MONITORING AND CLASSIFICATION OF LAKES IN FINLAND

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Introduction

In Finland, as in other member countries of the European Union, preparations for implementing the EC Water Framework Directive (WFD) have begun. Organisation of these preparations is described in the following article by Maunula et al. (pp. 33-38). Here I briefly describe the current monitoring and classification strategies for Finnish lakes.

Lakes in Finland

In Finland, there are about 5600 lakes with surface areas larger than 0.01 km^2, about 4500 larger than 0.5 km^2 and 47 that are larger than 100 km^2 (Raatikainen & Kuusisto 1990). About 81% are lowland lakes, i.e. less than 200 metres above sea level. Mean depths are known for only for about 800 lakes. Total lake area is about 33,350 km^2 and approximation for total volume is 235.2 km^3 (Kuusisto 1992). Estimated mean depth is then 7 metres. Lakes are typically dimictic, i.e. temperature stratification of the water column occurs twice each year: in winter, under ice, and again in summer. Ice-cover in the winter lasts for three to five months. In central and eastern parts of the country, lakes typically form chains, i.e. several basins are connected to each other by straits. This complex mosaic of land and water, formed by glacial activity, is a unique feature of Finland.

Monitoring

Hydrological monitoring began as early as the 1840s, and a complete national coverage for monitoring water levels was achieved in 1911. The local pollution control of waters receiving waste-waters started in 1961 and was followed by national water quality monitoring in 1965. In the 1990s, data was collected from 71 national lake sites and *c.* 1700 sites belonging to local pollution control. In addition, regional monitoring was performed in areas where national or local sites were rare. The Finnish Lake Survey has been carried out twice, in the autumns of 1987 and 1995 (Mannio et al. 2000), as part of the Nordic lake Survey (Henriksen et al. 1998). In this survey, lakes were selected using stratified random sampling from the

entire population of lakes (surface area > 0.04 km), with unequal sampling fractions from the national lake database. All physico-chemical and hydrological data of the above-mentioned monitoring programmes are stored to common databases of the Finnish Environment Institute and 13 Regional Environmental Centres. Biological data concerning local pollution control (mainly bottom fauna, fish and phytoplankton) are stored by private laboratories that carry out the monitoring.

Eurowaternet

Monitoring network design is currently being harmonized among the member states of the European Union. In Finland, 253 lake sites were included in the so-called Eurowaternet at the beginning of 2000 (Niemi et al. 2001 a,b). The 253 sites were selected as a sub-sample from regional and local networks; all 71 national monitoring sites were included. The site types comprise the following: 50 large lakes - all lake basins with surface areas greater than 100 km^2 are included; 105 representative sites - lakes with typical water quality in the watercourse; 33 reference sites - at least 90% of the catchment area of the lake is undisturbed; 48 impact sites from the local pollution control network; 17 small lakes impacted by agriculture. The programme for monitoring acidification (170 sites) will also continue.

The total surface area of the lakes included above covers 61% of the total surface area of Finnish lakes. The proportion represented by lakes less than 10 km^2 in area is relatively small, but they occur in large numbers (15,397 lakes in Finland have surface areas between 0.1 and 10 km). Therefore the Finnish Lake Survey should be repeated regularly, e.g. every 10 years, in order to assess the state of small lakes.

There are some 20 physico-chemical variables in the monitoring programme of Eurowaternet. Phytoplankton will be sampled every three years (in July) in all of the 253 sites mentioned above. However, in 15 of these sites our intensive programme of sampling phytoplankton (samples taken six times each year) is continuing, and macroinvertebrates are sampled in autumn. Macroinvertebrates are also monitored at about 200 lake stations for local pollution control and these usually are sampled every three or five years.

Classification of Finnish lakes

An overview of the state of Finnish surface waters is based on the index of general water quality (Vuoristo 1998). Waters are divided into five classes on the basis of oxygen content, colour, turbidity, transparency, nutrients,

hygienic indicator bacteria, chlorophyll-α, algal blooms and toxic compounds. This classification describes the suitability of waters for water supply, fishing and recreational activities. According to the most recent survey, concerning the period 1994 to 1997, 38% of total lake area in Finland was classified as excellent, 42% as good, 16% as satisfactory and 4% as poor (Antikainen et al. 2000). This information is based on data from nearly 5000 lake monitoring sites covering the whole country. Nearly 93% of lakes larger than 1 km were included. In addition, rivers wider than 2 metres and the whole coastal sea area were classified.

Finnish lakes are mainly polluted by diffuse loading from agriculture or forestry, and point-source loading from the pulp and paper industry and municipal wastewaters. The improvement of the quality of waters affected particularly by wastewaters from the pulp and paper industry, which began during the 1980s, has continued. The impact of diffuse loading on water quality has accentuated whereas that of point-source loading has decreased. This can be seen particularly in small lakes and rivers affected by agriculture and forestry.

Implementing the WFD

Preparing for implementation of the WFD has started in Finland under two ministries, the Ministry of Environment and the Ministry of Agriculture and Forestry. There is also an expert group for ecological classification. The catchment area of the River Vuoksi is our pilot area for discriminating lakes into types. Our largest lake, Lake Saimaa (4380 km"), is in that area. The River Vuoksi discharges to Lake Ladoga in Russia.

We have started to test systems A and B of the WFD. We must consider the high content of humic substances in our dystrophic lakes. The mosaic complex of land and water makes it very difficult to separate different lake basins and discriminate them into types. It seems obvious that trophic levels assessed with phosphorus concentrations and dystrophy with colour are the most important factors in characterisation. Nevertheless other factors should also be taken into account when typing lakes, such as morphology (e.g. development of shoreline and size), and thermal stability - is there one period of stratification in summer (monomictic lakes) or a second period in winter (dimictic lakes).

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