SLOVENSKI STANDARD
SIST EN 16698:2016

01-februar-2016

Kakovost vode - Navodilo za kvantitativno in kvalitativno vzorčenje fitoplanktona v celinskih vodah

Water quality - Guidance on quantitative and qualitative sampling of phytoplankton from inland waters

Wasserbeschaffenheit - Anleitung für die quantitative und qualitative Probenahme von Phytoplankton aus Binnengewässern

Qualité de l'eau - Lignes directrices sur l'échantillonnage quantitatif et qualitatif du phytoplancton dans les eaux intérieures

Ta slovenski standard je istoveten z: **EN 16698:2015**

ICS:

13.060.10	Voda iz naravnih virov	Water of natural resources
13.060.70	Preiskava bioloških lastnosti vode	Examination of biological properties of water

SIST EN 16698:2016 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16698

October 2015

ICS 13.060.70

English Version

Water quality - Guidance on quantitative and qualitative sampling of phytoplankton from inland waters

Qualité de l'eau - Lignes directrices sur l'échantillonnage quantitatif et qualitatif du phytoplancton dans les eaux intérieures

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COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. EN 16698:2015 E

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European foreword

This document (EN 16698:2015) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2016, and conflicting national standards shall be withdrawn at the latest by April 2016.

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Introduction

WARNING —Working in or around water is inherently dangerous, Persons using this European standard should be familiar with usual field and laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory guidelines.

IMPORTANT — It is absolutely essential that tests conducted according to this European Standard be carried out by suitably trained staff.

Series of phytoplankton samples provide information on the taxonomic composition as well as the spatial occurrence of the individual taxa and their relative abundances. They allow the calculation of the biomass of the individual taxa as well as for the phytoplankton assemblage as a whole.

For the purpose of limnological investigations like monitoring and status assessment of surface waters representative phytoplankton samples are necessary. Therefore suitable sampling methods and monitoring strategies are needed depending on the objectives of the investigation and the given natural conditions.

1 Scope

This European Standard specifies procedures for phytoplankton sampling in inland waters and describes methods of sampling techniques for phytoplankton in inland waters (e.g. rivers and channels, or lakes, ponds, reservoirs and other artificial water bodies, respectively).

This European Standard gives guidance for sampling of phytoplankton for qualitative and quantitative limnological investigations and monitoring of water quality, e.g. ecological status.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15204, *Water quality — Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl technique)*

EN ISO 5814, *Water quality — Determination of dissolved oxygen — Electrochemical probe method (ISO 5814)*

EN ISO 7027, *Water quality — Determination of turbidity (ISO 7027)*

EN ISO 10523, *Water quality — Determination of pH (ISO 10523)*

ISO 17289, *Water quality — Determination of dissolved oxygen — Optical sensor method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
deep chlorophyll maximum
DCM
local chlorophyll maximum below the epilimnion where the maximum chlorophyll concentration is at least 1,5 times higher than the average chlorophyll concentration measured in the epilimnion

3.2
depth gradient
parameter to distinguish between polymictic and di- or monomictic lakes as a measure for the mixing intensity of a water body calculated as the quotient of maximum depth and theoretical epilimnion depth

Note 1 to entry: See Annex C.

Note 2 to entry: Values > 1,5 indicate a thermally stable stratified lake. For further details see Annex C and [18].

3.3
dimictic lake
lake with uniform water temperature and holomictic conditions twice a year: during autumn (before ice cover) and during spring (after ice cover)

3.4
epilimnion
zone of the water body between surface and thermocline in which the water temperature and density is approximately uniform, showing a temperature gradient of < 1 °C/m

3.5
euphotic zone
zone of the water body where light intensity is sufficient for photosynthetic production

Note 1 to entry: The euphotic zone is the layer with more than 1 % of incident light intensity of subsurface light (see [13]). The euphotic depth is approximately 2,5 times Secchi depth [1], with exception of humic lakes (0,8 to 2,1 times Secchi depth) [13].

3.6
holomictic lake
lake that shows complete mixing of the water body every year

3.7
integral sampler
water sampler which provides a representative sample of a predefined continuous water column

3.8
mean depth
depth value obtained from dividing a lake's volume by its surface area

Note 1 to entry: To obtain the mean depth in metres (m), the lake's volume should be specified in cubic metres (m^3) and the surface area in square meters (m^2).

3.9
metalimnion
thermocline
water zone between epi- and hypolimnion with the greatest vertical density gradient caused by temperature gradients > 1 °C/m

3.10
complete mixing
full mixing of the whole water body, indicated by uniform temperature along the vertical axis

Note 1 to entry: Complete mixing of water is only possible when the density in the whole water column is equal which usually means the temperature is the same in every depth.

3.11
monomictic lake
lake with uniform water temperature and holomictic conditions from autumn to spring (no ice cover in winter) during which the water body is completely mixed

3.12
polymictic lake
lake with more than two circulation phases per year comprising the whole water body (depth gradient ≤ 1,5)

Note 1 to entry: See also [17].

3.13
shallow lake
in this European Standard shallow lakes are defined as polymictic lakes (3.12) – based on the depth gradient - independent of their mean or maximum depth

3.14
secchi depth
visibility through the water column (transparency measured using a white plate lowered into the water)

3.15
stratification
state of a water body during which a vertical density gradient in the water column (caused by a gradient of temperature or dissolved matter concentration) prevents its complete mixing

4 Principles of phytoplankton sampling

4.1 General

Phytoplankton samples are collected and preserved for later microscopic investigation. Phytoplankton samples are most often collected in lakes, reservoirs or ponds and in larger rivers where residence time and light conditions enable phytoplankton growth. The following sections provide detailed recommendations on when and where samples should be taken to enable a more or less detailed study of phytoplankton in any location.

Species composition, number of individuals and biomass of phytoplankton vary throughout the seasons as well as spatially across water bodies and within the water column. When setting up a sampling program it is important to be aware of this variability and adjust the sampling programmes accordingly. There is a range of recognized equipment and procedures used for the collection of phytoplankton samples and these can be selected according to the precise requirements of any particular study or sampling programme.

Most sampling procedures are based on the collection of water samples which contain phytoplankton in its natural composition and abundances. Preservation and subsequent sedimentation of the phytoplankton enable the investigation according to Utermöhl (EN 15204). This allows taxa identification and quantitative assessment of abundance and biomass. Samples taken using a plankton net concentrate the phytoplankton, increasing the likelihood of picking up rare taxa, but cannot be used for quantitative assessment of abundance.

Subsidiary information could include physical data such as water depth, temperature and oxygen profiles, assessment of euphotic zone and chemical determinants such as chlorophyll and nutrient concentrations. The frequency, location and type of samples collected to analyse phytoplankton in lakes and rivers should be determined by the requirements of the monitoring programme or study for which they are required.

Generally, it is distinguished between sampling in lakes and sampling in rivers. In rivers which are assumed to be vertically completely mixed, it is sufficient to take a sample from the main flow.

In lakes the mixed water layer or the zone in which phytoplankton is produced (euphotic zone) should be sampled. Generally, a vertical mixed sample should be taken. This is possible either with an integral sampler or by mixing of sub-samples from all depths of the mixed or euphotic water column.

In clear lakes (euphotic depth > epilimnetic depth) a mixed sample should be taken from the euphotic zone. In turbid and humic lakes (euphotic depth < epilimnetic depth) it is adequate to take the sample from the mixed zone (epilimnion in stable stratified lakes, whole water column in polymictic lakes). The spatial extent of these zones is determined by recording Secchi depth and depth profiles of water temperature. For ambiguous temperature-depth profiles also other parameters such as dissolved oxygen and pH should be measured. It is recommended to determine the vertical distribution of the phytoplankton by measuring chlorophyll-a using a fluorescence probe in order to define the sampling zone.

Samples for phytoplankton and other parameters (e.g. chlorophyll-a and nutrients) should be taken at the same time.

The number of samples, sampling depth range and location of sample sites should be determined by the purpose of the study or sampling programme.

4.2 Selection of sampling sites

4.2.1 General

The location(s) where samples are taken should take into account the spatial variability of phytoplankton.

4.2.2 Sampling sites in rivers and streams

Sampling should ideally take place in the main flow of the river. Samples may be taken from a bridge or boat if it is not safe to enter the river or obtain access to the appropriate location from the river bank.

If samples are collected from engineered stretches, for example those with reinforced banking, they should be representative of the river section as a whole, including the more natural areas. For this reason it is recommended that the width of the river at the sampling point is not larger than twice the mean width in more natural sections, and that the average cross-sectional depth does not exceed the depth of the natural section by more than one third. If lateral heterogeneity is known or expected, several samples along a cross section should be taken and either be mixed or analysed separately.

Samples should ideally be collected from a completely mixed water column. This can be confirmed by vertical measurements of temperature and, whenever possible, chlorophyll fluorescence. River sections which are not completely mixed, such as harbors and impoundments, should be sampled using methods suitable for lakes (see 4.2.3 and 6.3).

4.2.3 Sampling sites in lakes

The spatial distribution of phytoplankton in lakes can be very variable, with vertical variation typically greater than horizontal variation. Wherever possible, phytoplankton samples should be taken from the open water as this enables consideration to be given to the variation in abundance and species composition within the water column; integrated samples can be taken through a known water depth or discrete samples can be taken at intervals through the water column. Only open water sampling locations allow to gather temperature and oxygen profile data to determine the degree of stratification and position of the thermocline. Additionally, to indicate variability in nutrient or chlorophyll concentrations in the whole water column, samples for chemical analysis can be collected.

The location of open water sampling sites are depending on the bathymetry of the lake. Generally, more sampling stations are recommended for elongated fjord lakes and reservoirs (riverine/transitional/lacustrine zone [4]), for lakes with several basins separated by shallow sills, and for lakes with isolated large bays [2], [13], [14]. For lakes with a homogenous morphology, at least one sample should normally be taken at the bathymetric deepest point (z_{max}) as this allows the most complete profile of probe data to be gathered; the centre of the lake may also be used, although this may not be the deepest point. The position of sampling points should be recorded (e.g. by GPS) and should preferably be used again for successive surveys.

NOTE It is well known that in lakes patchiness (small-scale spatial variability of the phytoplankton abundance and/or species composition) can occur. For some monitoring purposes it is advisable to integrate this variability by pooling samples taken from different points. Pooling reduces error in the characterization of the lake phytoplankton community without increasing the number of samples that need to be processed; however information about the horizontal patchiness is necessarily lost [4].

In lakes that are segmented by a distinctive ground topography, samples generally should be taken in each basin and treated separately, i.e. they should not be pooled. If the objective is to investigate the patchiness, all samples should be taken using the same sampling method.

Open water sampling usually requires the use of a boat. Provided that the potential limitations of shore sampling are considered, samples can also be collected from the lake shore, ideally at or near the outflow, or from a jetty or promontory. These can be collected using a bottle fixed to a long pole or a weighted bottle with float, on the end of a long rope thrown out into the lake, away from the immediate influence of the shore. Samples should not be collected near the inflow, or in areas likely to be influenced by hotspots of pollution, such as effluent discharges. Shore/outflow samples collect only the subsurface phytoplankton, and results can differ from open water sampling. Furthermore this method of sampling does not allow collection of information on stratification, or spatial distribution of phytoplankton. Samples collected from the shore/outflow provide an indication of the lake phytoplankton community and biomass and can be used in the context of large-scale monitoring programmes where some data from many lakes covering a wide geographic area is required rather than more detailed information from relatively few lakes.

4.3 Sampling frequency and replicates

The sampling frequency is very important. The required number of samples per year depends on the objectives of the investigation and the intended type of data evaluation. The period without ice cover (which may be all year depending upon local climatic conditions) is also important. At least monthly sampling during the growing season is recommended; the growing season is often March/April to October/November, but can be shorter or longer depending upon local weather patterns. For a reliable assessment of a water body's ecological quality, an investigation period of at least three years is recommended. In particular cases the sampling frequency may be reduced in accordance with the details given in Table A.2.

Phytoplankton species composition and biomass varies strongly through the seasons (associated with, for example, spring peak, clear water phase, stratification period, circulation period). Thus, the more samples are collected, the more representative the results will be for the actual status of the water body. Infrequent sampling increases the likelihood of misrepresenting the actual conditions (see A.3, [13]).

Replicates (multiple samples taken at the same location and same time) are only required when it is an objective of the investigation to get information on the spatial variability of phytoplankton biomass (or chlorophyll concentration) results received from the individual samples taken from one sampling point.

5 Equipment and preservatives

5.1 Equipment for sampling:

5.1.1 Suitable water sampler.

See Annex B for examples of suitable samplers; B.1 for samplers for rivers and B.2 for samplers for lakes.

5.1.2 Electrochemical/photo-optical probe with depth sensor to measure water temperature and dissolved oxygen according to EN ISO 5814 or ISO 17289.

5.1.3 pH probe (optional), e.g. according to EN ISO 10523.

5.1.4 Secchi disk according to EN ISO 7027 (see A.2 for further information).

5.1.5 Chlorophyll fluorescent probe with depth sensor (optional). A probe for total chlorophyll measurement is sufficient.