Baltic Marine Environment Protection Commission

Making the HELCOM eutrophication assessment operational (EUTRO-OPER)
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Document title	Assessment of oxygen status in shallower areas of the Baltic Sea
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Agenda Item	5 – Developing new core eutrophication indicators
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Background

One task of the HELCOM EUTRO OPER project is to develop new core eutrophication indicators. EUTRO-OPER 1-2014 and 2-2014 identified a need for assessing coastal oxygen status, agreeing that Germany will take lead in investigating the options for an oxygen status indicator for coastal areas.

The TARGREV project has established a method to assess the oxygen status (in terms of oxygen debt) of the deep basins of the Baltic Sea. This method was successfully applied to the Northern Baltic Proper, Gotland Basin, Gdansk Basin and Gulf of Finland.

For shallower waters like the coastal seas and the coastal strip (WFD), there is no commonly agreed method yet to assess the quality of the oxygen conditions.

This document summarizes existing approaches that were or still are used in the western Baltic though not necessarily in MSFD context.

Action required

EUTRO-Oper is invited to discuss these methods, ask Contracting Parties to provide information about other national approaches that might exist and give recommendations for future work regarding the development and operationalization of a joint oxygen indicator for coastal and other shallow areas of the Baltic Sea.

Assessment of oxygen status in shallower areas of the Baltic Sea

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The following approaches are or have been used in the western area of the Baltic Sea:

1) **Danish Reports on oxygen conditions in the western Baltic Sea area**
   Since many years, oxygen reports have been published by DMU(Danish Environmental Research Institute) and in recent years by DCE (Danish Center for Environment and Energy, Aarhus University) on a regular basis. Often, Swedish and German data have been included as well. In the period 1997-2001 three reports and since 2002 four reports have been produced per year to cover the season where low oxygen values are likely to occur in order to follow the development of oxygen conditions (all years: July/August, September, October, since 2002: plus November) and assess the harmful effects. The results are presented in a three-class system:

   - no oxygen depletion (>4 mg/l oxygen)
   - oxygen depletion (2-4 mg/l oxygen)
   - severe oxygen depletion (0-2 mg/l oxygen)

   Examples are given in **Fig. 1.** The reports are available online.

In German waters, there are two approaches:

2) The **oxygen concentrations in near-bottom waters** (abt. 1 m from bottom) are classified according to the following scheme:

   >6 mg/l = good status
   6 - >4 mg/l = moderate status
   4 - >2 mg/l = poor status
   2 - >1 mg/l = bad status
   1 mg/l and less = very bad status (H_2S-production)

   Measurements are taken from August to Oktober/November with focus on September. If there are several measurements per station from this period, the worst of the measurement results is used for oxygen classification. The classification system is still in use, but a final decision regarding its use for MSFD purposes has not been taken yet. Some examples of how results are presented are given in **Fig. 2.** The reports are available online.

3) **Classification according to trophic status and organic matter**. This classification scheme was used in Mecklenburg-Vorpommern coastal waters from 1983 until about 2005 and builds on 3 sets of criteria which are assessed equally (no weighing):

   i) nutrients (o-PO_4-P, total phosphorus, DIN)
   ii) level of productivity (phytoplankton biovolume, chlorophyll a, Secchi depth)
   iii) oxygen regime and organic matter (oxygen saturation at surface, oxygen concentration near bottom and biochemical oxygen demand)

   This classification comprised 6 status classes depicting different trophic stages from oligo- to hypertrophic (see **Table 1**) and was based on at least monthly measurements in surface and bottom waters throughout the year. In case of shallow, well mixed water bodies without stratification,

classification was based on surface measurements only (the worst of the values was used for classification). In stratified waters, near-bottom oxygen concentration was used in addition. The classification was given up in the end because of differing demands coming with the Water Framework Directive.

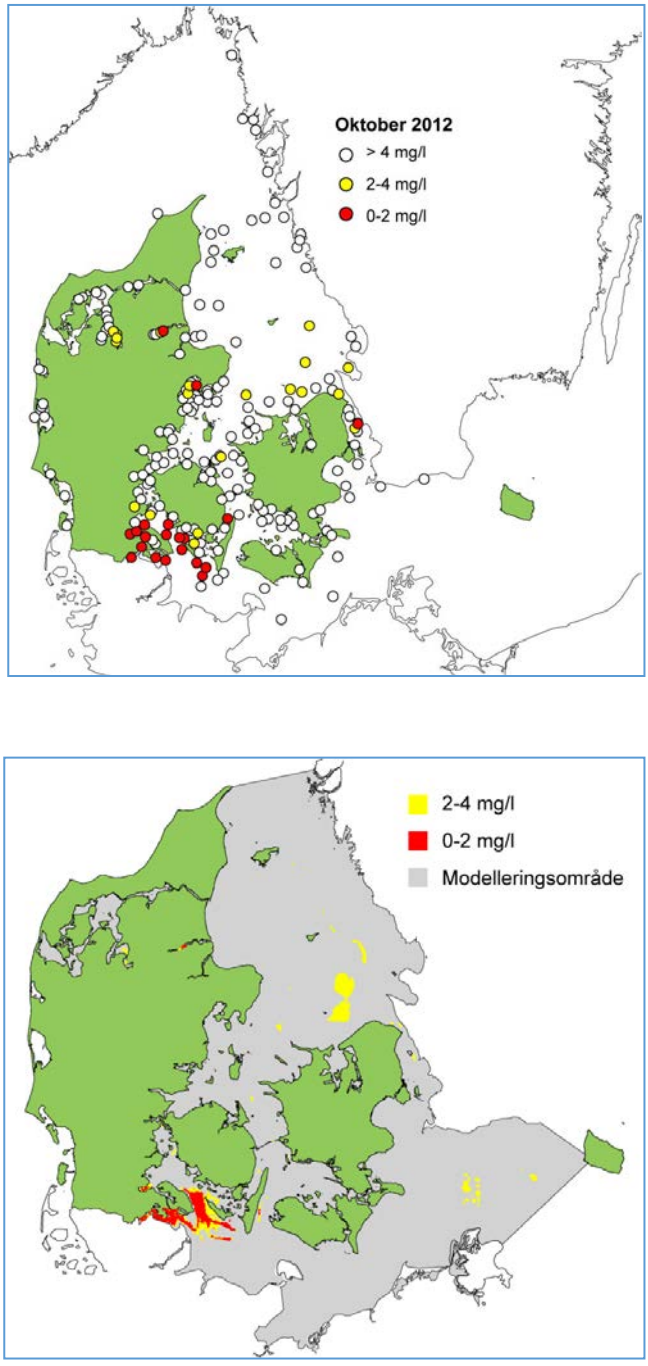
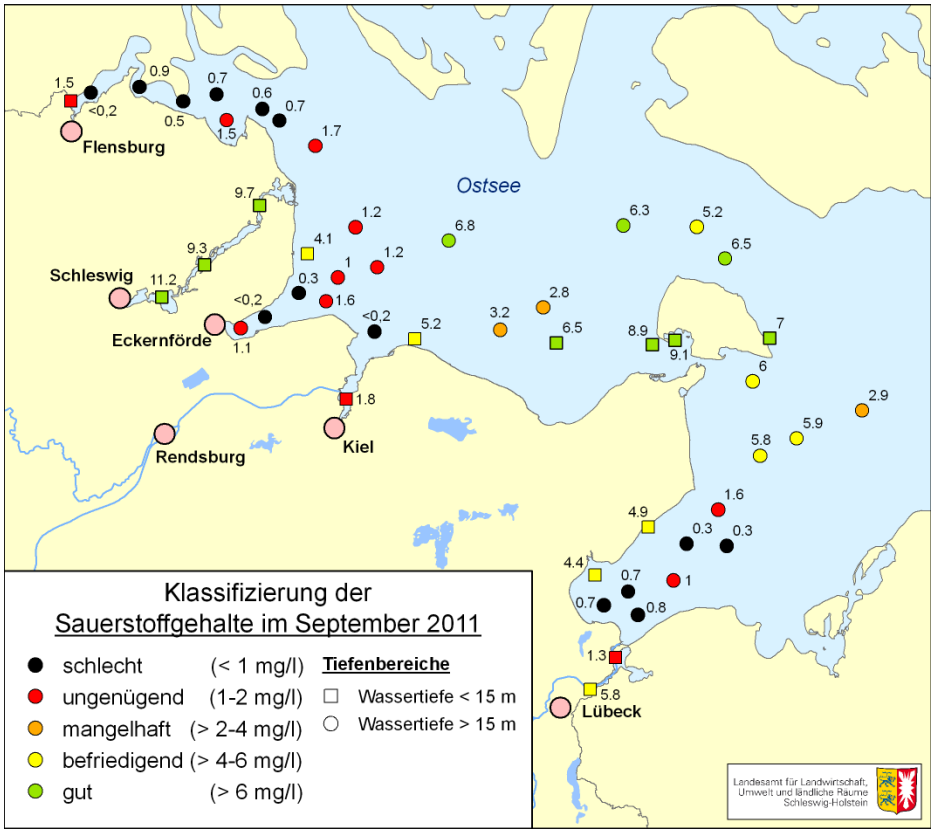


Fig. 1: Oxygen conditions in October 2012 depicting stations visited (top) and modelling results (bottom). Source: J. W. Hansen et al. 2012, Iltsvind i de danske farvande i oktober 2012. Available online: http://bios.au.dk/fileadmin/bioscience/Fagdatacentre/MarintFagdatacenter/Publikationer/Iltsvindsrapport_oktober_2012.pdf



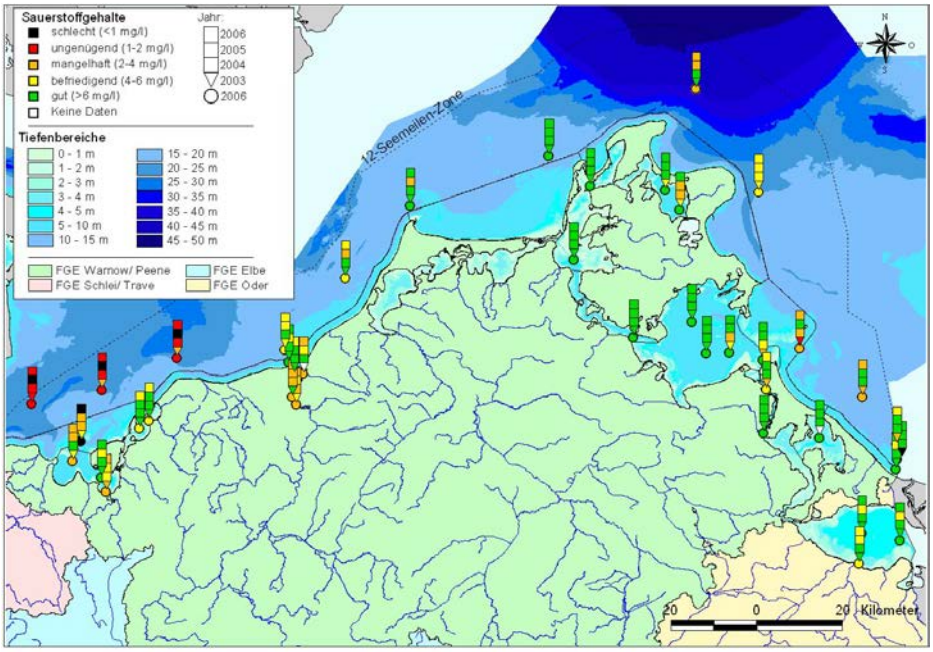


Fig. 2: Classification of oxygen concentrations in the bottom-near water layer of Schleswig-Holstein for 2011 (top) and for 2003-2006 in Mecklenburg-Vorpommern waters (bottom). Sources: T. Petenati/LLUR, report available online: http://www.bsh.de/de/Meeresdaten/Beobachtungen/MURSYS-Umweltreportsystem/Mursys_031/seiten/oso27_01.jsp
LUNG Water Quality Report 2003-2006, available online: http://www.lung.mv-regierung.de/dateien/a3_pub_ggb_2003_2006.pdf

Table 1: Classification according to trophic status and organic matter in Mecklenburg-Vorpommern coastal areas until about 2005. Note: o-PO_4-P not to be assessed in shallow sea areas with considerable interaction between phosphorous and sediment (sorption/desorption-equilibrium)

Status class		1	2	3	4	5	6
Trophic level		oligotrophic	mesotrophic	eutrophic	highly eutrophic	polytrophic	hypertrophic
Set of criteria/ criterion	*unit*						
Nutrient conditions							
o-PO_4-P	µmol/l	≤ 0,5	≤1,5	≤ 3	≤ 5	≤ 10	>10
Total P	µmol/l	≤ 1	≤ 3	≤ 6	≤ 10	≤ 20	>20
DIN (NO_3+NO_2+NH_4)	µmol/l	≤ 10	≤ 30	≤ 60	≤ 100	≤ 200	>200
Productivity level							
Phytoplankton biovolume	cm^3/m^3	≤ 1	≤ 5	≤ 10	≤ 20	≤ 40	>40
Chlorophyll a-concentration	mg/m^3	≤ 2	≤ 10	≤ 25	≤ 50	≤ 100	>100
Secchi depth	m	≥ 6	≥ 4	≥ 2	≥1	≥0,5	<0,5
Oxygen and organic matter							
Range of oxygen saturation (min. – max.)	% O_2	90-110	80-130	60-150	40-200	20-250	0-300
Near-bottom oxygen concen-tration	mg/l O_2	≥ 8	≥ 6	≥ 4	≥ 2	< 2	anaerob
BOD_5	mg/l O_2	≤ 2	≤ 4	≤ 6	≤ 8	≤ 10	>10