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Phoslock Europe Newsletter

Summer 2013

Phoslock - the best in situ solution for the remediation of eutrophied lakes and reduction of blue green algae

UK Environment Agency Projects

Phoslock Europe was awarded a prestigious tender by England's Environment Agency in January 2013 to restore two eutrophic lakes within the nationally important North West Midlands Meres and Mosses. A detailed summary of the project, which is aimed at achieving EU targets under the Water Frame-work Directive, appears on Page 2

Phoslock applied in the Norfolk Broads

The first ever application of Phoslock on one of the UK's fifty National Nature Reserves took place in March when a Phoslock application team and a group of dedicated Broads Authority staff and volunteers applied nearly 20 tonnes of the product to Cromes Broad within the How Hill National Nature Reserve.

Early signs of success are emerging with lower phosphorus levels, substantially reduced algal growth and the return of desirable macrophyte species being observed during August 2013. Full details of the project and the early results on Page 3.

Phoslock PhD completed

Four years of hard work are over for Sebastian Meis who was awarded his PhD by Cardiff University in December 2012. Undertaken at the Centre for Ecology and Hydrology in Edinburgh, the PhD assessed the potential of Phoslock to reduce internal P loading in a shallow Scottish loch and force a change in state in the lake. Overview on Page 4

Publications

The scientific literature relating to Phoslock grew substantially in the first half of 2013 with the publication of a number of articles in peer-reviewed journals. On Page 5, we provide a short overview of five new papers that have been published since the beginning of the year.

News from outside Europe

Canada & USA

The first half of 2013 was a busy time for Phoslock in North America, with four large scale projects being undertaken involving the application of nearly 150 tonnes of the product. Details of the projects as well as information about Phoslock's participation in the upcoming North American Lake Management Society's symposium and conference in San Diego, US, are provided on Page 6

The Mere and Hatchmere, UK

Phoslock selected for lake restoration trials by England's Environmental Agency

The UK's Environment Agency and the Centre for Ecology & Hydrology are trialling the use of Phoslock in two Cheshire lakes with an aim of reducing phosphorus levels and improving the ecological status of the lakes. Delamere Forest's Hatchmere and The Mere, near Knutsford, had both been earmarked for work to tackle long term pollution caused by the build up of phosphorus in the lake bed sediments and Phoslock was selected as the best measure to achieve this following an official tender process. Both applications were completed in March.

The two lakes form part of The Meres and Mosses of the North West Midlands, a nationally important series of open water and peatland sites which developed in natural depressions in the glacial drift. Hatchmere is designated as a Special Scientific Interest (SSSI) under the UK's Wildlife and Countryside Act (1981) due to its well developed floating and emergent vegetation while the Mere is a designated site due to its very diverse aquatic flora and high number of submerged macrophytes.

Excessive levels of phosphorus, caused by sewage inputs associated with population growth and intensive farming methods can have a detrimental impact on water quality. Phosphorus contributes to the dense growth of algae which can reduce the amount of sunlight available to plants and restrict oxygen for fish.

About 76% of lakes in England and 36% in Wales were recently assessed by the Environment Agency as requiring a reduction in phosphorus concentrations to meet water quality targets set by the EU Water Framework Directive.

The applications of Phoslock to the two lakes are aimed at improving water quality so that both lakes achieve "Good Ecological Status" under the Water Framework Directive. This is the first time Phoslock has been used by the Environment Agency.

The Environment Agency and the Centre for Ecology & Hydrology will monitor the phosphorus concentrations and ecology of the lakes for two years to assess the impact of the treatment.

Dr. Bryan Spears, the technical lead for CEH said, "Dealing with the phosphorus pollution left behind by previous generations is a difficult task for which there is no 'silver bullet'. The approach used in the current project is extremely innovative. Instead of the relatively destructive process of dredging and removing contaminated sediments, we are trying to develop new ways of containing, or capping, phosphorus pollution in lake bed sediments. However, it is important that we do not neglect our responsibility for continuing to reduce the phosphorus pollution footprint of our own. It is CEH's role to document the successes and failures of these innovative field trials to inform future generations."

Broads Authority
The Broads - a member of the National Park family

Phoslock applied on the Norfolk Broads

The first ever application of Phoslock on one of the UK's fifty National Nature Reserves took place in March when a Phoslock application team and a group of dedicated Broads Authority staff and volunteers applied nearly 20 tonnes of the product to Cromes Broad within the How Hill National Nature Reserve.

The Broad was sprayed with Phoslock to reduce phosphorus concentrations in the water and sediments and starve the excessive levels of algae that grow in the water body of a limiting food source. This is expected to create clearer water conditions that allow a diversity of water plants to grow which provide a home for aquatic invertebrates and fish.

Cromes Broad has been partly mud pumped twice in an attempt to remove excess nutrients in the water. However, half the broad is still dominated by thick mats of algae blocking out light that allows other plants to grow.

The Phoslock treatment was funded by Natural England and managed by the Broads Authority.

Andrea Kelly, the Authority's senior ecologist, said: "Restoring lakes from pollution is an expensive but essential business on which our wildlife depends. It's important in the nation's most protected wetland that we all do what we can to stop nutrients from getting into the water in the first place. For example checking septic tanks are working properly or stopping fertiliser rich sediment getting into our rivers and lakes".

"Phoslock will give this degraded lake a second chance, enabling us to kick start the ecosystem. We are hoping that a diversity of water plants, including stoneworts, pondweeds and lilies will return, and with them will come more birds and a more varied fish community".

The first signs of success appear to be emerging already with substantially lower algal growth being observed in summer 2013 than in previous seasons. Changes are also being observed in the plant community, with a significant reduction in high nutrient tolerating species such as Hornwort

(Ceratophyllum Spp.) in favour of more desirable oligogotrophic species such as Bladderwort (Utricularia Spp.). A full plant survey is planned for later in the year.

The Broads Authority and its scientific team are held in very high regard internationally for their innovative and cutting edge approach to ecological restoration and their decision to apply Phoslock on the How Hill National Nature Reserve is another milestone in the use of Phoslock by the world's leading conservation authorities.

the Broads
Britain's magical waterland

Phoslock related PhD completed

Four years of hard work and sleepless nights came to an end in December 2012 for Sebastian Meis of the Centre for Ecology and Hydrology in Edinburgh when he was awarded his PhD by Cardiff University. The study, titled "Investigating Forced Recovery from Eutrophication in Shallow Lakes", had as its main hypothesis the concept that Phoslock could be used to reduce internal phosphorus loading in a recovering shallow lake and force a change in state in the lake from a "phytoplankton dominated turbid state" to a "macrophyte dominated clear water state".

One of the main components of the study was the treatment of Loch Flemington, a 15 ha, shallow (mean depth c. 0.75 m) loch in northern Scotland with 25 tonnes of Phoslock in March 2010. Prior to the application, high phosphorus concentrations in the loch's water as a consequence of sediment phosphorus release had triggered frequent algal blooms and fish deaths had been reported. The loch's conservation status was under threat and the loch was classified as being in an unfavourable condition in relation to all of its conservation targets (i.e. rare aquatic plants and a breeding population of the Slavonian Grebe).

The treatment of Loch Flemington showed that Phoslock significantly reduced internal phosphorus loading by increasing the mass of phosphorus stored in more refractory (= permanently bound and non bio-available) sediment phosphorus fractions relative to potentially release-sensitive phosphorus fractions (Meis et al., 2013) and led to other ecological improvements such as a significant decrease in the phytoplankton biomass, an increase in water clarity and an increase in macrophyte colonisation depths (Gunn et al., *submitted*). The observed changes were generally comparable to those observed in long-term multi-lake studies investigating the recovery of shallow lakes following external phosphorus -load control, however the changes in Loch Flemington occurred over a shorter time scale (1 year compared to decades). The study concludes that alterations in ecological structure and function indicate that a change in state from a "phytoplankton dominated turbid state" to a "macrophyte dominated clear water state" was achieved in Loch Flemington and confirms that it is possible to force a state change in shallow lakes by reducing sediment phosphorus release.

In addition to the whole lake experiment on Loch Flemington, a range of other issues were also investigated as part of the PhD. These include experimental phosphorus adsorption studies (Meis et al., 2012), the effect of high areal loads of Phoslock on the vertical distribution of sediment dissolved oxygen concentrations and cycling of

nutrients other than phosphorus (Meis et al., *in prep*.). The study also proposes a new conceptual model for the use of Phoslock and other phosphorus -capping agents in lake remediation projects which highlights the benefits of applying multiple small doses over a single high dose in terms of cost-effectiveness and the avoidance of non-target effects (Meis et al., 2013).

The complete PhD can be downloaded from the Cardiff University website at http://orca.cf.ac.uk/45439/.

Written by Phoslock Europe GmbH using authorized extracts from S. Meis, 2012; Investigating forced recovery from eutrophication in shallow lakes. PhD Thesis, Cardiff University. Copy right of photographs: Sebastian Meis.

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*Meis, S., B. M. Spears, S. Maberly, and R. Perkins. 2013. Assessing the mode of action of Phoslock® in the control of phosphorus release from the bed sediments in a shallow lake (Loch Flemington, UK). Water Research **47**:4460-4473.*

Meis, S., B. M. Spears, S. Maberly, and R. Perkins. in prep. Control of sediment phosphorus (P) release in lakes using Phoslock® (P-capping agent): unintentional effects on sediment nitrogen (N) processes.

*Meis, S., B. M. Spears, S. C. Maberly, M. B. O'Malley, and R. G. Perkins. 2012. Sediment amendment with Phoslock® in Clatto Reservoir (Dundee, UK): Investigating changes in sediment elemental composition and phosphorus fractionation. Journal of Environmental Management **93**:185-193.*

New Publications

Phoslock in the Peer Reviewed Literature

Spears, B. et al; Lake Responses following lanthanum-modified bentonite clay (Phoslock) application: an analysis of water column lanthanum data from 16 case study lakes, Water Research, 2013

This paper is a joint publication authored by researchers from the Centre for Ecology and Hydrology (UK), Wageningen University (Netherlands), the Institut Dr Nowak (Germany), the National Institute of Water and Atmospheric Research (NZ) and Wessex Water (UK). The study investigates the potential for negative ecological impacts from elevated La concentrations by assessing post application La concentrations in 16 lakes treated with Phoslock. CHEAQS PRO modelling was also undertaken as part of the study on 11 of the lakes to predict concentrations of La3+ ions and the potential for negative ecological impacts. The modelling indicated that the concentrations of La3+ ions will be very low (<0.0004 mg L-1) in lakes of moderately low to high alkalinity (> 0.8 mEq L-1), but higher (up to 0.12 mg L-1) in lakes characterised by very low alkalinity. The paper discusses the implications of these results for the use of Phoslock in eutrophication management.

Crosa, G. et al, Recovery of Lake Varese: reducing trophic status through internal P load capping, Fundamental and Applied Limnology, 2013

This paper describes the large-scale mesocosm trials undertaken with Phoslock on Lake Varese in Northern Italy and provides an overview of results. The trial was undertaken in 2009-10 using three 15m mesocosms. An overview of the trial and the results that were obtained were presented in our December 2011 newsletter.

Reitzel, K. et al, Phosphate adsorption by lanthanum modified bentonite clay in Fresh and brackish water, Water Research, 2013

This paper presents the results of laboratory experiments undertaken at the University of South Denmark to assess and characterise the effects of pH, alkalinity and conductivity on the adsorption of soluble reactive phosphorus onto Phoslock. Eight different types of filtered water were used in the study, including those representing freshwater with low and normal alkalinity and those representing brackish water with high alkalinity. Different dosages were applied to determine the maximum P binding capacity of Phoslock at SRP concentrations typical of those of sediment pore water. The study concludes that the P uptake by Phoslock performs better in soft water than in hard water and suggests that the recorded differences in P adsorption between the two lakes could be attributed to a more pronounced dispersion of Phoslock in soft water.

Márquez-Pacheco , H. et al, Phosphorous control in a eutrophied reservoir, Environmental Science and Pollution Research, 2013

Another publication relating to mesocosm trials undertaken with Phoslock. This paper describes trials undertaken by researchers from the Mexican Institute of Water Technologies (IMTA) on the Valle De Bravo Reservoir, results of which were presented in our December 2012 newsletter.

Meis, S. et al, Assessing the mode of action of Phoslock in the control of phosphorus release from the bed sediments in a shallow lake (Loch Flemington, UK), Water Research, 2013

This publication is based on the work undertaken by Sebastian Meis as part of his PhD at the UK's Centre for Ecology and Hydrology and Cardiff University which is described earlier in this newsletter. The paper quantifies the effects of Phoslock on sediment elemental composition and P fractionation (one year pre- and post application) and concludes that the application caused a significant increase in the mass of P present in the more refractory "apatite bound P" fraction compared to the mobile P fraction. A conceptual model is also proposed for the use of P-capping agents such as Phoslock in lake remediation projects in order to increase cost-effectiveness and reduce non-target effects by applying multiple smaller doses compared to a single high dose.

News from outside Europe

News from Overseas: USA & Canada

The first half of 2013 was a busy time for Phoslock on the other side of the Atlantic with four major projects being completed in the United States and Canada since the beginning of the year, involving the application of more than 150 tonnes of Phoslock.

The first two projects were undertaken in the first quarter by Phoslock's US licensee, SePRO Corporation, on public water bodies in Florida and New York State which had been plagued by eutrophication caused by excessive phosphorus for many years.

The other two projects were spring-time applications and took place concurrently in California and Ontario, Canada. The Californian project was the largest ever application of Phoslock in North America and involved the application of more than 50 tonnes of the product to a 13 hectare lake in Orange County near Los Angeles. The lake is a storm catchment basin for an adjacent creek and has suffered from poor water quality for many years due to excessive phosphorus levels. The project was an initiative of Aquatechnex, the Californian distributor for SePRO Corporation.

The Canadian application took place on an urban lake in the Greater Toronto Area during April. Although Phoslock has been used in Ontario on storm water retention ponds, drainage canals and a variety of other water bodies over the past five years, this application was the first time that a municipally owned urban lake has been treated with the product in Canada.

All lakes are being monitored and we hope to be able to publish the results in future editions of the newsletter.

Phoslock at NALMS

Phoslock will be well represented at the upcoming 33rd International Symposium of the North American Lake Management Society, to be held from October 30 to November 1 at the Town and Country Resort & Conference Center in San Diego California.

In addition to an oral presentation from US licensees, SePRO Corporation, Phoslock related presentations have also been accepted from two European delegates: Dr Said Yasseri of the Institut Dr Nowak in Germany will present results from a number of long-term German case studies, while Dr Sebastian Meis will present results from his recently completed PhD relating to the recovery of a shallow Scottish loch following treatment with Phoslock.

Anyone interested in learning more about Phoslock is also welcome to visit our stand at the associated exhibition which will be adjacent to the SePRO stand.

Further details of the exhibition and conference can be obtained by visiting www.nalms.org or emailing info@phoslock.eu.

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