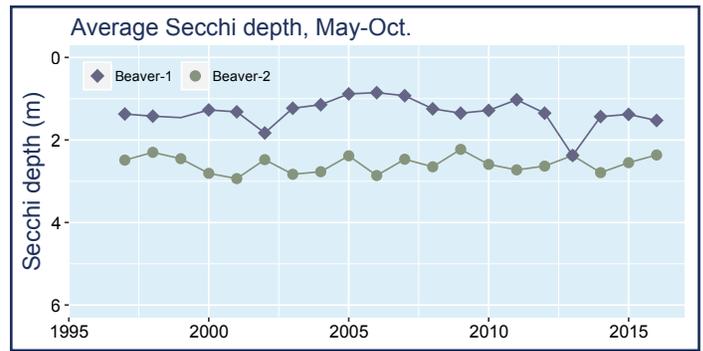
Beaver-1 has tended to have lower N:P ratios than Beaver-2, and N:P ratios in both basins have varied from year to year with no clear trends. In the last several years, Beaver-1's N:P ratios have been around 25, which means its algal blooms are more likely to be dominated by cyanobacteria that have the potential to produce harmful toxins.

Beaver Lake has been tested for algal toxins in most years since 2008. Very low toxin concentrations were detected in some of these samples, well below the state recreational guidelines, and have not posed a health concern.

## Water clarity

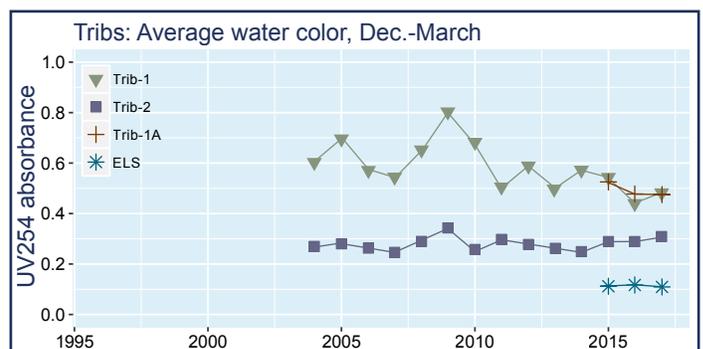
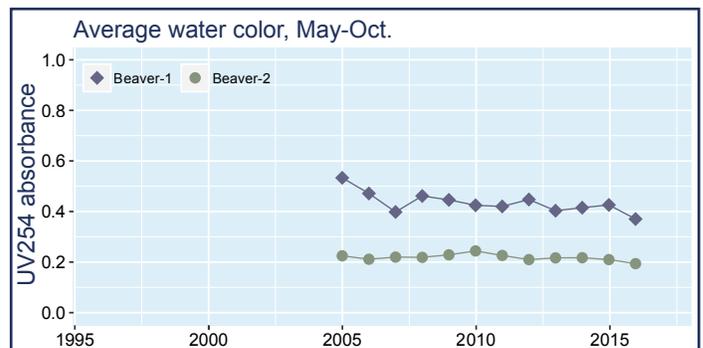
Water clarity is affected by algae, other particles (such as sediment), and dissolved organic compounds. Water clarity is measured by lowering a 20-cm (8-in) diameter black-and-white Secchi disk into the water, and recording the depth where it disappears from view. Note that the y-axis on the Secchi-depth graph is inverted, to mimic looking down into the water. Deeper Secchi depths indicate clearer water, and more sunlight reaching deeper waters.

Secchi depths have been fairly shallow in both basins, and relatively stable from year to year. As expected from the chlorophyll-a data, Beaver-1 has had shallower average Secchi depths than the clearer water of Beaver-2.



*Secchi depths have been fairly shallow in both basins (low water clarity), especially in Beaver-1.*

Water color also affects a lake's water clarity (and Secchi depth). The tea-like color in Beaver Lake is due to naturally occurring dissolved organic material. Water color is measured by shining a specific wavelength of ultraviolet light (254 nm) through the sample and measuring the percent that was absorbed. UV254 absorbance has been fairly high and fairly stable in both basins since measurements began in 2005, which is typical of a tea-colored lake like Beaver Lake. Beaver-1 has been substantially darker (higher absorbance) than Beaver-2, because much of this colored organic material comes from peat moss in the East Lake Sammamish Wetland, which flows into Beaver-1 through Trib-1. Colored organic material also comes from the Hazel Wolf Wetland and the organic-rich forest floor of the Beaver Lake Preserve, which flows into Beaver-2 through Trib-2.



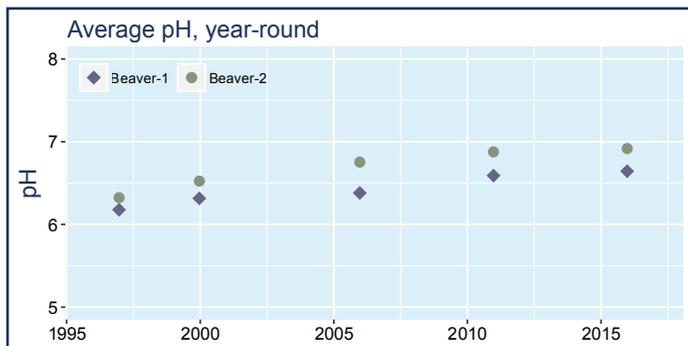
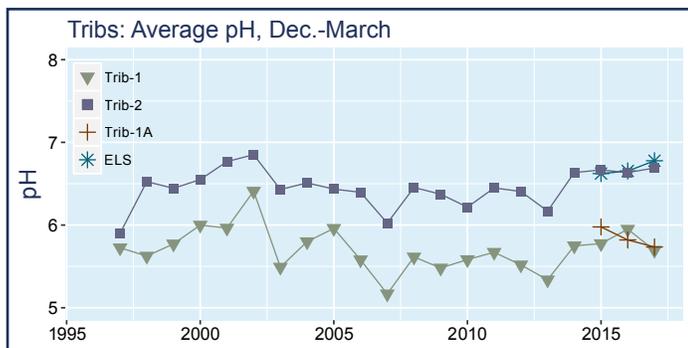
*Trib-1 is very deeply tea-colored, due to organic material from peat moss in the East Lake Sammamish Wetland. This results in more deeply colored water in Beaver-1 than Beaver-2.*

## Beaver Lake Water Quality Trends continued

### pH and Alkalinity

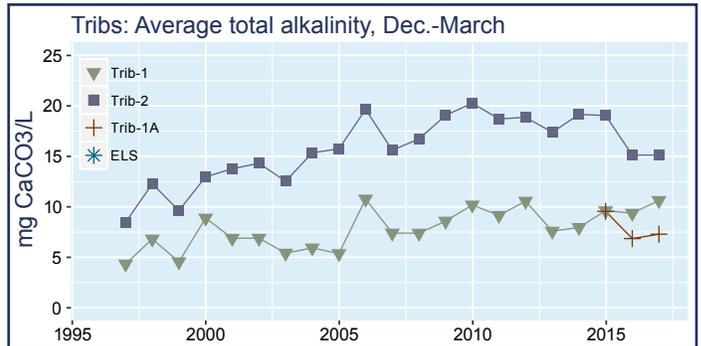
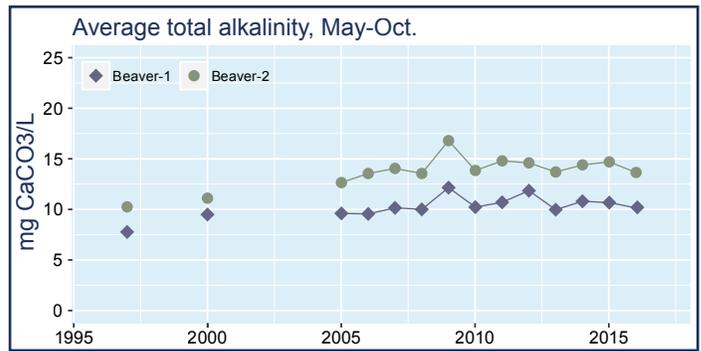
Beaver Lake has also been monitored for signs of lake acidification (low pH) that could harm fish and other aquatic life. Although the Pacific Northwest has much less acid rain than the eastern U.S., lake acidification can still be a problem here due to rainwater, stormwater runoff, or leaking septic systems. Many lakes in our region are sensitive to even small amounts of acidic inputs, since they have little ability to resist changes in pH.

At Beaver Lake, pH has been measured only during water years with enhanced lake monitoring (approximately every 5 years). Annual pH values appear to have increased (become less acidic) since 1997 in both basins. Beaver-1 has been slightly more acidic than Beaver-2, largely because of the lower-pH water entering it from the East Lake Sammamish Wetland through Trib-1.



*Trib-1 and Beaver-1 have had more acidic water (lower pH) than Trib-2 and Beaver-2, since the East Lake Sammamish Wetland is a naturally acidic peat bog.*

A lake's ability to resist acidification, also called its buffering capacity, is measured as "total alkalinity." Total alkalinity has remained below 20 in both basins, which means they have low ability to resist acidification. Beaver-1 has had lower total alkalinity than Beaver-2, which is expected since it has had lower pH (more acidic). Total alkalinity appears to have increased in both basins. If pH and alkalinity both continue to increase, the lake will become better able to resist future acidification.



*Caption for pair of graphs: Beaver Lake has had fairly low alkalinity, which means it has a low ability to resist acidification. Fortunately, alkalinity appears to be increasing.*

While increasing pH in Beaver Lake may not disrupt the lake ecology, increasing pH in the wetlands can cause problems. The East Lake Sammamish Wetland is naturally an acidic bog, and changes in pH are likely to alter its nutrient cycling. Samples from the ELS monitoring station show that stormwater entering the wetland has a higher pH than water within the wetland (Trib-1 and Trib-1A). Increasing pH in the wetland could convert stored, stable forms of phosphorus to more mobile forms that can flow readily into Beaver Lake. If this conversion happens in the wetland, it would increase total phosphorus concentrations in Beaver Lake and likely cause more algal blooms.



*Photograph by Bassem Bejjani*

# 50 WAYS TO LOVE YOUR LAKE!



## PLANTING & LANDSCAPING



**1 Practice natural yard care.** Build healthy soil. Use the right plant for your site. Water the right amount. Think twice before using pesticides. Practice natural lawn care.

**2 Go native.** Native plants are adapted to our climate and thrive with little maintenance, fertilizer and water.

**3 Plant a buffer** between your lawn and your lake. It will help decrease run-off from your property, and geese will stay away to boot!

**4 Landscape to slow rainwater run off** between your house and the lake, making it easier for water to soak into the ground. Place small swales where water naturally drains off your property, create twists in your paths or driveways, or plant a rain garden – using water tolerant plants that absorb rainfall.

**5 Plant trees and shrubs** on your property in places that allow them to frame your view of the water, rather than obstruct it, even when they have reached mature size.

**6 Plant extra shoreline plants for critters.** Beavers, otters and muskrats find willows and dogwoods tasty treats and good for building.

**7 Garden to benefit nature.** Create a wildlife sanctuary in your backyard. Place emergent plants on a small part of your beach. Plant decorative, non-native aquatic plants in a separate water feature, not along your shoreline.

**8 Reduce or eliminate pesticides or herbicides.** Gardening chemicals end up in the lake in measurable amounts. Pesticides also kill good bugs; can poison birds and fish; and should be used sparingly around children and pets.

**9 Use organic, slow-release fertilizers on your lawn** – or none at all! Conventional fertilizers and weed-and-feed type products are released all at once and end up mostly in the lake. Use phosphorus-free or slow-release natural fertilizers on your lawn areas.

**10 Shrink your lawn.** Less lawn = less maintenance, mowing, watering, fertilizing, money and more rain soaking into the ground instead of running off into the lake. Geese love large lawns. Reduce your lawn, reduce your fowl visitors.

**11 Replace concrete and asphalt** with permeable alternatives. Rather than letting water flow off your driveway, walkways and outdoor living spaces, check out alternatives that let rain soak in like “grasscrete,” gravel, pavers, or other surfaces.

**12 Leave large trees** and shrubs on your property to create wildlife habitat and shade, especially over the water.

**13 Keep your shoreline natural.** Bulkheads and artificially sandy beaches can destroy critical habitat for fish, cause erosion and add toxins to the lake.

## WEEDS & TROUBLESHOOTING



**14 Learn to identify the noxious weeds on your lake.** Check for noxious weeds, such as Eurasian milfoil, fragrant waterlily, Brazilian elodea, purple loosestrife and yellow flag iris. Learn what you can do to control and eradicate them before it becomes a problem and who to notify if it does.

**15 Pull up or cut lily pads.** Fragrant waterlily (pink or white flowers) is a noxious weed. If uncontrolled, it can overcome small lakes. But don't confuse it with the native yellow waterlily, which is beneficial.

**16 Check boat trailers for noxious weeds.** Boats can carry aquatic weed fragments from lake to lake, creating infestations. Wash boats and trailers thoroughly between use at different lakes.

**17 Don't ever dump aquarium contents, fish or amphibious pets in the lake.** These plants and animals can create serious negative impacts to lake ecology.

## WILDLIFE & HABITAT



**18 Discourage geese - shrink your lawn.** Goose poop, in excess, can negatively affect water quality. Reduce the wide open spaces they love so much by replacing grass with taller plants.

**19 Leave fallen trees in the lake and on the shoreline.** If not a threat to safety, they provide food and shelter for native fish, amphibians and birds.

**20 Don't feed the ducks.** Bread isn't good for ducks. And when they gather in large flocks – to be near a consistent food source – they can transmit diseases. Also, excess goose poop can contribute to water quality problems.

**21 Leave beaver dams alone.** Or find out how you can legally modify them. Alert authorities if beavers are altering your lake level. Improperly removing dams can cause major flooding damage downstream and beavers will likely return to build again using more trees.

**22 Put up wood duck boxes.** They can substitute for the nests ducks usually make in large trees, which are disappearing from lake shores.

**23 Let the birds have some fish.** When your lake is stocked and is suddenly visited by a hundred cormorants, they're just following the food and soon they'll be gone.

**24 Put up bat boxes.** Bats eat pounds of insects every night – that's serious relief from mosquitoes!

**25 Love the fact that your lake is not a bathtub or swimming pool.** Abundant and varied native plants are fun to explore and good for the wildlife you share this ecosystem with.

## COMMUNITY ACTIVISM



**26 Join or form a lake association.** Research local and statewide organizations online at home or the library. Visit other lake groups to see what they do.

**27 Attend public meetings.** Stay informed about what's happening in your area. Ask questions about how projects and development will impact you and the lake.

**28 Talk to your neighbors.** Caring and sharing about your lake is something you probably have in common. Take a new neighbor on a lake tour.

**29 Create a “Welcome Packet” for new neighbors.** Many newcomers to lakeside living would welcome information about how to protect water quality and the environment. Include this flyer!

**30 Organize a public meeting.** Invite experts to your lake group meetings to discuss topics of interest or attend a public meeting. You'll learn what is happening in your watershed and how it affects you.

**31 Keep hazardous waste out of the lake.** Organize a neighborhood trip to the Hazardous Wastemobile. Check your car for oil leaks. And don't dump anything down storm drains or ditches.

**32 Create wildlife corridors.** Work with your neighbors and the community to organize and plan landscaping projects together to create “wildlife corridors” between properties, the lake and forested areas away from the water. This gives critters somewhere to go besides your yard or patio.

**33 Be a zebra mussel monitor.** Join the Volunteer Zebra Mussel Monitoring Project and be part of the early warning system for these tiny Asian invaders that can cause damage to water structures and native ecosystems.

**34 Communicate with your elected officials.** Let them know what you love about your lake, what issues residents face and be sure to vote!

**35 Research the history of your lake.** In a library, local agency or on the Web – from facts and photos to legends and lore – you'll be amazed at what you find.

## MAINTENANCE



**36 Pick up trash around the lake.** Organize a community, clean up day to remove litter and illegal dumps in the neighborhood that might impact lake water quality.

**37 Clean up after your pets promptly.** Pet waste can contribute significant fecal contamination to your lake, even if it's just from rain or sprinklers washing over it.

**38 Maintain your septic system.** Failed septic systems can cause significant water quality problems for lakes. Get regular inspections every three months or three years, depending on the type of system by an experienced professional.

**39 Clean up your yard.** Old equipment, machinery or debris lying around can leach contaminants into the soil, impacting lake water quality.

**40 Keep a lid on it.** Something as simple as securing your trashcan lid will prevent litter from accidentally being blown into the lake on windy days.

**41 Monitor public access points.** Report vandalism, destruction or maintenance needs to the city, county or state agency responsible for the right of way.

**42 Manage domestic livestock manure.** Get assistance in developing management plans to protect water quality.

## AROUND THE HOUSE



**43 Use non-toxic dock preservative.** Avoid harming water and the critters in it, while protecting your dock. Research and choose alternative, environmentally-friendly maintenance materials before treating lumber.

**44 Wash your car at a car wash.** Washing it in your driveway sends harmful car oil and residue right into your lake and yard.

**45 Install a rain barrel.** Collecting water from your rain gutters is a great source for watering your yard and reduces utility bills.

**46 Take the canoe or row boat.** Good exercise, and you're quiet and closer to the water, so you might see a river otter up close.

**47 Don't drive golf balls (or cars!) into the lake.** Golf balls in a lake are trash and can harm fish and other critters.

**48 Don't shoot fireworks into the lake.** They contain chemicals.

**49 Go for a quiet, moonlight paddle** in a canoe. You'll see a whole new side of your lake.

**50 Enjoy the beauty.** It's what makes the other 49 things worth doing!

For more information on the 50 Ways to Love Your Lake, visit: [kingcounty.gov/loveyourlake](http://kingcounty.gov/loveyourlake)





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*The Beaver Lake Monitor*

The Beaver Lake Monitor is published by the Beaver Lake Management District Advisory Board with the assistance of the King County Water and Land Resources Division.

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*Photograph by Bassem Bejjani*

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