BQE Macrophytes – Intercalibration Phase III

Documentation of the EQR-calculation matrix SKIPPER-DE for the sub-BQE "Reeds, Brackish and Salt Marsh Vegetation“ in German coastal and transitional waters (Intercalibration types NEA 1/26, 3/4 and 11)

- Status 2016 -

=WENN(K5=1;F5;WENN(K5=0,8;G5;WENN(K5=0,6;H5;WENN(K5=0,4;I5;WENN(K5=0,2;J5)))))

			SMAr											
			Metric class boundaries (lower class limits (ha))						Metric score to EQR					Metri
Area_Name	Goal	Year	Applicable SM area (ha)	H	G	M	P	B	Upper bound of EQR class	Upper bound of metric score class	Lower bound of metric score class	EQR	Pioneer	Low
Year 2														
er Ems-Küste	GES	2013	1089	1035	817	545	272	0	0,4	545	272	**0,325**	2	1
er Ems-Inseln	GES	2013	1242	1180	932	621	311	0	0,8	1180	932	**0,793**	2	2
und angrenzende Küstenabschnitte-Küste	GES	2013	2067	1964	1550	1034	517	0	1,0	2067	1964	**0,861**	2	2
und angrenzende Küstenabschnitte-Insel	GES	2013	147	140	110	74	37	0	1,0	147	140	**0,864**	2	2
der Ems-Küste	GES	2013	1364	1296	1023	682	341	0	1,0	1364	1296	**1,000**	2	2
der Ems-Inseln	GES	2013	1515	1439	1136	758	379	0	0,8	1439	1136	**0,783**	2	2
	GES	2013	648	616	486	324	162	0	0,4	324	162	**0,210**	1	0
der Elbe-Küste	GES	2013	76	72	57	38	19	0	1,0	76	72	**0,895**	2	1
der Elbe-Inseln	GES	2013	190	181	143	95	48	0	0,6	143	95	**0,472**	0	0
Weser (Außenweser)	GEP	2013	1325	1259	994	663	331	0	0,6	994	663	**0,505**	1	0
Weser (Unterweser)	GEP	2012-2013	2417	2296	1813	1209	604	0	0,8	2296	1813	**0,659**		
-Astuar	GEP	2013	2698	2563	2024	1349	675	0	0,4	1349	675	**0,392**	0	2
(Unterems)	GEP	2011-2013	824	783	618	412	206	0	1,0	824	783	**0,981**		
Year 1														
er Ems-Küste	GES	2004	1089	1035	817	545	272	0	0,4	545	272	**0,336**	2	1

Riprap protected dike foreshore at the Lower Ems (25-10-2013), calculation matrix SKIPPER-DE (extract)

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21-05-2017

On behalf of the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency

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Documentation of the EQR-calculation matrix SKIPPER-DE for the sub-BQE "Reeds, Brackish and Salt Marsh Vegetation“ in German coastal and transitional waters

(Intercalibration types NEA 1/26, 3/4 and 11)

– Status 2016 –

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1 Introduction

According to the WFD, the ecological status respectively the ecological potential of the coastal and the transitional water bodies is to be determined and monitored, among other parameters, by means of the biological quality elements (BQE) 'Macroalgae' and 'Angiosperms' (transitional waters) respectively 'Macroalgae and angiosperms' (coastal waters). Concerning the component angiosperms, the sub-BQE 'Seagrasses' and the sub-BQE 'Reeds, brackish and saltmarshes' are considered as part of it. The German assessment method of the biological health of reeds, brackish and saltmarshes in coastal and transitional waters is a multimetric index composed of various parameters and can be applied to reed beds, brackish marshes and saltmarshes.

The results of the monitoring and assessment are an essential basis of creating the management plans and measure programs. Furthermore the assessment scales for the BQEs are to be intercalibrated with those of the Member States of the respective geographical intercalibration group (GIG).

For the intercalibration work on saltmarshes in the NEA GIG (North East Atlantic Geographical Intercalibration Group), the participating Member States had agreed to provide a calculation matrix for the calculation of the EQR (Ecological Quality Ratio) for their respective assessment procedures. The British calculation system SKIPPER (Saltmarsh Key Indicators Processed Precisely and Estimated Robustly) should be taken as a model for the EQR calculation matrix.

The calculation matrix (SKIPPER-DE) presented for this purpose for the German assessment method for 'reed beds, brackish marshes and saltmarshes' is accordingly adapted to the British matrix SKIPPER. Additional to the German data sets imported into the intercalibration, SKIPPER-DE can also be used for the calculation of the EQR with data from other regions/member states; in this case, the region-specific reference values have to be replaced.

The data bases as well as the individual calculation steps are documented in the following short report. Further information on the data sets which have been introduced by Germany in the intercalibration phase III and on data from the first and second management plan, which have been calculated exemplary using the calculation matrix SKIPPER-DE are given in the footnotes. [1]

[1] **Note:** In 2004-2008 for the first management plan, as well as in 2013/2014 for the second management plan data on area size, zoning and further parameters of the reed beds, brackish marshes and saltmarshes along the Lower Saxony coast, on the islands as well as along the lower reaches of the rivers of Ems and Weser was collected.

A fundamental update of the assessment method developed by ARENS (2006, 2009) - the reference parameter 'water body' was spatially redefined - also necessitated a re-calculation of the reference value and the data/assessment from 2004-2008. The procedure and the results for the coastal waters of the euhaline and polyhaline Wadden Sea (N2, N4) and of the transitional waters 'Ems-Ästuar T1' and the sub region 'Außenweser T1' of the transitional waters of the Weser were reported by ARENS (2015a). The results for the transitional waters 'Ems T1' and the sub region 'Unterweser T1' of the transitional waters Weser were reported by ARENS (2015b, Fig. 1) as well.

For further information see ARENS (2015a, 2015b).

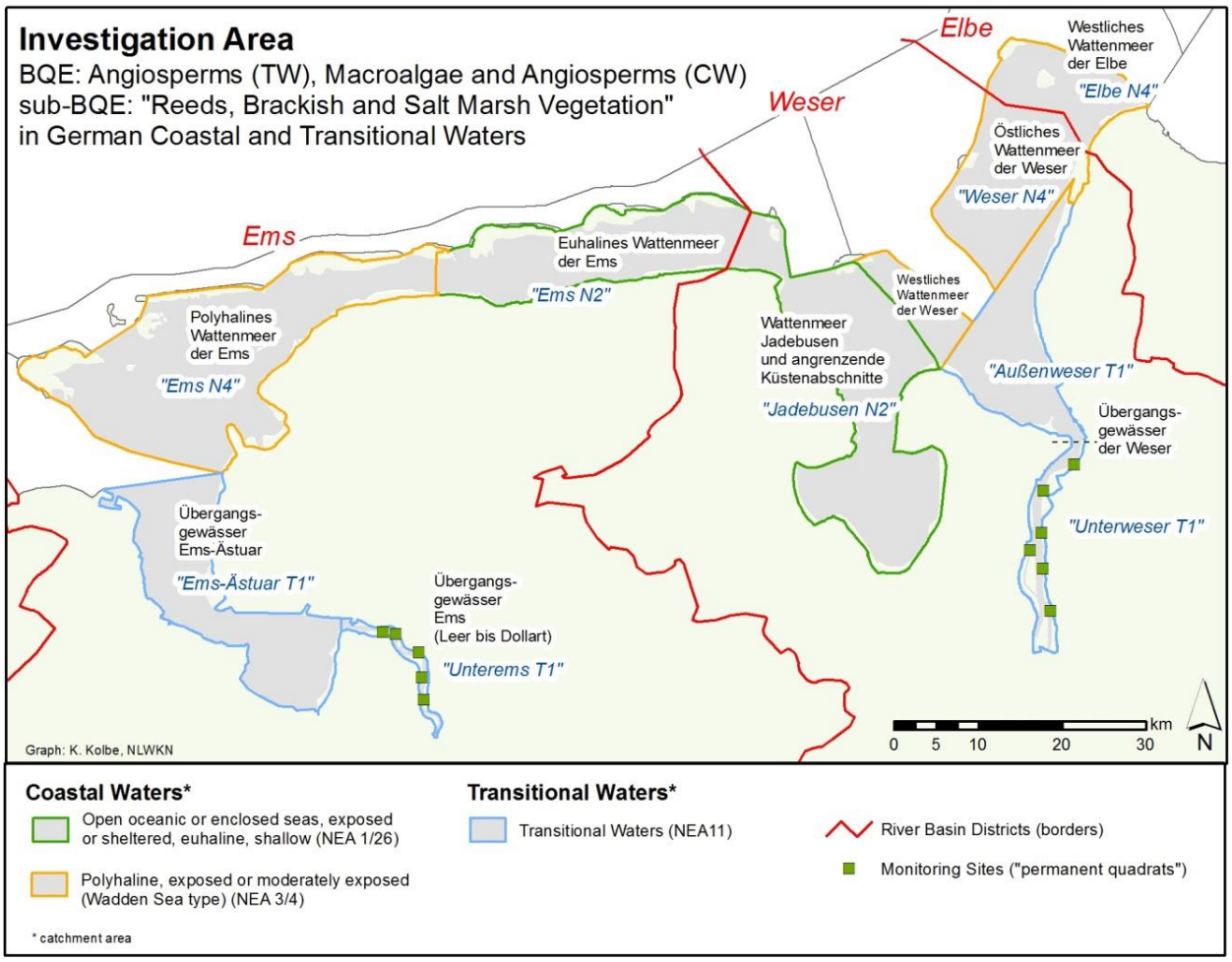

Fig. 1: Names and boundaries of the water bodies or catchment areas

2 Using the calculation matrix SKIPPER-DE

2.1 General principles, calculation of the EQR for the whole water body and for sub-areas

With the present calculation matrix, the ecological quality ratio (EQR) can be calculated for water bodies of those transitional and coastal waters to which the evaluation method for reeds, brackish and salt marshes is to be applied by way of various calculation steps which are explained in more detail below. For this purpose, the basic data for the metrics of the assessment method, previously determined for different observation periods (management plans), must be entered into the matrix for each water body. The further calculation of the indices, including possibly required intermediate steps, is carried out automatically according to the valid specifications (for example, class limits) of the assessment system which are implemented. An overview of the data requirements for different water bodies is given in appendix 1.

In Germany the coastal waters (CW) are reported as 'natural water bodies' (NWB). Therefore the EQR represents the ecological status of the water body. The aim is to achieve the 'good ecological status' (GES) of the water body. The transitional waters (TW) in Germany are reported as 'heavily modified water bodies' (HMWB) and therefore the EQR represents the ecological potential of the water body. The aim is to reach the 'good ecological potential' (GEP)[2].

Coastal waters are assessed on the basis of the following two metrics:

- Brackish marsh and saltmarsh **area** (foreland and grassland without pioneer zone and vegetation of summer polder) – SMAr

[2] **Note:** In the intercalibration, phases I to III, only the assessment of the ecological status, but not of the ecological potential, was processed. Nevertheless in the outer reaches of the Weser and Ems estuaries the GES is identical with the GEP and therefore the EQR are usable for the intercalibration process.

- **Zonation** of vegetation of brackish and salt marshes (including pioneer zone; calculation in relation to total area, including grassland and summer polder)

In case a coastal water body comprises both mainland and islands with salt marshes, islands and mainland are first assessed separately using these two metrics. From the unweight individual SubspaceEQRs of the two subareas of a water body (mainland coast and islands), the FinalEQR for the water body is calculated as arithmetic mean[3].

Transitional waters (TW) are assessed on the basis of the following metrics:

For TW outer reaches (polyhaline and α-mesohaline) the same two metrics as in the coastal waters apply:

- Brackish marsh and saltmarsh **area** (foreland and grassland without pioneer zone and vegetation of summer polder) – SMAr
- **Zonation** of vegetation of brackish and salt marshes (including pioneer zone; calculation in relation to total area (including grassland and summer polder))

For TW inner reaches (β-mesohaline and oligohaline) four metrics apply (the first metric 'Area of foreland' corresponds to the parameter 'Area of foreland' of the CW and of the outer TW):

- **Area of foreland** of salt/brackish marsh (potential flooded marshland) – 'SMAr'
- Area of **typical landscape biotopes** (biotope area as proportion of total saltmarsh (%))
- Total **reed bed width** along the shoreline
- **Species & structure** of reed bed below MHWL

If a transitional water body comprises both outer and inner reaches (e.g. 'Übergangsgewässer Weser') the two subareas are first assessed separately using the two respectively four parameters mentioned above. The FinalEQR is than calculated from the two SubspaceEQRs as arithmetic mean.

In worksheet 'MetricEQR' within the SKIPPER-DE calculation matrix a single Metric-EQR is calculated and reported for each metric in each subarea of a water body (islands or mainland coast, outer or inner estuary) to be distinguished.

In worksheet 'FinalEQR' at first the MetricEQRs of each sub region are aggregated to the 'SubspaceEQRs' and in a second step the 'FinalEQR' for each water body is calculated by aggregation of the 'SubspaceEQRs'. The Final-EQRs are reported as 'FinalEQR - ecological status' for CW respectively 'FinalEQR - ecological potential' for TW.

In the following the data requirements and calculations for the individual metrics are explained in more detail.

As a rule the regional SubspaceEQRs are aggregated to the FinalEQR of a water body by simple calculation of the arithmetic mean. However, it must be noted that both subareas must be at least have 'moderate' ecological status / potential so that the ecological status of the water body as a whole can be assessed as 'good'.

If, therefore, the assessment for the sub-area of a water body is merely 'poor', but the arithmetic mean for the overall FinalEQR would be calculated 'good', the overall evaluation is automatically set to 'moderate' by the calculation matrix SKIPPER-DE.

The EQR is calculated for the individual metrics in general by means of linear interpolation between class boundaries according to the formula below.

$$EQR_{measured\ data} = upper\ limit_{EQR\text{-}class} - \frac{(measured\ metric\ data - upper\ limit_{metric\ class})}{(lower\ limit_{metric\ class} - upper\ limit_{metric\ class})} * 0{,}2$$

[3] **Note:** This case applies to most CW relevant in Germany (see Fig. 1). Only in the 'Wattenmeer der Weser' (N4) are no islands with reed beds, brackish and salt marshes, so that a subdivision of the water body is omitted.

Tab. 1: Classification boundaries for the five metrics and assignment to the MetricEQR values (Screen-shot from SKIPPER-DE, here: worksheet 'EQRboundaries')

	SMAr - proportion of reference Saltmarsh	Classification of SM-zones (TW and DE_CW_N4_5900_01)	*Calculated value of SM-zones (TW and DE_CW_N4_5900_01)*	Classification of SM-zones (CW)	*Calculated value of SM-zones (CW)*	Typical landscape biotopes	Classification of reed width	Classification of species & structure of reed zone below MHWL	EQR (upper bound of class)
H	100 - 95%	8	*7,5 - 8,0*	7	*6,5 - 7,0*	100 - 95%	5 - 4,5	5 - 4,5	**1,0**
G	< 95 - 75%	6 - 7	*5,5 - 7,5*	5 -6	*4,5 - 6,5*	< 95 - 75%	< 4,5 - 3,5	< 4,5 - 3,5	**0,8**
M	< 75 - 50%	4 - 5	*3,5 - 5,5*	4	*3,5 - 4,5*	< 75 - 50%	< 3,5 - 2,5	< 3,5 - 2,5	**0,6**
P	< 50 - 25%	2 - 3	*1,5 - 3,5*	2 - 3	*1,5 - 3,5*	< 50 - 25%	< 2,5 - 1,5	< 2,5 - 1,5	**0,4**
B	< 25%	0 - 1	*0 -1,5*	0 - 1	*0 -1,5*	< 25%	< 1,5	< 1,5	**0,2**

2.2 Calculation of MetricEQRs

The metric-specific evaluation (worksheet 'Metric-EQRs') is calculated on the basis of the input data (worksheet 'InputData') using the classification limits (worksheet 'EQRboundaries'). The procedure is explained in chapters 2.2.1 to 2.2.6 for each metric.

The MetricEQR values are then automatically transferred to the 'FinalEQR' worksheet for calculating the 'SubspaceEQRs' of the sub regions respectively the 'FinalEQRs' of each water body (aggregation rules see chapter 2.1).

2.2.1 Class boundaries (worksheet 'EQRboundaries')

The values of each of the five metrics addressed above (2.1: saltmarsh area, saltmarsh zones, typical landscape biotopes, reed width and species & structure of reed zone below MHWL) are converted to a common EQR scale of 0-1, with an equal distance for each class unit according to the classification scheme in Tab. 1.

2.2.2 Metric 'Saltmarsh area' SMAr (CW and poly- und α-mesohalinicum of TW)

The metric is defined as the saltmarsh extent[4] as proportion of the water body.

Data input (Worksheet 'InputData'):

- Extent of water body - historic[5]
- Saltmarsh extent - historic

[4] **Note:** For CW and for the outer reaches of TW (e.g. 'Ems-Ästuar T1', 'Außenweser T1') the metric saltmarsh area comprises brackish and marine marshes and grassland (excl. pioneer zone and summer polder). For the inner reaches of TW (e.g. 'Unterems T1' and 'Unterweser T1') where brackish and marine marshes are rare the entire foreland (potential flooded marshland) is included in the metric.

[5] **Note:** As reference for CW and TW in Lower Saxony the year 1860 was chosen (but 1897 for the Ems area due to lack of data from 1860).

- Extent of water body – period 1
- Saltmarsh extent – period 1

+ In case

- Extent of water body – period 2
- Saltmarsh extent – period 2

+ In case

- Equivalent data of following management periods

For each valuation run – in general once in a management period of six years - the ratio between the area of the water body and the foreland area is calculated.

For each water body the so far highest percentage of the foreland area is selected as the reference ('Ref-Cond SM area (%)') which is used for the calculation of the current target size ('Applicable SM area (ha)') that corresponds to 'high ecological status' / 'good ecological potential').

In the worksheet 'MetricEQRs', the comparison of the target value and the actual value with consideration of the class boundaries (Tab. 1 or worksheet 'EQR-boundaries': 'SMAr proportion of reference saltmarsh') is used to calculate the MetricEQR 'SMAr' for each (partial) water body. These individual values are finally passed to the calculation of the FinalEQR in the worksheet 'Final EQR'

2.2.3 Metric 'Saltmarsh zones' (CW and Poly- und α-Mesohalinicum of TW)

The current number and dominance of the main saltmarsh zones is judged.

Data input (Worksheet 'InputData'):

- Area of pioneer zone (ha)
- Area of lower saltmarsh (ha)
- Area of upper saltmarsh (ha)
- Area of brackish marsh (ha)
- Area of grassland (ha)

For the evaluation of the parameter 'saltmarsh zones', the occurrence and relative area of the following saltmarsh zones are quantified with respect to the entire foreland area (including grassland and summer polder seaward the main dike):

- Pioneer zone
- Lower saltmarsh
- Upper saltmarsh
- Brackish marsh

The grassland is not taken into account directly at the level of the vegetation zones in the assessment system. In the calculations, the grassland areas, which in the German coastal area are largely recruited from former saltmarsh areas that today are embanked by low level dikes (summer polder), have an indirect effect on the corresponding reduction in the percentages of the other zones.

Note: In contrast to the metric 'saltmarsh area' (SMAr) the pioneer zone as well as grassland and summer polder are included for the 'total area' of this metric. As a consequence the sum of the zones which enter into the parameter 'saltmarsh zones' is larger than the 'applicable saltmarsh area' from the metric 'SMAr'.

In accordance with the relative area size of each saltmarsh zone, points are awarded according to the rules of the evaluation system (Tab. 2). This is implemented in the worksheet 'MetricEQRs'. From the sum of the point values, the MetricEQR for each water body or for its sub-areas is then calculated, taking into account the class limits (Tab. 1: 'Calculated value of SM-zones' TW or CW). This value is passed to further calculations in worksheet 'FinalEQR'.

2.2.4 Metric 'Typical landscape biotopes' (β-mesohalinicum- und oligohalinicum of TW)

The proportion of the typical landscape biotopes relative to the entire foreland is calculated and assessed for each water body (ARENS 2015b).

Data input (worksheet 'InputData'):

- Area of typical landscape biotopes (ha)
- Area of foreland (ha)

The reference value amounts 100%.That means at high ecological status the entire foreland should be covered by typical landscape biotopes.

For heavily modified water bodies the ecological potential has to be assessed. In this case the area covered by specific utilisation is excluded from the assessment. Examples are: Coastal protection structures harbour basins, green areas of settlements, buildings, traffic and industrial areas, arable and horticultural biotopes as well as anthropogenic altered lakes.

Based on the valid class boundaries (Tab. 1; here: 'Typical landscape biotopes') and the data entries in worksheet 'InputData' the MetricEQR for each water body is calculated in worksheet 'MetricEQRs' and passed to the worksheet 'FinalEQR'.

Tab. 2: Metric 'Saltmarsh zones': point evaluation for the proportion of saltmarsh zones present

	Proportion of saltmarsh zones relative to the total foreland (incl. grassland and summer polder seaward the main dike)		
Saltmarsh zone	maximum score 2 points	reduced score 1 point	
Pioneer zone	10 - 30%	5 - 10%	30 - 35%
Lower saltmarsh	20 - 50%	10 - 20%	50 - 60%
Upper saltmarsh	20 - 50%	10 - 20%	50 - 60%
Brackish marsh (TW) + (CW) Elbe N4*	20 - 40%	5 - 20%	--
Brackish marsh (CW)	--	1 - 10%	--

CW = coastal waters; TW = transitional waters

* Due to the fresh water inflow of the Elbe River (especially in the area of the islands) and the fresh water drains from moraines above the salt marshes, the CW water body Elbe N4 has a comparatively high percentage of brackish marsh. Thus it is treated like TW with respect to salt/brackish marsh zonation score.

Tab. 3: Metric ‘Reed width’ - Class boundaries and point values for the assessment of the ecological potential (oligo- / β-mesohaline reaches of the TW Weser and Ems: ‘Unterweser’ and ‘Ems’) – (after ARENS 2009, NLWKN 2010)

	high	good	moderate	poor	bad
Reed width (m) ‘Unterweser’	≥75	<75 - 50	<50 - 25	<25 - 10	<10
Reed width (m) ‘Ems’	≥30	<30-20	<20-10	<10 - 5	<5
point value	5	4	3	2	1

2.2.5 Metric ‘Reed width’ (β-mesohalinicum- und oligohalinicum of TW)

The total width of the reed bed present is to be assessed. For data input pre-classified data are required (Tab. 3).

Data input (worksheet ‘InputData’):

- Reed width ‘high’ - sum of segments (m)
- Reed width ‘good’ (GES) - sum of segments (m)
- Reed width ‘good ecological potential or better’ (GEP) - sum of segments (m)
- Reed width ‘moderate’ - sum of segments (m)
- Reed width ‘poor’ - sum of segments (m)
- Reed width ‘bad’ - sum of segments (m)

The classification of the reed width is carried out beforehand by means of regional reference values. Corresponding point values are assigned to the five classes. A reed width of 75 m for the river Weser respectively 30 m for the river Ems are set as reference value.

The collection of the input data is carried out in the following steps:

- Relevant shore sections[6] are assigned to the rating classes (Tab. 3) according to the width of their reed beds.
- The lengths (m) of the shore sections of the same evaluation class are added,
- The sums (m) of the respective classes are entered in worksheet ‘InputData’

Within the Excel-matrix in worksheet ‘MetricEQR’, the data are processed according to the rules of the evaluation system: The percent share of each assessment class is multiplied by the respective point value (Tab. 3) and the ‘MetricEQR’ based on the class boundaries (Tab. 1: ‘Classification of reed width’) is calculated for each (sub) water body. Finally the ‘MetricEQR’ is passed to worksheet ‘FinalEQR’ where the Final-EQR for each water body is computed.

2.2.6 Metric ‘Species & structure of reed zone below MHWL’ (β-mesohalinicum- und oligohalinicum of TW)

In this metric, the species stock of the reed bed and the population structure below the MHWL are compared with a water type specific reference. The percent share of stenotope and eurytope species as well as the extent, zonation and vitality of the reeds are considered. By means of a specific evaluation procedure (STILLER 2011), data collected on monitoring sites (permanent quadrats) along the shore are assessed and the results are transferred to those sections of the shoreline which resemble the character of the respective permanent quadrat. In addition to the vegetation characteristics, the bank structure and the reed width below MHWL also play a role.

Input data pre-classified according to STILLER (2011) are required. Depending on the characteristics mentioned above, four evaluation classes are assigned to the route segments. The lengths of the segments are summed by class.

Data input (worksheet ‘InputData’):

- Sum of segments (m) ‘good ecological potential or better’
- Sum of segments (m) ‘moderate’
- Sum of segments (m) ‘poor’
- Sum of segments (m) ‘bad’

[6]Reference value is the total shore length at MHWL (= reference route for the ecological status calculation). For the determination of the ecological potential, the share of the stretches with specific utilisation is not included.

Within the Excel-matrix in worksheet ‘MetricEQR’, the data are processed according to the rules of the evaluation system (STILLER 2011): The percent share of each assessment class is multiplied by the respective point value (‘good ecological potential or better’: 4 p; ‘moderate’: 3 p; ‘poor’ 2 p; ‘bad’: 1 p) and the ‘MetricEQR’ based on the class boundaries (Tab. 1 ‘Classification of species & structure of reed zone below MHWL’) is calculated for each (sub) water body. Finally the ‘MetricEQR’ is passed to worksheet ‘FinalEQR’ where the FinalEQR for each water body is computed.

3 Summary

For the evaluation of the coastal and transitional waters according to the European Water Framework Directive calculation tools are helpful which perform both the required conversion of parameter data from various biological quality elements (BQE) into an EQR (ecological quality ratio) between 0-1 and perform a classification according the five-class evaluation system (high, good, moderate, poor, bad).

This document explains the EQR calculation matrix ‘SKIPPER-DE’: An Excel workbook based on the British Excel application SKIPPER (*Saltmarsh Key Indicators Processed Precisely and Estimated Robustly*). SKIPPER-DE is used to calculate the EQR for ‘Reeds and saltmarsh vegetation in coastal and transitional waters’ according to the German assessment system.

SKIPPER-DE can also be used for the calculation of the EQR with data from other regions/member states; in this case, the region-specific reference values have to be added.

4 Literature

ARENS, S. (2006): Bewertungssystem nach WRRL für die Angiospermen der Übergangs- und Küstengewässer der FGE Weser und für das Küstengewässer der FGE Elbe. Bericht des NLWKN - Betriebsstelle Brake-Oldenburg-Wilhelmshaven. 94 p. + appendices 19 p.

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Appendix 1: Overview on data requirements of SKIPPER-DE for the evaluation of reeds, brackish marshes and saltmarshes for different water body types

		WB	Coastal wb with barrier islands		Coastal wb without barrier islands	Transitional wb with salinity subzones		Transitional wb without salinity subzones	Transitional wb without salinity subzones
		WB_Cat	CW		CW	TW		TW	TW
		Goal	GES		GES	GEP		GEP	GEP
		Subregion	Mainland coast	Barrier islands	Mainland coast	Poly- / α-Mesohaline	β-Meso-/ Oligohaline	Poly- / α-Mesohaline	β-Meso-/ Oligohaline
		Location	outer		outer	outer	inner	outer	inner
From historic reference (in Germany 1860)	Historic SM and WB extent	Historic data: WB area (ha)	X	X	X	X	X	X	X
		Historic data: SM area (ha)	X	X	X	X	X	X	X
From former and recent investigations	Measured extent	WB area (ha)	X	X	X	X	X	X	X
		SM area (ha)	X[1]	X[1]	X[1]	X[1]	X	X[1]	X
From recent investigations	Saltmarsh zones (ha)	Pioneer	X	X	X	X	not applicable	X	not applicable
		Low	X	X	X	X		X	
		Upper	X	X	X	X		X	
		brackish	X	X	X	X		X	
		Grassland	X	X	X	X		X	
	Typical biotopes (ha)	Typical biotopes (ha)	not applicable		not applicable	not applicable	X	not applicable	X
		Total SM (ha)					X		X
	Reed width (m)	Length of shoreline (m) per reed-width-class					X		X
	Species & structure of reed zone below MHWL	Length of shoreline (m) per spec/struct. - class					X		X

[1]: without pioneer zone and diked marsh