DK Water Resource Consulting LLC

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December 17, 2017

Rosie Hartzler and Board of Directors
Highland Lake Association
Rosie Hartzler <rosie@rosieworks.com>

RE: Highland Lake Science Roundtable.

Dear Rosie Hartzler and Board of Directors:

The following summary of the December 1, 2017 Science Roundtable on Highland Lake has been prepared for the board of directors of the Highland Lake Association. Highland Lake is an important resource to the region and well worth the stewardship required to protect it. This represents fulfillment of the first subtask under Task 1 of the proposal submitted by DK Water Resource Consulting LLC on November 1, 2017. Jeff Dennis prepared a summary of historic Highland Lake water quality dated September 20, 2017. Some of the information from that report is included by reference below but the bulk of the report is not repeated. That report should be consulted as background material that laid the groundwork for the Science Roundtable. This summary was presented to the Highland Lake Board of Directors on December 14, 2017.

In recent years, a small species of cyanobacteria (picocyanobacteria or PC) has been observed in Highland Lake. Over the past 4 years, the PC species has reached much higher densities than previously observed. From mid-July to mid-August of 2014 -2017, densities of the PC were sufficient to reduce water transparency from approximately 5 meters before and after this period to 2 meters during this period. Reports of lake users during this period suggest that the lake looks "cloudy.' This has been characterized as a "bloom." The nature, origins and control of this "bloom" was the focus of the Science Roundtable discussion.

The PC "bloom" has been characterized as being comprised primarily of a single celled cyanobacteria of the genus *Synechoccus.* This is the only known "bloom" of this genus in New England although this genus is commonly present in lakes. Identification of the particular species or groups of species comprising the bloom will take additional analysis. DNA fingerprinting was discussed as possible cost effective way to identify the individual species. Bigelow labs has the capability to perform such fingerprinting. During the onset of the "bloom" both chlorophyll *a (*a measure of the greenness of the water) and total phosphorus (the most critical nutrient in lakes) concentrations were relatively low perhaps suggesting that the PC were obtaining phosphorus from another source. The shallow sediments were suggested as a possibility.

The initial part of the science roundtable was focused on what information was known. This included the following:

1. There is currently a very long and detailed water quality data set available for Highland Lake thanks to the volunteer monitoring team led by Keith Williams. This puts Highland Lake in strong position for identifying and characterizing changes in water quality.
2. Work from Steve Norton of the University of Maine suggests that the deep sediments of highland Lake are currently not a large source of phosphorus due to the amount of aluminum in the soils in the Highland Lake watershed. Aluminum holds onto phosphorus and keeps it in the sediments even when oxygen is depleted in the overlying water (oxygen depletion in deep waters is observed in Highland Lake).
3. Increased development pressure without aggressive phosphorus controls will add additional phosphorus to Highland Lake.
4. The populations of adult and young alewives have increased in recent years due to the re-establishment of the natural run. Adult alewives live in the ocean and run into freshwater lakes and ponds to spawn in the spring to early summer. They then return to salt water over the summer. Young alewives hatch in the lake and grow to approximately 3 inches over the summer and then leave the lake for the ocean in the late summer or early fall.

5. Highland Lake has experience warmer summers in recent years with a longer growing season.

The second part of the science roundtable identified important pieces of the story that are currently unknown and highlighted a number of questions to be answered. These included:

1. Do the PC pick up phosphorus from the sediment surface and then transport this phosphorus up to the surface layers of the lake?
2. Where are the PC in the water column? We know they are in the surface layers but are they in other layers as well?
3. Do food chain effects make the bloom worse?
    a. Is zooplankton grazing on algae (and PC) reduced in the summer?
    b. Do alewives transport phosphorus to the lake, make phosphorus available through excretion, reduce zooplankton population?
    c. What is the role of other fish species in the lake on the "bloom?"
4. Is warming making the "bloom" worse?
5. Is the "bloom" toxic? If so, under what conditions is it toxic and what toxins are present?
6. What is the species(s) responsible for the "bloom?"
7. What is the current phosphorus budget for Highland Lake? Where is the phosphorus coming from currently and how is that likely to change in the future?

There was considerable discussion of possible scientific reasons for the PC "bloom" on Highland Lake. Many of these hypotheses need to be tested through specific testing and analysis in the coming months and years. It is likely that there are a number of contributing factors to the "bloom." A combination of the factors will likely need to be addressed to reduce the "bloom."

1. The PC "bloom" is fueled by phosphorus wither from the water column, the sediments or both.
2. Biological interactions in Highland Lake make the bloom worse or more persistent.
3. Warming has made lake conditions more favorable for blooms.

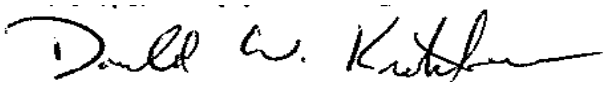
The final portion of the science roundtable focused on what the next steps were and what needed to be done. These included:

1. Fill gaps in the data that will help understand the factors contributing to the PC "bloom." To that end, the science group should reconvene to set up monitoring priorities for 2018 and beyond.
2. Control phosphorus. There are no future scenarios where additional phosphorus loading will make the situation better. A goal might be to keep in-lake phosphorus concentrations consistently below 10 ug/l. Reevaluation of the watershed planning efforts from the early 2000's would be worthwhile to see what is working, what is not working and to inventory new potential sources that did not exist when the plan was developed.
3. Evaluate alewife (and other fish species) impact further.
    a. This might include population estimates, timing of migrations and impacts on the zooplankton community. One of the tools that may be helpful is bioenergetics (already being used by University of Southern Maine to answer questions on Highland Lake)
    b. Evaluate data from other similar lakes to Highland lake both with and without alewife populations.
4. Apply for grant funding to help pay for future efforts to understand and control the PC "bloom." One potential source of funding is the Mitchell Center. It is highly recommended that the Highland Lake Association and collaborating researchers apply for funding this year.

The level of concern and the talent of the board and committees of the Highland Lake Association is not common among lake associations. That coupled with the interest from the academic and regulatory community greatly increases the chances that the origins of this bloom will be determined and the lake association will be able to take the actions necessary to reduce or eliminate it. I applaud your continuing efforts.

I appreciate the opportunity to work with you on this project. Please feel free to contact me at 603-569-4100 (office), at 603-387-0532 (mobile) or via email at dkretchmer@metrocast.net if you have any questions.

Sincerely,



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