

UPDATE ON THE LOWESWATER CARE PROGRAMME

by Leslie Webb



Aerial view of Loweswater courtesy of John Macfarlane

Loweswater is possibly best-known, at least amongst quiz compilers, for the fact that it is the only Cumbrian lake where the outlet flows inwards rather than outwards towards the edge of the Lake District. Its name comes from the Norse meaning “leafy water” suggesting that the surrounding land was more afforested than it is today, although Holme Wood is still a very notable feature of its topography. Looking back through my notes, it appears that the last mention of the LCP in the Link was in January 2018 ahead of a local meeting where we launched the reports from the DEFRA-funded project “Improving water quality in Loweswater”.

The P in LCP started out standing for *Project* in the original “Understanding and Acting in Loweswater: A Community Approach to Catchment Management” project run by Lancaster University over 2007-10. Apparently, some people found this name confusing, thinking that it referred to a Care Home (or maybe the age of the local participants, me included, suggested this), but what a great location this would be! In 2011, the P morphed into *Partnership* for a short time when we tried to continue as an independent group and finally came to rest as *Programme*, when we became part of West Cumbria Rivers Trust (WCRT) in 2012.

The current stream of scientific work on Loweswater goes back to the last century (just), when, as a result of a recommendation in the Environment Agency’s West Cumbria Local Environmental Action Plan in 1999, University College London was commissioned to carry out a study into the increasing incidence of algal blooms in the lake. This study was very useful in bringing together all the historical data on the chemistry and biology of the lake, but the scientists also took a core sample of the lake sediment showing how the accumulation of various elements and certain algae varied over the last 2000 years (calculated from radiochemical dating).



Photomicrograph taken by Andrew Shaw

Most types of algae break down in lake sediments, but one type (the diatoms) are better preserved as they have a skeleton composed of silica. In the above core sample, it was thus possible to identify the species of diatoms in different periods and utilise this to estimate the lake conditions at those times. A mini-study within the later Loweswater Care Project in 2010 (by Angus Winchester) combined this information with an analysis of land use in the lake catchment to try to see why the lake's condition has changed over time. The picture here is of a diatom

called Asterionella, which the core analysis showed was only sporadically present before about 1850.

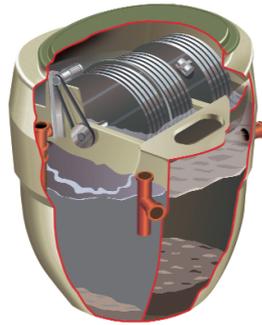
This type of diatom is still present in the lake during their normal Spring period of growth and it so happens that, as I write, the lake has experienced a strong bloom of these algae, captured in the photograph here. The types of diatoms present from around 1850 suggest that the lake water is now more productive than previously - this is coincident with agricultural developments such as the installation of field drains and liming of the land to raise the slightly acidic pH and improve grass productivity. In the second half of the 20th century, arable land use (such as for production of oats) disappeared and chemical fertilisers began to be used to enhance grass growth for the increasing numbers of sheep and cattle.



Loweswater lake edge at Watergate
Image by John Macfarlane

The subject of fertilisers brings us to almost certainly the single most important factor in the higher levels of algae evident in the lake over the last 50 years or so and this is the increasing concentration of phosphates in the lake water. As well as requiring carbon dioxide, water and light, the growth of algae requires an adequate supply of other nutrients and, from many studies around the world, it is usually the level of phosphorus in phosphates that limits their ability to proliferate. (One should add that the growth of diatoms can also be limited by the amount of silicon as well.) The importance of phosphorus to algae is confirmed by the substantial increase in its level in the lake core taken in 2000 - there's now 4 times as much phosphorus in what's deposited in the lake sediment as there was 1000 years ago.

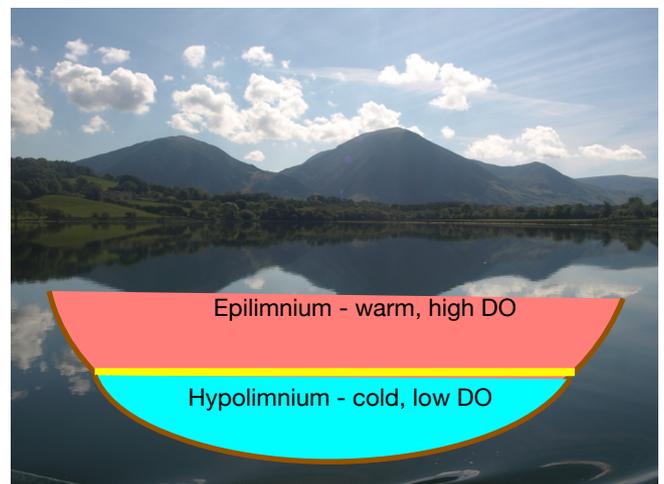
It's impossible to prove where this increased phosphorus comes from, but the most likely source is residual fertiliser-derived phosphates washed out of the soil by the rain. In lakes like Bassenthwaite, a major source of phosphates is the treated sewage from towns (in this case, from Keswick), although, like Keswick today, the sewage can be treated chemically to reduce this if needed. In Loweswater of course, there is no centralised sewage treatment as all the properties have their own small treatment plant. In another mini-study in the original LCP, I carried out a small project to do something that I didn't envisage doing when I moved here in 2006, which was to study all the sewage treatment plants in the Loweswater catchment to see how they were



working and also to see how many people were using phosphate-free detergents. This was quite interesting and allowed me to get to know people in a completely new way. The treatment plants ranged from old septic tank systems (some not having been touched for many years) through to modern fully-

mechanised plants (like the one shown here) and a reed bed. The trouble with all such plants is that they are not designed specifically to remove phosphorus, although some does get transferred into the “sludge”, but this still has to be disposed of. Quite a few people were using phosphate-free detergents, but a lot of dishwasher powders still contained high levels of phosphate.

This study estimated that the various sewage outlets contributed around 15% of the phosphorus input to the catchment. One of the other sources of phosphorus is the lake sediment itself. In the Summer, deeper lakes like Loweswater stratify into two layers due to the warmer water of the incoming becks being unable to mix with the cold, denser water already there (see picture). Shallower lakes like Bassenthwaite don't do this as normal mixing (such as by the wind) prevents this occurring. The bottom of Loweswater loses its dissolved oxygen (DO) at this time, becoming virtually anoxic for a few weeks - this very poor water quality



is the main reason why the lake is only classified as of moderate quality. The low DO allows phosphorus in the bottom sediment to be re-dissolved which returns to the main body of water once the lake re-mixes itself in the Autumn. In the last LCP project, the University of Liverpool were able to calculate that, in 2013, this recycled phosphorus was a minor contribution (<10%) to the lake's total input and that over half of the total incoming phosphorus remained in the sediment (rather than leaving in the Dub Beck outflow).

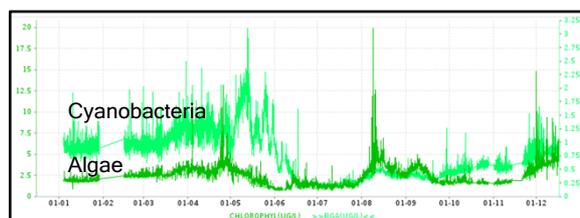
A £325k DEFRA grant funded this last LCP project “Improving water quality in Loweswater”, which we carried out after we became part of the local Rivers Trust. The bulk of the money was spent on improving the infrastructure at various farms with the objective of reducing their phosphorus input to the lake catchment. This gave the project a strong link back to a farmer's group in 2002 that kick-started efforts to improve the environment in Loweswater. As the University-led project in 2007-10 had concentrated on sociological aspects arising from the lake's problems, we were determined that this new project would get its hands dirty by focussing on practical measures. Here's a photo-montage of some of the farm projects:



In 2013, as part of this same project, we also started our own monitoring of the lake and its feeder becks although we do also make use of the data from monthly samples taken by the Environment Agency. You may have noticed a small raft that has been on the lake for the past 7 years, located over its deepest point (where it's 16m to the bottom). Originally, we used this to house a small ultra-sound generator (to try to kill the algae, but we don't talk about this any more as it didn't work) plus a monitoring module (as shown in the photo here). This clever box of tricks allows us to monitor pH, temperature, conductivity, dissolved oxygen, turbidity and, the best bit, two measures of the algal numbers in the lake.

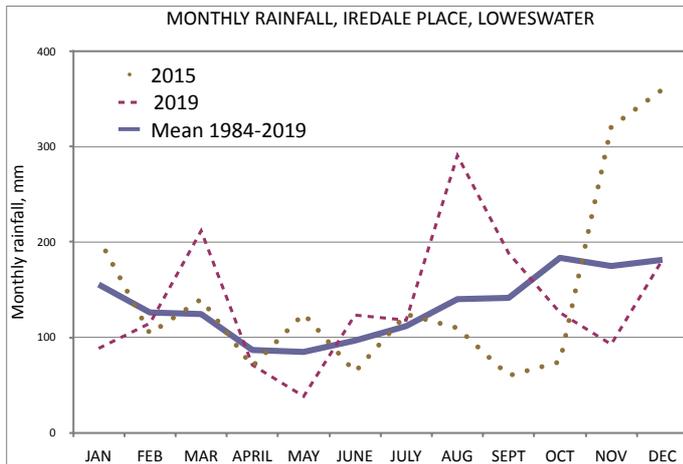


There's lots of different species of algae (which we also identify via analysis down the microscope), but we can classify them broadly into green algae (like the diatoms) and blue-green algae (better termed cyanobacteria, which are amongst the oldest life forms on Earth, present 2 billion years ago). The big issue with blue-green algae is that some are toxic when they break down. As you can see in this trace from the sensor, we can see the hourly concentrations of both types (in real time on the computer if we telemeter the data).



We still carry out all these measurements (plus annual electro-fishing expeditions) to see the effect of the farm improvements that we funded in the project on the lake and its becks. However, a big factor in what reaches the lake from the catchment is something over which we have no control - rainfall. We are lucky that we have our own weatherman in Loweswater (Neil Spencer at Iredale) who supplies us with rainfall figures, from which the data below is taken.

Over the last 35 years, the average annual rainfall in the catchment has been just under 1600mm. The wettest period is usually the Autumn, although, as we know from last year (see graph), August is rarely dry. You can also see the impact of Storm Desmond in December 2015 although the rainfall and river flows were in fact higher during the 2009 flood event. Incidentally, after two very dry months in April and May this year, we had nearly all June's average rainfall in 2 days near the



end of the month (83mm), but this was much less than that recorded at Honister in just 24 hours (210mm).

None of the flows in the Loweswater becks are measured, but, allowing for evaporation, the rainfall tells us that the water stays in the lake for about 200 days on average, that is once it gets there. Rain that percolates into the water table takes a lot longer to reach the lake and this is why lakes can quickly deteriorate in quality from land run-

off, but take a long time to recover. So, it isn't surprising that we haven't seen any clear improvement in Loweswater from our interventions in the last project - this means that we'll have to continue our monitoring for some time yet.

One of the mini projects carried out in the original LCP was a hydrogeomorphology study of Loweswater. This suggested that the level of Loweswater 100 years ago may have been up to 1m lower than it is now and that there could be benefits from re-connecting the canalised Dub beck inflow with its flood plain. As part of a current WCRT project on Natural Flood Management in the Cocker catchment, the Trust will shortly be looking into ways of moderating peak flows into and out of Loweswater, which should also reduce phosphorus inputs from particulate matter.

All our work (and that by others before us) is described in various reports on the LCP pages of the WCRT website. Do have a look - you probably won't have a better period to find the time do this. Many thanks to Andrew Shaw for his contribution to all we have done over the last 10 years and to Neil Spencer for rainfall data.