Document title	Results of the eutrophication test assessment using indicator scaling by applying EQRs
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Agenda Item	4-1 - Test assessment using indicator scaling by applying EQRs
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Background

Based on the proposal for indicator scaling to HEAT 3.0, which was discussed at IN-EUTROPHICATION 11E-2018, it has been agreed to set up a workspace for eutrophication test assessment by applying ecological quality ratio (EQR) instead of the previously used method of eutrophication ratio (ER), thereby changing the value range from 0-2 back to 0-1 for open sea and coastal areas. The results of the indicator scaling test assessment 2011-2016 with EQRs in open sea areas can be accessed from https://ocean.ices.dk/core/heat?assessmentperiod=20112016_2019Test.

This document presents the results of test calculations using EQRs in comparison with ER assessments in open sea areas for different indicators in order to support the decision how indicator scaling should be performed in future assessments. The test calculation in coastal areas will soon be included in the test workspace based on the latest version of the Excel data file for indicator scaling taking account of national corrections.

The existing problem of different ranges of EQR values in coastal assessments and ER values in open sea areas can be overcome by simply applying EQRs in all areas. An improved comparability between indicators and criteria groups can be achieved by the proposed additional normalisation step. Furthermore, the adoption of EQRs will allow the direct use of normalised results of the eutrophication indicators in the biodiversity assessment and thus, avoid further processing or recalculation. This will provide a harmonised assessment procedure of BEAT and HEAT without producing inconsistent results as in HOLAS II.

Action requested

The Meeting is requested to:

- discuss the results of the eutrophication test assessment using indicator scaling by applying EQRs
- agree on the future scaling method and possible necessary amendments in the HEAT 3.0 assessment procedure

Results of the eutrophication test assessment for scaling of eutrophication indicators using EQRs compared to ER in open sea areas

As agreed at IN-EUTROPHICATION 11E-2018, a test workspace (IN-EUTROPHICATION3) has been set up by ICES to compare potential differences in the outcome between ER (Eutrophication Ratio) and EQR (Ecological Quality Ratio). The test calculations were based on ES (observed) and ET (target) values of HOLAS II data (2011-2016) from the HELCOM IN-EUTROPHICATION workspace. Acceptable deviations were set to 50 % for nutrients and chlorophyll a and 25 % for Secchi. On the basis of the target values and the acceptable deviation, best values were calculated for the subsequent calculation of EQRs. Within the test assessment, target values were always used as set by HELCOM, whereas calculated best values differed from the best values originally set by HELCOM (to support the use of eutrophication indicators in the biodiversity assessment BEAT) to reach acceptable and consistent deviations of 50 % for nutrients and chlorophyll. Please, note that best values calculated from target values and fixed acceptable deviation value of 50 % have not been derived by simply halving the target value. Instead, the calculated best value was set in the way that the best value as the starting point or 'anchor' as described by Andersen et al. (2011) plus 50 % acceptable deviation led to the ET value used in HELCOM. The same applies to the calculation of best values for Secchi depth as an indicator with negative response to eutrophication.

The test assessment for open sea areas yielded 134 results for nine different indicators, of which four were related to the different data types of chlorophyll (in-situ, Earth Observation, Ferry Box). The comparison of the ER and EQR values showed that 86 of a total of 134 results were classified in the same class, while 48 classifications differed in the assessment results, all based on the classification with five subclasses. The percentage share of matching and deviating classifications is shown in Figure 1.

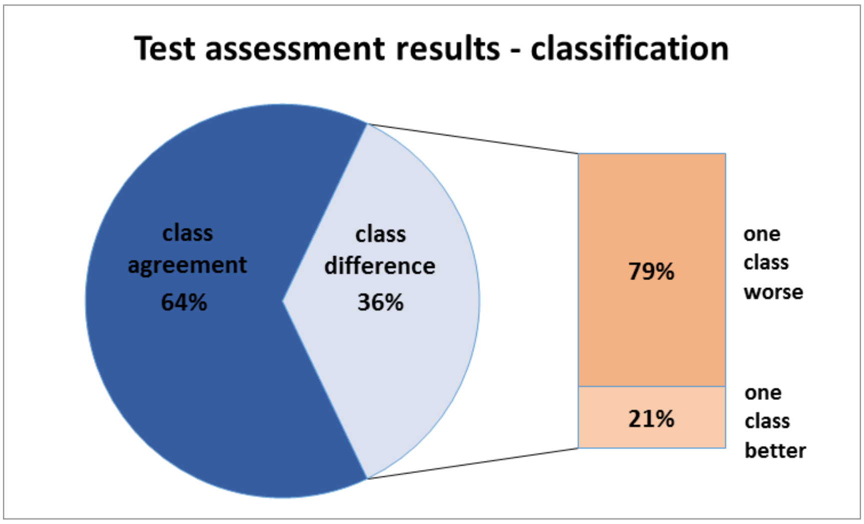

Figure 1: Results of the eutrophication test assessment for open sea areas in terms of matching or deviating classifications.

Of the 48 deviating classifications, 10 showed an improvement (from class 2 to 1), while 38 showed a decline by one class (mainly from class 3 to 4). The percentage share of improved and worsened classifications in relation to the total number of differing class results is also shown in Figure 1. The analysis has been based on the observed values for the various indicators in the assessment period from 2011-2016. The outcome may generally shift towards class improvement if the values improve due to lower nutrient inputs in the future.

The reason for the classification differences between ER and EQR is most likely related to the differing class widths, which are based on the acceptable deviation from the best value in the EQR approach on a scale from 0 to 1, while the class boundaries for the ER values are uniformly defined in 0.5 steps from 0 to 2. The decisive class boundary between 'good' and 'moderate' in terms of a low or high eutrophication status was consistently correct for all assessment results in the open sea areas.

The following tables and figures present some detailed results of the comparison between ER and EQRS (final scaled EQR after normalisation to five classes of 0.2 width) classifications for individual indicators.

Table 1: Comparison of ER (Eutrophication Ratio) and EQRS (Ecological Quality Ratio scaled) assessment results for DIN in HELCOM sub-basins.

DIN 2011-2016						
Code	**Description**	**ER**	**class**	**EQRS**	**class**	**Diff**
SEA-001	Kattegat	1.18	3	0.46	3	
SEA-002	Great Belt	1.29	3	0.39	4	1
SEA-003	The Sound	1.82	4	0.19	5	1
SEA-004	Kiel Bay	1.07	3	0.54	3	
SEA-005	Bay of Mecklenburg	1.48	3	0.30	4	1
SEA-006	Arkona Basin	1.37	3	0.34	4	1
SEA-007	Bornholm Basin	3.73	5	0.09	5	
SEA-008	Gulf of Gdansk	1.09	3	0.52	3	
SEA-009	Eastern Gotland Basin	1.36	3	0.35	4	1
SEA-010	Western Gotland Basin	1.64	4	0.23	4	
SEA-011	Gulf of Riga	2.00	5	0.17	5	
SEA-012	Northern Baltic Proper	1.70	4	0.21	4	
SEA-013	Gulf of Finland	2.26	5	0.15	5	
SEA-014	Åland Sea	1.44	3	0.31	4	1
SEA-015	Bothnian Sea	1.36	3	0.35	4	1
SEA-016	The Quark	1.29	3	0.39	4	1
SEA-017	Bothnian Bay	1.25	3	0.41	3	

In eight out of 17 HELCOM sub-basins, the EQRS classification for DIN was one class worse than the ER classification (Table 1). All assessment results for DIN were below the threshold and predominantly in the range of class 3. In seven sub-basins, the classification changed from class 3 to 4 in the EQR approach.

The class boundaries listed in Table 2 were the basis for the classification of assessment results according to the ER or EQR approach.

Table 2: Class boundaries for the classification of ER and EQRS assessment results

Class boundaries	**high/good**	**good/moderate**	**moderate/poor**	**poor/bad**
ER	0.5	1.0	1.5	2.0
EQRS	0.8	0.6	0.4	0.2

The deviating classification results of the ER and EQRS classification with five subclasses are visualised for DIN in Figure 2 and can be viewed in detail in the dataview of the HELCOM test assessment workspace.

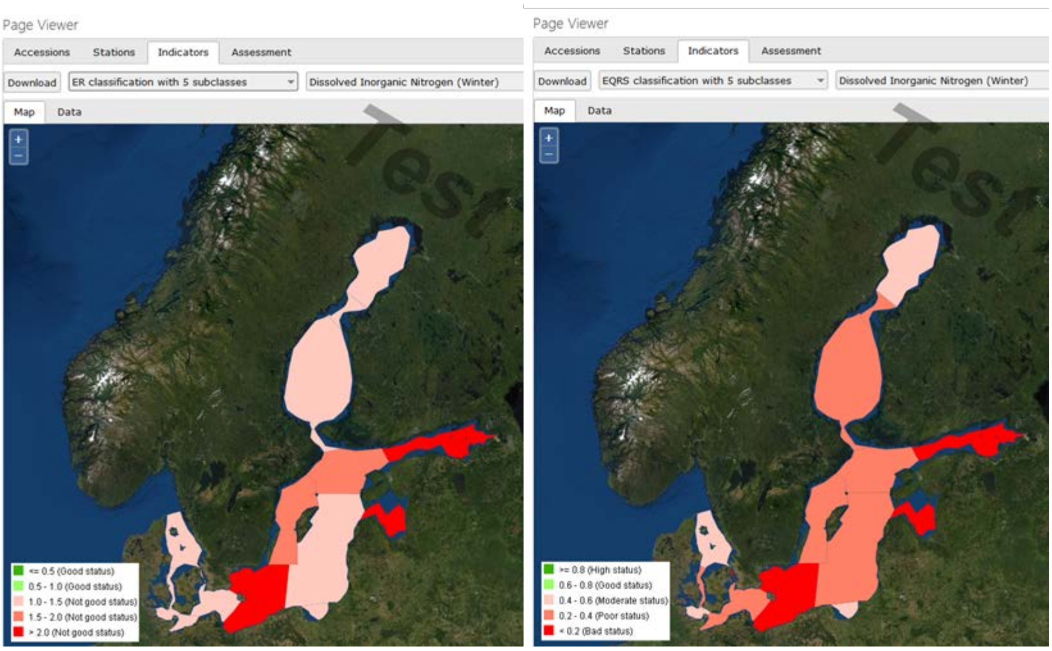

Figure 2: Map of DIN assessment results from the HELCOM IN-EUTROPHICATION3 test workspace for ER and EQRS classification

In contrast to DIN, only four deviating classifications were identified for DIP, as can be seen in Table 3, of which three were one class lower and one was one class higher.

Table 3: Comparison of ER (Eutrophication Ratio) and EQRS (Ecological Quality Ratio scaled) assessment results for DIP in HELCOM sub-basins.

DIP 2011-2016						
Code	**Description**	**ER**	**class**	**EQRS**	**class**	**Diff**
SEA-001	Kattegat	1.09	3	0.53	3	
SEA-002	Great Belt	1.11	3	0.50	3	
SEA-003	The Sound	1.52	4	0.28	4	
SEA-004	Kiel Bay	1.13	3	0.49	3	
SEA-005	Bay of Mecklenburg	1.43	3	0.32	4	1
SEA-006	Arkona Basin	1.72	4	0.21	4	
SEA-007	Bornholm Basin	2.19	5	0.16	5	
SEA-008	Gulf of Gdansk	1.45	3	0.31	4	1
SEA-009	Eastern Gotland Basin	1.95	4	0.18	5	1
SEA-010	Western Gotland Basin	2.04	5	0.17	5	
SEA-011	Gulf of Riga	2.54	5	0.14	5	
SEA-012	Northern Baltic Proper	2.54	5	0.14	5	
SEA-013	Gulf of Finland	1.62	4	0.23	4	
SEA-014	Åland Sea	2.14	5	0.16	5	
SEA-015	Bothnian Sea	1.78	4	0.20	4	
SEA-016	The Quark	2.39	5	0.15	5	
SEA-017	Bothnian Bay	0.85	2	1.00	1	-1

The comparison of ER and EQRS for in-situ chlorophyll a assessment results revealed a good agreement with only three deviating classifications (Table 4), one higher and two lower classifications. The observed values showed a wide range and were distributed over four different classes.

Table 4: Comparison of ER (Eutrophication Ratio) and EQRS (Ecological Quality Ratio scaled) assessment results for chlorophyll a (in-situ) in HELCOM sub-basins.

Chlorophyll a (in-situ) 2011-2016						
Code	**Description**	**ER**	**class**	**EQRS**	**class**	**Diff**
SEA-001	Kattegat	0.65	2	1.00	1	-1
SEA-002	Great Belt	1.26	3	0.40	3	
SEA-003	The Sound	1.08	3	0.53	3	
SEA-004	Kiel Bay	1.13	3	0.49	3	
SEA-005	Bay of Mecklenburg	1.23	3	0.42	3	
SEA-006	Arkona Basin	1.47	3	0.30	4	1
SEA-007	Bornholm Basin	2.73	5	0.13	5	
SEA-008	Gulf of Gdansk	1.61	4	0.24	4	
SEA-009	Eastern Gotland Basin	1.50	4	0.29	4	
SEA-010	Western Gotland Basin	2.24	5	0.16	5	
SEA-011	Gulf of Riga	1.51	4	0.28	4	
SEA-012	Northern Baltic Proper	2.23	5	0.15	5	
SEA-013	Gulf of Finland	2.16	5	0.16	5	
SEA-014	Åland Sea	1.79	4	0.19	5	1
SEA-015	Bothnian Sea	1.64	4	0.23	4	
SEA-016	The Quark	1.26	3	0.40	3	
SEA-017	Bothnian Bay	1.19	3	0.45	3	

The assessment results for the Secchi values showed deviating classifications in nine out of 17 HELCOM sub-basins, all declining from class 3 to 4 with only one exception improving from class 2 to 1 (Table 5). The values had been almost all in a similar range. This and the stricter classification due to the acceptable deviation of -25% for Secchi (as an indicator with negative response to eutrophication) could have been the reason for the relatively high number of deviating results.

Table 5: Comparison of ER (Eutrophication Ratio) and EQRS (Ecological Quality Ratio scaled) assessment results for Secchi in HELCOM sub-basins.

Secchi 2011-2016						
Code	**Description**	**ER**	**class**	**EQRS**	**class**	**Diff**
SEA-001	Kattegat	0.81	2	1.00	1	-1
SEA-002	Great Belt	1.12	3	0.44	3	
SEA-003	The Sound	0.99	2	0.61	2	
SEA-004	Kiel Bay	1.07	3	0.50	3	
SEA-005	Bay of Mecklenburg	1.34	3	0.22	4	1
SEA-006	Arkona Basin	1.31	3	0.24	4	1
SEA-007	Bornholm Basin	1.35	3	0.21	4	1
SEA-008	Gulf of Gdansk	1.13	3	0.43	3	
SEA-009	Eastern Gotland Basin	1.14	3	0.42	3	
SEA-010	Western Gotland Basin	1.32	3	0.23	4	1
SEA-011	Gulf of Riga	1.37	3	0.20	4	1
SEA-012	Northern Baltic Proper	1.38	3	0.20	4	1
SEA-013	Gulf of Finland	1.23	3	0.32	4	1
SEA-014	Åland Sea	1.28	3	0.27	4	1

SEA-015	Bothnian Sea	1.29	3	0.27	4	1
SEA-016	The Quark	1.09	3	0.48	3	
SEA-017	Bothnian Bay	1.23	3	0.42	3	

Classification differences in the final eutrophication assessment are shown in the following maps for ER and EQRS classifications in Figure 3. In six HELCOM sub-basins, the classification was one class lower for EQRS than for ER. The classification had changed from class 3 to 4 in the Sound and the Gulf of Gdansk, whereas in the Western Gotland Basin, Northern Baltic Proper and the Gulf of Finland the classification had changed from class 4 to 5. This was due to different indicators (DIN, DIP and Secchi), which influenced the classification results of the categories 1 and 2. Oxygen as indicator of category 3 has not yet been included in the test assessment.

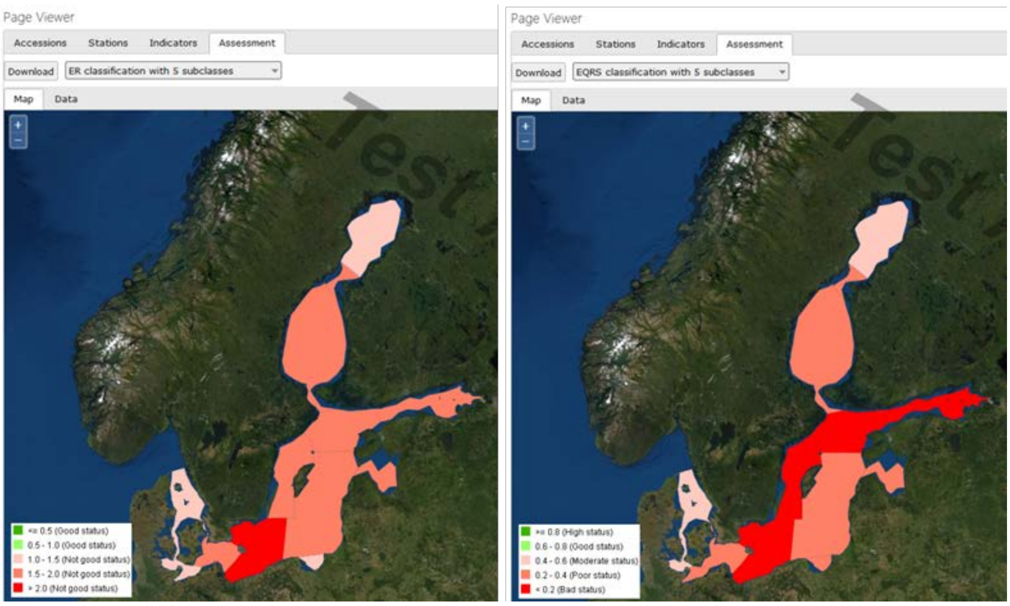

Figure 3: Map of final eutrophication assessment results from the HELCOM IN-EUTROPHICATION3 test workspace for ER and EQRS classification.

In conclusion, the assessment results were slightly worse with the EQR approach in some cases related to the classes 3-5 of the five-class classification. For individual indicator results, which were already above the assessment level, classification improvements from class 2 to 1 were also determined. However, this was not reflected by the final assessment results, as most indicator results were below the thresholds. The important good/moderate boundary was set correctly in all cases of the test calculations.

The main advantage of the EQR approach will probably become visible when coastal waters are included in the eutrophication test assessment, in addition to the open sea areas. The direct use of EQR assessment results will ensure the transfer of national WFD results in the HELCOM eutrophication assessment without deviations due to duplicate calculation and without losing e.g. adaptations of specific class boundaries based on expert judgement in national assessments. The EQR approach will also solve the existing “zero value” problem caused by the usage of ER values.

The additional normalisation step will help to further align already normalised EQR values and calculated EQRs. This would also improve the comparability between indicators and criteria groups as well as between coastal and open sea assessment results. Limiting the range of EQR values to the range of 0 to 1 will ease the calculation of the distance to GES, compared to the use of the open-ended maximum ER values. The influence of acceptable deviation values on class boundaries and the resulting assessment (dependent on the range of acceptable deviation values) can be reduced by using harmonised and consistent values for the acceptable deviation on a scientifically sound basis according to area and indicator specific needs. After the inclusion of coastal areas and the evaluation of the respective assessment results, further steps for modifying the HELCOM workspace procedure could be taken, if the meeting agreed on the common scaling approach for future eutrophication assessments.

The implementation of EQRs would also allow the normalised results of the eutrophication indicators to be directly incorporated into the biodiversity assessment without further processing or recalculation. This would provide a harmonised assessment procedure of BEAT and HEAT and thus, avoiding producing inconsistent results as in HOLAS II.

References

Andersen et al. (2011): Getting the measure of eutrophication in the Baltic Sea: Towards improved assessment principles and methods. Biogeochemistry 106 (2): 137-156.