# THE CUMBRIAN LAKES
# WHY: MONITOR LAKES?

This project is directed through the topic Variability and Change in Water Systems (Topic 1; Objective 1.1) within the CEH Water Programme

*Derwent Water: a mesotrophic lake (Photo M.M. De Ville)*

# BECAUSE:

Lakes supply diverse ecosystem services including water supply, flood regulation and fishing and are important components of global biogeochemical cycles. Cumbria is one of the major lake districts in the UK and here the lakes define the landscape and also provide additional recreational, aesthetic and cultural services that underpin a large tourist industry. Lakes are extremely sensitive to a range of stressors operating at global, regional and local scales and are 'sentinels' of environmental change. The monitoring allows interrannual variation to be distinguished from directional change and provides insights into the causes of change. It supports the EU Water Framework Directive that provides a legal basis for the wise management of lakes. Finally, lakes are excellent systems to develop and test ecological theories and many modern approaches to ecology have been led by scientists working on lakes.

Wastwater: an oligotrophic lake (Photo I.J. Winfield)
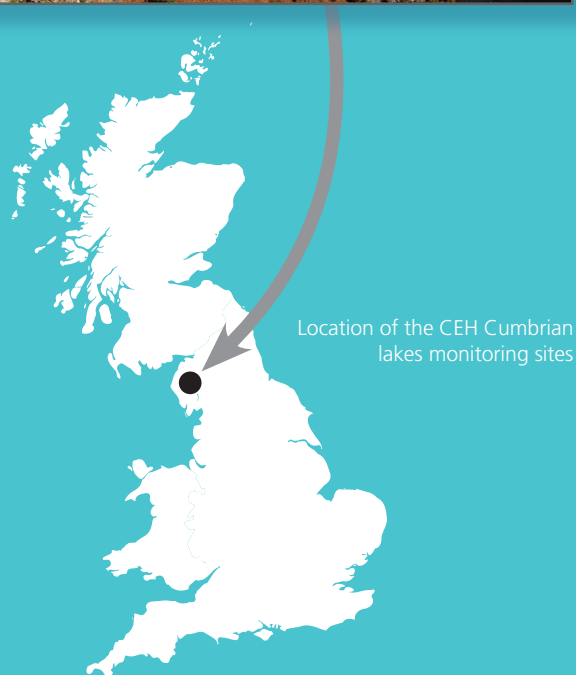
Location of the CEH Cumbrian lakes monitoring sites

**Centre for Ecology & Hydrology**
NATURAL ENVIRONMENT RESEARCH COUNCIL

enquiries@ceh.ac.uk
www.ceh.ac.uk

Blelham Tarn: a eutrophic lake *(Photo S.C. Maberly)*

# Focus on the Cumbrian Lakes

The lakes of Cumbria were formed by glaciation over 15,000 years ago, they comprise over 300 lakes ranging in size from less than 0.01 $km^2$ to England's largest natural lake, Windermere, at 15 $km^2$. The varied geology and human impact has produced lakes with a range of trophic states ranging from pristine oligotrophic lakes, such as Wastwater, to heavily impacted eutrophic lakes that will require remediation to comply with the Water Framework Directive. In addition to nutrient enrichment they are impacted by multiple stressors such as climate change, invasion of non-native species and altered fishery practices. They are home to fish of high conservation value including the UK's rarest fish, the vendace, that is now confined to Derwent Water. This combination of diversity, ecological issues and long-term data produce an unrivalled natural system to understand how lakes function and to apply that knowledge to give practical advice on lake management and remediation.

# The monitoring programme

The long-term monitoring that CEH carries out on these lakes was instigated by the Freshwater Biological Association and transferred to CEH in 1989. The dataset covers around 340 lake-years and is probably the longest, most consistent and important of any in the world. Samples have been collected every week or fortnight (currently fortnight) for a suite of physical, chemical and biological variables since 1945 for some sites and variables. Currently, the two basins of Windermere, Esthwaite Water, Blelham Tarn, Grasmere, Derwent Water and Bassenthwaite Lake are monitored. Fish are monitored annually at four basins and some records extend back to the early 1940s. In addition, high-resolution data are produced by automatic

water quality monitoring stations located on four lakes. Three of the sites contribute data to the Environmental Change Network.

# The key elements of the long term monitoring programme include:

- Fortnightly monitoring at 7 sites for temperature & oxygen profiles, Secchi depth, nutrients, pH, alkalinity, phytoplankton chlorophyll *a* & species composition, zooplankton density

- Annual fish surveys at four sites

- Detailed day and night monthly hydroacoustic surveys at two sites

- High resolution AWQMS data at minute intervals at four sites

- Broad surveys four-times a year, approximately every 5 years, at 20 sites.

# For further information:

Please contact Dr Stephen Maberly.
E-mail: scm@ceh.ac.uk or Tel: 01524 595851.


Setting a perch trap on Windermere

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# www.ceh.ac.uk