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Water Framework Directive, European Standards and the Assessment of Macrophytes in Lakes: A Methodology for Scientific and Practical Application

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Macrophytes are not only a source of organic carbon and of oxygen for aquatic ecosystems, they are also the most important source of structure in the littoral of still waters. Respecting this fact, the Water Framework Directive (WFD-EU) has made the survey of macrophytes obligatory: they are one of the four biological elements needed for assessing the ecological status of surface waters. The method proposed here is adapted to the needs of aquatic plant surveys in lakes under practical conditions, e.g. for the monitoring of still waters under the regime of the WFD-EU or as a basis for CEN (= European) Standards. As the method incorporates all basic prerequisites regarding accuracy and quality, it can be applied to scientific problems as well.

JANAUER G. A., 2002: Wasserrahmen-Richtlinie, europäische Standards und der Beitrag von Makrophyten in Gewässern: Eine Methode für wissenschaftliche und praktische Anwendung.
Makrophyten sind nicht nur eine Quelle von organischem Kohlenstoff und Sauerstoff im aquatischen Ökosystem. Sie sind auch die wichtigsten Strukturelemente im Litoral von Stillgewässern. Dies respektierend wurde die Untersuchung der Makrophyten als eines von vier „biologischen Elementen" verpflichtend für die Erfassung des ökologischen Status von Oberflächengewässern unter der Wasser-Rahmenrichtlinie der EU (WRRL-EU). Die vorgestellte Methode ist an die Anforderungen zur quantitativen Erfassung der aquatischen Vegetation in Seen unter Praxisbedingungen angepasst, wie sie z. B. beim künftigen Monitoring nach der WRRL-EU zu erwarten sind oder für CEN (= Europäische) Standards gelten. Da die Methode alle Voraussetzungen bezüglich Genauigkeit und Maßnahmen zur Qualitätssicherung erfüllt, sind die so gewonnenen Daten auch einer wissenschaftlichen Auswertung zugänglich.

Keywords: aquatic vegetation, macrophytes, methodology, lakes, plant mass, water framework directive

Introduction

This publication proposes a methodology for the assessment of macrophytes in lakes. It is based on the experience of scientific teams (MELZER et al. 1986, PALL, unpublished data), on published expertise of practitioners (ATV-DVWK, 2001, SKRIVER, 2001) and on the author's personal experience. The method follows the general outlines given by the Austrian Standard "Guidelines for the ecological survey and evaluation of stagnant surface waters" (ÖNORM, 2001). The method is quantifying within the limits of accuracy reached by estimates of plant mass ("Pflanzenmenge", KOHLER et al. 1971) for rivers, and by MELZER et al. (1986) for lakes, and it was successfully applied under scientific and practical conditions over more than 30 years. Resulting data sets and spatial accuracy are superior to that of earlier surveys which were only based on small scale maps with the approximate outline of plant stands. The method is suited for surveying still water bodies of any size, if a full length survey of the shoreline and the littoral is not needed.

Methodology

The method uses belt transects of 2–5 m width. The belt transects shall protrude into the lake at right angles with respect to the shore line. All transects must be of the same width.

The number of belt transects to be surveyed around a still water body depends on the spatial arrangement of the aquatic plant stands, and on the adjacent land use types (e.g. agricultural land, shrub, meadows, settlements, recreation areas, mountain slopes etc.). At least four transects shall be surveyed for each land use type present around a lake, even if species number saturation (SNS = the number of species does not increase in an additional transect) is reached with a smaller number of transects. This assures a minimum sample size for statistical treatment of the field data. The number of transects must be increased if the species number is increasing when surveying another transect in the same shore reach, or if the abundance of at least one species varies by more than 1 (one) level in the estimate scale (see below).

If identical land use types occur several times around a lake pooling of transect data can reduce the working effort. Four transects – or the number necessary for reaching SNS – must be surveyed in the first shore reach. In other shore reaches with the same type of land use only one transect needs to be surveyed, if SNS is still met. Otherwise, e.g. if at least one new species occurs or one species is missing, the original approach (4 transects minimum) must be followed.

Within the belt transect depth zones can be differentiated, if appropriate (usually 0–1 m, 1–2 m, 2–4 m, 4–8 m, and deeper than 8 m). This may contribute to discerning human impact e.g. from sport boating, which has the greatest impact in the upper layers, or from man-induced increase in turbidity, which affects the lower part of the littoral.

For the full length of the belt transect, regarding each depth zone, or any other subdivision of the transect, Plant Mass Estimates (PME = "Pflanzenmenge" – which is not synonymous to "biomass" [= $kg.m^{-2}$], KOHLER et al. 1971, KOHLER and JANAUER 1995) are made for each species occurring there. These estimates form the field data set for each transect or its subdivisions.

Surveys are made by boat, unless the whole lake can be waded (about 1.0 m maximum depth; refer strictly to all relevant safety regulations). The use of a hydroscope is recommended. Sunglasses with polarising coating reduce reflexes at the water surface, and may so enhance visibility to a great extent.

To assess the PME of each species the use of a rake for getting the plant material up to the surface has been suggested by several sources (e.g. ATV-DVWK 2001): this is only recommend if the water is very clear. Even in water depths less than 3.5 m (about the deepest a rake with extended shaft can be operated with high efficiency) "raking" will result in (i) missing smaller species and those intermingled in deeper layers of plant stands and invisible from the surface and (ii) in wrong estimates of the plant mass (personal experience with test persons, unpublished). In water depths beyond 4 m depth, and in turbid conditions, a greater rate of misinterpretation and failing species recognition must be expected. Moreover, the time spent to reach species saturation by raking can be considerably longer than using diving techniques (see below).

For the assessment of PME diving equipment is strongly recommended. In water bodies not deeper than 2 m wetsuit, mask and snorkel are sufficient. In deeper lakes SCUBA

equipment (trained and certified personnel only!) is necessary. The use of SCUBA and submersible note pads minimises the need to re-surface. Depth marks are also easily made. Belt transects of 2 to 5 m width can be viewed easily in one lap; wider transects need more laps in succession, which is more time consuming.

Estimating PME: The vertical development of aquatic plant stands is different in seasonal periods, depending on habitat conditions. It is of indicative value, and it can not be neglected (KOHLER et al. 1971, NIEMANN 1980). Therefore the estimates are not based on the area (% cover) but on the three-dimensional development of the species. Five levels are distinguished (English terminology follows HOLMES and WHITTON 1975a,b: 1 = rare; 2 = occasional; 3 = frequent; 4 = abundant; 5 = very abundant, German terminology see KOHLER *et al.* 1971, MELZER *et al.* 1986, KOHLER and JANAUER 1995, SCHNEIDER 2000).

Based on the field survey data Standard Diagrams for Relative Plant Mass (a metric for dominance, but superior to frequency), Mean Mass Index (a metric for the average abundance of each species) and the sum of PMEs may be calculated (see KOHLER and JANAUER 1995, PALL and JANAUER 1995, JANAUER *et al.* 1993).

With regard to the Water Framework Directive/EU (WFD) the preconditions for describing Reference Conditions, and the aquatic plant assemblage in Representative Sites (which represent different parts of the lake littoral, as defined by different land use types in the adjacent shore reaches) are met. According to the WFD species composition and abundance of species are the basic parameters for the assessment of the Ecological Status. The concise species list and the Plant Mass Estimate meet these preconditions. However, based on the same numerical information (the field data sets) one can produce metrics for a more detailed picture of the aquatic vegetation (dominance: Relative Plant Mass; distribution types and interpretation of rareness: Mean Mass Index; KOHLER and JANAUER 1995). Species with conservational value (e.g. Red List Species, species with local/regional/national importance), or species threatened by extinction are subject of the WFD, as other EU-regulations like FFH Directive and Natura 2000 are also relevant. Information on the assessment of the Ecological Status according to the WFD will be presented after first experiences with new field data sets.

For getting an even more detailed picture, it is recommended to use contiguous survey units around the whole lake shore according to the experience of MELZER et al. (1986), which is based on KOHLER's PMEs. This type of aquatic plant survey in lakes is more time consuming and is not recommended for the routine survey within the WFD assessment of Ecological Status. Yet, each lake littoral should be assessed in total at least once every ten years or whenever marked changes in environmental conditions (e.g. changes in macrophyte composition noticed during the monitoring) have occurred.

Conclusion

Macrophytes are the prime structural elements in the littoral of lakes. Taking into account this functional aspect the Water Framework Directive (WFD-EU) introduced species and abundance related data on macrophytes into the assessment of the ecological status of surface waters (other biological indicators are fish, benthic invertebrates, phytoplankton, and benthic algae). Just as well macrophytes and their habitat conditions are subject to scientific studies. Methods suited for the quick and accurate assessment of the aquatic vegetation are therefore an urgent practical and scientific need. The method described above is both applicable to practical and scientific surveys of still waters. It quan-

tifies the species composition and abundance in belt transects, which mirror the environmental conditions in lake shore reaches, which in turn characterise different land use types in the adjacent landscape. As the assessment of the abundance of species is based on KOHLER's approach specially developed for aquatic macrophytes, it avoids shortcomings of other methods which estimate only area and/or follow pure plant sociological procedures. As the belt-transect method is time-efficient it may form the basis of standard procedures to be developed for the European level by CEN, the European Standard Organisation. With minor adaptations like the increase of the frequency of the transects it can be used for scientific purposes, too, which could form a background for better understanding distribution and growth strategies of the aquatic vegetation of lakes.

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