



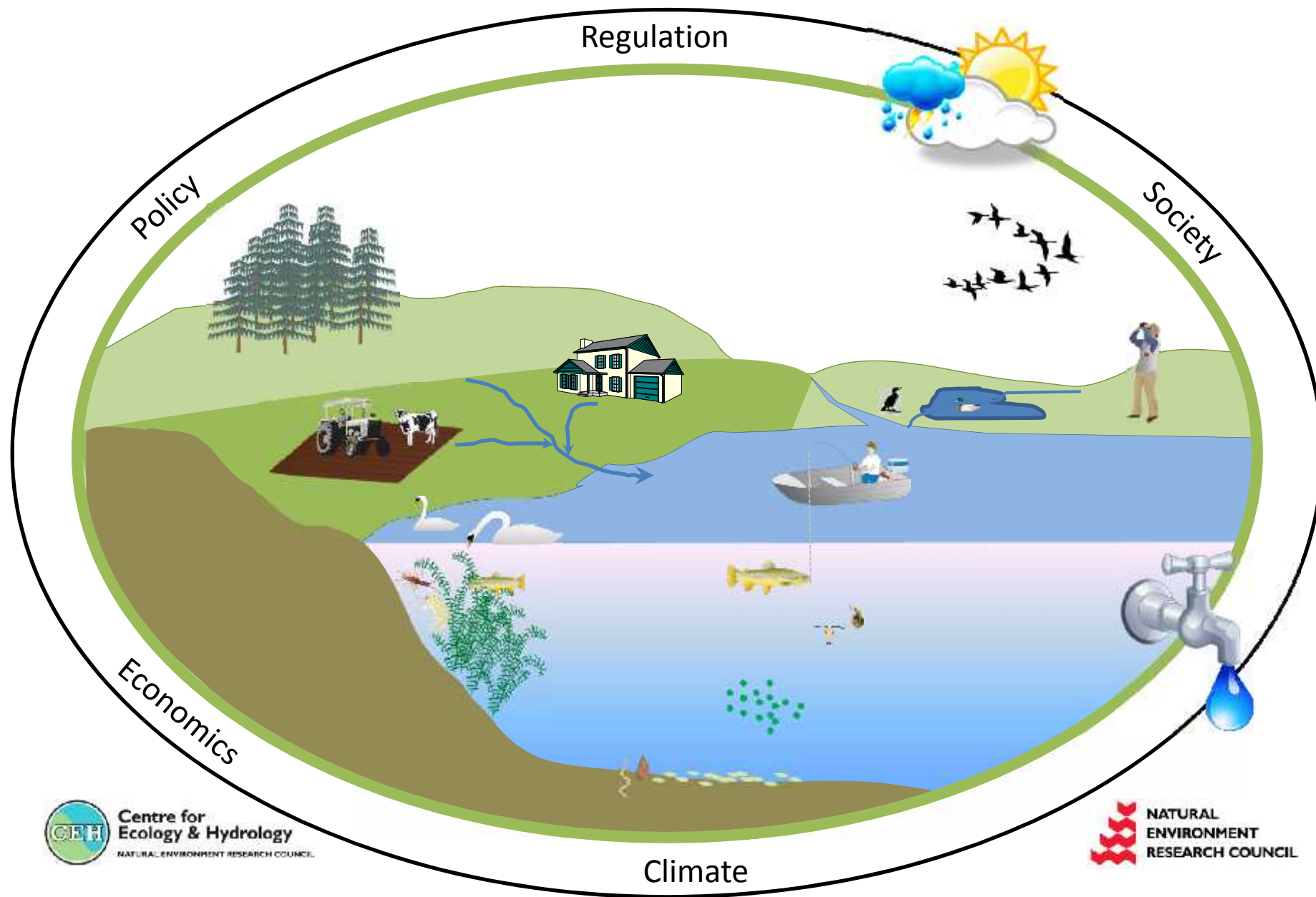
Lake Restoration in the UK: lessons from the CEH case studies

Linda May, Bryan Spears, Sebastian Meis, Bernard Dudley, Stephen Maberly, Laurence Carvalho, Iain Gunn, Dave Carss, and Ian Winfield

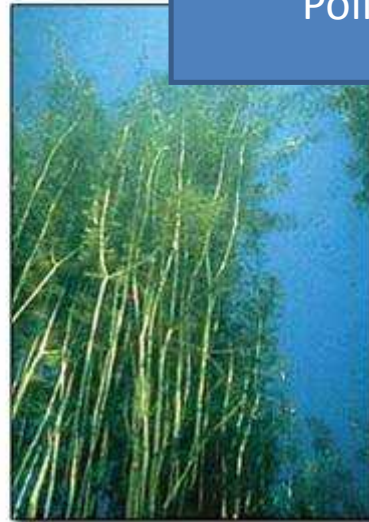


- Why is lake restoration important?
- Improving our understanding of restoration and recovery processes
- Providing the evidence base to support decision makers

Why is lake restoration important?



Direct impacts: degradation of water quality



Good water quality

Bad water quality

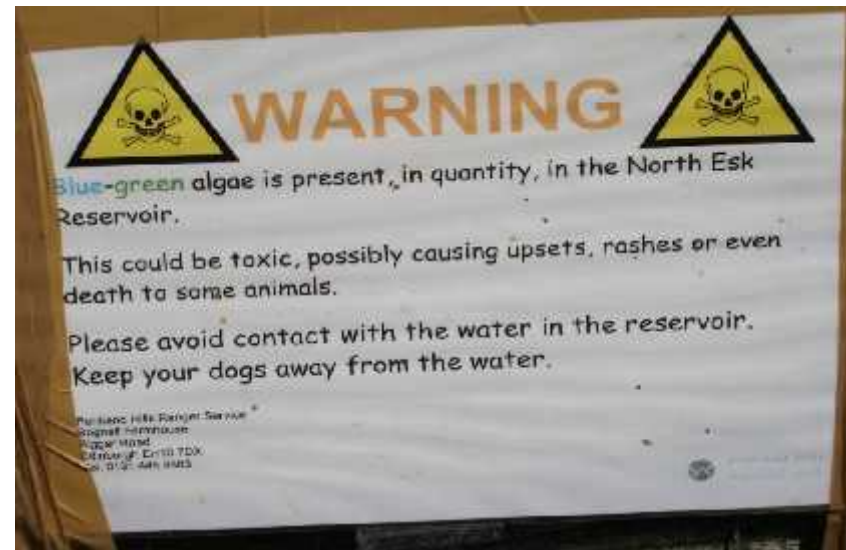
Indirect impacts: loss of wildlife habitat & amenity value



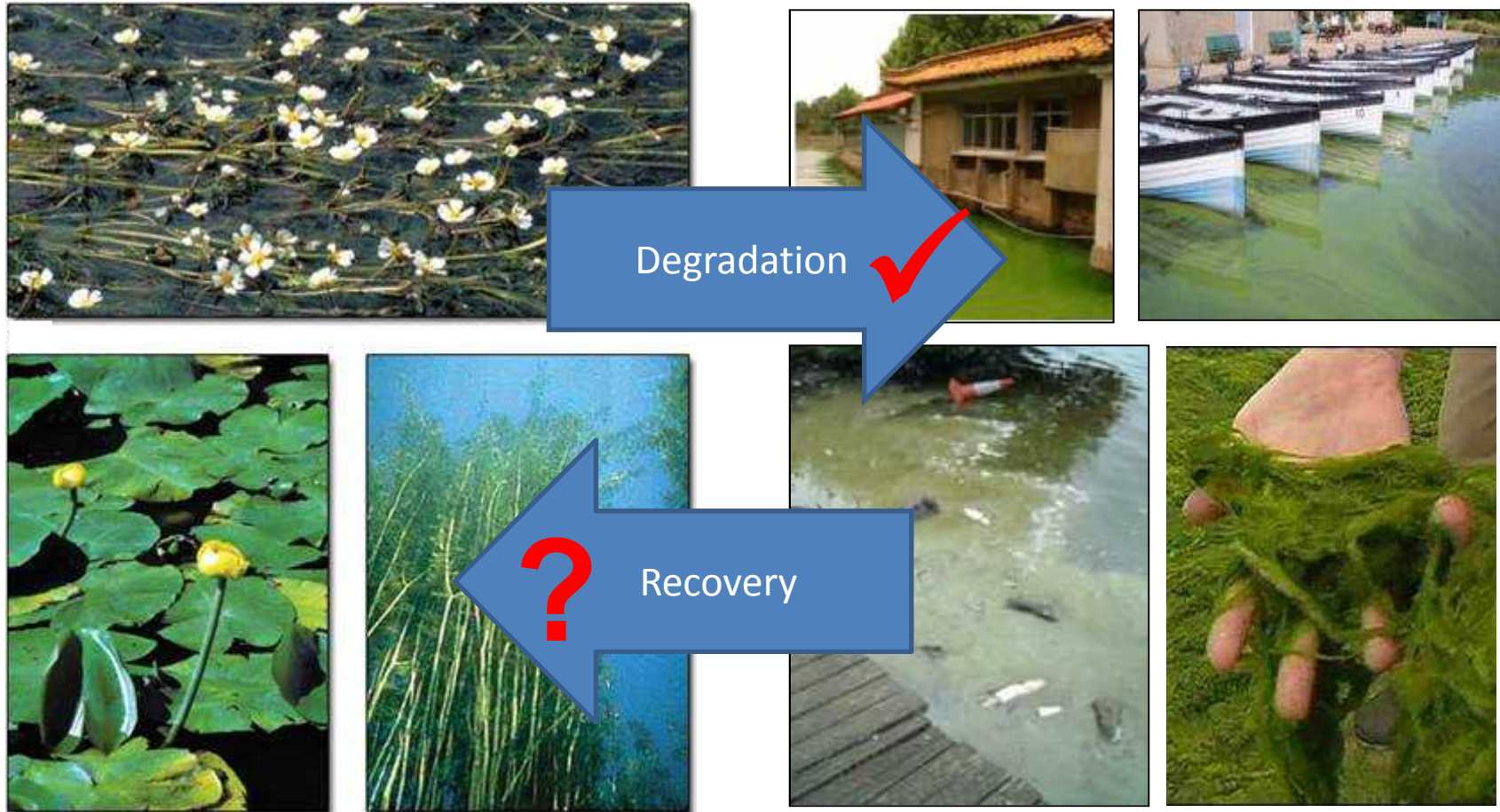
POCHARD



GREAT CRESTED NEWT



Impacts of pollution on lake water quality



Good water quality

Bad water quality

CEH's aim



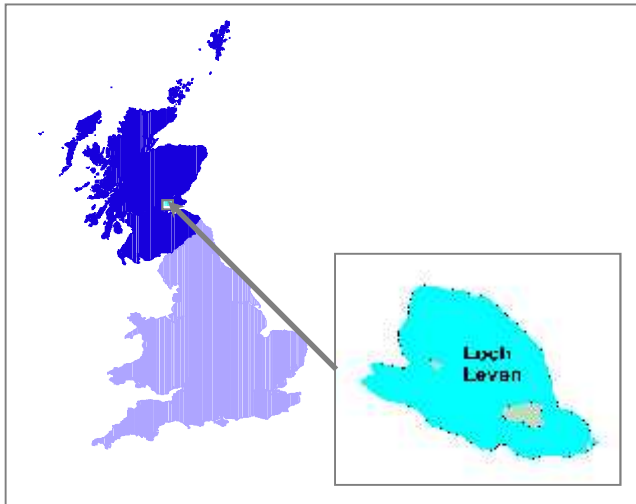
To provide the scientific evidence that helps lake managers to:

- Identify water quality problems
- Diagnose the causes (correctly!)
- Set restoration targets
- Manage the recovery process

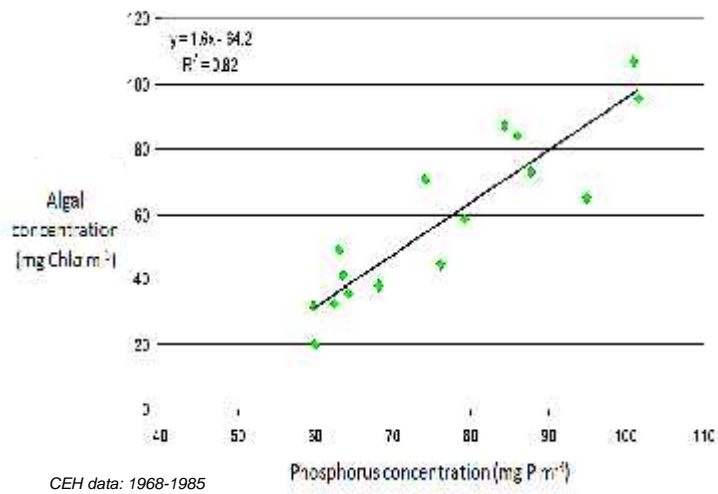
Based on a series of case studies.

Evidence based management decisions are the key to success

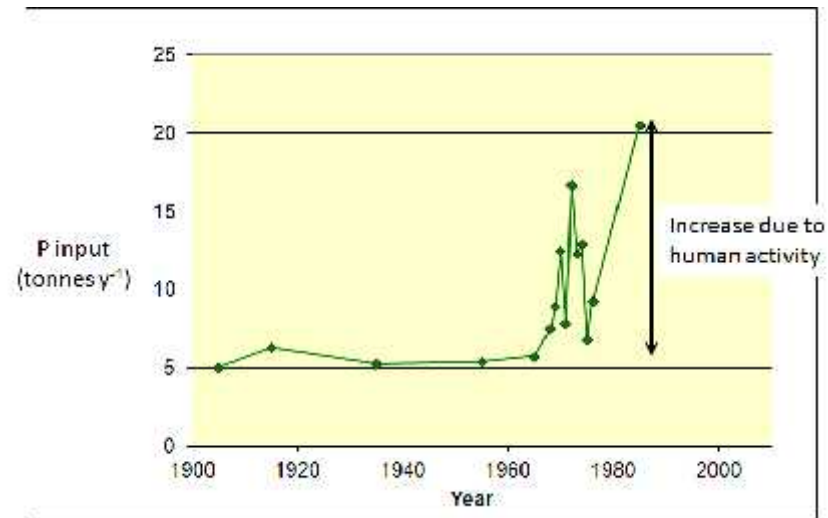
CASE STUDY 1: Loch Leven (natural recovery)



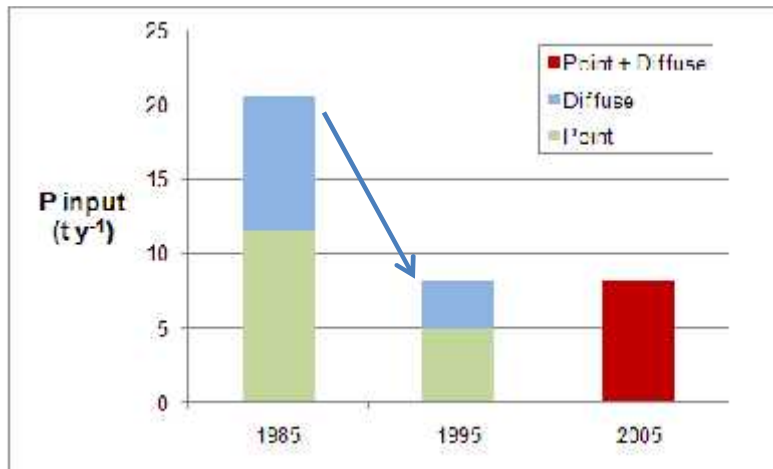
Cost of 'Scum Saturday' (1992): £1M



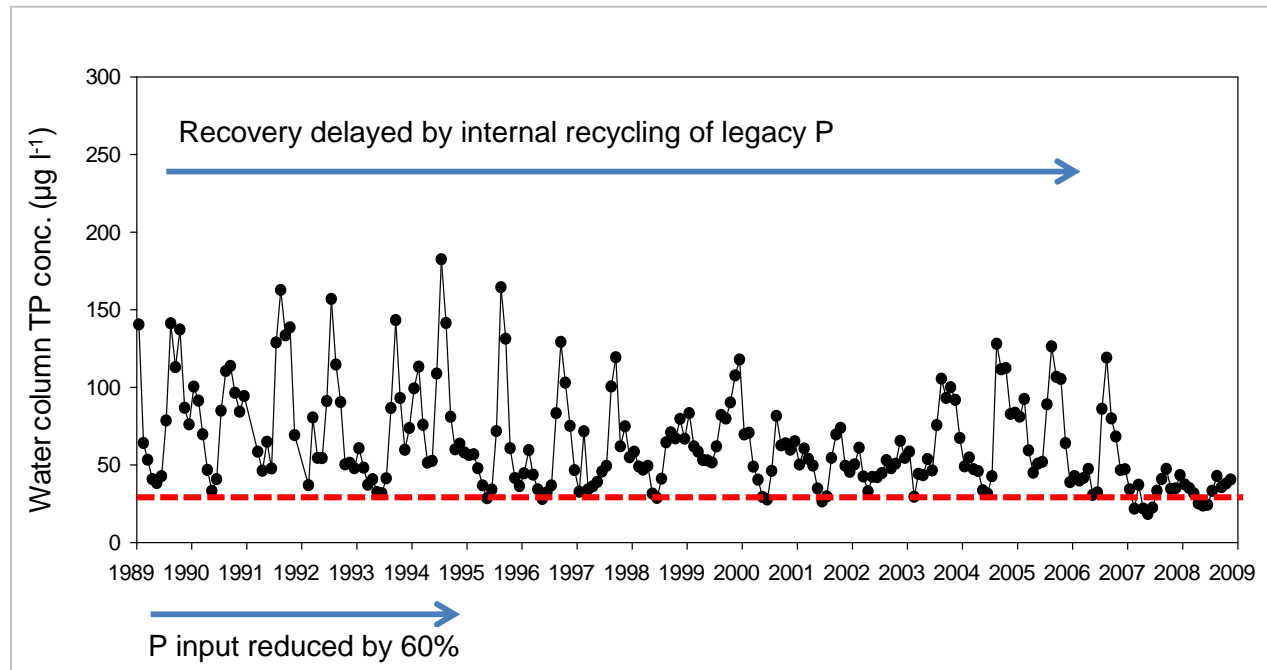
CEH data: 1968-1985



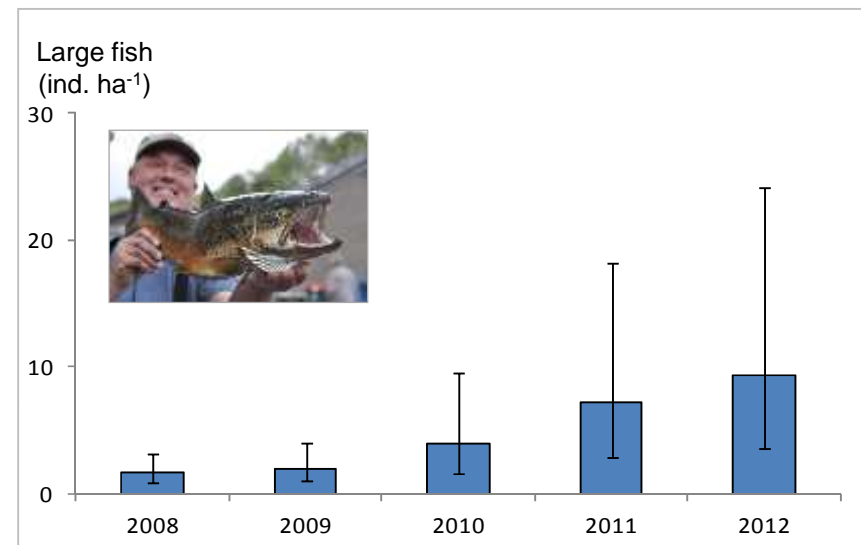
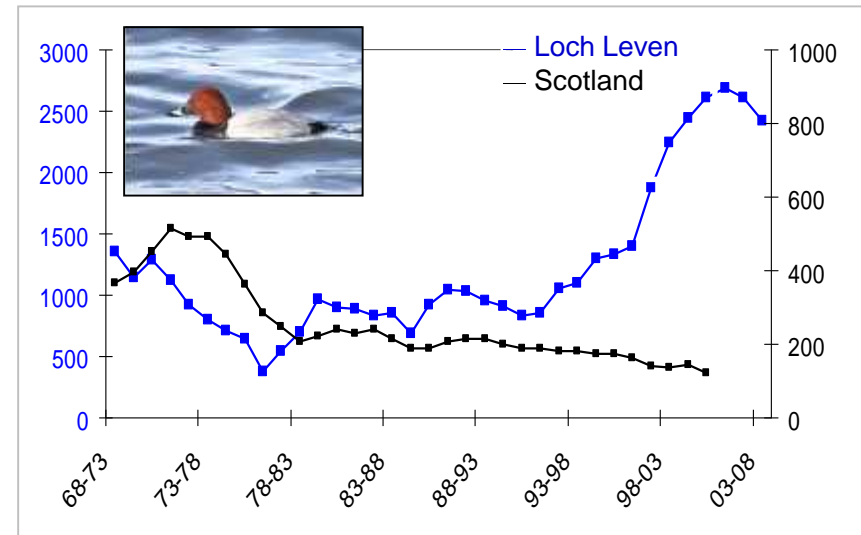
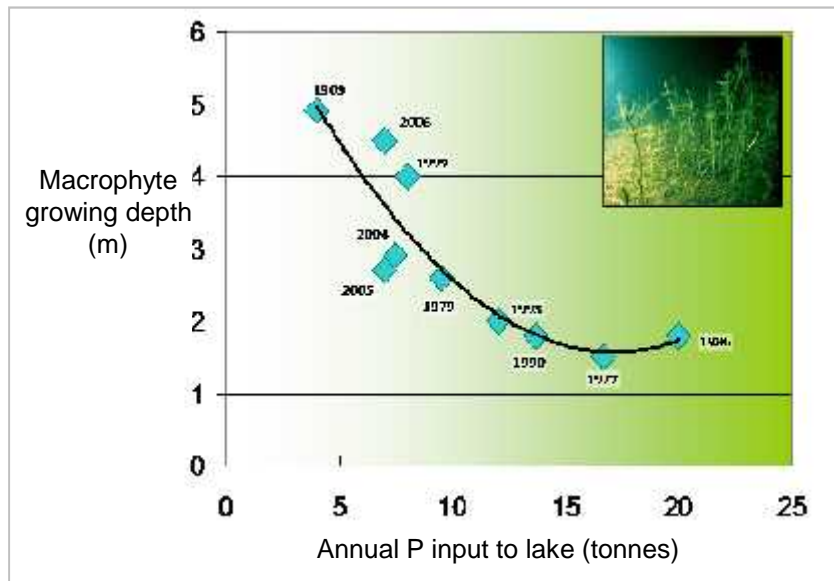
CASE STUDY 1: Loch Leven (natural recovery)



- Catchment P sources reduced by 60%
- Chemical recovery took > 15 years
- Slow recovery driven by release of legacy P from sediment stores



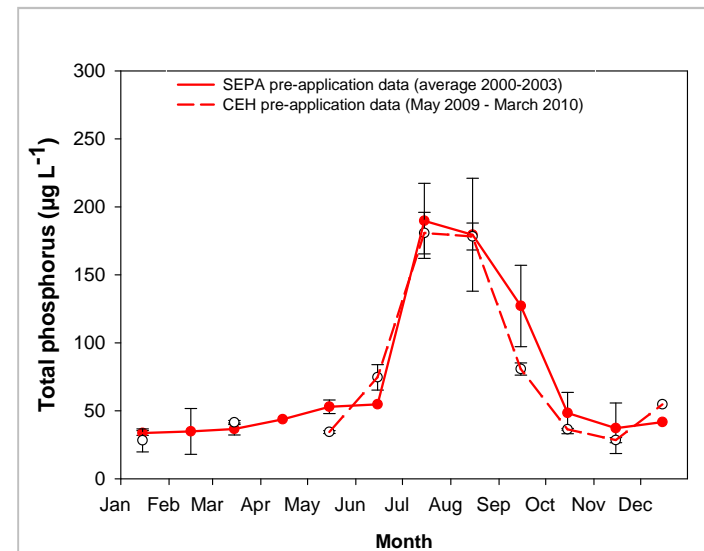
CASE STUDY 1 : Loch Leven (natural recovery)



CASE STUDY 2: Loch Flemington (managed recovery)



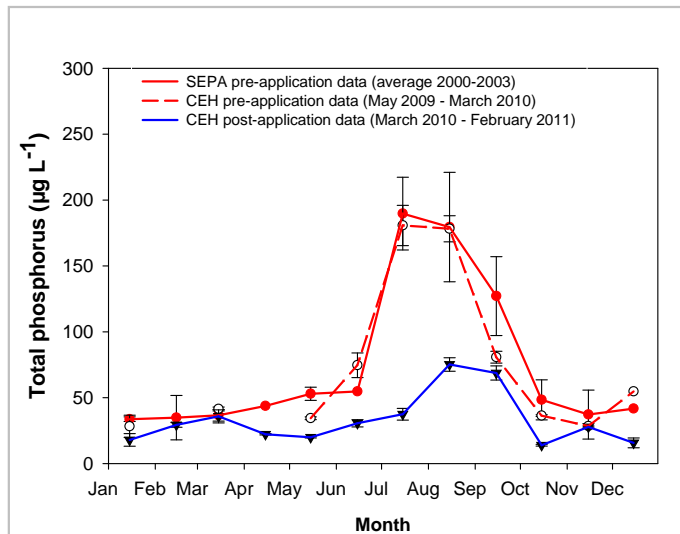
- Long history of eutrophication
- P inputs from WWTW, agriculture & pig farm
- Cyanobacterial blooms in summer
- Natural recovery unlikely; no surface outflow



CASE STUDY 2: Loch Flemington (managed recovery)



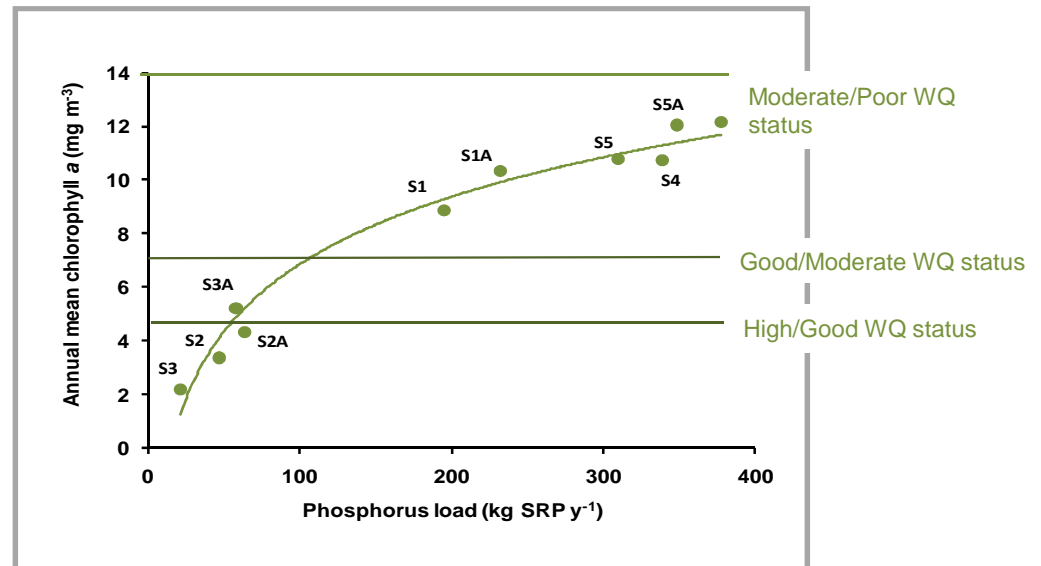
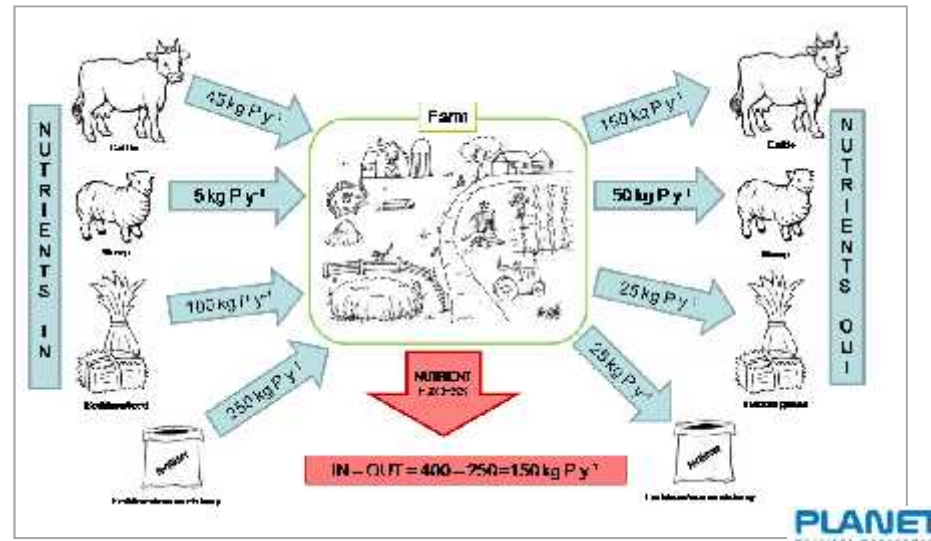
- Phoslock® controlled release of legacy P from lake sediments
- Potential to speed up chemical recovery from eutrophication demonstrated
- Ecological recovery still being monitored
- Other P binding products under development, e.g. from waste products



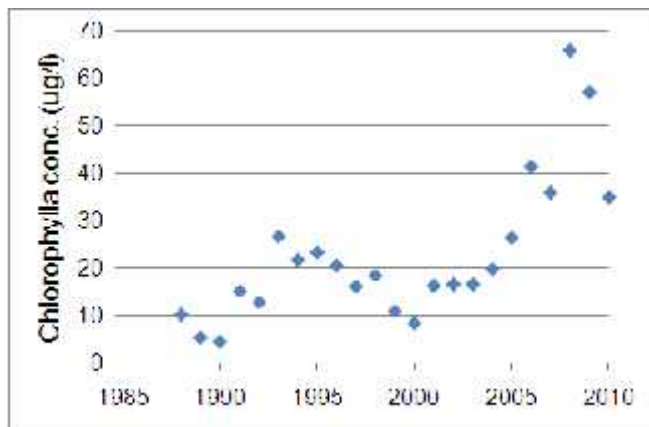
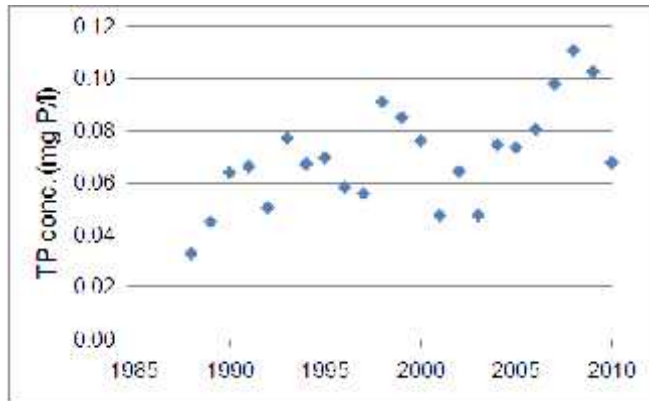
Average P concentration

Before application	74 $\mu\text{g P l}^{-1}$
After application	37 $\mu\text{g P l}^{-1}$
WFD target	32 $\mu\text{g P l}^{-1}$

CASE STUDY 3: Loweswater (stakeholder involvement)



CASE STUDY 4: Loch Fitty (extreme restoration)



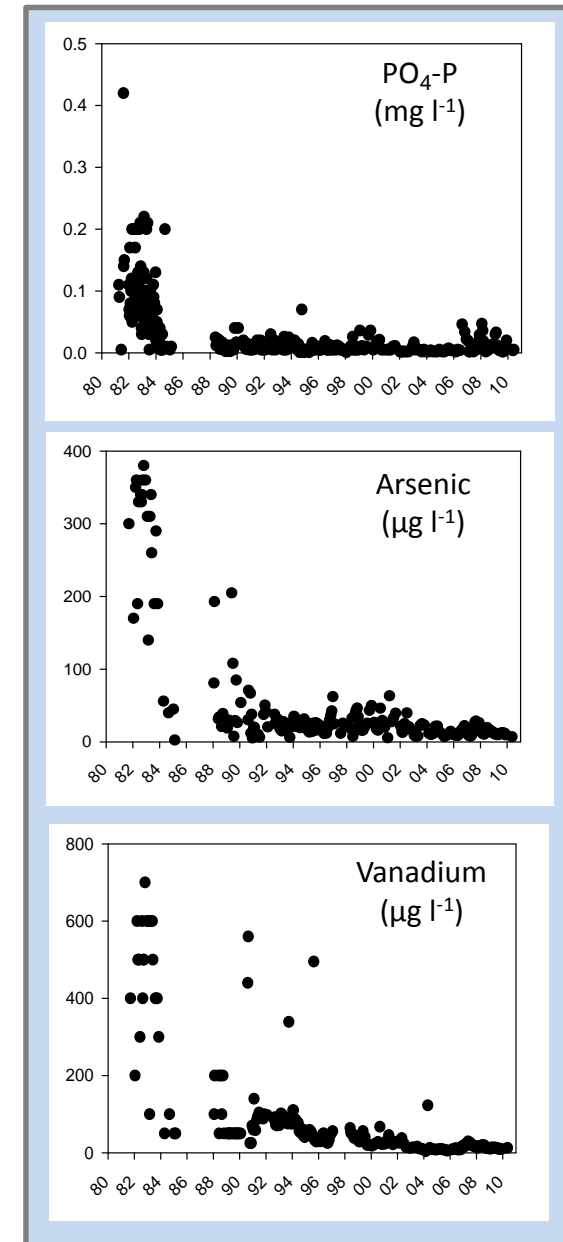
Aim: to “de-water”, extract coal, solve pollution problems and rebuild to meet water quality targets

But: causes of problem need to be properly identified and advice needs to be based on sound scientific evidence

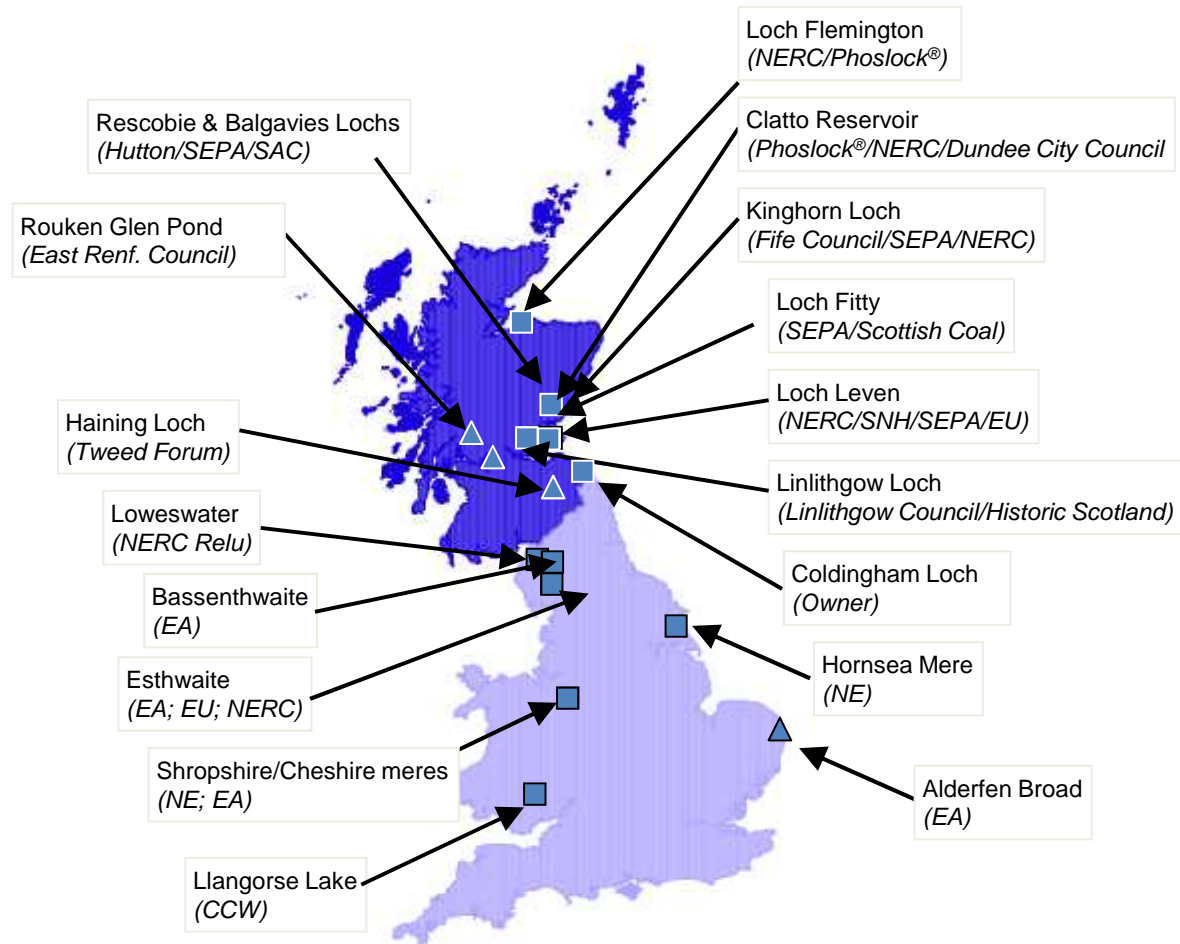
CASE STUDY 5: Kinghorn Loch (multiple pollutants)



- Polluted by red mud from an aluminium works 1950s to 1983; recovery since 1984
- Symptoms: algal blooms, fish kills, less macrophytes and macroinvertebrates
- 30 years of data enables recovery from multiple pressures to be investigated
- Initial results suggest that chemical recovery is slow (decades) and pollutant specific
- Ecological response still being investigated

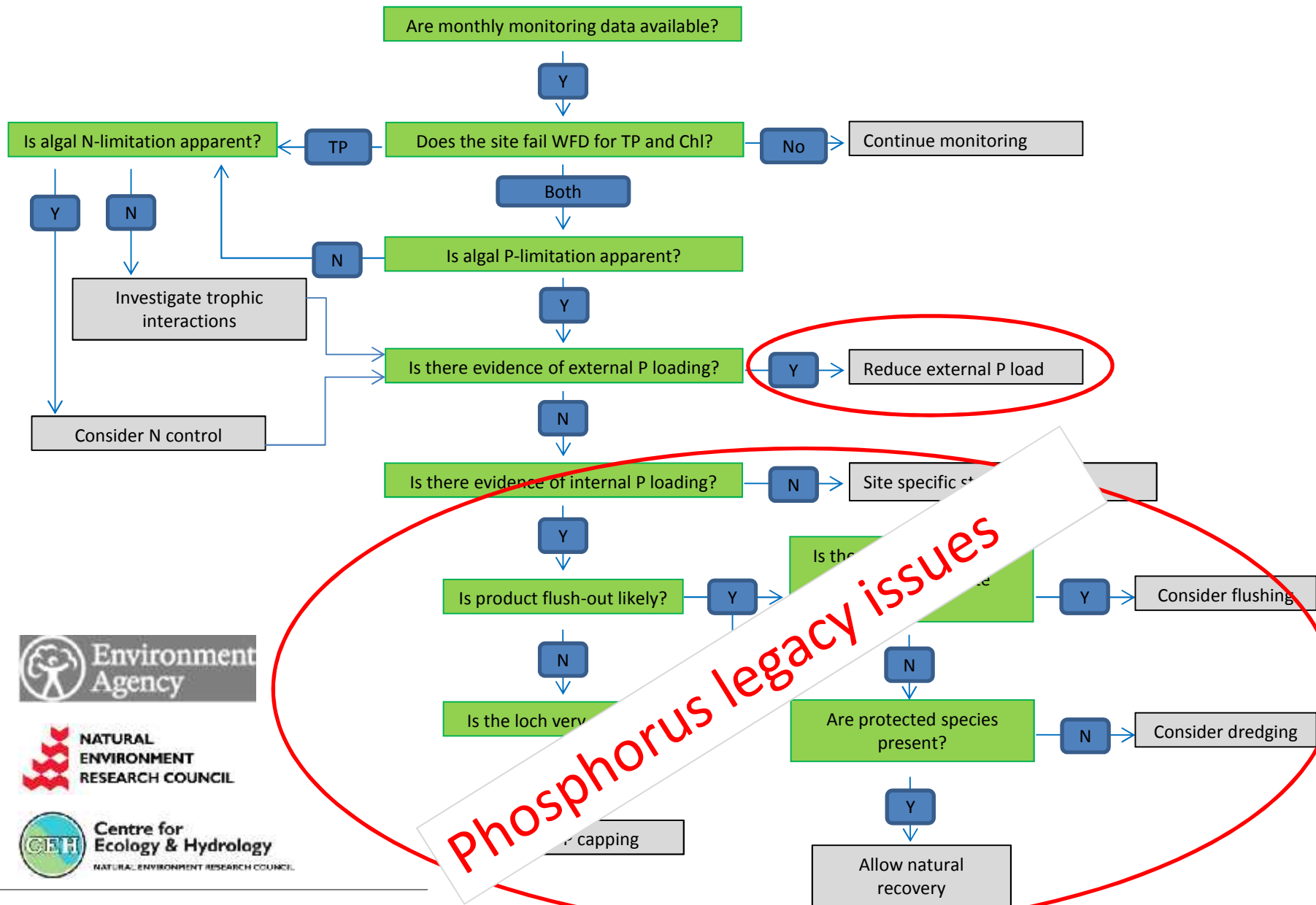


Accumulating knowledge from multiple case studies ...



... helps inform future decision making

Delivering decision support tools for water managers



Information available via the CEH website

The screenshot shows the CEH website interface. At the top left is the CEH logo and the text 'Centre for Ecology & Hydrology' and 'NATURAL ENVIRONMENT RESEARCH COUNCIL'. A search bar is located at the top right. Below the header is a navigation menu with tabs for 'HOME', 'OUR SCIENCE', 'NEWS CENTRE', 'DATA HOLDINGS', and 'PRODUCTS'. A breadcrumb trail reads 'You are here: CEH Web | Our Science | Water Programme | UK Lake Restoration'. The main content area features a large image of a lake with mountains in the background, titled 'UK Lake Restoration'. To the left of the image is a vertical sidebar menu with links: 'About Us', 'Working with Others', 'CEH Science', 'Biodiversity', 'Ecochemistry', 'Water', 'Environmental Information Data Centre', 'Publications', and 'Contact Us'. Below the image is a list of links: 'Diagnosing the problems', 'Identifying the solutions', 'Case studies', 'Datasets', and 'Publications'. To the right of the image is a 'UK Lake Restoration' section with sub-sections: 'Diagnosing the problems', 'Identifying the solutions', 'Datasets', 'Publications', and 'Freshwater lakes research presentation by CEH's Dr Bryan Spears'. Below this is a 'Case Studies' section with a list of links: 'Basenorthwold Lake', 'Clatto Reservoir', 'Coldingham Loch', 'Loch Herrington', 'Kingham Loch', 'Laweswater', 'Rimrose Mere', 'Lindrigow Loch', 'Loch Leven', 'Loweswater', and 'Windermere'. At the bottom right is a 'News' section with a link: 'Long-term Lake District research documented in journal special issue'. A paragraph of text below the image reads: 'CEH conducts multi-disciplinary research that provides process-based understanding on how lakes function. Our results help with the planning, assessment and implementation of whole-lake restoration programmes within the UK and beyond. We have been working in this area for several decades and now have a number of long term datasets that detail pressure response-recovery chains in impacted systems. By synthesising knowledge from these studies, we can help water managers to make evidence-based decisions about lake restoration programmes across the world.'

Thank you for your attention!