Baltic Marine Environment Protection Commission

Working Group on the State of the Environment and Nature Conservation

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Document title	Draft guidelines for measuring Secchi depth
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Submitted by	Finland

Background

This document contains the draft guidelines for measuring Secchi depth produced by Finland. Comments to the guidelines have been provided by Poland, Sweden, and Germany.

Action requested

The Meeting is invited to:

- consider and amend as needed the draft guidelines for measuring Secchi depth,
- endorse and agree to include the guidelines in the HELCOM Monitoring Manual.

A template for HELCOM monitoring guidelines: MONITORING OF TRANSPARENCY (SECCHI DEPTH) (DRAFT 3)

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1st draft	9th Mar, 2016	Mika Raateoja
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2nd draft	17th Mar, 2016	Mika Raateoja
Revision	21st Mar, 2016	Petra Schilling
3rd draft	21st Mar, 2016	Mika Raateoja

1. Background

1.1 Introduction

Water transparency serves as an index of the trophic status of a water body and often reflects eutrophication through changes in the phytoplankton abundance; increase in the ambient nutrient status in the water leads to higher phytoplankton biomass that diminishes the propagation of light in the water.

Water transparency is approached by Secchi depth (Cialdi and Secchi 1865, Whipple 1899) that is used as a proxy for the level of light attenuation in the water column. It is influenced by dissolved and/or colloidal inorganic and organic substances as well as total suspended solids and resident seston. It is thus affected by substances unrelated to eutrophication as well. This source of error has to be taken into consideration whenever eutrophication status is assessed using Secchi depth in the Baltic Sea that is optically classified as a Case II water body (Morel and Prieur 1977), i.e., the body of water relatively higher in inorganic particles than in phytoplankton. Those Secchi depth estimations should be treated with special caution that are collected in the sub basins possessing high absorption by chromophoric dissolved organic matter (the Gulf of Riga, the Gulf of Bothnia).

Secchi depth relates to primary production by serving as an estimation of the thickness of the euphotic zone wherein the large bulk of the gross production takes place. In principle, euphotic depth is twice Secchi depth, but this relation varies largely in practice (French et al. 1982).

1.2 Purpose and aims

The purpose for Secchi depth monitoring is to describe spatiotemporal trends in water transparency.

Secchi depth provides information of water transparency that is a direct effect of eutrophication (with certain limitations shown above). It is thus an element of eutrophication monitoring, and its monitoring collects input data for the HELCOM core indicator “Water transparency”.

2. Monitoring methods

2.1 Monitoring features

Transparency is measured *in situ* at fixed HELCOM / COMBINE stations by using of a Secchi disk. The depth where the Secchi disk settles beyond visual recognition, Secchi depth, is an index of water transparency.

2.2 Time and area

Secchi depth monitoring is carried out by all HELCOM contracting parties, and the monitored area covers the entire Baltic Sea area, both the open sea and coastal areas.

Secchi depth is a mandatory element of COMBINE monitoring and it is recommended to be measured all year round whenever meaningful. It is to note that Secchi measurements during the summer and winter

months are not necessarily commensurate to each other due to seasonal variation in the amount of seston in the water.

2.3 Monitoring procedure

2.3.1 Monitoring strategy

Being straightforward to determine and not relying on contemporary technical solutions, Secchi depth has been measured longer than any other index of eutrophication, and thus serves as the primary parameter for long-term water quality investigation.

To fulfill the status confidence criteria of the core indicator, the joint monitoring should produce annually at least 15 measurements during June-September for each assessment unit, i.e., for open sea sub-basins. The measurement should be as evenly spatially distributed as possible.

Light attenuation in the water column can be determined more accurately by underwater radiometry - and is required in the context of primary production studies - but the approach misses the simplicity of Secchi depth measurement. Underwater radiometry is optimally used to supplement Secchi disk based monitoring of water clarity by being attached to a CTD system.

2.3.2 Measuring method(s) and equipment

The methodology is based on the forthcoming standard ISO/WD 7027-2.

Measuring equipment

- **Testing disk (Secchi disk**). A white disk with a diameter of 30 cm. The disk should weigh at least 1.7 kg so as to descend quickly and not be affected by horizontal water movements. Should the disk be lighter, an additional weight can be fastened to the down-facing side of the disk. Should other types of testing discs be in use, it is important to ensure that within an investigation campaign or period and at the defined investigation sites the same device is always used.
- **Measuring tape/rope** of non-elastic material. Depth recognition:
    - cm scale. The upper side of the disk equals 0 cm.
    - colour-coded marks every 10 cm. The upper side of the disk equals 0 cm. Half and full meters should be marked so as to be easily distinguishable.
    - depth indicator of a winch
- **Weight** for waters with currents, fixed in the middle of the bottom side of the disc.
- **Optional devices** for suppression of reflections, e.g., polarized glasses for the observer.

Measuring method

Secchi depth is measured at stations when the ship is still: under calm seas, or while being held at the position using thrusters. Should the thrusters / side-propellers being used, they may cause considerable advection at typical Secchi depths which has to be accounted for.

Allow sufficient time (preferably 2 min) when looking at the disc near its extinction point for the eyes to adapt completely to the prevailing luminance level. Lower the disc on its measuring tape or rope into the water until it is no longer visible. The achieved depth is to be read and write down. After that, the disc is lowered from this point approximately another 0.5 m deeper. Then, during slow pulling up, the disc becomes visible as a bright-white spot. The depth of this point is also reading from the measuring tape or rope marks. It is recommended to repeat the test two times as a minimum. From all readings the arithmetic average is formed and noted as the Secchi depth.

The precision of a Secchi measurement depends on the turbidity of the water. In the waters of high turbidity, the precision is 0.1 m. In clearer waters, the precision ranges 0.2 to 0.5 m, depending on actual circumstances (e.g., waving; see later).

2.3.3 Sample handling and analysis.

Nothing to note.

2.4 Data analysis

Secchi depth is documented in a field protocol and the metadata of the station.

3. Data reporting and storage

The data is included in the station data along with depth-dependent variables, stored by the contracting parties, and reported annually to the COMBINE database hosted by ICES.

The depth of transparency is expressed in meters (m). The diameter and shape of the disc should be noted.

Reported data shall be rounded to 0.1 m to 0.5 m depending on the optical properties of the water, and actual circumstances.

4. Quality control

4.1 Quality control of methods

Secchi depth is an apparent optical property, and its determination is thus sensitive to weather conditions.

- Waving. Optimally, Secchi depth should be measured when the sea is relatively calm, only this is not often the case. Waving introduces a source of error in the Secchi measurement by obscuring the identification of the surface and worsening the overall visibility. The observer should try to ensure that the rope stays in an as upright position as possible. The length reading of the rope at the surface should be judged to be an average of the extreme values due to waving. The determination of Secchi depth is not meaningful in high seas.
- Sunlight: Secchi depth should be determined on the shaded side of the ship to avoid direct sunlight reflections from the water surface. Sun glitter decreases the Secchi depth estimation irrespective of optical properties of water; on the average by 12 % (Aas et al. 2014). Already this decrease exceeds the uncertainty of Secchi measurement in the typical optical conditions of the Baltic Sea water. However, the observer has to consider the source of error in the shaded side that occurs whenever the Secchi depth stretches beyond the shade of the ship. In this case, the disk is suddenly lighted by the sun and a higher reading will be attained.

The length markings of the rope should be checked and made clearer annually. The rope should be changed whenever it stretches > 5 %.

4.2 Quality control of data and reporting

For overall QC guidelines, see HELCOM (2015).

The measuring accuracy of the Secchi depth information should be 2 % of the mean reading value in low Secchi depths and under optimal conditions. Waving considerably increases this percentage.

5. Contacts and references

5.1 Contact persons

Mika Raateoja, Finnish Environment Institute

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5.2 References

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5.3 Additional literature