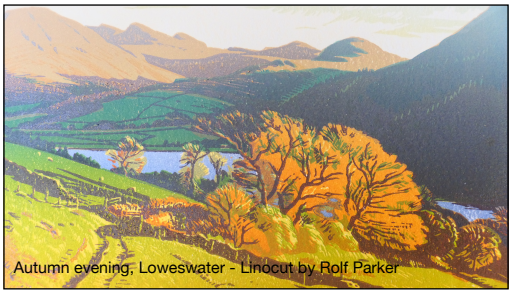
LOWESWATER AND CLIMATE CHANGE


Autumn evening, Loweswater - Linocut by Rolf Parker

At the meeting last month of the Loweswater Care Programme (part of West Cumbria Rivers Trust), we reported that, in recent years, Loweswater has shown signs of an improvement in terms of levels of algae and their key nutrients (phosphorous compounds), but these are inherently variable due to natural processes in the lake and the weather. One of the issues that we talked about at the meeting was what happens when the lake stratifies during the summer. During this time, phosphates from lake sediments get recycled, but we discovered that this amount is relatively small compared to what continuously comes in with the becks.

Most of the energy from global warming ends up in the earth's water (mainly the oceans) which causes ice melt and destroys habitats like coral reefs. One of the adverse consequences of this in lakes is that the stratification period gets longer - for example, research has shown that Blelham Tarn now stratifies for 40 days longer since the 1960s. We don't know whether this happens in Loweswater (there's no reason why not), but, if it did, one possible consequence would be that more phosphates are thus re-dissolved and contribute to enhanced algal growth in subsequent years. This is a good example of a legacy issue with phosphorous compounds where they can get held up in a catchment for many years so that a lake takes a long time to recover from an earlier deterioration in quality.

An under-reported consequence of increased CO_2 in the atmosphere is increased CO_2 in water. Because of this, the pH of the world's oceans has declined by about 0.1 units, which doesn't sound very much but it represents a significant increase in acidity and will contribute to the adverse effects of higher temperatures. In Loweswater, the pH might have dropped by about 0.15 units over the last 150 years, more than sea water as its alkalinity (acid neutralising capacity) is much lower. In fresh water lakes like Loweswater, the consequences of this shift may well be much less than in sea water as they experience a much greater natural variation in pH. In Loweswater for short periods, algal growth drives the pH up to above pH 9 from its more normal pH of around 7.5. Some of Loweswater's feeder becks are quite acidic (pH 5-6), whereas others are closer to neutral pH 7 due to past liming of the land.

It seems a bit bizarre with the current very dry weather to write about the third effect of climate change which is the increased frequency of intense rainfall. As I write, we are experiencing the normal period of dry weather in

the late Spring/early Summer, but it's going on for longer than normal - on the edge of my garden, there is a small beck coming off Low Fell that has dried up for the first time since we've been here.

Droughts such as this increase the retention time of water in any lake - this is normally quoted as 200 days for Loweswater (coincidentally the same as for Crummock Water). However, the retention time is quite a dynamic feature of a lake and will also vary with how stratified the lake is in Summer and how full it is. The longer retention time allows the lake to warm up more quickly, particularly so if the drought is combined with high temperatures (as now). All this puts stresses on the lake's aquatic life, which is often difficult to predict. In Loweswater, summer is rarely the time of maximum growth of algae, which have their own seasonal rhythms.

However, what I originally wanted to talk about here was the other end of the rainfall spectrum, which normally occurs in the Autumn, as in the 2009 and 2015 storms. These events are of relatively short duration, so they do not impact much on the lake's retention time, but they do mobilise sediments and soils in the catchment, flushing them into the lake. The picture at left shows Crabtree Beck in August 2013 when a very localised storm sat over Loweswater for 24 hours. At that time, we had only just started our in-lake monitoring and had little data on "normal" levels of turbidity in the lake. We now know that the short-term increase in lake turbidity following this storm was around 10x normal, much of this originating from High Nook Beck which managed to flow into Loweswater, whereas normally it joins the Dub Beck outlet downstream of the lake.

We have no clear data yet showing that the frequency of intense storms (or droughts) is increasing in Loweswater or whether the nutrients contained in the turbid particles contribute to algal growth. Some of the turbidity will settle to the lake bottom and its nutrients may not become available until later years after they have been broken down in the stratified lake's bottom sediments. As fresh water lakes see more natural variations than the oceans, they may be better equipped to deal with the changes brought about by climate change, but the timescale for such impacts may be lengthy and require vigilant monitoring to assess their scale.

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