

Loch Flemington, Inverness, Scotland

Application dates: 13th -15th March 2010

Summary

The Lake

Aim: to improve water quality in the eutrophied lake

Description: shallow lake of international conservation and scientific importance.

Size (ha): 15

Max. depth (m): 3

Average depth (m): 1

Dosage (tonnes): 25



Figure 1: Loch Flemington, Scotland (image from Google Maps).

Located near Inverness in Scotland, UK, Loch Flemington is a shallow lake that lies within the Kildrummie Kames Site of Special Scientific Interest (SSSI). The Loch was notified in 1974, in part, for Loch Flemington's eutrophic lake habitat and for supporting populations of aquatic macrophyte species of conservation interest. However due to eutrophication and the establishment of non-native invasive aquatic macrophytes its status has declined. The lake experiences frequent cyanobacterial blooms in the summer months.

Since the 1960's Loch Flemington has become increasingly eutrophied. This is due to high nutrient water entering from the catchment and has resulted in a build up of phosphorus in the lake and its sediments. This has caused algal blooms to proliferate annually during the summer months.

In 1995 there was an overnight fish kill of all of the trout in Loch Flemington. The blame was

directed to a major blue green algal bloom occurring at the time.

By 2003/04, the SSSI eutrophic lake habitat feature was found to be in an "unfavourable condition". This was due to the lakes continuing poor water quality, the dominance of non-native vegetation and the disappearance of all aquatic macrophyte species of a national conservation interest. A study undertaken in 2001 indicated that the majority of total phosphorus (TP) (about 85%) was from internal sediment-driven loads to the water

column and approximately 15% was attributed to the external load from the catchment (May et al., 2001). The comparatively high internal loading is most likely due to one inflow and no outflow points from the lake and from a build up of P in the sediment.



Figure 2: Loch Flemington on the day of the Phoslock application.

The Treatment and Results

The Loch Flemington was treated from 13th-15th March 2010. Twenty-five tonnes of Phoslock was applied using a barge and GPS. Samples were collected from 3-5 areas in the lake prior to the application and on a monthly basis. The samples consisted of both the water chemistry and ecology of the lake. The application and monitoring also formed part of a research project being undertaken by a CEH PhD candidate. As a result, the lake was intensively monitored by the Centre of Ecology and Hydrology (CEH) before and after (for 2 years) the treatment. Some of the data is presented in journal papers by Gunn *et al.*, *Hydrobiologia* (2013), . During summer 2010 the surface water TP concentration decreased by 65% and in 2011 by 81% from the summer

2009 values (prior to the Phoslock application). Chlorophyll *a* also significantly reduced after the application. In 2010 there was a 77% reduction and the following summer there was a 95% reduction from levels recorded in 2009. However the most notable reduction was in the volume of cyanobacteria. The biovolume reduced by 98% over 2 years. Total phosphorus and chlorophyll *a* were below the Water Framework Directive target for the lake. In turn, this led to a significant reduction in algal levels in the lake, highlighted in Figure 3 with increased water clarity.

Data also showed that the coverage of the plants increased from 30-40% to about 80% of the lake bed after the application of Phoslock.



Figure 3: Comparison of Loch Flemington in the summer of 2009 (prior to the application) and 2010 (after the Phoslock application) (photos courtesy of Sebastian Meis).

REFERENCES

- Gunn, I., Meis, S., Maberly, S., and Spears, B. 2013. Assessing the responses of aquatic macrophytes to the application of a lanthanum modified bentonite clay, at Loch Flemington, Scotland, UK. *Hydrobiologia*.
- May, L., Gunn, I., and Kirika, A. 2001. Phosphorus study at Loch Flemington. Report to Scottish Natural Heritage. SNH contract no.: HT/LE08/00/01/35
- Meis, S., Cardiff University, 2012, PhD Thesis: Investigating Forced Recovery from Eutrophication in Shallow Lakes.
- Meis, S., Spears, B., Maberly, S., and Perkins, R. 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).