

## Lake Colden Fisheries and Chemistry Survey # 519087 and 519123: Jonathan Fieroh, Region 5 Fisheries

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Lake Colden (UH-P706) is a remote 41-acre lake at an elevation of 2763 feet, located in the High Peaks Wilderness. The maximum depth is 24 feet with a mean depth is 7.5 feet, the calculated flushing rate is 11.6 times/year. It was likely privately stocked before brook trout were caught in a 1932 fish survey (#532023475) when natural reproduction was noted. Lake Colden was known as an excellent trout fishery from the 1930s to the 1950s before the fishery began to decline due to acid impacts. No fish were caught in the 1970 (#570023499) and 1987 (ALSC) surveys. Lake Colden is classified as Adirondack Brook Trout water in the High Peaks Unit Management Plan. In 2018, water samples were drawn from Lake Colden (#518087) and advanced chemical analyses were performed by the Adirondack Lakes Survey Corporation (ALSC). These advanced samples were collected to identify and better understand waters recovering from the effects of acid precipitation that may once again be able to support native fish communities. The 2018 chemical metrics indicated that brook trout could survive in Lake Colden and it was determined that the lake could be stocked and that further chemistry sampling in 2019 should occur. In 2019, water sampling of Lake Colden's outlet occurred from February to September and both shallow and deep lake samples were drawn from June through September (Table 1).

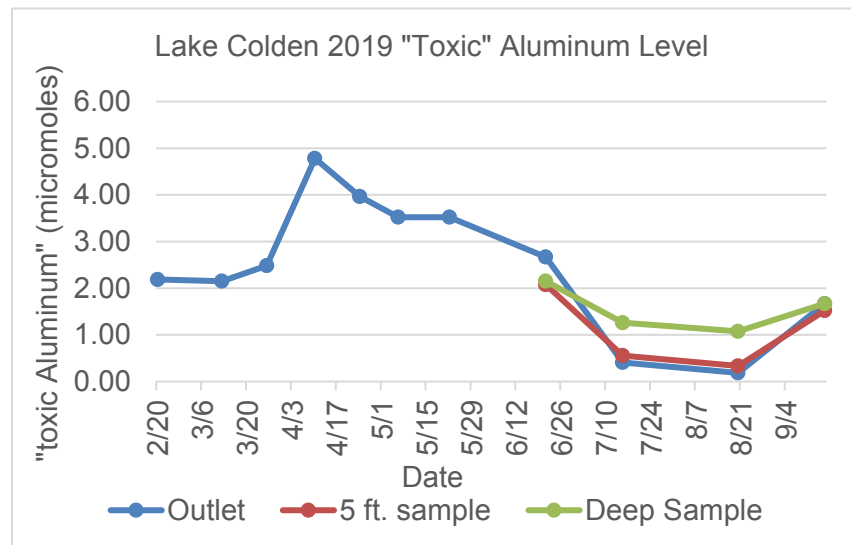
Table 1. Selected water chemistry variables for Lake Colden, 2019.

Date	Sample location	Air Equilibrated pH (pH units)	Acid Neutralizing Capacity (ANC) ( $\mu\text{eq/L}$ )	Inorganic Monomeric "toxic" Aluminum ( $\mu\text{M/L}$ )	Base Cation Surplus ( $\mu\text{eq/L}$ )	BC/RCOOs-	Conductivity ( $\mu\text{mhos/cm}$ )	Silica $\text{mg L}^{-1}$
2/20	Outlet	5.59	11.4	2.19	-3.8	6.7	14.5	5.7
3/12	Outlet	6.05	20.1	2.15	7.6	6.5	15.1	6.2
3/26	Outlet	5.59	9.8	2.48	-6.6	5.7	15.8	5.2
4/10	Outlet	4.97	-0.8	4.78	-41.1	4.0	15.4	3.9
4/24	Outlet	5.14	5.1	3.97	-15.6	2.5	11.6	3.1
5/6	Outlet	5.28	8.4	3.52	-21.3	1.7	10.6	3.2
5/22	Outlet	5.05	1.4	3.52	-12.9	2.0	9.6	2.7
6/21	Outlet	5.34	8.5	2.67	-3.5	2.2	8.8	3.4
7/15	Outlet	6.08	20.4	0.41	1.4	1.7	8.2	3.1
8/20	Outlet	6.32	26.6	0.19	19.1	3.0	9.2	3.4
9/16	Outlet	5.72	15.0	1.67	10.8	2.7	9.8	5.7
6/21	Lake shallow	5.45	8.5	2.08	1.7	2.4	8.8	3.3
7/15	Lake shallow	6.17	22.5	0.56	4.3	1.8	8.6	3.2
8/20	Lake shallow	6.40	27.7	0.33	7.4	2.0	9.4	3.8
9/16	Lake shallow	5.70	12.5	1.52	9.9	2.6	10.0	5.7
6/21	Lake deep	5.47	12.4	2.15	1.5	2.4	8.8	3.3
7/15	Lake deep	5.78	21.8	1.26	-10.2	1.5	8.6	3.4
8/20	Lake deep	6.01	21.0	1.07	7.5	2.3	9.0	3.3
9/16	Lake deep	5.78	14.8	1.67	10.5	2.6	10.0	5.7

Advanced chemical analyses includes the calculation of inorganic monomeric or “toxic” aluminum (ALIM), Base Cation Surplus (BCS) and the ratio of Base Cations to Strong Organic Anions (BC/RCOOs). These water chemistry values were selected to give a deeper understanding regarding the ability of Lake Colden to sustain a brook trout population. The BCS may be a more useful tool for the evaluation of recovery from acidification in the presence of increasing dissolved organic carbon (DOC) than ANC alone, which was often used in the past in the same manor. The BC/RCOOs helps to quantify the strength of “naturally acidic conditions” found in some Adirondack waters. Preliminary data

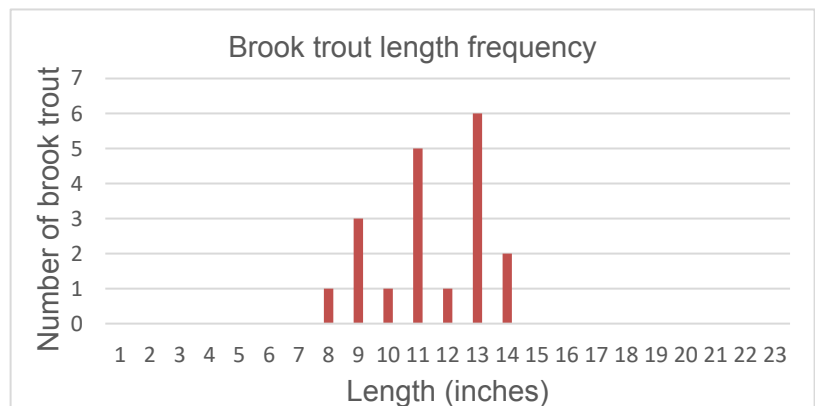
suggests, in a summer sample, for a water to support brook trout BCS values should be above -15 µeq/L, BC/RCOOs ratio should be above 1.5 and the “toxic” aluminum level should be less than 2 µML<sup>-1</sup>. While summer samples met these thresholds, it is noteworthy that many 2019 samples did not, despite the decades long trend of decreasing ALIM (2018 Lake Colden, Avalanche Lake Technical Brief). Shallow samples from February through June were in excess of 2 µML<sup>-1</sup> which proves the importance of refugia with regard to lake sampling. One possible refuge would be an inlet flowing into Lake Colden, Cold Brook (#519124), which appears to have excellent water chemistry.

Additionally, it has been documented (Schofield, 1996) that young brook trout avoided lethally acidic shallow water by moving to greater depths during acidic episodes.



In the summer of 2019, an angler called the NYSDEC Ray Brook Fisheries office and reported that he had caught several brook trout in Lake Colden. Fisheries staff immediately began to plan a fisheries survey and also informed ALSC staff of the angler phone call. During their next chemistry sampling visit ALSC staff were able to take a picture of a small brook trout in the aforementioned inlet stream, Cold Brook.

On 9/16/2019 three 150-ft Swedish experimental gill nets, a 30-ft minnow net and a minnow trap were set in Lake Colden. In a separate survey (#519088), the tributary, Cold Brook, was also surveyed with a backpack electrofishing unit. A total of 19 brook trout were collected in Lake Colden averaging 12.0 inches in length and 0.77 lbs. Not only are brook trout present here but they appear to have established a self-



sustaining population. Natural reproduction of brook trout was noted in 1932 and is consistent with the high silica values that Lake Colden exhibits. Silica can be a signature of groundwater inputs and brook trout are obligatory groundwater spawners. A total of 15 brook trout were aged using scale analysis and growth appears to be reasonable and the trout were in good condition (Table 2.).

In an effort to identify the origin of this trout population, fin clips from 14 Lake Colden brook trout were collected and preserved in ethanol for genetic testing. Testing was performed by Dr. Spencer Bruce of the University at Albany (Bruce, 2020). Samples were analyzed using DNA extraction and genotyping at 13 microsatellite loci. Dr. Bruce compared the Lake Colden fish to 6 brook trout strains commonly stocked in New York and 9 previously identified native Adirondack populations. Tests showed that the

Lake Colden brook trout population is genetically identical to the Temiscamie x Domestic Hybrid (TxD) strain used for stocking by NYSDEC. While the lake was stocked with a variety of strains (including privately stocked strains and the Honnedaga strain) over

Table 2. Average size at age of brook trout, Lake Colden 2019.

Age	Average Length (inches)	Average weight (pounds)	Sample Size
1	9.4	0.36	5
2	11.9	0.74	7
3	13.3	1.06	3

the decades, the last stocking of Lake Colden was 1972, long before fish surveys confirmed that the lake was fishless. The outlet of Avalanche Lake flows into Lake Colden and Avalanche Lake has a chemical history somewhat similar to Lake Colden. Avalanche Lake currently continues to exhibit water chemistry that is more impacted by acidity than is that of Lake Colden. Avalanche Lake was limed in 1981 and 1982 and was stocked by NYSDEC with domestic and then TxD hybrid brook trout from 1984 to 1987. This was the last purposeful addition of brook trout into the system. No fish were caught in Avalanche Lake in a 1987 ALSC fish survey. The origin of the current population remains an unknown but there are **several possibilities**. The first is that TxD hybrid brook trout remained in the system at a very low level in an area providing a refuge from acidity such as Cold Brook. A similar scenario has been well documented by Cornell University at Honnedaga Lake. There is also a slight possibility that the TxD hybrid brook trout stocked nearby in Livingston Pond found their way through tributary systems to the base of the dam at Lake Colden and through a leak in the dam.

A self-sustaining brook trout population now exists in this formerly fishless, acid impacted water. Lake Colden will not be stocked, but water chemistry and the fish population should continue to be monitored.

Schofield C.L. and Keleher C. 1996. Comparison of Brook Trout Reproductive Success and Recruitment in an Acidic Adirondack Lake Following Whole Lake Liming and Watershed Liming. *Biogeochemistry*. 32 3: 3223-337.

Bruce, S. 2020. Summary of Findings: Prepared for Adirondack lakes Survey Corporation- Lake Colden Brook Trout Study. Unpublished.