Conclusion of Working Group 1:

MONITORING LAKES AND PONDS

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WHY MONITOR?

Monitoring is necessary to record long term trends in ecological changes caused by human impacts; i.e. direct impacts (e.g. fertilizers) and indirect impacts (e.g. global changes).
The following functions of lakes and fishponds were considered:

- conservation
- retention (water source, water cycling)
- recreation
- fish production

Short term monitoring enables an understanding of some key processes (e.g. development of algal blooms, phenological phenomena, competition, predator - prey relationships, occurrence of epidemics). The aim of long term monitoring is to gain documentation and understanding of long term ecological changes. Such monitoring provides data and information for a better understanding of ecosystem functioning, the structure of scientific research, anthropogenic impact, education, management and conservation. **Obvious changes in the catchment area are the signal for monitoring.**

SIZE OF THE MONITORING PROGRAMME

A realistic monitoring programme for lakes and fishponds has to be based on the capacity of the institutions involved plus additional financial support (1-2 university graduates, 1 technician, transport costs, chemical analyses, material).

For a given region the monitoring programme should cover in the case of

- **lakes**: as many as possible annually, one to five lakes frequently (sampling interval of 14-20 days), if possible lakes of different trophic status.
- **fishponds**: up to 100 localities once a year (preferably in August) and three to five localities more frequently (sampling interval 14 days)

WHAT TO MONITOR

Meteorological, physical and chemical parameters
Precipitation, evaporation, radiation - recorded continuously at one to three localities in a region; retention time (inflow, outflow), water level fluctuations, temperature - recorded continuously; transparency, pH, conductivity, alkalinity, oxygen, BOD, COD, anions, cations, nutrients (if possible nutrient budget), heavy metals, toxins (in the food chains), blue green toxins, sedimentation rate, sediment stratigraphy.

Biological parameters
Bacteria - numbers, biovolume, activity (for short and/or characteristic periods of time).
Phytoplankton - numbers, biovolume, chlorophyll a, dominant algae (group of algae), primary production (for short and/or characteristic periods of time).
Zooplankton - numbers, biomass, size-classes and/or species distribution, dominant species (or group), grazers, predators, secondary production (for short and/or characteristic periods of time).

Macrophytes - vegetation structure and cover (remote sensing using aerial photography and satellite imagery), vegetation mapping (biodiversity), biomass (nutrient and toxin content), bioindicators (care required in interpreting results - their presence might mean a lot, whilst their absence does not mean anything).

Fish - species, size, condition, numbers and biomass if possible, growth and production (for distinct periods of time), diseases.

Birds and/or other animal - species richness, dominant species, indicator species, community structure, population structure, reproduction characteristics and success.

Management practices

Drainage, littoral cutting of vegetation, shoreline management (swimming, boating), fish stocking, fertilizing, liming, external nutrient load, management of the catchment area (e.g. capacity and quality of sewage treatment plants, development of sewerage, land use, degree of industrialization).

MONITORING TECHNIQUES

The recent limnological methods are adequate. Remote sensing using satellite imagery and aerial photography should become routine tools.

New technology needed:

Automation of analytical methods, new tools in analytical organic chemistry, groundwater monitoring, limnigraphs, software for the analysis of data (e.g. geographical information systems (GIS), non - parametric methods, multivariate statistics, modelling).

INTERPRETATION OF RESULTS

The most obvious need is for integrated interpretation (holistic view). In many cases no background data (reference data) are available and therefore only trends can be discussed; e.g. improvement of water quality, correspondence of loading, nutrient content and production, relationship between the various levels of production (primary production, consumer production - first consumer level up to the top consumers). Complex parameters should be defined and explained at the beginning of the programme.

Natural fluctuations within ecosystems may be large enough to conceal long-term trends. Therefore, if monitoring is used as an "Early Warning System (or Alarm Clock)" some formal kind of presentation of the results to decision makers and politicians is necessary. Obviously, some guidelines from statisticians are needed which describe the procedure for such analyses and the presentation of the results.

In any case, database and evaluation methods have to be defined before the programme is started.

APPLICATION OF RESULTS

The need for a link between the scientific report and realization as a management measure is obvious. "Biopoliticians" or well trained civil servants should fill this gap. In any case, the results of monitoring programmes should be presented in a lucid and clear form so that they are understood and the need for implementation through management measures is recognized.

ADMINISTRATION AND COORDINATION

Until now, no monitoring programme in the sense defined for this workshop is being performed for lake and fishpond ecosystems: such data are in the best case a byproduct of other research activities. On the other hand in water supply reservoirs, water quality monitoring has a long tradition. Universities, Academies of Science, National Park administrations, ecological

management institutions for catchment areas and institutions of provincial and federal administrations should be capable of performing monitoring programmes. The coordination and financial support should be the task of one institution/agency (e.g. Ministry of Environment).
There is an urgent need to train civil servants as well as investigators in monitoring procedures and their successful application to management measures.

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