

Lindenwood Lake Today

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Lindenwood Lake is the beautiful centerpiece of the HBS campus — what Station visitor has not admired its lovely rhododendron- and mountain laurel-lined shores? In summertime the blooming water lilies and swooping Rough-winged Swallows abound, while in winter such interesting waterfowl as Bufflehead and Hooded Merganser can often be found on the lake. The lake is also home to a host of native fish including Largemouth Bass, Bluegill, Redbreast Sunfish, and Creek Chub, as well as turtles (we seem to be "snapping turtle central"), salamanders, frogs, otters, muskrat, and a host of aquatic insects. And, there have been interesting studies on the lake's micro-biota: curiously enough our lake was the first reported locality in North America for the unusual freshwater dinoflagellate alga *Hemidinium nasutum*.

But perhaps the greatest ecological and scientific value of Lindenwood Lake today lies in its wetlands and the sunny open field-like habitat afforded by the dam. Both are relatively uncommon in our area — the wetlands far more so than the open habitat. Ironically, these were probably not what the early HBS founders envisioned would have research value. Rather, they thought that the lake itself would be an excellent resource for scientific research. But insofar as this lake, like most in the region, is not natural, with a mixture of native and non-native fish and other species not typical of our elevation, its usefulness for scientific investigation is limited.

Natural lakes are of course not entirely lacking in the mountains — they may be rare here (for obvious reasons, namely the terrain), but ephemeral lakes and ponds naturally come and go in this landscape, typically associated with the damming activity of beavers. But the vast majority of lakes and ponds in the Highlands-Cashiers area are human-made, of limited utility for scientific study and can even be ecologically harmful. This is because it is the warmer, more oxygen-depleted upper water layer of the lake that tends to flow over the dam spillway, artificially warming the downstream stretches and reducing oxygen levels, greatly altering the ecology and extirpating the native fauna.

One way to mitigate this negative "thermal pollution" effect, as we do at HBS, is installing a cold-water siphon: a standpipe at mid-depth that feeds through the dam and empties directly into the waterway below the spillway, infusing the stream with the colder and more oxygen-rich water needed to sustain native biota of our streams and rivers. Given the rarity of natural lakes here it is unsurprising that most aquatics research in our region focuses on

our myriad river and stream systems. Oddly enough, perhaps, river and stream research is actually one way we utilize Lindenwood Lake: we can divert water from the cold-water siphon into the experimental tanks and artificial stream runs of the Aquatics Laboratory at HBS, simulating a river or stream environment under controlled conditions.

But although water lower down in the lake's water column is relatively colder and more oxygenated than the surface water, we can see that the lake is warming on the whole. One result of this is that the lake can no longer support trout. From earlier records we know that trout were once stocked in the lake, but today the water becomes too warm in the summer to support these fish. For the past few years we have been monitoring the lake's water quality (the data can be found here: https://highlandsbiological.org/monitoring_data/stations/index.html), and our data show that the water temperatures exceed 20 degrees C (68 degrees F) in the summer, which is the temperature that starts to be stressful for trout. We also can see from the data how development and gravel roads impacts water quality (increased turbidity), and how salt used to melt snow and ice on surrounding paved roads ends up in the lake and increases salinity.

Despite the unnatural origin and qualities of Lindenwood Lake and its dam, these do have ecological value by creating habitat. Since the earthen dam must be kept clear of trees and shrubs, the roots of which could create weaknesses in the dam if they are allowed to get big enough, it presents an opportunity to create a meadow-like habitat with native wildflowers — which in turn are highly beneficial to a host of native insects and thus birds and other wildlife. This is the intent behind the "pollinator conservation garden" that now occupies much of the dam area, and in recent years this garden has been the site of on-going research into native bee diversity of the Highlands area, as well as a citizen-science project monitoring bumble-bees spearheaded by volunteers Janet and Scott Clarke.

But it is the wetlands that have been the site of most of the research pertaining to the lake over the years, notably our well-developed montane bog. There is evidence in HBS records that wetlands occupied the site before it was flooded to form the lake, and was home to such rarities as the purple pitcher plant (*Sarracenia purpurea* var. *montana*) and perhaps the bog turtle (*Glyptemys muhlenbergii*). Extensive wetlands, marked by characteristic mats of sphagnum moss, fringe the lake today, supporting several pitcher plant species and more. The rare, threatened, or endangered status of most of the wetland-associated plant species found here underscores the tremendous conservation value of HBS wetlands, and their research interest.

Accordingly, a number of master's theses and doctoral dissertation research projects have taken place in our wetlands over the years, notably involving the pitcherplants. For

example, some researchers have examined the diversity of specialized organisms that live in the water within pitcherplant "pitchers," from protozoa to certain native mosquitoes. Others have studied a kind of spider that makes its living stealing prey from the pitcherplants, called "kleptoparasitism" by biologists. These spiders spin their webs in the mouth of the pitcher, intercepting prey. They eat their fill and leave the remains for the plant. More recent investigations have been spearheaded by biologists from UNC-Asheville, examining hybridization between pitcherplant species, a serious conservation concern for rarer species.

Wetlands are among the most endangered habitat type in North Carolina, with over 50% of the original wetlands of the state estimated to have been lost, including about 90% of western North Carolina's montane bogs — problems exacerbated by recent Federal regulatory changes to the Clean Water Act such as redefining wetlands. In this light, the educational, research, and conservation value of HBS's wetlands takes on a far greater significance — even artificial lakes have their virtues