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**The European Water Framework Directive. Consequences for lake protection and management in Austria. Concepts and Approaches.**

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Details of the Water Framework Directive of the European Community relevant to lake protection and management are discussed. River basin districts and ecoregions form the basis for the classification of surface waters throughout Europe with the final goal to define and establish ecological types of water bodies. Variables used to group lakes are altitude, average depth, area, geology and others. For each established lake-type ecological reference conditions with respect to several biological organism groups shall be identified.

The Austrian approach to the problem identifies lakes important for further consideration in a first step. Lake types and biological type-specific reference conditions are then developed by using a variety of existing lake classification techniques. Ecological and limnological data and relevant references on past conditions and on the present 'status quo' of Austrian lakes are collected. These data are subjected to a deficit analysis to identify information needs and open questions for further investigations.

Finally, aims and goals of the present approach together with future management perspectives are discussed.

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Lake classification, Water Directive, Europe

### Basic concepts of the Directive relevant to lake n

The purpose of the EC-Directive is to establish a framework for the protection of all types of waters throughout the European member states. The three essential targets are:

1. To prevent further deterioration, to protect and enhance the status of aquatic ecosystems
2. To promote sustainable water use based on long-term protection of available water resources
3. To mitigate the effects of floods and draughts

It thereby contributes to the provision of sufficient supply of good quality surface water as needed for sustainable, balanced and equitable water use.

The main units for management are the River Basin Districts (RBD), defined as one or more neighbouring river basins together with their associated ground- and coastal waters, assigned by the individual member states (Article 3.1). These are divided into river basins and sub-basins. For each River basin district member states shall ensure a River Basin Management Plan for the districts lying entirely within their territory. (Article 13.1) or shall ensure co-ordination in the case of an international RBD within or beyond the Community (A 13.2 & 3).

Within each River basin district surface water body types must then be identified. Grouping and classification of lakes shall be achieved by assigning them first to European Ecoregions as defined by ILLIES (1978) followed by typifying according to altitude, depth, size, geology etc.

For each of the established lake types, type-specific reference conditions must be established, including hydromorphological and physicochemical quality elements. In addition, type-specific **biological** reference conditions must be based on the following biological elements:

- Composition, abundance and biomass of **phytoplankton**
- Composition and abundance of **other aquatic flora**
- Composition and abundance of **benthic invertebrate fauna**
- Composition, abundance and age structure of **fish fauna**

With these instruments at hand the **ecological status**, defined as the quality of the structure and functioning of aquatic ecosystems, can then be evaluated, monitored and, if necessary managed. In essence, the directive for the first time tries to implement a biological evaluation system. When this procedure must be applied to heavily modified or artificial lakes the maximum ecological potential as defined by the Directive in Annex V shall be used as reference condition.

Finally, the ecological status is classified at length in several tables for the various types of waters by normative definitions for 'High status', 'Good status' and 'Moderate status' for all the

quality elements listed above. Waters achieving a status below moderate shall be classified as poor or bad.

Lakes to be investigated shall include all those economically or recreationally important.

**Approaches used to establish lake-types in Austria**

From an inventory of all freshwater lakes in Austria, all natural and artificial lakes larger than 0.5 km<sup>2</sup> have been selected for analysis. Basic data for these 80 lakes, including morphometry, hydrology and water-chemistry etc., were then collected, summarised in a data-bank and continuously updated as data became available.

The Water Directive identifies 25 ecoregions for Europe. The Austrian state shares six of these ecoregions. All of them are relevant for running water classification (FINK *et al.* 2000, WIMMER & CHOVANEC 2000). For lakes, only three regions are essential (Fig. 1). The Alps harbour 80% of the 80 lakes, 12.5% are located in the Central highlands, while only 7.5% are in the Hungarian Lowland region. If shallow ponds of the lowlands and high alpine, hydro-power storage reservoirs are excluded from the data-base (reduced data set), the distribution of the remaining 61 lakes within ecoregions is not significantly altered.

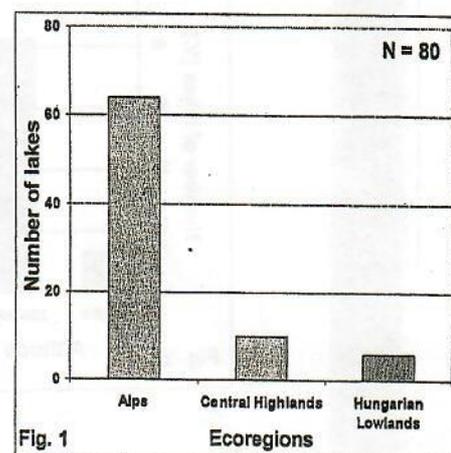


Fig. 1

When lakes are arranged according to geology about 44% are calcareous, 30% are siliceous and 26% lie within tertiary or quaternary sediments (Fig. 2). These geological features differentiate lakes according to their basic water-chemistry, their nutrient availability and environmental susceptibility.

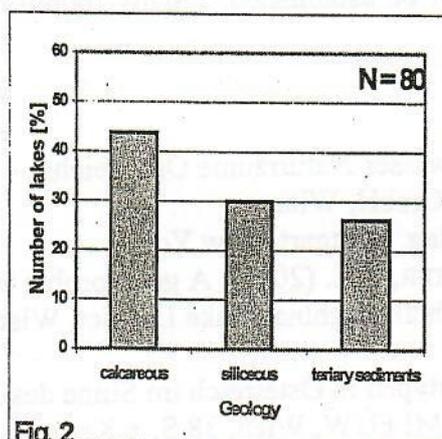


Fig. 2

Because the Austrian landscape is very mountainous, lakes are arranged along a continuum of altitudes from lowlands to high alpine regions above the tree-line. When lakes are grouped into several size categories of altitude largely following terrestrial vegetation landscapes, 44% of all lakes fall into the 200 to 600 m zone (in reality, 400-600 m because of no relevant lakes in the 200 to 400 m region). The altitude between 600 and 1000 m contain another 30%, while 23% of all lakes are at heights above 1000m. Lakes of the Austrian lowlands larger than 0.5 km<sup>2</sup> comprise about 6% only (Fig. 3)

Altitud effects control various limnological features such as temperature regime, the amount and duration of ice-cover, mixing events etc.

Adapting the concept of lake order (Riera *et al.* 2000) to the Austrian situation arranges the lakes as shown in Fig.4. Most lakes (24%) belong to order 4, followed by orders 3 (19%), 2 (16%), 1(15%) and 5 (14%). Lakes of an order >5 are rare (1% or less) as well as lakes which are spring-fed (order 0). About 9% of the lakes are completely dependent on groundwater having no surface in- or outlet. These lakes were assigned lake order -1.

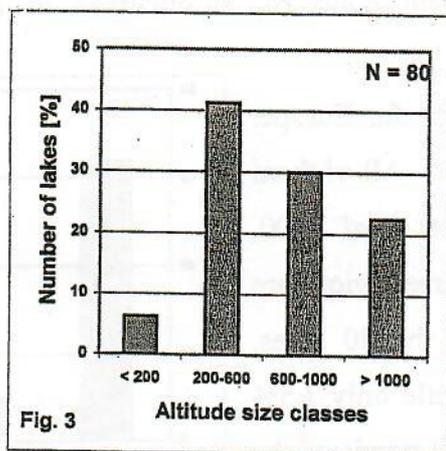


Fig. 3

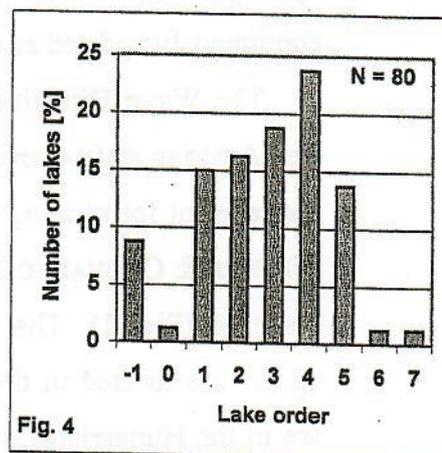


Fig. 4

The next step in establishing ecological lake types is to test whether the preliminary classification of the water bodies can be assigned to specific differences within the individual groups of organisms mentioned above. Type-specific reference conditions for each lake type, degradation level and group of organism must then be established. Finally monitoring programs must be developed, established and implemented.

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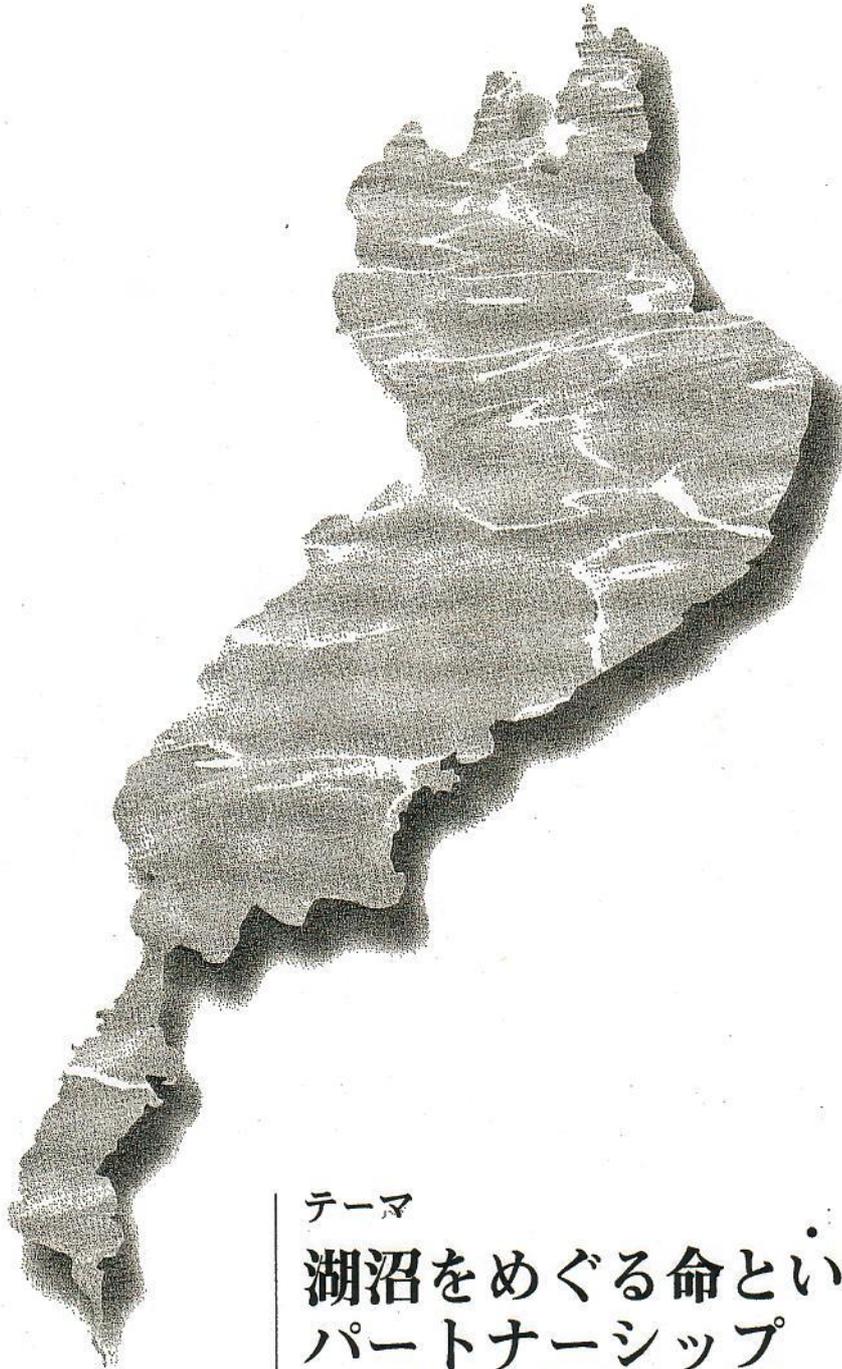
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