Using Phoslock® to control cyanobacteria in a shallow eutrophic Scottish Reservoir: ecological responses across multiple trophic levels

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We did all the hard work......
• Introduction

• The tale of a very important little bucket!

• Assessing the ecological responses following Phoslock® application
The national scale - 2008

The national scale - 2008

Mean annual TP (μg/L) Mean annual Chl (μg/L)

Pass TP; Pass Chl - 45 %
Pass TP; Fail Chl - 2 %
Fail TP; Pass Chl - 35 %
Fail TP; Fail Chl - 18 %
- Control of sediment P release using P-capping
- Managed flushing to speed up recovery
- Interactions of management with climate change
- Biomanipulation
- Control of sediment P release using aeration
- Identification of un-consented small discharges
- Industrial point source reduction in catchment
- Control of pesticide use
- Control of diffuse sources in catchment
- Reduction of agricultural inputs

+ site condition survey of
~ 140 Scottish lochs *(SNH)*

> 6,000 lakes in GB have eutrophication problems
Microbial decomposition of P-rich organic material

Sediment-P release is buffered by macrophytes

Phoslock applied as slurry....

...a few weeks later...

...a few months later...

Sediment-P release is buffered by macrophytes

Microbial decomposition of P-rich organic material

Time after treatment

.....perhaps a little simplistic?
Shutting down the phosphorus pump

Bioavailable P pathways
Organic P pathways
Competition for light

Bioavailable phosphorus

Catchment P sources

P-rich organic material

Microbial remineralisation of P-rich organic material

Sediment P processes
Shutting down the phosphorus pump

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PUBLIC WARNING
BLUE-GREEN ALGAE
High concentrations of Blue-Green Algae have been found in this water body
MEMBERS OF THE PUBLIC AND THEIR ANIMALS SHOULD STAY OUT OF THE WATER

DUNDEE CITY COUNCIL
Environmental Health & Trading Standards
1 Highland Chief Way, Claverhouse West Ind. Park,
Dundee DD4 8UA
Telephone: 01382 436250
experiment with straw addition
Clatto Reservoir

Surface area - 9.4 ha
Perimeter - 2.5 km
Max fetch - 0.97 km
Altitude - 162 m
Mean depth - ~ 3 m
**Set management objectives:**

1. To reduce blue green algal numbers to below 20,000 cells/ml
2. To reduce TP concentrations to below 35 µg/L over summer

“100 g Phoslock® will remove 1 g PO₄-P”

- Total water column P – 27.7 kg P
- Releasable sediment P – 180 kg P
- Phoslock® dose – 20.8 tonnes (24 t)

Environment agencies treating Clatto as a trial application
Phoslock application – 3rd - 5th March 2009
Shutting down the phosphorus pump

Bioavailable P pathways
Organic P pathways
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Catchment P sources

Bioavailable phosphorus

P-rich organic material

Sediment P processes

Microbial remineralisation of P-rich organic material
Total lanthanum in the water column

http://www.phoslock.eu/?subject=en-clatto
Physicochemical responses in the water column

- **Total P**: TP (μg L⁻¹)
- **Dissolved P**: SRP (μg L⁻¹)
- **Water clarity**: Secchi depth (m)
- **DIN**: DIN (μg L⁻¹)
- **DO**: Dissolved oxygen (mg L⁻¹)
- **pH**
Phytoplankton responses

![Image of phytoplankton samples]

![Graph showing chlorophyll a (μg L⁻¹) over time]

Chlorophyll a (μg L⁻¹)

Feb | Apr | Jun | Aug | Oct | Dec
Blue-green algal response

WHO guidelines (20,000 cells/ml)

Total blue-green algal cells/ml

Jan/07 Jul/07 Jan/08 Jul/08 Jan/09 Jul/09 Jan/10

Anabaena spp.
Coelosphaerium spp.
Gloeocapsa spp.
Microcystis spp.

Blue-green algal response
Benthic algal response
Macrophyte response

Species list

- Callitriche sp.
- Eleocharis acicularis
- Elodea canadensis
- Nitella sp.
- Potamogeton crispus
- Potamogeton sp. (fine leaved)

Depth (m)

Macrophyte colonisation zone

Lake bottom

Mar May Jul Sep Nov
Macronvertebrate response

Hydra oligactis Pallas 1766; 27th April 2009 - Clatto Res.
Seed shrimp - Ostracoda
Pea-mussel – *Pisidium sp.*
Leech – *Helobdella sp.*
Non-biting midge larvae - Chironomidae
True worm - Oligochaeta
Crustacean zooplankton response

- Bosmina spp.
- Eudiaptomus spp.
- Cyclops spp.
Wind direction as a driver of sediment P release?

- **Chl (µg L⁻¹)**
  - P < 0.001; \( r^2 = 0.86 \)

- **TP (µg L⁻¹)**
  - P < 0.003; \( r^2 = 0.73 \)
  - P < 0.001; \( r^2 = 0.89 \)
Summary

- TP concentrations did not exceed 35 µg L\(^{-1}\)
- Cyanobacterial abundance did not exceed 20,000 cells per ml
- Phytoplankton biomass appeared to be P limited and remained below 12 µg L\(^{-1}\)
- Benthic algal biomass did not increase with water clarity
- The macrophyte community responded positively with water clarity
- The macroinvertebrate community showed a mixed response
- The zooplankton community was driven by the phytoplankton
- Wind mixing may confound the effects of Phoslock® in shallow water bodies