



Can a Lake Die?

Lake Mixing Helps Lakes to Breathe but Lake Protection is also Crucial for their Health

By: Mimi O'Handley, Wetlands and Water Officer at the Ecology Action Centre

Summer 2021

What is Lake Mixing?

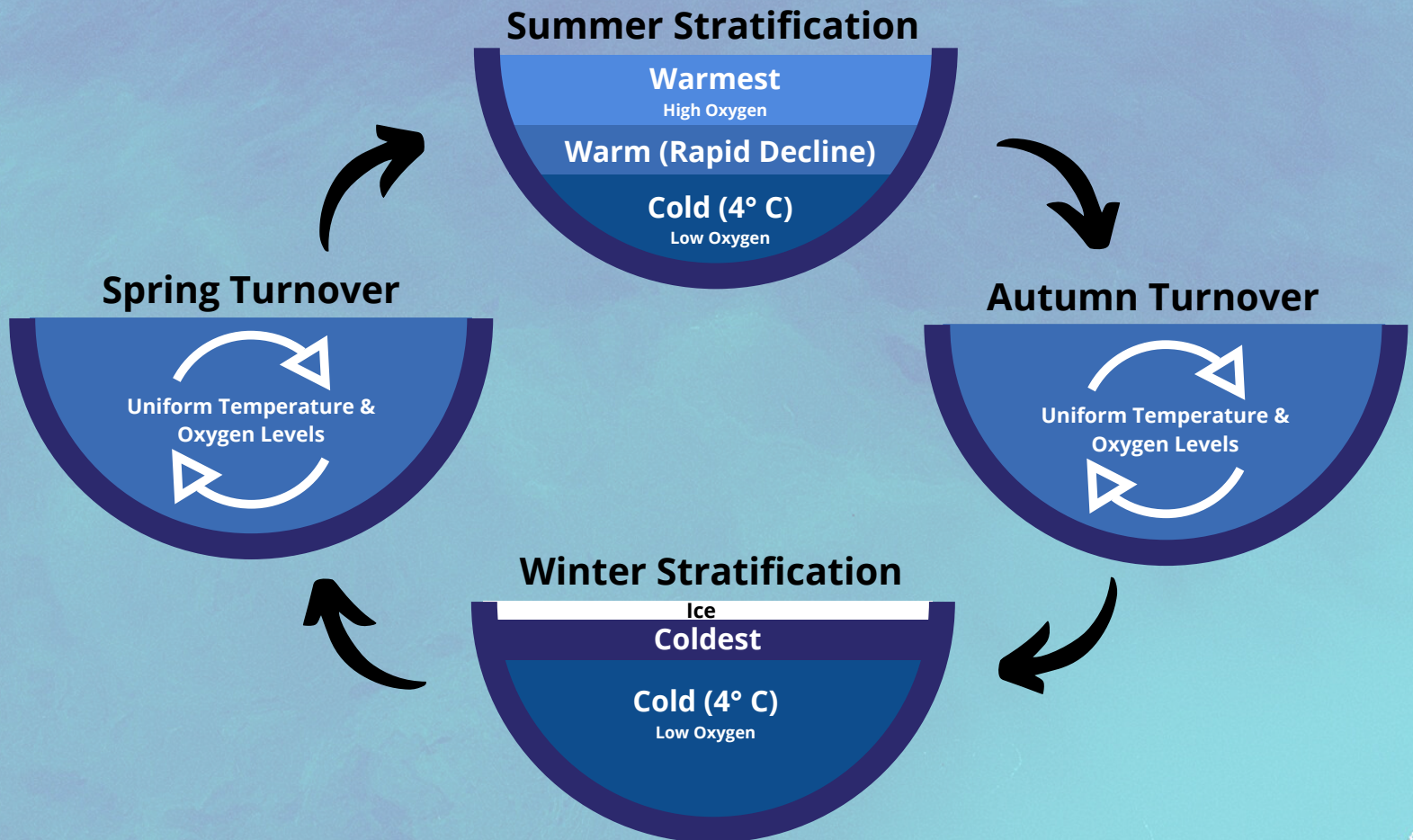
Nothing says summer in Nova Scotia like spending time at your favourite lake. Whether you're there to sit by the shore and relax, to explore the nearby trails and neighbourhood, or to go for a refreshing dip in the water, lakes are places where we learn, unwind and play. Those of you who spend time swimming or splashing about in the water are probably quite familiar with the sensation of having the water around your toes feel cooler than the water near the surface, and know that if you dive a little deeper, the water temperature drops quite rapidly.

This range of temperature is caused by lake stratification: from late spring until early fall, some freshwater lakes separate into three distinct layers. When the days start to get longer and the temperatures rise, the sun warms the surface water of the lake, which in turn creates variation in water density (weight). The densest water (about 4 degrees Celsius) falls to the bottom of the lake, while the warmest, least dense, water remains at the top.

Eventually, the surface layer warms to the point where the water densities within the lake are so extreme that neither wind nor waves can generate sufficient energy to mix the layers. When this happens, the different layers essentially act independently from one another. The bottom layer, cut off from oxygen exchange with the atmosphere, is often too dark for plants and algae to grow, therefore also missing out on the oxygen produced by photosynthesis.

Photo: Sandy Lake,
by Skyline Studios

Annual Lake Turnover Cycle



In lakes that are nutrient-rich, this bottom layer can even become anoxic (i.e., containing no oxygen) as the summer progresses because the supply of oxygen is consumed by bacteria and other bottom-dwelling organisms. In lakes that are contaminated with excess nutrients and organic matter from runoff, algae can grow out of control at the surface. Eventually, these algae blooms sink to the bottom of the lake and decompose; subsequently, "dead zones" form at the bottom of the lake due to both the decomposed algae and the lack of vertical mixing.

"In lakes that are contaminated with excess nutrients and organic matter from runoff, algae can grow out of control at the surface."

As summer comes to an end, chilly fall temperatures begin to cool the surface water. As a result, the water density becomes more uniform throughout the whole water column, and the layers begin to mix with the help of wind energy. In the coldest months of the year, winter stratification can then take place: the coldest, and lightest, a layer of water (or ice) remains at the top, and the densest water (about 4 degrees Celsius) once again is found at the bottom. The lake waters mix again come spring before summer stratification occurs.

The spring and autumn lake turnover, or lake mixing, is extremely important to freshwater lakes, as it replenishes oxygen levels in the deepest lake waters and redistributes nutrients throughout the water column. This process is critical for the health of the lake and its aquatic life.

However, if the summer stratification period is prolonged due to higher than usual seasonal temperatures, or excess nutrients and organic matter cause a longer and more severe anoxic period, a dangerously short turnover in the fall can result. A too-short turnover can significantly reduce the oxygen in the surface layer and may actually cause the death of large numbers of fish and other organisms.

Oathill Lake

Oathill Lake, situated in the middle of Dartmouth a few streets away from Lake Banook, is no stranger to anoxic conditions. Not so long ago, like many natural areas of the province, Oathill Lake was bordered by a number of wetlands including where Brownlow Park and the former Penhorn Mall are located. There was also a small stream at the south end of the lake.

Among the many incredible things they do, wetlands act as natural sponges that absorb rainfall, allowing groundwater to replenish. Wetlands also provide water purification by trapping sediment, and by absorption of pollutants and excess nutrients via wetland plant roots and microorganisms in the soil. Also important to any lake's ecosystem are the surrounding forested areas. Like wetlands, trees and forests help to capture and absorb stormwater runoff before it enters nearby watercourses.



*Photo: Oathill Lake,
by Oathill Lake Conservation Society*

By the early 1970s, the part of Dartmouth surrounding Oathill Lake had been developed and the wetlands and stream were infilled. A significant amount of the forested area was also removed. Thus their support of the lake ecosystem was lost.

Like other lakes in highly developed areas, Oathill Lake is vulnerable to high levels of chlorophyll, phosphate and nitrate concentrations that stormwater drains into the lake. Excess nutrients within the watershed flow into the lake via storm sewers, augmented by contamination from road salt during the winter.

"Taken together, all these factors have had serious impacts on the health and ecosystem of Oathill Lake: once home to a number of different species of plants, fish, birds and frogs, its biodiversity had been significantly reduced because of the decline in the lake's health. "

Another factor adding to the stress of Oathill Lake is that, while the lake has not yet failed to turnover in the autumn, lake mixing in the springtime happens inconsistently. This is not uncommon in Nova Scotian lakes, depending on the ratio of surface area to depth. However, given Oathill Lake's vulnerability to excess nutrients and pollutants, the lack of spring mixing means that the risk and severity of anoxic zones during the summer are exacerbated.

Moreover, the runoff from road salt is even heavier than the 4 degree water causing it to settle at the deepest part of the lake; this, in turn, contributes to the issues with the lake's spring turnover. To make matters worse, there have been issues resulting from the improper disposal of dog waste in and around the water.

Taken together, all these factors have had serious impacts on the health and ecosystem of Oathill Lake: once home to a number of different species of plants, fish, birds and frogs, its biodiversity had been significantly reduced because of the decline in the lake's health.

In response to the lake's troubles, a group of concerned citizens came together in 2010 to form the Oathill Lake Conservation Society. These volunteers advocate for its protection, monitor the water, and educate the public about caring for the lake.

Since its formation, the Society has installed a solar-powered aerator that helps to mix the layers of the water column and supply crucial oxygen to deeper levels of the lake, reducing the risk of anoxic episodes. Another remedy for the lake problems is the creation of an artificial wetland to create a buffer near Oathill Crescent.

The hard work of the Oathill Lake Conservation Society has restored the health of the lake significantly. Some species of the local ecosystem have returned, including Bullfrogs, peepers, and an increased minnow population that is important in the lake's food web.

However, other challenges still need to be tackled. Improper stormwater management is an on-going and significant issue for the lake and excess contaminants, nutrients, and road salt, still drain into the lake. The nearby Penhorn Lake has had the same problems and a solar power aerator has been installed there too with support from the Penhorn area developers.

Both lakes will receive runoff from the proposed 900-unit housing complex at the former Penhorn Plaza which means that stormwater management needs to be prioritized to ensure that contaminants from the development are properly dealt with and not directed into lakes and watercourses.

Why does this matter for Sandy Lake?

Each spring and fall, members of the Sandy Lake Conservation Association feel great relief when reports confirm that lake mixing in Sandy Lake has taken place: lake mixing means oxygen levels throughout the water column have unified and the risk of deadly anoxic conditions reduced. Like the conservation society dedicated to Oathill Lake, the Sandy Lake Conservation Association includes engaged and caring citizens who dedicate time and energy to protecting Sandy Lake.

Unlike Oathill Lake, however, Sandy Lake has not yet faced such extreme health and ecosystem issues. The decline of Oathill Lake's health is the consequence of a number of factors including increased development, removal of wetlands, poor stormwater management, excessive pollutants and road salt input, resulting in improper lake mixing.



*Photo: Oathill Lake aerator,
by Oathill Lake Conservation Society*



*Photo: Sandy Lake,
by Karen Robinson*

However, it is important not to deal with each factor in isolation, but rather consider them as a collective and examine how they interact with each other. While the removal of a limited number of wetlands next to a lake, or the development of roads or infrastructure near a feeder stream may each seem insignificant, taken together they can synergistically contribute to the disruption of natural cycles and the health of the lake.

"Shifting to a systems thinking approach is crucial to finding ways to protect waterways, maintain natural ecosystems, prepare for the impacts of climate change, and keeping lakes healthy, safe and fun."

Shifting to a systems thinking approach is crucial to finding ways to protect waterways, maintain natural ecosystems, prepare for the impacts of climate change, and keeping lakes healthy, safe and fun. Studies have shown that Sandy Lake is already stressed by physical disturbance, contamination from road salt, and excess nutrients from sewage and stormwater, and it is important to ensure that matters do not become worse. Though the health of Oathill can now be maintained with the help of the aerator, it is important to protect other lakes, like Sandy Lake, so that they can continue to function by relying on their own natural cycles.