



Overview summary report of the
Loweswater Care Programme Project

IMPROVING WATER QUALITY IN LOWESWATER

funded by the Defra Catchment Restoration Fund 2012-2015

JANUARY 2018



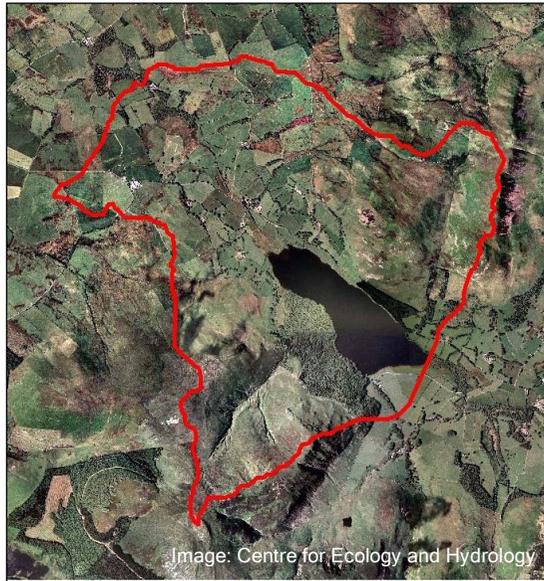
Foreword

When the Trustees at West Cumbria Rivers Trust were approached by Leslie Webb and Andrew Shaw on behalf of the volunteers at the then Loweswater Care Partnership to explore options for taking their successful project bid forward, it was immediately clear that there was much synergy between the two groups; discussions quickly bore fruit with the Trust employing the staff to manage the project and Leslie Webb becoming a Trustee at WCRT. The Loweswater Care Partnership morphed into the Loweswater Care Programme (retaining the LCP acronym) and, as has been often said, the rest is history!

And what a successful "history" we now celebrate - the continuing enthusiastic input from key volunteers supplemented by Vikki Salas' skills as the project officer combined to produce the key outcomes of a far greater understanding of the problems in the catchment and a lasting legacy of major improvements in local infrastructure. Enthusiastic cooperation and support from all the landowners and farmers in the valley added the other essential ingredient for success. So as we look back on the successful completion of the original Defra-funded project, we can all look forward to continuing cooperation amongst all key stakeholders to the ongoing benefit of the ecology of the valley. On behalf of all at WCRT, I record grateful thanks to all participants.

David Calvert, Chair of WCRT Trustees

Loweswater is one of the smaller lakes in the Lake District having a volume of 5,400,000 m³ and retention time of about 200 days. The catchment (see image below) is largely agricultural for sheep grazing on improved grassland with rough grazing on the open fells. Over many years, farming practices in the catchment, together with inputs from septic tanks, have led to nutrient enrichment in the lake and elevated levels of phytoplankton.



In addition to regular monitoring by the Environment Agency (EA), various studies since 2000 have given us a sound picture of some of the sources of the key nutrient supporting algal growth (phosphorus compounds) and the dominant types of algae within the phytoplankton. An important feature of the algal population is the prevalence of blue-green algae (more accurately termed cyanobacteria), some of which can be toxic. Despite this abundance of information on the lake, little was known, before this project started, about things such as the level of phosphorus recycling from lake sediments and there had, up to this time, been few interventions to try to expedite improvement in the lake's water quality.

The Catchment Restoration Fund Project

In early 2012, Defra announced funding for a new programme to tackle, amongst other things, diffuse pollution from rural and urban land use – the Catchment Restoration Fund (CRF). Grants totalling £24.5M were distributed to support 42 projects running over 2012-2015. Our project "Improving water quality in Loweswater" received £327k from the CRF and was completed in September 2015. A comprehensive technical report on the project's findings is available on the LCP pages of the WCRT website (see back page).



The picture at left is typical of the algal growth (a small "bloom") that occurs on Loweswater from time to time. The project was aimed at trying to eliminate such blooms and help the lake achieve "good" ecological status under the EU Water Framework Directive. This was to be achieved through implementing major improvements at farms to reduce inputs of phosphorus compounds from land run-off and treatment of the body of the lake with ultrasound generated at two points on the lake surface.

A key element in the work programme was monitoring of the lake's water chemistry and the species of algae present. This was essential for judging the impact of the ultrasound lake treatment and future impacts of the farm improvements. Loweswater is fed by several becks which were also monitored for key chemical parameters and fish populations (see photo at right of volunteers helping the Project Officer carry out an electro-fishing survey).



Farm Projects

Farm	Work completed
A	Drainage channels across lane Fencing
B	New cattle shed Fencing
C	Back Yard Roof Slurry Store Roof Replacement hardcore bale pad Concrete base for dry muck midden Cattle house roofing/flooring over tank
D	Watercourse crossings New sheep shed
E	Fencing
	Himalayan Balsam spraying/pulling Purchase and use of sward lifter and slitter

Firstly, two studies were commissioned from local consultants so that we could identify and then prioritise those features of the land and farming practices within the lake catchment with the greatest potential for reducing their contributions to phosphorous loading on the lake. Eventually, we spent about half of the project budget on improvements at farms as in the table above.



Himalayan Balsam is an invasive plant that destabilises river banks so volunteers (as shown in the photo at left along Dub Beck in 2015) enjoyed several evenings pulling them up before the plants could flower and set seed.

Soil compaction from passage of stock and equipment is a common problem, leading to poor drainage and excessive run-off. The project funded the purchase of a sward lifter and sward slitter (as in photo at right) for use by local farmers in the lake catchment to negate these problems.



Some examples of improvements at farms in Loweswater



New drainage channel across laning to prevent rainwater reaching the lake.



New cattle shed above enlarged slurry tank.



New sheep shed.

New roofing over yard to keep rain water out of slurry tank.



New bale pad.

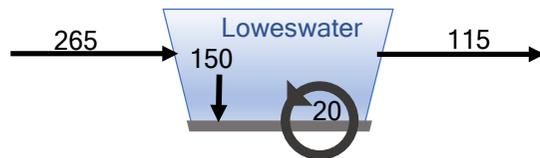
Catchment studies – waterfowl and lake sediments

Waterfowl, such as the Greylag Goose shown in the photo, are quite common on Loweswater and we were lucky to have data on their numbers from surveys by the British Trust for Ornithology. Excreta from waterfowl is a potential source of phosphorus, about which we had no data, so we commissioned the Wildfowl and Wetlands Trust to estimate this for us. They calculated that waterfowl guano amounted to about 1.3 tonne pa, containing around 5 kg of phosphorus, which is low compared to other sources.



In lakes like Loweswater that stratify for several months in the summer, the dissolved oxygen near the lake bottom gets used up by bacterial action that breaks down any biodegradable organic matter in the bottom sediments. This tends to release into solution any phosphorus in the organics, some of which is phosphorus from dead algae that have previously sunk to the lake bottom. This re-dissolved phosphorus can then be recycled into the whole lake when it turns over again in the autumn. In some lakes, most of the phosphorus in the lake originates from recycled lake sediments, but we had no idea how significant this was for Loweswater.

So, working with University College London in 2013, a lot of samples were taken of the lake water at various depths and of the surface sediments at the lake bottom. This allowed us to calculate not only the amount of recycled phosphorus from sediments, but also how much of the incoming phosphorus from other sources ended up in the lake sediments (see Figure below for the calculated quantities in kg phosphorus pa). This shows that the major part (56%) of the incoming fresh phosphorus (150 kg) is buried in sediments and that the recycled sediment phosphorus (20 kg) equates to just 8% of the annual fresh input.



Monitoring of becks and lake

The surface of the lake was monitored continuously at one location above the deepest part of the lake using a YSI EXO2 Sonde (as in photo at left) fitted with sensors for pH, specific conductivity, temperature, dissolved oxygen, turbidity, chlorophyll (the green pigment in all algae) and phycocyanin (the blue-green pigment only present in cyanobacteria). The Sonde was carried by the raft that also supported the ultrasonic generators and associated equipment (see photo on next page).



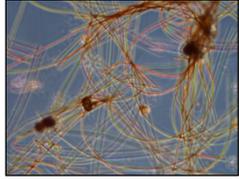
As part of its regular monitoring, the Environment Agency already took monthly samples for chemical analysis and we purchased a microscope for identification of the algae present in these samples. This generated a massive amount of data, which are summarised in detail in the full technical report. One of the main drivers of water quality in the feeder becks and the lake is rainfall, which is rather heavy in Loweswater, averaging about 1600mm pa. The impact on the turbidity of the lake of one storm event in 2013 is shown in the photo above.



There are many feeder becks entering Loweswater and fifteen of these (see map left) were monitored monthly for pH, temperature, specific conductivity, dissolved oxygen and turbidity. Becks in the Dub Beck catchment above the lake contain the highest levels of dissolved and particulate solids.

Lake monitoring and ultrasound trial

Ultrasound has been shown in laboratory and full-scale tests to be able to destroy cyanobacteria without adversely affecting other species and without introducing other materials into the lake environment.

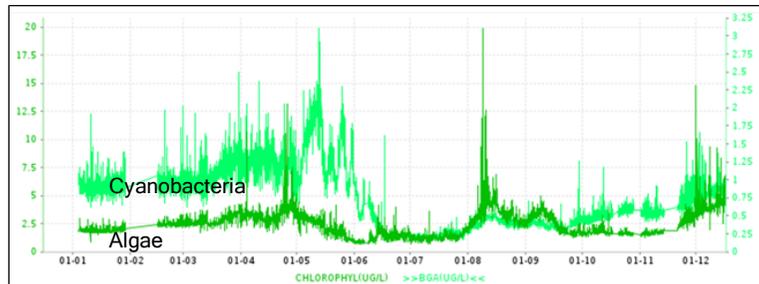


Cyanobacteria are particularly susceptible to ultrasound due to their internal gas bubbles, which are utilised to regulate their buoyancy. However, before this work at Loweswater, ultrasound treatment of the species that are dominant in Loweswater such as *Planktothrix* spp (see photo at left) had not been tried.

Ultrasound generators were installed beneath rafts (see photo at right showing the solar panels that provided power to the units) at two positions so that the whole lake surface would be covered by the sound waves generated. Over an 18 month period in 2013-14, the ultrasound units were operated continuously, but we did encounter a number of intermittent operating problems.



Below are shown 2014 data from the in-lake Sonde for two key parameters. Notwithstanding the uncertainties in the levels of ultrasound exposure for significant periods of time (due to equipment problems), this and other data showed that, much to our disappointment, the ultrasound treatment had no effect on the levels of cyanobacteria.

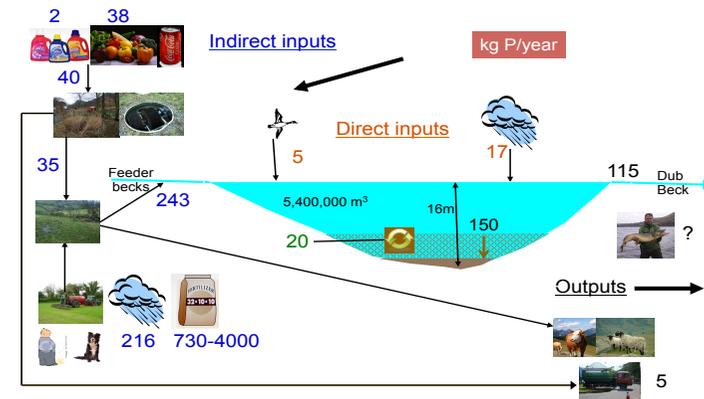


Lake phosphorus summary

It is important to note that, even if all the data were known, it would be inappropriate to try to compare phosphorus inputs and outputs in any one year, as movement of phosphorus-containing water over and within soils is complex. In particular, phosphorus-containing compounds can adsorb and desorb from particulate surfaces and be incorporated in biomass, thus slowing down their egress from a catchment.

As described above, this project has thrown fresh light on the contributions to the phosphorus loading on the lake from bottom sediments and waterfowl. Other loads were known from previous studies, but the input of phosphorus in fertilisers is very variable depending on soil requirements and growing conditions.

These loads are collected together in the "mass balance" in the figure below. It is evident that sewage releases from septic tanks (35 kg P pa) are a relatively minor source of phosphorus (P) compared to rain water (216 kg P pa) and from fertilisers (730-4000 kg P pa). Phosphorus in sheep and cattle wastes originates from grass and any bought-in feed, but requires optimal management in order to be taken up again by growing grass. The improvements at farms funded by this project should ensure that up to 1300 kg P pa from cattle wastes alone has a better chance of being recycled in this way rather than reaching the lake.



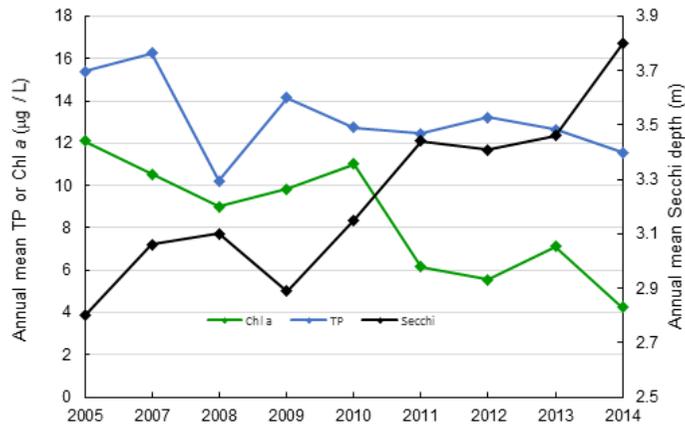
Lake status and future

Under international guidelines, the trophic status of a lake is classified using the concentrations of total phosphorus and phytoplankton chlorophyll plus the depth of Secchi disc (a measure of water clarity), as shown for recent years in the figure below. This procedure classifies Loweswater as mesotrophic, meaning that it is intermediate between low and high nutrient status.

Of more importance in recent years has been the status of Loweswater in terms of the EU Water Framework Directive (WFD). The lake assessment under WFD includes concentrations of chlorophyll and total phosphorus (but not Secchi depth) and several other parameters. Loweswater has always been classified as of “moderate” ecological status in WFD terms (whereas the aim is to achieve “good” status).

A key WFD parameter is the concentration of dissolved oxygen at the bottom of the lake when it is stratified in the summer. Currently, this concentration is close to zero, which, if continued, would be a major impediment to achieving good WFD status. So, it is encouraging to note this project’s findings that the lake sediments did not release a particularly significant amount of phosphorus - this suggests that the quantity of deoxygenating material in the lake sediments is not as high as it might have been.

The potential reduction in algal growth brought about by lowering phosphorus inputs to the lake (through the farm improvements funded by this project) should help to reduce deoxygenation and hopefully facilitate earlier compliance with the WFD in the future.



Acknowledgements

West Cumbria Rivers Trust (WCRT) is very grateful to Defra for funding the work described in this report and to the Environment Agency CRF team for helpful advice as the project proceeded. The project could not have been run as efficiently as it was without the collaboration of the National Trust and the Penrith office of the Environment Agency.

The project was run by a Steering Committee, to all of whom many thanks:

- Mark Astley (local ranger, National Trust)
- Ken Bell (local resident and farmer)
- Charlie Bradshaw (Environment Agency, Penrith)
- David Calvert (WCRT Chairman)
- Andrew Shaw (local resident)
- Vikki Salas (WCRT Project Officer/Assistant Director)
- Leslie Webb, Chairman (WCRT Trustee/local resident)

The Committee would also like to thank:

- Professor Stephen Maberly of the Centre for Ecology and Hydrology (CEH), Lancaster for his expert advice
- John Macfarlane (local resident) for the image supplied (as credited).

The original Loweswater Care Project with Lancaster University and CEH established a thriving partnership with the local community and other stakeholders, which we endeavoured to continue in this project. So, many thanks to all the local people that attended the project meetings at Loweswater Village Hall and who helped “bash the balsam” and with electro-fishing on the becks.

Published by West Cumbria Rivers Trust
32 Lake Road, Keswick, Cumbria CA12 5DQ.
Tel: 017687 75429
Website: www.westcumbriariverstrust.org
Email: info@westcumbriariverstrust.org