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Annex

North East Atlantic GIG: Coastal Waters - Macroalgae and Angiosperms

Macroalgae - Parameter intertidal or subtidal macroalgae rocky bottom

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1. Introduction

- Seven Member States (France, Portugal, Spain, Ireland, Norway, United Kingdom and Sweden) compared and harmonised their national assessment systems for the common types NEA1/26 A2 intertidal macroalgae (France, Portugal and Spain), NEA1/26 B21 intertidal macroalgae (Ireland, Norway, United Kingdom), NEA7 intertidal macroalgae (Norway, United Kingdom), Type NEA8a/9/10subtidal macroalgae (Norway, Sweden).
- The intercalibration for the common type NEA 1/26 subtidal (ES, FR) has not been possible due to the scarcity of potential common sites to be considered in time. The intercalibration for the Type NEA 5 (DE) has not been possible because there is only a MS involved in this type. The Intercalibration for the common type NEA 8b subtidal has been not possible due to differences of assessment concept.
- **The information provided in the present report is only regarding the national methods with results included in the Annex I of the EC Decision.** The rest information on national methods, and provided by the work group, is not included in this report, but you can find it in the CIRCA website.
- The national methods for the common types intercalibrated address eutrophication pressure.
- In the case of the common types NEA1/26 A2 intertidal macroalgae, NEA1/26 B21 intertidal macroalgae, and NEA7 intertidal macroalgae a IC Option 2 was used- indirect comparison of assessment methods using a common metric. In the case of the common type NEA 8a/9/19 subtidal macroalgae a IC option 1 was used, as the MS use the same method and there are no significant differences in the data acquisition.
- The final results include EQRs of France, Portugal, Spain, United Kingdom, Ireland, Sweden and Norway, CW intertidal and subtidal macroalgae rocky bottom assessment systems for 4 CW common intercalibration types: NEA1/26 A2 intertidal macroalgae, NEA1/26 B21 intertidal macroalgae, NEA7 intertidal macroalgae and NEA8a/9/10subtidal macroalgae.

2. Description of national assessment methods

Table 2.1 Overview of the national assessment methods.

Member State	Method	Included in this IC exercise
Intertidal Macroalgae		
Belgium (BE)	Intertidal or subtidal macroalgae not relevant due to absence of natural rocky habitat[1]	No
Germany (DE)	HPI = Helgoland Phytobenthic Index (Macroalgae at intertidal and subtidal rocky shores)	No
Spain (ES)-Cantabria region	CFR = Quality of Rocky Bottoms (Calidad de Fondos Rocosos in Spanish)	Yes
Spain (ES)-Basque country	RICQI = Rocky Intertidal Community Quality Index	Yes
Spain (ES)-Andalusia region	RSL = Reduced Species List	Yes
France (FR)	CCO = Cover, Characteristic species, Opportunistic species on intertidal rocky bottoms	Yes
Ireland (IE)	RSL = Rocky Intertidal Macroalgae - Reduced Species List	Yes
Norway (NO)	RSLA = Macroalgae - Rocky Shore Reduced Species List with Abundance	Yes
Portugal (PT)	PMarMAT = Marine Macroalgae Assessment Tool	Yes
United Kingdom (UK)	RSL = Macroalgae - Rocky Shore Reduced Species List	Yes
Subtidal Macroalgae		
Denmark (DK)	Total macroalgal cover, No. of perennial species, ratio of opportunists.	No
France (FR)	QI Sub Mac Fr – Quality Index of Subtidal MACroalgae of French channel and Atlantic coast	No
Spain (ES)	CFR = Quality of Rocky Bottoms (*Calidad de Fondos Rocosos* in Spanish)	No
Norway (NO)	MSMDI = Multi Species Maximum Depth Index	Yes
Sweden (SE)	MSMDI = Multi Species Maximum Depth Index	Yes

[1] As justified in Van Damme *et al.*, 2007 p. 43 Macroalgae and angiosperms are not included in the analysis for the Belgian Coastal Waters due to the fact that they are not occurring along the Belgian Coast. The only macroalgae occurring along the Belgian Coast grow on man-made hard constructions like dikes and groins. Because they need a hard substrate (e.g. rocky shores) to attach themselves they were not likely to occur along the sandy beaches of Belgium before these anthropogenic alterations of the beach area took place. The sandy intertidal Belgian strip also couldn't be colonised by macroalgae due to the strong current effects and wave action upon the coastline.

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2.1. Methods and required BQE parameters

Table 2.2 Overview of the metrics included in the national assessment methods. The information provided in the present report only is regarding the national methods with results included in the Annex I of the EC Decision.

Member State	Full BQE method	Abundance	Disturbance sensitive taxa	(Diversity)	Combination rule of metrics
INTERTIDAL MACROALGAE					
Spain-Cantabria Region (CFR)	Yes	Yes	Yes	Yes (Richness of Characteristic species)	Weighted average
Spain –Basque Country (RICQI)	Yes	Yes	Yes	Yes, as species richness	Weighted average
Spain-Andalusia (RSL)	Yes	No	Yes	Species richness	Weighted average
France (CCO)	Yes	Yes	Yes	Yes, (as richness of characteristic species	Weighted average
Ireland (RSL)	Yes	No	Yes	Species richness	Average of EQRs for normalised metrics
Norway (RSLA)	Yes	Yes	Yes	Yes (Selected species with abundance)	Weighted average
Portugal (PMarMAT)	Yes	Yes	Yes	Yes (from a Reduced Taxa List)	Weighted average
United Kingdom (RSL)	Yes	No	Yes	Species richness	Average of EQRs for normalised metrics
SUBTIDAL MACROALGAE					

NO (MSMDI)	Yes	Yes	3 to 9 selected perennial eutrophication sensitive species	Minimum 2-5% cover of 9 indicative species	Weighted average
SE (MSMDI)	Yes	Yes	3 to 9 selected perennial eutrophication sensitive species	No	Weighted average

Intertidal Macroalgae

Spain(Cantabria region) - CFR = Quality of Rocky Bottoms
V-3.0. Continuous EQR Scale)
(Perennial Intertidal/Subtidal Macroalgae & Opportunistic macroalgae)

The CFR Index (Quality of Rocky Bottoms) was developed in Spain by Juanes *et al.* (2008). The method tried to provide a quantitative approach that may reflect, in a homogeneous way, the ecological condition of the hard substrate habitats all through the extent of the water bodies (intertidal+subtidal). Based on independent assessments of the status at different bathymetric levels (intertidal/ depth ranges), the index provides a tool for the consideration of all the possible "coastal reef habitats" that, according to the normative (e.g. Habitat Directive) or the expert judgements, are important in each water body. The first version of the index was composed of four indicators and was tested against different pollution gradients, from urban and industrial discharges (Guinda *et al.*, 2008). Main results from that sensitivity analysis against specific pressures suggested the elimination of one of the four indicators, the "physiological status of macroalgae", because of the subjectivity associated to the evaluation of this variable. The simplified assessment concept of the CFR index was successfully intercalibrated with the PMarMAT index of Portugal during the first intercalibration phase (Carletii and Heiskanen 2009). However, the requirements established in the second IC phase demanded a more precise scoring system based on a "continuous quality scale", in accordance to the Ecological Quality Ratio (EQR) scale of the WFD. Finally, its widespread application to different coastal areas within the southern NEA justified the acceptance of the CFR as the "common metric" for the IC of this sub-element within the type 1/26 A2 (ES/FR/PT).

The final structure of the CFR index (Guinda *et al.*, 2014. Information in web application: https://cfr.ihcantabria.com/) includes three indicators:

- Coverage of "characteristic macroalgae" (C)
- Fraction of opportunistic species (F)
- Richness of "characteristic macroalgae" (R)

The first indicator (**C: Coverage of CM**) accounts for the total percentage coverage of characteristic macroalgae species (CM), considered all together. This group of species is mostly composed of late successional or perennial macroalgae occurring at the application site.

The second indicator (**F: Fraction of opportunistics**) accounts for the fraction of opportunistic species relative to the total vegetated surface. It is calculated according to:

$$F = \left(\frac{O}{(C+O)} \right) \times 100 \qquad \text{where,} \quad \begin{cases} \text{F : Fraction of Opportunistics (\%)} \\ \text{O : Coverage of Opportunistics (\%)} \\ \text{C : Coverage of CM (\%)} \end{cases}$$

The third indicator (**R: Richness of CM**) accounts for the number of different "characteristic macroalgae" species that present a significant coverage (ca. >1%).

The list of characteristic and opportunistic macroalgae should be elaborated according to the species composition in the application region. The following table resumes the most common species for the Cantabrian coast (N Spain):

Table 2.3 List of most common opportunistic and characteristic macroalgae species for the Cantabrian coast (N Spain).

Characteristic Macroalgae		**Opportunistic species**
Intertidal	Subtidal	
Bifurcaria bifurcata	*Calliblepharis ciliata*	*Blidingia* spp.
Caulacanthus ustulatus	*Cladostephus spongiosus*	*Bryopsis* spp.
Champiaceae	*Codium tomentosum*	*Ceramium* spp.
Chondracanthus spp.	*Corallina / Jania* spp.	*Chaetomorpha* spp.
Chondrus crispus	*Cystoseira baccata*	*Cladophora* spp.
Cladostephus spongiosus	*Cystoseira tamariscifolia*	Ectocarpales
Codium tomentosum	*Desmarestia ligulata*	Filamentous *Ulva* spp.
Corallina / Jania spp.	*Dictyopteris membranacea*	Foliose *Ulva* spp.
Cystoseira baccata	*Dictyota dichotoma*	*Rhizoclonium* spp.
Cystoseira tamariscifolia	*Gelidium corneum*	
Fucus spp.	*Halidrys siliquosa*	
Gelidium corneum	*Halopithys incurvus*	
Gelidium spinosum	*Halopteris filicina*	
Gigartina spp.	*Halurus equisetifolius*	
Gymnogongrus / Ahnfeltiopsis spp.	*Heterosiphonia plumosa*	
Halurus equisetifolius	*Himanthalia elongata*	
Himanthalia elongata	*Laminaria ochroleuca*	
Laminaria ochroleuca	*Peyssonnelia* spp.	
Laurencia / Osmundea spp.	*Phyllophora* spp.	
Leathesia / Colpomenia spp.	*Saccorhiza polyschides*	
Mastocarpus stellatus	*Spatoglossum solieri*	
Nemalion helminthoides	*Sphaerococcus coronopifolius*	
Saccorhiza polyschides	*Stypocaulon scoparium*	
Stypocaulon scoparium	*Taonia atomaria*	

The final CFR value is calculated by a weighted average of the scores obtained for each of the three indicators.

Spain (Basque country) - RICQI = Rocky Intertidal Community Quality Index

RICQI (Díez *et al.,* 2012) is a quantitative multimetric method for assessing the ecological status of rocky intertidal communities on open coastal stretches of the Iberian peninsula (Atlantic). Several metrics were combined in the RICQI, following the expression: RICQI = SpBio (ESS + PC) + MCA + R (Ra +Rf) + FC (Pf + Ch + Cs)

SpBio: Indicator Species. The term SpBio consists of two components (ESS: ecological status similarity, and PC: presence of *Cystoseira*). The first component (ESS) is related to the similarity between the average inventory representing the benthic assemblages under quality evaluation and the five reference inventories that represent communities from bad to high ecological conditions.

Algae of the genus *Cystoseira* are used as sensitive species to anthropogenic disturbances. This indicator is used to establish differences between pristine and degraded environments by means of the PC component, which acts as a correction factor.

MCA: Morphologically Complex Algae.

R: Species Richness. The term R consists of two components (Ra: algal species richness, and Rf: faunal species richness).

FC: Faunal Cover. The term FC consists of three components (Pf, Ch and Cs). Pf is the percentage of faunal cover with respect to the whole benthic community cover (invertebrates plus algae).

Spain (Andaludia region) - RSL = Reduced Species List

The RSL index was developed by Wells *et al.* (2007) for the coasts of the British Isles. This is a multimetric index based on species occurrence from a reduced species list in 50 meters transects. In this case, this index was applied according to the adaptation proposed by Bermejo *et al.* (2012) for the Atlantic coast of Andalusia, which provided a new reduced species list for this area (table 2.4), a new correction factor (eqs. 1, 2, 3 and 4; shore score is calculated according to the table 2.5 extracted from Wells *et al.*, 2007), and some elements modified used to assess the ecological status: species richness of a reduced species list; number of red algae – instead of percentage of red algae-; proportion of green algae; proportion of ESG I (ecological status group) – instead of ESG ratio -, and proportion of opportunist species.

Table 2.4 Reduced species list of macroalgae for the Atlantic southern Spanish coast, Ecological Status Group (ESG) and opportunistic character.

Chlorophyta	**ESG eco.**	**Rhodophyta**	**ESG eco.**
Bryopsis spp.	II	*Delesseriaceae****	I
Chaetomorpha spp.	II (o)	*Asparagopsis armata*	II
Cladophora spp.	II	*Botryocladia botryoides*	I
Codium spp erect*	II	*Caulacanthus ustulatus*	I
Codium spp encrusting**	II	*Ceramium spp.*	II
Codium bursa	II	*Chondracanthus Acicularis*	II
Derbesia spp.	II (o)	*Corallina sp.*	II
Flabellia Petiolata	I	*Gelidium microdon*	I
Pedobepsia simplex	II	*Gelidium spinosum*	II
Enteromorpha spp.	II (o)	*Gelidium corneum*	I
Ulva spp.	II (o)	*Gelidium pusillum*	II
Valonia utricularis	II	*Gymnogongrus & Ahnfetiopsis*	I
Ochrophyta	**ESG eco.**	Halopithys incurva	I
Cladostephus spongiosus	I	*Halurus equisetifolius*	II
Colpomenia sinuosa	II	*Hildenbradia rubra*	I
Cystoseira compressa	I	*Jania rubens*	I
Cystoseira spp.	I	*Laurencia obtusa*	II
Cystoseira usneoides	I	*Lithophyllum byssoides*	I
Dictyota dichotoma	II	*Lithophyllum dentatum*	I
Dictyopteris polypodioides	II	*Lithophyllum incrustans*	I
Fucus spiralis	I	*Nemalion helminthoides*	I
Halopteris spp.	II	*Lomentaria articulata*	II
Saccorhiza polyschides	I	*Osmundea pinnatifida*	I
Padina pavonica	I	*Osmundea hybrida*	II
Laminaria ochroleuca	I	*Peyssonnelia spp.*	I
Ectocarpus & Sphacelaria	II (o)	*Plocamium cartilagineum*	II
		Pterocladiella capillacea	II
		Pterosiphonia complanata	II
		Rhodymenia & Schottera	I
		Sphaerococcus coronopifolius	II

(o) Species considered as opportunists

* Erect *Codium*: *C. tomentosum*, *C. fragile*, *C. vermilara* and *C. decorticatum*

**Encrusting *Codium*: *C. adhaerens* and *C. effusum*.

*** Deleseiraceae: *Acrosorium uncinatum*, *Cryptopleura ramulosa* or *Haraldiophyllum bonnemaisonnii*.

1. Shore score = Presence of turbidity (0 or 2) + Sand scour (0 or 2) + Dominant shore type (from 0 to 4) + Subhabitats (from 0 to 4)* + Total number of subhabitats (from 0 to 4)
2. Expected species richness = 6.3371 * $e^{0,0982 \cdot \text{Shore score}}$
3. Correction factor = 23/expected species richness
4. Corrected species richness = Correction Factor * observed species richness

* For subhabitat scoring only must be considered a type of subhabitat, which have the maximum value. For instance, if in the locality basic rock pools (3) and caves (1) appear, the subhabitat scoring value is 3.

Table 2.5 Scoring system to calculate the correction factor (Wells et al., 2007).

General information							
Shore name			Date				
Water body			Tidal height				
Grid ref.			Time of low tide				
Shore descriptions							
Presence of turbidity (known to be non-anthropogenic)	Yes	=0	Sand scour	Yes	=0	No	=2
	No	=2	Chalk shore	Yes	=0	No	=2
Dominant shore type			*Subhabitats*				
Rock ridges/outcrops/platforms		=4	Wide shallow rock pools (>3 m wide and <50 cm deep)				=4
Irregular rock		=3					
Boulders large, medium and small		=3	Large rockpools (>6 m long)				=4
Steep/vertical rock		=2	Deep rockpools (50% >100 cm deep)				=4
Non-specific hard substrate		=2	Basic rockpools				=3
Pebbles/stones/smallrocks		=1	Large crevices				=3
Shingle/gravel		=0	Large overhangs and vertical rock				=2
Dominant biota			Others habitats (please specify)				=2
Ascophyllum							
Fucoid							
Rhodophyta mosaics			Caves				=1
Chlorophyta			None				=0
Mussels			*Total number of subhabitats*				
Barnacles			>4	3	2	1	0
Limpets							
Periwinkles							
General comments							

(FR) France - CCO = Cover, Characteristic species, Opportunistic species on intertidal rocky bottoms

This index has been adapted first to the Breton shore line, and then to Atlantic and Channel coasts of France from the CFR index developed in Spain (Juanes *et al.*, 2008).

It is applied on shores exhibiting essentially bedrock surfaces (reduced surface of boulders, sand, mud or gravels, large boulders being acceptable at lowest levels), if possible within the range 30 – 100 m width and 100 – 300 m length, and comprising most of the intertidal belts occurring in a given area.

It takes into account 3 metrics:

- the contribution of each macroalgal community / habitat, referred to as a belt, to the global plant covering of a given intertidal rocky shore (maximum 40 points) = ponderating / correcting factor
- the number of characteristic species (maximum 30 points)
- the total cover of opportunist species in every belt (maximum 30 points).

The index corresponds therefore to a notation out of 100, summing the points obtained in the calculation of the above three sub-indexes, and this notation is converted into an EQR (scale from 0 to 1).

A total of 6 belts can be considered, depending on their availability on the shore: *Pelvetia canaliculata* (Pc); *Fucus spiralis* (Fspi) ; *Ascophyllum nodosum* (An) / *Fucus vesiculosus* (Fves); *Fucus serratus* (Fser) / Rhodophyceae, *Himanthalia elongata* (He) / *Bifurcaria bifurcata* (Bb) / Rhodophyceae ; *Laminaria digitata* (Ld) / Laminariales.

The complete list of characteristic macrophytic species on Breton rocky shores (extended to North of Biscay and West Channel) in the intertidal zone (microhabitats such as ponds are excluded), is the following:

Ascophyllum nodosum

Asparagopsis armata / Falkenbergia rufolanosa

Bifurcaria bifurcata

Calliblepharis jubata

Catenella repens

Chondracanthus acicularis

Chondrus crispus

Cladophora rupestris

Corallina spp. pour C. elongata + C. officinalis + Haliptilon squamatum

Cryptopleura ramosa

Cystoclonium purpureum

Fucus serratus

Fucus spiralis

Fucus vesiculosus

Gelidium spinosum = G. pulchellum = G. latifolium

Gelidium pusillum

Hildenbrandia rubra = H. prototypus

Himanthalia elongata

Laminaria digitata

Laminaria saccharina

Laurencia obtusa ou L. hybrida

Lichina pygmaea

Lithophyllum incrustans

Lithothamnion lenormandii

Lomentaria articulata

Mastocarpus stellatus / Petrocelis cruenta

Osmundea pinnatifida = Laurencia pinnatifida

Palmaria palmata
Pelvetia canaliculata
Plumaria plumosa
Rhodothamniella floridula
Saccorhiza polyschides
Verrucaria maura

The number of characteristic species per belt is not the same in every coastal zone of France, in order to take into account bio-geographical variations:

	Pelvetia+ Fucus spriralis	***Ascophyllum / F. vesiculosus***	***Fucus serratus***	***Himanthalia /Bifurcaria***	***Laminaria digitata***
Bretagne (Vendée - Cotentin)	7	13	15	19	17
Charentes	7	12	11	14	17
Manche Orientale	7	13	15	15	14
Basque Country	*Corallina spp.* + *Caulacauthus* (higher intertidal)		*Stypocaulon scoparium* + *Gelidum spp.* (lower intertidal)		
	7		12		

Concerning the cover by the opportunistic species, the sub-index takes into account the following taxa, whatever the level:

Phaeophyceae	Ectocarpales (Ectocarpaceae : *Ectocarpus spp.*, *Pylaiella spp.*, *Hincksia spp.*)
Chlorophyceae	*Enteromorpha compressa*
	Enteromorpha ramulosa
Rhodophyceae	*Ulva spp.*
	Ceramium spp.
	Polysiphonia spp. (excluding both : *P. lanosa* and *P. elongata*)
Colonial microalgae	*Boergeseniella spp.*
	Diatoms (either epiphytic or epilithic)

Ireland & (UK) United Kingdom - RSL = Rocky Intertidal Macroalgae - Reduced Species List (NEA 1/26, NEA 7)

The RSL is a multi-metric index developed by the UKTAG (United Kingdom Technical Advisory Group; Wells, 2010) and applied also to the Republic of Ireland. The tool applies to natural, stable rocky substrata in coastal waters and is based broadly on the principle that species richness has been shown to remain constant in the absence of anthropogenic disturbance (Wilkinson & Tittley, 1979). The individual metrics have been combined on order to best describe the changes in the structure and composition of intertidal rocky shore macroalgae communities due to anthropogenic pressures. There are no universally recognised disturbance-sensitive taxa per se, but opportunist species are incorporated into the index. Abundance is not included in the tool, as it was deemed to be an inappropriate metric, and the justification for this is given below.

The main pressures applicable to the tool are toxic substances, habitat modification and general disturbance (organic enrichment and nutrient enrichment impacts may be detected if the impact is severe, but are considered to be secondary pressures).

The index is composed of 5 equally-weighted metrics:

- Numerical species richness which incorporates a de-shoring factor to correct for the overall physical nature of the shore and its suitability for algal attachment;
- The proportion of Rhodophyta species within the overall sample;
- The proportion of Chlorophyta species within the overall sample;
- The proportion of opportunistic species (fast-growing potentially nuisance algae) within the overall sample;
- The ratio of perennial forms (ESG I) to annual or ephemeral forms (ESG II).

The species richness component is normalised against a shore factor to enable different shore types to be directly comparable regardless of localised natural environmental factors such as diversity of sub-habitats.

Full species lists were used initially to derive 3 overlapping geographically-related RSLs covering the British Isles. These lists are comprised of 68-70 taxa identified to define mixed taxon level (generally species level, see Table 2.6). All algal taxa at a site are registered qualitatively; the site extent is defined on locally-determined geographic boundaries, but in the UK should generally be between 100m and 300m in lateral extent: in Ireland a stretch of 8m is used. Sampling should take place between late April and September and at times of good spring tides, with three or more sites per waterbody). Studies of overall shore structure and assemblage, using data from the Northern Ireland Littoral Survey (Wilkinson *et al.*, 1988), indicated a link between species richness and localised intertidal variables (Wells and Wilkinson, 2002). In response to this, localised environmental factors were incorporated into the metric system to enable the shore to be normalised ("de-shored") for their levels of species richness and therefore directly comparable regardless of the shore type. Shore description factors are shown in Table 2.7 The number of species is therefore adjusted according to the expected number found on the site based on a 'de-shoring' factor for the shoreline. This uses an exponential-type model of the form:

RICHNESS = a + b exp (cSHORE)

where a, b and c are parameters to be estimated from the data. Using least squares, these parameters were estimated to be:

a = 14.210

b = 4.925

c = 0.108

Correction factors are shown in Table 2.8.

Table 2.6 UK and Ireland Reduced Species lists

Species List	Eng Wales RoI	NI	Scot Eng		Eng Wales RoI	NI	Scot Eng
Greens				**Reds**			
Blidingia sp.	1	1	1	Aglaothamnion/Callithamnion	1	1	1
Bryopsis plumosa	1			Ahnfeltia plicata	1	1	1
Chaetomorpha linum	1	1	1	Audouinella purpurea		1	
Chaetomorpha mediterranea	1	1		Audouinella sp		1	
Chaetomorpha melagonium	1		1	Calcareous encrusters	1	1	1
Cladophora albida		1		Callophyllis laciniata			1
Cladophora rupestris	1	1	1	Catenella caespitosa	1	1	
Cladophora sericea	1	1	1	Ceramium nodulosum	1	1	1
Enteromorpha sp.	1	1	1	Ceramium shuttleworthanium	1	1	1
Monostroma grevillei		1		Ceramium sp.	1		
Rhizoclonium tortuosum		1		Chondrus crispus	1	1	1
Spongomorpha arcta		1		Corallina officinalis	1	1	1
Sykidion moorei			1	Cryptopleura ramosa	1	1	1
Ulothrix sp		1		Cystoclonium purpureum	1	1	1
Ulva lactuca	1	1	1	Delesseria sanguinea			1
Sub-totals	**9**	**12**	**8**	Dilsea carnosa	1	1	1
Browns				Dumontia contorta	1	1	1
Alaria esculenta		1	1	Erythrotrichia carnea	1		1
Ascophyllum nodosum	1	1	1	Furcellaria lumbricalis	1	1	1
Asperococcus fistulosus		1	1	Gastroclonium ovatum	1		
Chorda filum	1		1	Gelidium sp.	1	1	
Chordaria flagelliformis			1	Gracilaria gracilis	1		
Cladostephus spongious	1	1	1	Halurus equisetifolius	1		
Desmarestia aculeata			1	Halurus flosculosus	1		
Dictyosiphon foeniculaceus			1	Heterosiphonia plumosa	1		
Dictyota dichotoma	1	1	1	Hildenbrandia rubra	1	1	
Ectocarpus sp.	1	1	1	Hypoglossum hypoglossoides	1		
Elachista fucicola	1	1	1	Lomentaria articulata	1	1	1
Fucus serratus	1	1	1	Lomentaria clavellosa			1
Fucus spiralis	1	1	1	Mastocarpus stellatus	1	1	1
Fucus vesiculosus	1	1	1	Melobesia membranacea		1	
Halidrys siliquosa	1	1	1	Membranoptera alata	1	1	1
Himanthalia elongata	1	1	1	Nemalion helminthoides	1		
Laminaria digitata	1	1	1	Odonthalia dentata		1	1
Laminaria hyperborea	1		1	Osmundea hybrida	1	1	1
Laminaria saccharina	1	1	1	Osmundea pinnatifida	1	1	1
Leathesia difformis	1	1	1	Palmaria palmata	1	1	1
Litosiphon laminariae			1	Phycodrys rubens			1
Pelvetia canaliculata	1	1	1	Phyllophora sp.	1	1	1
Petalonia fascia		1		Plocamium cartilagineum	1	1	1
Pilayella littoralis	1	1	1	Plumaria plumosa	1	1	1
Ralfsia sp.	1	1	1	Polyides rotundus	1		1
Saccorhiza polyschides	1			Polysiphonia fucoides	1	1	1
Scytosiphon lomentaria	1	1	1	Polysiphonia lanosa	1	1	1
Sphacelaria sp		1		Polysiphonia sp.	1	1	1
Spongonema tomentosum		1	1	Porphyra leucosticta			1
Sub-totals	**20**	**22**	**26**	Porphyra umbilicalis	1	1	1
				Ptilota gunneri			1
				Rhodomela confervoides	1	1	1
				Rhodothamniella floridula	1	1	1
				Sub-totals	**40**	**34**	**36**
				Totals	**69**	**68**	**70**

Table 2.7 Field sampling sheet to record basic shore descriptions with scores indicating the weighting of each of the shore characteristics to be used in the final scoring system.

General Information			
Shore Name		**Date**	
Water Body		**Tidal Height**	
Grid Ref.		**Time of Low Tide**	

Shore Descriptions							
Presence of Turbidity (known to be non-anthropogenic)	**Yes**	=0	**Sand Scour**	**Yes**	=0	**No**	=2
	No	=2	**Chalk Shore**	**Yes**	=0	**No**	=2

Dominant Shore Type		**Subhabitats**				
Rock Ridges/Outcrops/Platforms	=4	Wide Shallow Rock Pools (>3m wide and <50cm deep)				=4
Irregular Rock	=3					
Boulders large, medium and small	=3	Large Rockpools (>6m long)				=4
Steep/Vertical Rock	=2	Deep Rockpools (50% >100cm deep)				=4
Non-specific hard substrate	=2	Basic Rockpools				=3
Pebbles/Stones/SmallRocks	=1	Large Crevices				=3
Shingle/Gravel	= 0	Large Overhangs and Vertical Rock				=2
Dominant Biota		Others habitats (please specify)				=2
Ascophyllum						
Fucoid						
Rhodophyta mosaics		Caves				=1
Chlorophyta		None				=0
Mussels		**Total Number of Subhabitats**				
Barnacles		>4	3	2	1	0
Limpets						
Periwinkles						

General Comments

Table 2.8 De-shoring correction factors for the RSL

Points	Predicted species richness	Correction-factor
5	22.66	1.72
6	23.62	1.65
7	24.7	1.58
8	25.89	1.51
9	27.22	1.44
10	28.7	1.36
11	30.36	1.29
12	32.2	1.21
13	34.25	1.14
14	36.53	1.07
15	39.08	1
16	41.91	0.93
17	45.07	0.87
18	48.58	0.8
19	52.5	0.74
20	56.87	0.69

Justification for the UK/Ireland rocky shore tool for non-inclusion of abundance

The U.K./Ireland tool for macroalgae applies only to natural, hard surfaces in coastal waters, where a broad range of algae can be found under good conditions. It responds to the primary pressures of toxic substances and disturbance. Eutrophication may be considered a secondary pressure, but only where effects are severe.

Various studies (e.g. Wilkinson & Tittley, 1979; Wells, 2002; Wells & Wilkinson, 2003) have shown that there is a regular turnover of ephemeral species in communities of seaweeds even under good ecological conditions, but that numerical species richness remains broadly constant. Species composition at a site is known to vary only very slightly on consecutive days solely through variation in field sampling (Wells, 2002), while richness remains constant. The reasons for the variation in ephemeral species are not well understood. Taxonomic composition is therefore not constant and so is not defined as such in the tool. Rather, it is represented by additional measures such as the ratio of numbers of species in ecological status groups, ESG1:ESG2 (derived from Orfanidis et al, 2001) and the proportions, by species number, of red and green algae which reflect changes in community composition (Wells et al., 2007), in combination with species richness.

Annex 5, section 1.4.1 (i) of the Directive (WFD, 2000) states that “Member States shall establish monitoring systems for the purpose of estimating the values of the biological quality elements specified for each surface water category ... Such systems may utilise particular species or groups of species which are representative of the quality element as a whole." The reduced species list (RSL), derived through analysis of a large data set, is considered to fulfil this criterion.

Although taxonomic richness is included in the tool, there is no definition of sensitive species, as there is no agreed list of sensitive taxa for any particular situation (Wells et al, 2007; Wilkinson & Wood, 2003).

Abundance, as required by the WFD, presents a difficulty as the abundance of seaweeds on a rocky shore may undergo massive changes over a period of time due to natural variability (Wilkinson & Wood, 2003). Hawkins & Hartnoll (1983) documented change in permanent quadrats from total fucoid domination to barnacle domination and back again in a cyclic succession over a period of about 10 to 15 years. Contrary to what might be expected, such changes in abundance of dominant seaweeds may not result in a large change in seaweed species richness (Wells & Wilkinson, 2002, 2003). It is therefore virtually impossible to determine "The levels of macroalgal cover…consistent with undisturbed conditions" (WFD, 2000) given as a normative definition for rocky shores. Unimpacted shores in the British Isles may be dominated by animal cover or by plant cover or by an intermediate situation (Lewis, 1964), but the seaweed species richness may be similar on both animal dominated and plants dominated shores (Wells & Wilkinson, 2002). Abundance is further complicated by the influence of hydromorphological factors, with no general established relationship between algal cover and these factors.

Given the complex range of natural factors affecting seaweed abundance on rocky shores, and the often cyclical, successional nature of abundance, it was considered impractical and potentially misleading to include abundance *per se* in the assessment tool. Abundance of opportunist algae was also considered inappropriate, largely for the same reasons, but also because it can be due to natural factors such as sand scour and freshwater ingress. The possibility of macroalgal nuisance blooms on rocky shores in the British Isles was examined by Wilkinson and Wood (2005) in relation to the naturally high abundance of opportunistic green algae on soft chalk substrata in south-east England, and it was concluded that nuisance macroalgal blooms were not a rocky shore problem. Abundance is assessed on suitable substrata using the opportunistic macroalgae blooming tool. Further credence is given to this approach by an analysis of Irish %cover data against RSL values. Figure 2.1 shows no relationship between RSL EQRs and the percentage cover of opportunistic algae at the same sites.

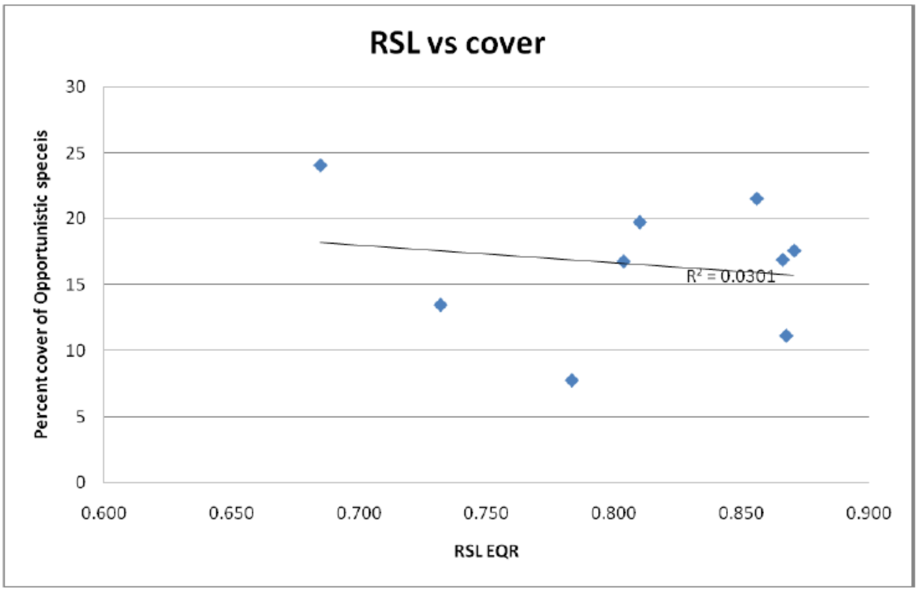


Figure 2.1 Reduced Species List EQR vs. Percent cover of opportunistic species

In summary

- The tool is applicable to natural hard surfaces in coastal waters.
- The tool responds to the primary pressures of toxic substances and disturbance.
- The tool is primarily based on species richness but includes elements of species composition, as based on the current state of ecological knowledge.
- The approach is consistent with Annex 5 of the Directive.
- The tool does not include estimates of abundance, as these have been shown to be naturally highly variable, and to show no correlation with EQRs.

Norway- RSL (Nea7 FROM PHASE I).

Norway has a water type NEA 7 which is shared with Scotland. This is a fjord which has a characteristic sill in the mouth of the fjord before opening out towards NEA 1/26. Due to more sheltered conditions and sometimes variable water exchange, the RSL for this water type has been customized to the species commonly occurring in this water type. Some species of the RSL for NEA 1/26 have been exchanged with species found more frequently in these waters and some species excluded from the RSL for NEA 1/26. In the new index RSL for NEA 7, 65 species are included. The list is shown in Table 2.82.9.

Table 2.9 Species included in the RSL to be used in NEA 7 are listed below

Species	Class	Opportunistic	ESG-group
Acrosiphonia /Spongomorpha sp	G		2
Blidingia sp.	G	1	2
Chaetomorpha / Rhizoclonium	G	1	2

Species	Class	Opportunistic	ESG-group
Chaetomorpha melagonium	G		2
Cladophora rupestris	G		2
Cladophora sp.	G	1	2
Codium fragile	G		1
Enteromorpha sp.	G	1	2
Ulothrix / Urospora	G	1	2
Ulva lactuca	G	1	2
Sum Greens	10	6	
Ascophyllum nodosum	B		1
Chorda filum	B		1
Chordaria flagelliformis	B		1
Dictyosiphon foeniculaceus	B		2
Dictyota dichotoma	B		1
Ectocarpus sp.	B	1	2
Elachista fucicola	B		2
Fucus ceranoides	B		1
Fucus serratus	B		1
Fucus spiralis	B		1
Fucus vesiculosus	B		1
Laminaria digitata	B		1
Laminaria hyperborea	B		1
Leathesia difformis	B		1
Mesogloia vermiculata	B		2
Pelvetia canaliculata	B		1
Pilayella littoralis	B	1	2
Ralfsia sp.	B		1
Saccharina latissima	B		1
Scytosiphon lomentaria	B		2
Sphacelari cirrosa	B		2
Sphacelaria sp.	B		2
Spongonema tomentosum	B	1	2
Sum Browns	23	3	
Aglaothamnion/Callithamnion	R		2
Ahnfeltia plicata	R		1
Audouinella purpurea	R		2
Audouinella sp	R		2
Calcareous encrusters	R		1
Ceramium nodulosum	R		2
Ceramium shuttleworthanium	R		2

Species	Class	Opportunistic	ESG-group
Ceramium sp.	R	1	2
Chondrus crispus	R		1
Corallina officinalis	R		1
Cystoclonium purpureum	R		2
Dumontia contorta	R		2
Furcellaria lumbricalis	R		1
Gloeosiphonia capillata	R		2
Heterosiphonia plumosa	R		2
Hildenbrandia rubra	R		1
Lomentaria clavellosa	R		2
Mastocarpus stellatus	R		1
Melobesia membranacea	R		2
Membranoptera alata	R		2
Nemalion helminthoides	R		2
Osmunda sp.	R		1
Palmaria palmata	R		2
Phyllophora sp.	R		1
Plocamium cartilagineum	R		2
Plumaria plumosa	R		2
Polysiphonia fucoides	R		2
Polysiphonia lanosa	R		2
Polysiphonia sp.	R		2
Porphyra sp	R	1	2
Ptilota gunneri	R		2
Rhodomela confervoides	R		2
Sum Reds	32	2	
Total sum of algae	65	11	

(NO) Norway RSLA = Macroalgae - Rocky Shore Reduced Species List + Abundance Phase II

The RSL does not include any measurement of abundance or biomass, hence to comply with the WFD Norway has included a measurement of abundance into the RSL. Several extra submetrics were tested among which 3 were included in a new version of the RSL. The number of abundance submetrics included, varies from NEA 1/26 and NEA 7, due to different response to nutrient pressure in the two IC-water types.

(PT) Portugal - PMarMAT = Marine Macroalgae Assessment Tool

(Perennial Intertidal Algae & Opportunistic macroalgae)

PMarMAT (**Mar**ine **M**acroalgae **A**ssessment **T**ool) was developed in Portugal to assess the intertidal rocky shores based on marine macroalgae. The method, is a multi-parametric tool comprising metrics to cover “abundance” and “taxonomic composition” parameters. PMarMAT requires that a Reduced Taxa List (RTL) is previously developed for each sub-typology. The RTL for the Portuguese coasts includes a total of 52 taxa entries (8 green, 20 red and 24 brown), characterised in terms of life strategy (annual or perennial) and their sensitivity to pollution (opportunists or not opportunists).

The metrics included on PMarMAT are:

Taxa richness
Proportion of Chlorophyta.
No. of Rodophyta
ESG Group Ratio
Proportion of Opportunist
% Cover of Opportunist
Shore description

The scores for the Taxa richness, proportion of greens, number of reds, ESG ratio, and the proportion of opportunists are calculated from the *taxa* entries included in the RTL, and the shore description followed the procedures proposed by Wells et al. (2007). The coverage of opportunists represents the percentage cover of opportunists (defined from the RTL) on the total area covered by marine macroalgae in the assessed shore. The metrics species richness and % coverage of opportunists have a factor of 2 on the contribution to the total score. The sum of scores is converted in a 0 to 1 scale (EQR according to the WFD definitions) that afterwards allows the determination of the EQS of the shore (according to WFD normative definitions).

The *Reduced Taxa List* (RTL) is the basis for the following **PMarMAT** metrics:

- *"Taxa richness"* is the total number of different RTL entries recorded in the sample
- *"No. Rhodophyta"* is the number red algal RTL entries recorded in the sample
- *"Proportion Chlorophyta"/"Proportion Opportunists"* are the proportions of green algal/blooming opportunist RTL entries recorded in the sample.
- *"ESG Group Ratio"* is calculated as: ESG I (late successional or perennial taxa) / ESG II (opportunist or annual taxa); *sensu* Orfanidis *et al.* (2001)

Due to the recognition of 3 CW sub-typologies, the RTL also includes minor geographical adjustments as it can be seen in Table 2.10

Table 2.10 Reduced Taxa List (RTL) for PMarMAT: Op= Opportunists; ESG = Ecological State Groups I / II; North PT (A5), Center PT (A6), and South PT (A7) = PT CW sub-typologies (NEA 1/26)

ESG	RTL	Bl Op	A5	A6	A7
ESG II	Bryopsidales		X	X	X
ESG II	Codium erecto		X	X	X
ESG I	*Codium prostrated*			X	X
ESG II	Filamentous greens	Op	X	X	X

ESG	RTL	Bl Op	A5	A6	A7
ESG II	Ulvales	Op	X	X	X
ESG II	*Valonia spp.*			X	X
ESG I	*Ascophyllum nodosum*		X		
ESG I	*Bifurcaria bifurcata*		X	X	X
ESG II	Filamentous browns, Ectocarpales	Op	X	X	X
ESG II	Prostrated browns		X	X	X
ESG II	Tubular form browns		X	X	X
ESG II	*Cladostephus spongiosus*		X	X	X
ESG II	*Colpomenia spp.*		X	X	X
ESG II	*Colpomenia spp.*			X	X
ESG I	*Cystoseira spp.*		X	X	X
ESG I	*Desmarestia spp.*		X	X	X
ESG I	*Dictyopteris polypodioides*		X	X	X
ESG II	*Dictyota dichotoma*		X	X	X
ESG I	*Fucus spp.*		X	X	X
ESG II	*Halopteris spp.*		X	X	X
ESG I	*Himanthalia elongata*		X		
ESG I	*Laminaria spp.*		X	X	
ESG I	*Padina pavonica*		X	X	X
ESG I	*Pelvetia caniculata*		X		
ESG I	*Phyllariopsis spp.*			X	X
ESG I	*Ralfsia verrucosa*		X	X	X
ESG I	*Sacchorhyza polyschides*		X	X	X
ESG I	*Sargassum muticum*		X	X	X
ESG I	*Sargassum spp.*			X	X
ESG II	*Sphacelaria spp.*		X	X	X
ESG II	*Halopteris spp*		X	X	X
ESG I	*Taonia atomaria*		X	X	X
ESG I	*Undaria pinnatifida*		X		
ESG I	*Ahnfeltia plicata*		X	X	
ESG II	*Anhfeltiopsis devoniensis*		X	X	X
ESG II	*Asparagopsis armata (Fase Falkenbergia rufolanosa)*	Op	X	X	X
ESG I	Calcareas erectas		X	X	X
ESG I	Calcareas crustosas		X	X	X
ESG I	*Calliblepharis spp.*		X	X	X
ESG I	*Callophyllis laciniata*		X	X	X
ESG II	*Catenella caespitosa*		X	X	X
ESG II	*Caulacanthus ustulatus*		X	X	X

ESG	RTL	Bl Op	A5	A6	A7
ESG II	Ceramiaceae		X	X	X
ESG II	Champiaceae		X	X	X
ESG II	*Chondracanthus spp.*		X	X	X
ESG I	*Chondrus crispus*		X		
ESG II	*Cordylecladia erecta*		X		
ESG II	*Cryptonemia spp.*			X	X
ESG II	*Cryptonemia lomation*		X		
ESG II	Dasyaceae		X	X	X
ESG II	Delesseriaceae		X	X	X
ESG I	*Dilsea carnosa*		X		
ESG II	*Dumontia contorta*		X		
ESG I	Gelidiales		X	X	X
ESG II	*Gigartina pistillata*		X	X	X
ESG I	*Gracilaria spp.*		X	X	X
ESG II	*Grateloupia spp.*		X	X	X
ESG II	*Grateloupia turuturu*		X	X	
ESG II	*Gymnogongrus spp.*		X	X	X
ESG II	*Halopithys incurva*			X	X
ESG II	Heterosiphonia plumosa		X	X	X
ESG II	*Hildenbrandia spp.*		X	X	X
ESG II	*Hypnea musciformis*		X	X	X
ESG II	*Laurencia spp. Osmundea spp., Chondria spp.*		X	X	X
ESG I	*Liagora spp.*			X	X
ESG II	*Lomentaria articulata*		X	X	X
ESG I	*Mastocarpus stellatus (Fase Petrocelis cruenta)*		X	X	X
ESG II	Nemaliales		X	X	X
ESG II	Other Rhodomelaceae		X	X	X
ESG I	*Palmaria palmata*		X	X	
ESG I	*Peyssonelia spp.*		X	X	X
ESG I	*Phyllophora spp.*		X	X	X
ESG I	*Plocamium cartilagineum*		X	X	X
ESG II	*Porphyra spp.*	Op	X	X	X
ESG II	*Rhodophyllis divaricata*		X	X	X
ESG II	*Rhodymenia spp.*		X	X	X
ESG II	Rytiphlaea tinctoria				X
ESG I	*Schizymenia dubyi*		X	X	
ESG I	*Sphaerococcus coronopifolius*		X	X	X
ESG II	*Stenogramme interrupta*		X	X	

ESG	RTL	Bl Op	A5	A6	A7
ESG II	*Symphyocladia marchantioides*			X	X

Since all algae may respond to increased nutrient availability, but opportunist algae have the ability to bloom very rapidly, and to occupy most available free subtract and/or canopy taxa, and lager, perennial taxa cannot inhabit these niches:

- "% Cover opportunists" is given by the percentage of area covered by these taxa (Op, Table II), in relation to the total covered area (all taxa) in each replicate
- For a given sampling site "% Cover opportunists" is calculated as the arithmetic average of all replicates.
- "Shore description" in PMarMAT (Table 2.11) functions as a correction factor whereby shores that have high species richness due to favorable substrate conditions can be equally compared with shores of low species richness due to unfavorable natural conditions (Wells *et al.* 2007).

Table 2.11 Shore description used in PMarMAT

General Information							
Shore Name			Date				
Water Body			Tidal Height				
Grid Ref.			Time of Low Tide				
Shore Descriptions							
Presence of Turbidity (known to be non-anthropogenic)	Yes	=0	Sand Scour	Yes	=0	No	=2
	No	=2	Chalk Shore	Yes	=0	No	=2
Dominant Shore Type			Sub habitats				
Rock Ridges/Outcrops/Platforms		=4	Wide Shallow Rock Pools (>3m wide and <50cm deep)	=4			
Irregular Rock		=3					
Boulders large, medium and small		=3	Large Rockpools (>6m long)	=4			
Steep/Vertical Rock		=2	Deep Rockpools (50% >100cm deep)	=4			
Non-specific hard substrate		=2	Basic Rockpools	=3			
Pebbles/Stones/Small Rocks		=1	Large Crevices	=3			
Shingle/Gravel		=0	Large Overhangs and Vertical Rock	=2			
Dominant Biota			Others habitats (please specify)	=2			
Ascophyllum							
Fucoid							
Rhodophyta mosaics			Caves	=1			

Chlorophyta		None				=0
Mussels		Total Number of Sub habitats				
Barnacles		>4	3	2	1	0
Limpets						
Periwinkles						
General Comments						

The final PMarMAT value is calculated by ponderating the scores obtained for each of the three indicators, according to the procedures described in the sections 1.4 to 1.6.

Subtidal macroalgae

(SE) Sweden - Multi Species Maximum Depth Index (MSMDI)

The fact that the depth distribution of perennial species is affected by shading from the overgrowth of opportunistic species, increased phytoplankton biomass and increased siltation following eutrophication is the basis for the MSMDI assessment method. It is based on depth distribution (abundance) of 3 to 9 (dependent on national type) selected common conspicuous perennial eutrophication sensitive species (disturbance sensitive taxa) in Scandinavian coastal waters. In Table 2.12 the selected species in each national type are shown, see Leonardsson *et al.*(2009) for a map of SE national typology. There is the rule that says if one of these species disappears from an area due to anthropogenic reasons it will get a low score (0.2) and hence our indicator will react to decrease (worse depth limit) and disappearance of disturbance sensitive taxa. There is a well-documented strong relationship between eutrophication and the depth limit of perennial aquatic vegetation (e.g. Krause-Jensen *et al.*, 2008). Method was developed in 2006 (Kautsky *et al*. 2007, in Swedish) and implemented in Swedish law 2008 (NFS 2008:1).

Table 2.12Selected perennial eutrophication sensitive taxa in each national type having an assessment method for BQE macroalgae and angiosperms in Sweden. Type 13, 24 and 25 lack assessment method due to lack of data.

		North East Atlantic						Baltic															
Group	Taxon	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	22	23
Rhodophyceae	Delesseria sanguinea	X	X	X	X	X																	
Rhodophyceae	Phycodrys rubens	X	X	X	X	X																	
Rhodophyceae	Rhodomela confervoides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Rhodophyceae	Furcellaria lumbricalis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Rhodophyceae	Chondrus crispus	X	X	X	X	X	X																
Rhodophyceae	Phyllophora pseudoceranoïdes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Phaeophyceae	Halidrys siliquosa	X	X	X	X	X	X																
Phaeophyceae	Fucus															X	X	X	X	X	X		
Phaeophyceae	Fucus serratus								X														
Phaeophyceae	Fucus vesiculosus								X	X	X	X	X	X	X								
Phaeophyceae	Saccharina latissima	X	X	X	X	X	X																
Phaeophyceae	Sphacelaria arctica								X	X	X	X	X	X	X	X	X	X	X	X	X		
Chlorophyceae	Aegagropila linnaei															X	X	X	X	X	X	X	X
Chlorophyceae	Cladophora rupestris															X	X	X	X				
Characeae	Chara baltica																					X	X
Characeae	Nitella																					X	X
Characeae	Tolypella nidifica													X	X	X	X	X	X			X	X
Magnoliophyta	Potamogeton perfoliatus													X	X			X			X	X	X
Magnoliophyta	Zostera marina	X	X			X	X	X			X	X		X	X								
No of taxa		*9*	*9*	*8*	*8*	*9*	*7*	*4*	*6*	*5*	*6*	*6*	*5*	*8*	*8*	*8*	*8*	*7*	*6*	*3*	*4*	*5*	*5*

(NO) Norway - Multi Species Maximum Depth Index (MSMDI)

Norway has implemented the Swedish methods in the Skagerrak region in NEA 8a, 9 and 10, with minor modifications. Norway does not include *Zostera marina* in the metric in NEA 8a and 9 as Sweden does and the sampling procedures are a bit different. Otherwise the methods are identical.

2.2. Sampling and data processing

Table 2.13 Overview of the sampling and data processing of the national assessment methods included in the Annex I of the EC Decision. For the rest of the national methods, you can see the information in the report uploaded in the CIRCA website.

Sampling/survey device	FR: Field sampling is carried out within permanent spots (3 spots per level/belt) marked by a flexible, removable frame, after localization by GPS / photograph tracking. Both diversity and structure of each macroalgal community (corresponding to a given belt) are noted on the field (visual determination). Points are materialized on the soil by a removable 1.65 m X 1.65 m frame comprising 5 X 5 squares.

	ES(Cantabria region): Field surveying: Visual estimation of % coverage of CM, % coverage of opportunistic species and number of CM populations. Non-destructive qualitative assessment. ES(Basque Country): Field surveying: Stratified sampling, registering all sub-habitats (pools, caves and emerged substrate). Surveyed area: 50 – 60 m width of the whole rocky inter-tidal shore. ES (Andalusia region): Sampling is under-taken through the use of visual assessment, where, following the scale proposed by Braun-Blanquet (1951): + (< 1%), 1 (1 – 5%), 2 (5 – 25%), 3 (25-50%), 4 (50-75%) and 5 (75-100%). The mean cover of species is calculated for each inventory using the median of each range. UK & IE: The individual site is defined by local geo-graphic parameters, and for the UK should generally be between 100m and 300m of lateral intertidal shore extent. In IE a defined stretch of 8m is surveyed. All algal species including epiphytes at the site are registered quantitatively; surveys normally take from 90 to 120 minutes but sampling effort depends on the complexity of the site; all sub-habitats should be sampled. The physical nature of the shore is also recorded and scored SE: No information provided PT: Visual assessment: Shore description – Fill out form at each sampling site GPS location of transects Field sampling: Imaging - 50 x 50 cm quadrats for "% Cover opportunists"; digital photography, Scraping – 20 x 20 cm quadrats for composition metrics; preserved for QC/QA
How many survey occasions (in time) are required to allow for ecological quality classification of survey site or area?	FR: Once every three years for each site (2 days per site), during neap low tides. ES(Cantabria region): 1 per sampling season ES(Basque Country): 1 per sampling season ES (Andalusia region): UK & IE: Sites are surveyed once per annum, and generally at least twice within a WFD reporting period. PT: 1 sampling/ 3 years SE: No information provided
Sampling/survey months	FR: From early March to late July, ES(Cantabria region): June to September ES(Basque Country): May to September ES (Andalusia region): All the surveys are undertaken in summer, to avoid seasonal variability within the phytobenthic assemblages. UK & IE: Sampling is conducted on low spring tides between April and the end of September. SE: Monitoring is conducted during late summer (August-September). PT: Summer - July-September
Which method is used to select the	FR: Rocky shore with more than 50% rocks and large boulders reduced surface of boulders, sand, mud or gravels, large boulders being

sampling /survey site or area?	acceptable at lowest levels), 30-100 m large X 30-150 m long, with 2 to 6 bathymetric levels / belts. ES(Cantabria region): Survey period for intertidal zone: Preferably during spring low tides ES(Basque Country): Preferably during spring low tides ES (Andalusia region): Replicates representing the lower intertidal zone (tidal range: 0.5 – 1.3 m) lying closest to the open shore, on a flat or slightly sloped substratum. Pools, overhangs, unstable substrate, crevices and other different habitats are not considered, in order to reduce the natural variability associated with physical differences between the habitats. UK & IE: The rocky shore macroalgal index is only applicable where the natural substratum consists primarily of solid bedrock, such as rocky outcrops, ridges and platforms or extensive areas of large boulders. Shingle, pebble and sandy shores are too unstable to support the attachment of a diverse community of algae and although it may be possible for some opportunist species to survive such conditions this will naturally not yield a high diversity of algae and may misclassify the water body. SE: No information provided PT: Spring low tides (preferably)
How many spatial replicates per sampling/ survey occasion are required to allow for ecological quality classification of sampling/ survey site or area?	FR: Three 33 cm X 33 cm squares per spot, determined by drawing lots, within three 1.65 m X 1.65 m permanent spots per belt, so within 9 squares and 0.9 m^2 per belt and per year. ES(Cantabria region): Recommended Nº of replicates per site: 3 replicates per assessed level: Intertidal, 5-15m, 15-25m. ES(Basque Country): Recommended Nº of replicates per site: 1 ES (Andalusia region): On each sampling event, ten replicates are obtained. UK & IE: At least three transects from different sites in a water body are required for assessment. SE: No information provided PT: It is recommended that a minimum of 3 shores per water body should be sampled, but the number of shores should be proportionate to the size of the water body and the severity and range of pressures identified
Total sampled area or volume, or total surveyed area, or total sampling duration on which ecological quality classification of sampling/survey site or area is based.	FR: No information provided ES(Cantabria region): Variable (10*100 m2 approx.). Intertidal stations only from low to middle intertidal ES(Basque Country):. ES (Andalusia region): Estimates of algal and animal cover are measured in 50 x 50 quadrats. UK & IE: No information provided SE: No information provided PT: No information provided

Record of biological data: level of taxonomical identification – what groups to which level	FR: Based on both a pre-defined global list of opportunistic species (for NEA coasts of France) and on lists of characteristic species per bathy-metric level and per coastal zone. ES(Cantabria region): Based on a predefined, well-established list of "Characteristic" and "Opportunistic" macro-algae for each biogeographic region (see Table 2.3), identified to the higher possible taxonomical level (e.g. Gelidium corneum, Ceramiales, etc.) ES(Basque Country): Based on a predefined Reduced Species List suitable for the biogeographic region, where species are classified as "Opportunistic (yes/no)", "ESG-I/ESGII" and "Green/Red/Brown algae". ES (Andalusia region): No information provided UK & IE: No information provided SE: No information provided PT: Based on predefined RTL (Reduced Taxa list) for each sub-typology. According to ALGAEbase (hgp://algaebase.org/)

Information on sampling procedure and data processing

Spain (Cantabria region) - CFR = Quality of Rocky Bottoms (*Calidad de Fondos Rocosos* in Spanish) (V-3.0. Continuous EQR Scale)

Perennial Intertidal/Subtidal Macroalgae & Opportunistic macroalgae

General aspects of the sampling procedure:

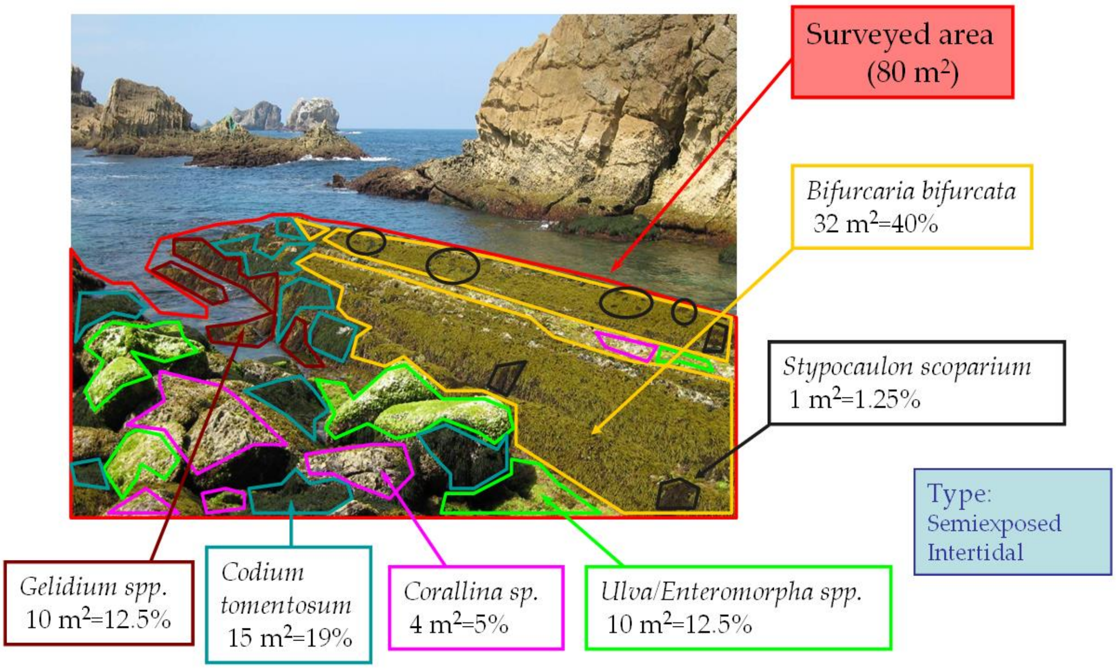


Figure 2.2 Example of data acquisition during the sampling survey

Data processing:

Obtaining of indicators values:

- **C: Coverage of CM**

Bifurcaria bifurcata	40%
Codium tomentosum	19%
Gelidium spp.	12.5%
Corallina sp.	5%
Stypocaulon scoparium	1.25%
Total....................	77.75%

- **F: Fraction of Opportunistics**

Coverage of opportunistics → *Ulva/Enteromorpha spp.* 12.5%

Fraction of opportunistics → $F = \left(\frac{O}{(C+O)}\right)\times 100$ → $F = \left(\frac{12.5}{77.75+12.5}\right)\times 100 = $ **13.8 %**

- **R: Richness of CM**

Nº of CM with coverage >1%: 5

Score assignment:

C: Coverage of CM

If ***C > RC****, *then* ***Cscore=1***

If not, $C_{score} = \frac{C}{RC^*}$ → Cscore for C=77.75% → $\frac{77.75}{90} = 0.864$

**RC=Reference conditions according to section 4*

R: Richness of CM

If ***R > RC****, *then* ***Rscore=1***

If not, $R_{score} = \frac{R}{RC^*}$ → Rscore for R=5 → $\frac{5}{10} = 0.5$

**RC=Reference conditions according to section 4*

F: Fraction of Opportunistics

If ***F < RC****, *then* ***Fscore=1***

If ***F > RC0****, *then* ***Fscore=0***

**RC and RC0=Reference conditions according to section 4*

If not, $F_{score} = \frac{RC_0{*}-F}{RC_0{*}-RC{*}}$ → Fscore for F=13.8 → $\frac{(40-13.8)}{40-5} = 0.748$

CFR index calculation by the ponderation of the three indicators:

$$CFR = 0.45 * C + 0.35 * F + 0.2 * R \rightarrow \begin{Bmatrix} C = 0.864 \\ F = 0.748 \\ R = 0.5 \end{Bmatrix} \rightarrow CFR = 0.75$$

EQR and Quality status assignment according to the boundaries obtained in the 2nd IC phase:

CFR = 0.75 → EQR = 0.75 ⇨ Status: Good

CFR = EQR	Status
0.81 - 1	High
0.6 - 0.81	Good
0.4 - 0.6	Moderate
0.2 - 0.4	Poor
0 - 0.2	Bad

Boundary values according to the results of the 2nd IC phase

Spain (Basque Country) - RICQI = Rocky Intertidal Community Quality Index

See Table 2.13.

Spain (Andalusia region) - RSL = Reduced Species List

A case study to show the sampling procedure:

Species List

Opportunist	ESG	Species
N	I	*Cladostephus spongiosus*
N	II	*Colpomenia sinuosa*
N	I	*Cystoseira spp.*
N	I	*Cystoseira usneoides*
N	II	*Dictyota dichotoma*
N	I	*Fucus spiralis*
N	I	*Padina pavonica*
N	I	*Saccorhiza polyschides*
N	I	*Sargassum vulgare*
N	II	*Stypocaulon & Halopteris*
N	II	*Asparagopsis armata*
N	II	*Ceramium spp.*
N	II	*Chondracanthus acicularis*
N	II	*Corallina sp.*
N	I	*Gelidium microdon*
N	II	*Gelidium spinosum*

Opportunist	ESG	Species
N	I	*Gelidium corneum*
N	II	*Gelidium pusillum*
N	I	*Gymnogongrus y Ahnfetiopsis*
N	I	*Hildenbrandia rubra*
N	I	*Jania rubens*
N	I	*Lithophyllum byssoides*
N	II	*Lithophyllum incrustans*
N	I	*Osmundea pinnatifida*
N	I	*Peyssonnelia spp.*
N	II	*Plocamium cartilagineum*
N	I	*Pterosiphonia complanata*
N	I	*Rhodymenia y Schottera*
N	I	*Sphaerococcus coronopifolius*
N	II	*Bryopsis spp.*
N	II	*Cladophora spp.*
N	II	*Codium spp* encrusting**
Y	II	*Enteromorpha spp. (=Ulva)*
Y	II	*Ulva spp.*
N	II	*Valonia utricularis*

Intertidal scoring system

Turbidity	No (2)
Sand scour	No (2)
Chalk shore	Not considered
Dominant shore	Large overhangs (3)
Subhabitat	Wide rock pool (4)
	Large crevices (-)
	Large overhangs (-)
Nº of subhabitats	3 (3)
Dominant biota	Corallina & Cystoseira
Total	14

Corrected species richness:

Expected species richness = $6.3371 * e^{0.0982 \cdot 14} = 25$

Correction Factor (CF) = 23/25 = 0.92

Corrected species richness = 0.92 * 35 ≈ 32

Data set:

Corrected species richness = 32

N° of red seaweeds = 19

Proportion of chlorophytas = 0.17

Proportion of ESGI = 0.51

Proportion of opportunist = 0.06

Calculation:

when the value of the element increased with increasing EQR (Corrected Species Richness, Number of red seaweeds, Proportion of ESG I).

EQR CSR = {((32-29)/5) x 0.2 }+0.8 = 0.84

EQR red = {((19-18)/6) x 0.2}+0.8 = 0.83

EQR ESGI = {((0.51-0.40)/0.10) x 0.2}+0.8 = 0.84

when the value of the element decreased with increasing EQR (Proportion of Green Seaweeds, Proportion of Opportunist)

EQR green = 1 - {((0.17-0)/ 0.60) * 0.2} = 0.83

EQR opport = 0.8 - {((0.06-0.05)/ 0.05) * 0.2} = 0.77

Total = (0.84+0.83+0.84+0.83+0.77)/5 = 0.82

0.82 > 0.70 • HIGH Ecological Status Class

France - CCO = Cover, Characteristic species, Opportunistic species on intertidal rocky bottoms

Sampling procedure

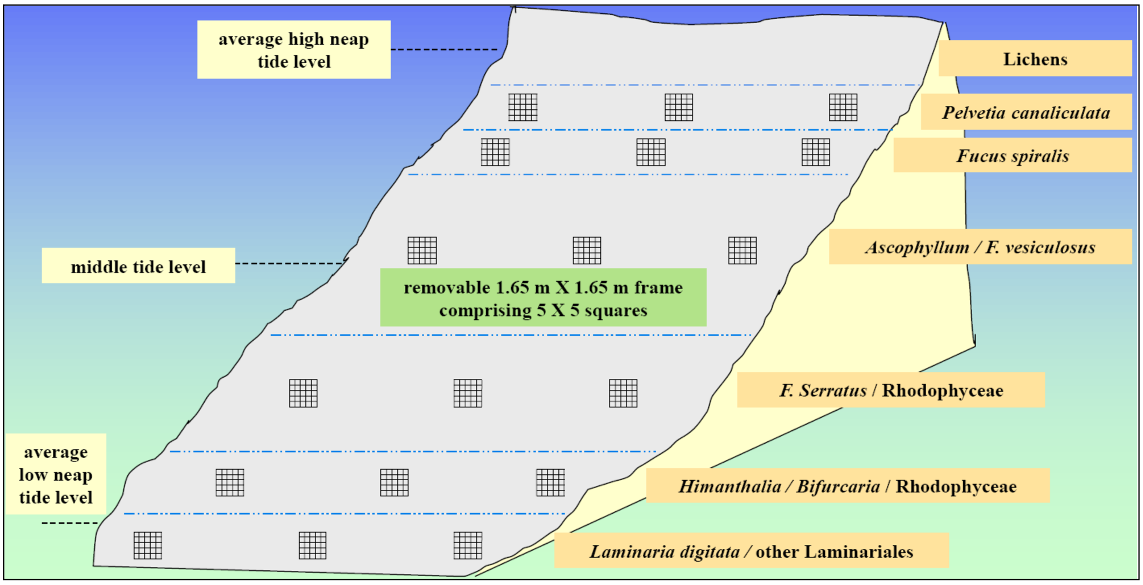


Figure 2.3 Diagram showing the sampling strategy of a theoretical 6 level site with dominating species as found in Brittany

Data processing:

- <u>Characteristic species: score on 30</u>

Number of characteristic species per level / belt versus the geographical zone

	Pelvetia + Fucus spiralis	*Ascophyllum / F. vesiculosus*	*Fucus serratus*	*Himanthalia / Bifurcaria*	*Laminaria digitata*
Bretagne (Vendée - Cotentin)	7	13	15	19	17
Charentes	7	12	11	14	17
Manche Orientale	7	13	15	15	14

	Corallina spp. + Caulacanthus (higher intertidal)	*Stypocaulon scoparium + Gelidium spp.* (lower intertidal)
Pays Basque	7	12

Index table for the number of characteristic species per level

percentage of characteristic species of the list	score per level (belt)
> 50	30
[35 - 50]	20
[20 - 35]	10
[5 - 20]	5
0	0

Scores of each level/ belt of the site are summed, and then divided by the number of levels occurring in the site.

- <u>Opportunistic species: score on 30</u>

Opportunistic species per level (quadrat sampling) score	coverage
6	< 5 %
4	5 – 25 %
2	26 – 50 %
1	51 – 75 %
0	76 – 100 %

List of opportunistic species	
Phaeophyceae:	Ectocarpales (Ectocarpaceae : *Ectocarpus spp.*, *Pylaiella spp.*, *Hincksia spp.*)
Chlorophyceae:	*Enteromorpha compressa* *Enteromorpha ramulosa* *Ulva spp.*
Rhodophyceae:	*Ceramium spp.* *Polysiphonia spp.* (excluding both *P. lanosa* and *P. elongata*) *Boergeseniella spp.*
Colonial microalgae	Diatoms (either epiphytic or epilithic)

The coverage of opportunists is given by the percentage of the area covered by the following taxa (table below) for a given level.

For a given sampling site, the scores of all levels (belts) are added to give the global notation. When fewer than 6 levels occur, a rule of three has to be applied.

- Plant covered area per level : notation on 40

The total surface of each bathymetric level corresponding to a given seaweed belt is estimated on the field and gives the rank of the level to be taken into account in the following grid (NB: solid rocks or large boulders only).

The percentage of the level area covered by macrophytes gives the score.

The global notation equals the sum of scores for 6 levels.

When fewer levels occur a rule of three has to be applied to get the final notation.

Index table for plant covering per level

% covering	rank 1	rank 2	rank 3	rank 4	ranks 5 and 6
0 - 2,5	0	0	0	0	0
2,6 - 5	2	2	1	1	1
6 -10	4	3	2	2	2
11 - 25	5	5	3	3	3
26 - 50	6	6	5	4	3
51 - 75	7	7	6	5	4
76 - 100	9	8	7	6	5

Finally, scores of the 3 metrics are summed to get a global score which is afterwards derived (/100) into both an EQR and an EQS.

Ireland and United Kingdom - RSL = Rocky Intertidal Macroalgae - Reduced Species List (NEA 1/26; NEA 7)

Data processing:

Species richness is calculated as indicated above. EQRs were calculated for each metric as shown below. It should be borne in mind that species richness, proportions of red algae and ESG ratio EQRs increase as the metrics' values increase, while the reverse is true for the proportions of greens and opportunist algae.

For Species Richness, Proportion of Red and Brown Algae, Abundance of Brown and ESG1/ESG2-ratio uses the following equation in calculating EQR:

$$EQR = \left\{ \left[\frac{Value - Lover\ class\ range}{Class\ width} \right] x\ EQR\ band\ width \right\} + Lower\ EQR\ Band\ range$$

For the Proportion Green Algae, Abundance of Green Algae and % Opportunistics the following equation is used:

$$EQR = Upper\ EQR\ band\ range - \left\{ \left[\frac{Value - Lower\ class\ range}{Class\ width} \right] x\ EQR\ band\ width \right\}$$

Each individual site EQR is calculated and the EQRs of all sites within the waterbody are averaged to obtain an overall waterbody EQR.

Norway - RSLA = Macroalgae - Rocky Shore Reduced Species List with Abundance in NEA 1/26 and NEA 7.

All species of visible macroalgae found in an about 10-15m wide part of the eulittoral zone are all registered. The time used at each station are normally between 30 to 45 minutes. The RSLA methods are using a semiquantiative Blanche-Blanket - or Domino scale (Maarel E. 1979) 0-4 scale. This will probably be modified at the next revision of the index.

The recorded values (0-4) in the scale were transformed - e^x (x = registed semiquantitaive abundance) and occurrence were summarized for all Chlorophyta and Phaeophyta for each station.

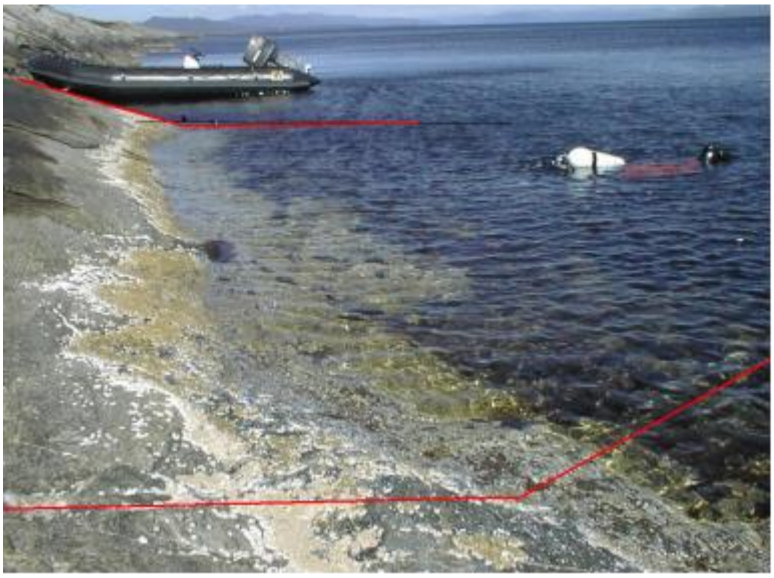


Figure 2.4 Registration of macroalgae at high tide in Norway for use in RSL or RSLA

The species lists used in NEA1/26 and 7 are different. The number of species is adjusted according to the expected number found on the site based on a 'de-shoring' factor for the shoreline i.e. normalized to the shores physical characteristics

This uses an exponential-type model of the form:

RICHNESS = a + b exp (cSHORE)

where a, b and c are parameters to be estimated from the data. SHORE is the actual number of **points** obtained from the description sheet for each station. Using least squares, these parameters were estimated to be (Wells *et al.*,2007):

a = 14.210

b = 4.925

c = 0.108

The shoreline is described based on its toughness, cracks and crevices, boulder, out-springs, piers and so on and points are given for each type that occur on the site. The number of points are then summed up and a generic shoreline will get around 15 points which gives a correction factor of 1 , which corresponds to about 40 recorded species. To be able to normally find 40 species at a generic shoreline without any special nutrient pressure, Norway increased the total number in the RSL from 69 to 80 to compensate for less diversity among macro-algae in Norwegian waters. The 'de-shoring' factor will be lower than 1 if the shoreline has more than "normal" variety/numbers of sub-habitats and crevices where specific algae can occur. On the opposite, if the shoreline consists of smooth rock, one does not expect to find so many species and the 'de-shoring'/correction factor is higher than 1. In this way the number of species is normalized to a generic shoreline.

Table 2.14. The number of point scored during the shore description and its corresponding correction factor. From Wells et al 2007

Points	Predicted species richness	Correction-factor
5	22.66	1.72
6	23.62	1.65
7	24.7	1.58
8	25.89	1.51
9	27.22	1.44
10	28.7	1.36
11	30.36	1.29
12	32.2	1.21
13	34.25	1.14
14	36.53	1.07
15	39.08	1
16	41.91	0.93
17	45.07	0.87
18	48.58	0.8
19	52.5	0.74
20	56.87	0.69

The ESG-ratio has been modified as there were some discrepancies among previous versions of the RSL and the new versions of RSLA.

Calculations of EQR for both RSL and RSLA

The species richness is adjusted according to the description given insection on BQE required parameters.

The EQRs were calculated for each parameter as shown below:

For Species Richness, Proportion of Red and Brown Algae, Abundance of Brown and ESG1/ESG2-ratio uses the following equation in calculating EQR:

$$EQR = \left\{ \left[\frac{Value - Lover\ class\ range}{Class\ width} \right] x\ EQR\ band\ width \right\} + Lower\ EQR\ Band\ range$$

For the Proportion Green Algae, Abundance of Green Algae and % Opportunistics the following equation is used:

$$EQR = Upper\ EQR\ band\ range - \left\{ \left[\frac{Value - Lower\ class\ range}{Class\ width} \right] x\ EQR\ band\ width \right\}$$

Final calculations

The EQR for a site/station is the mean value of the above EQRs. Minimum two stations make up the status for the water body. If less than 14 species are found at a site, the proportion of red and ESG-ratio are excluded from the calculations as these did not show very good correlation (see Annex) and will dominate too much in calculating the indices.

Portugal - PMarMAT = Marine Macroalgae Assessment Tool

(Perennial Intertidal Algae & Opportunistic macroalgae)

General aspects of the sampling procedure:

Sampling strategy

- In each WATER BODY, 3-5 SHORE LOCATIONS with adequate intertidal rocky platform (separated by several Kms)
  - Shore locations should be chosen within an *a priori* quality gradient (presence of point-sources, intensive urbanization, extensive industrial/agricultural shoreline use, etc.), if present in the WB

- In each SHORE LOCATION, sample 3 SITES (separated by >=100m)
- In each SITE, sample 3 TRANSECTS (separated by >= 20M), 10m long, parallel to water line, located at 3 different shore levels
  - 1 LOW TRANSECT --- at the lowest possible shore zone accessible during all spring tides
  - 1 MIDDLE TRANSECT --- at the level of the *Lithophyllum tortuosum* belt
  - 1 UPPER TRANSECT --- at the level of the *Fucus spiralis* belt

- In each TRANSECT, photograph 5 50x50cm quadrats (upper side) and collect 3 20x20cm quadrats (lower side) by scraping
  - Quadrats randomly positioned within each transect

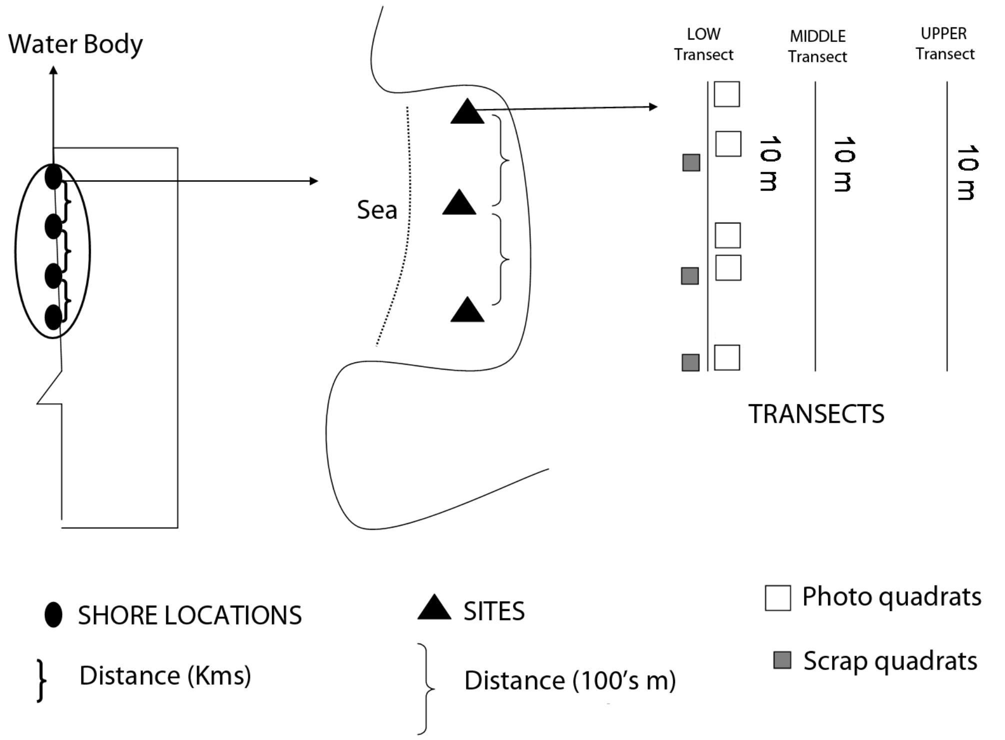


Figure 2.5 Sampling strategy for the application of PMarMAT in the Portuguese coast.

Subtidal Macroalgae

Sweden - Multi Species Maximum Depth Index (MSMDI)

According to the dominating monitoring method in Sweden, a diver swims along a transect perpendicular to the shoreline from deeper to shallower water. The diver takes notes on depth, distance from shoreline, substrate cover and species occurrence along the transect measuring tape. Whenever a change in species occurring or cover of species or substrate is observed, a new section is started and a new note is made. Each section should cover an area of at least 10 m2. Cover is estimated using a seven-point scale (i.e. 1, 5, 10, 25, 50, 75 or 100% cover) representing the cover over the whole section for both species and substrates, i.e. cover of a species is expressed in relation to the section area and not the area of suitable substrate. Observations are made in a 6–10-m wide corridor along the transect measuring tape. From these data collected by a diver, maximum depth limits of the 3–9 selected species are extracted as the lower depth of the deepest section where each species occurs. Monitoring is conducted during late summer (August-September). At least three transect from different sites in a water body are required for assessment.

Cover of macroalgae and angiosperms along a transect perpendicular to depth curves are monitored by a diver. Maximum depth of each species is one of the variables noted by the diver in the field. Each selected species from the national type of the transect is given a score based on its maximum depth along the transect. The index is calculated by taking an average of the scores of selected species found in a transect. To get a score a species depth distribution should be limited by light and not by lack of suitable substrate. Each selected species can get a score of 1, 0.8, 0.6 or 0.4 based on maximum depth distribution in relation to the reference depth limit for that species in the present national type. The reference depth limit and the scoring boundaries are set for each species in each national type based on historical data and relations between depth distribution, secchi depths, chl a and nutrients. The final scoring boundary values are set by expert judgment. If a species has disappeared from an area due to anthropogenic reasons it is given a score for this species of 0.2 in each transect in that area where the species has previously occurred. An example of calculation of MSMDI is given in Figure 2.6.

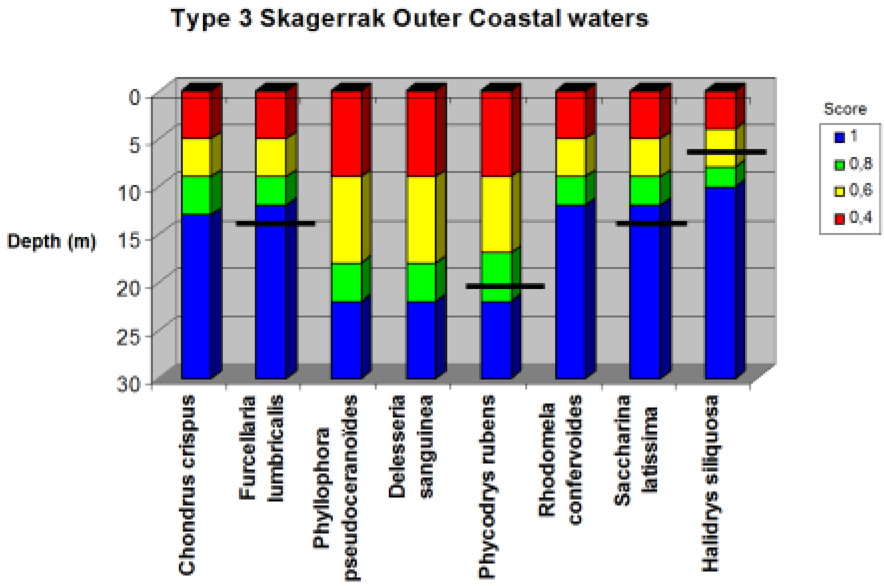


Figure 2.6 Example of calculation of MSMDI. Each bar show the scoring depths for the selected species in national type 3 Skagerrak outer coastal waters. The black lines on four bars show an example where four of the selected species were found in a transect. The scores 1, 0.8, 1 and 0.6 gives a MSMDI value of 3.4/4=0.85.

Water body assessment:

The average MSMDI values for all transects within a water body are used for assessment against an equidistant 5 class status scale. The adjustment against a reference is done in the scoring system for each species and not for the whole index. The boundaries are also given in the scoring system for each species rather than derived from a relationship between the whole index and a pressure.

Norway - Multi Species Maximum Depth Index (MSMDI)

The Norwegian methology of acquiring the nessesary data for MSMDI is a bit different from the Swedish method. A diver is recording the lower depth limits for the 9 species included in the list for MSMD along a line from -30m and up to the shoreline. The diver can also be guided by compass directions from an assistant on shore. On the way to the surface, the lowest depth where the species in question are found at an amount of 2-5%, are noted for the particular species. The algae have to be fully developed and capable of reproducing – not small underdeveloped specimens are included. During a normal Norwegian transect dive all species – flora and fauna, are recorded for every 2nd meter from -30m to the surface. However to save time and expenses of using a second diver with competence of a zoology, as well as for accuracy, we do now concentrate on the 9 macroalgae in question for every meter. The diver examines an 8-10m wide transect/corridor from -30m up to the shoreline and type of substrate, slope, current, visability and sedimentation are also registered. The monitoring is conducted during the summer/fall period from July to September. At least two transects from different sites in a water body are required for assessment, but 3 replicate sites are preferred.

Figure 2.7 Diving transect collecting data for the MSMDI-metric

2.3. National reference conditions

Table 2.15 Overview of the methodologies used to derive the reference conditions for the national assessment methods included in the Annex I of the EC Decision.

Member State/ Method	Methodology used to derive the reference conditions	Number of reference sites (if they exist)	Location of reference sites (if they exist)	Criteria used for selection of reference sites (if they exist)
INTERTIDAL MACROALGAE				
Spain - CFR	Least impacted sites, frequency distribution curves, expert knowledge	>20	Various sites in the Cantabrian sea	Sites not affected by anthropogenic pressures and suitable for macroalgae colonization
Spain-RICQI	Historical data (1996-2009) from an undisturbed site (Kobaron),	5	Kobaron, San Juan de Gaztelugatxe, Berriatua, Itziar and Jaizkibel	Absence of significant pressures, as defined in Borja *et al.* (2006), in <3 km

Member State/ Method	Methodology used to derive the reference conditions	Number of reference sites (if they exist)	Location of reference sites (if they exist)	Criteria used for selection of reference sites (if they exist)
	additionally, four undisturbed sites sampled in 2009 along the Basque coast			
Spain-RSL	Least impacted sites, expert knowledge,	>5	Sites in El Estrecho Natural Park	Protected Rocky shores not affected by anthropogenic pressures
France-FR CCO	RC derived from both existing near-natural reference sites & least impacted sites, expert knowledge	5	North & West rocky shores of Brittany + Basque country	Reference sites were identified according to low influence of major anthropogenic pressures affecting the rocky shores macroalgal communities: eutrophication, professional and recreational shellfish fishing, industrial exploitation, turbidity…
Ireland-IE RSL	Reference conditions were developed in conjunction with the UK using available IE data	Ca. 350 sites used to derive reference conditions and boundary conditions	Individual sites not specified	Reference conditions were developed in conjunction with the UK using available IE data
Norway - NO RSL	RC derived from both existing near-natural reference sites & expert knowledge	14	West Coast of Norway + Nordland	Sites not affected by anthropogenic pressures and suitable for macroalgae colonization
Norway - NO RSLA	RC derived from both existing near-natural reference sites & expert knowledge	10	West Coast of Norway + Nordland	Sites not affected by anthropogenic pressures and suitable for macroalgae colonization
Portugal (PMarMAT)	Least disturbed sites, Historical	>10	Various sites along the PT coast	Sites not affected by anthropogenic

Member State/ Method	Methodology used to derive the reference conditions	Number of reference sites (if they exist)	Location of reference sites (if they exist)	Criteria used for selection of reference sites (if they exist)
	data, expert knowledge			pressures and suitable for macroalgae colonization
United Kingdom - UK RSL	Expert knowledge, historical data (large data set) and sites of least disturbed conditions. Multi-variate analyses indicated class discontinuities.	Ca. 350 sites used to derive reference conditions and boundary conditions	Individual sites not specified	All sites used were suitable for macroalgae colonisation; sites free from anthropogenic pressures included
SUBTIDAL MACROALGAE				
Norway- MSMDI	Expert knowledge, Historical data (1950-ties), Least Disturbed Conditions	8	The western part of Skagerrak	Sites not/ or very little affected by anthropogenic pressures and suitable for macroalgae colonization
Sweden- MSMDI	Expert knowledge, Historical data (1940-ties), Least Disturbed Conditions	No actual reference sites	Two data sets from the 1940-ties, one in the Gräsö region, Åland Sea and one in Gullmaren	

Intertidal Macroalgae

Spain (Cantabria region) - CFR = Quality of Rocky Bottoms (*Calidad de Fondos Rocosos* in Spanish)
(V-3.0. Continuous EQR Scale)

(Perennial Intertidal/Subtidal Macroalgae & Opportunistic macroalgae)

Table 2.16 summarizes the Reference Conditions (RC) to be applied for each indicator (C, F and R) for both intertidal types ("semiexposed": slope<45º aprox. or "exposed": slope >45º aprox.) and depth-range subtidal areas (5-15m or 15-25m).

Table 2.16. Reference conditions (RC) for the application of the CFR index.

Metric	Semiexposed intertidal	Exposed intertidal	5 – 15 m	15 – 25 m
C: Coverage of CM (%)	90	70	90	70
F: Fraction of Opportunistics (%)	5	5	2	2
R: Richness of CM	10	7	6	6

Spain (Basque Country) - RICQI = Rocky Intertidal Community Quality Index

As the WFD requires determining reference conditions in absence (or little) of human pressure, two approaches were used: (i) a time data series collected from 1996 to 2009 at an undisturbed site (Kobaron) was used as control for the series obtained in the sampling sites adjacent to Abra of Bilbao; and (ii) additionally, four undisturbed sites (following the study of pressures undertaken by Borja et al. (2006)) were sampled in 2009 along the Basque coast: San Juan de Gaztelugatxe (SJ), Berriatua (BE), Itziar (IT) and Jaizkibel (JA).

The MDS diagram shows the spatial and temporal relationships between all of the sites studied, between 1996 and 2009 (Figure 2.8). The period 1984-1996 was not included in the analysis, because of the lack of quantitative data on invertebrates. The most degraded site (Arrigunaga) lies to the right of the MDS diagram, whereas Azkorri, Meñakoz and Matxilando are located between the most degraded site and the reference conditions (Figure 2.8). The displacement of each site, with respect to its initial position, reflects the changes in community composition, over time. A net movement of all of the disturbed sites, towards the reference conditions, can be seen clearly over the time period, reflecting the improvement in water quality. The pollution gradient was divided into four levels of quality, under the WFD: High, Good, Moderate and Poor (Bad is considered as extreme degradation, present over the area prior to 1996). For each quality level the average inventory of flora and fauna, taking into account the samples within each range, was calculated. Among the 237 species recorded, those that exceeded 1% cover (40 taxa) in at least one of the five potential ecological status were selected. These 40 taxa were considered to be the indicator species, from bad to high ecological conditions. The Spearman correlation, between the matrix derived from the full species dataset and that obtained from the selected species, is r = 0.925, with a significance level of 0.1%, i.e. the spatial-temporal distribution model of communities is very similar. In the case of Bad ecological status, corresponding to situations recorded in the Abra of Bilbao bay before 1996, a theoretical inventory was defined, based upon the biological information available prior to 1996.

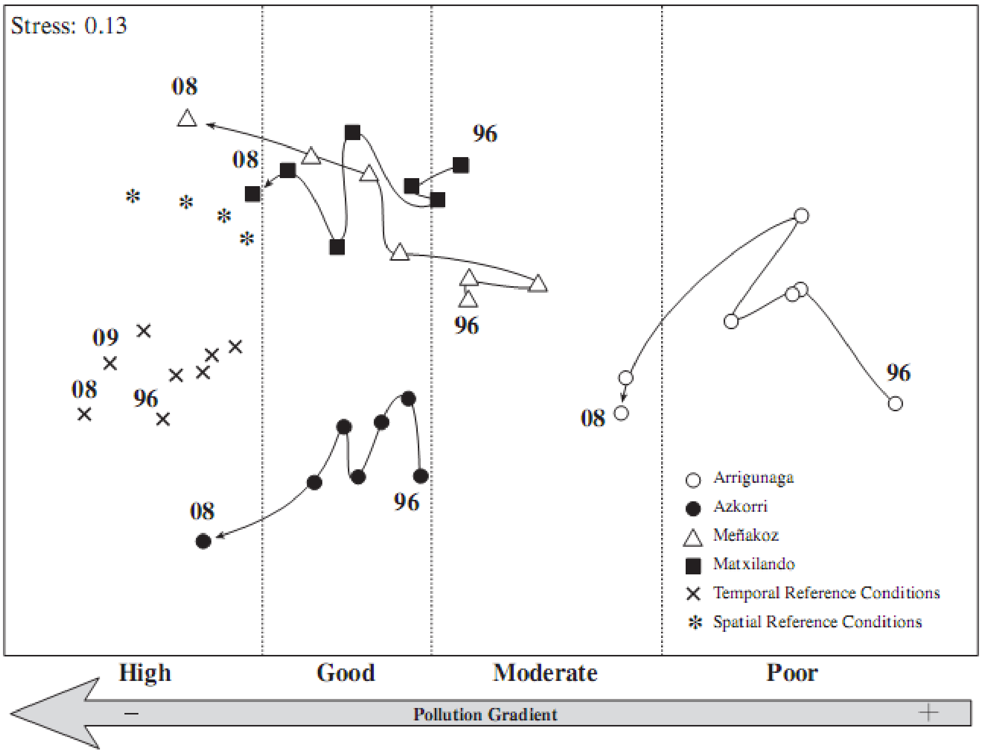


Figure 2.8 Non-metric multidimensional scaling ordination plot, based upon species cover, showing separation of assemblages according to sites and time of sampling. The lines reflect the displacement of each site, with respect to its initial position (from 1996 to 2008). Dotted lines separate the pollution gradient into four levels of degradation. Temporal Reference Conditions (Kobaron). Spatial Reference Conditions (San Juan de Gaztelugatxe, Berriatua, Itziar and Jaizkibel.

Spain (Andalusia region) - RSL = Reduced Species List

Table 2.17 Reference conditions for the application of the RSL index in Southern Spain.

	High
Common elements	
Corrected species richness	> 29
Number of red seaweeds	> 18
Proportion of green seaweeds	< 0.20
RSL – ecological	
Proportion of ESGI	> 0.40
Proportion of opportunists	< 0.05
EQR-RSL	> 0.75

France - CCO = Cover, Characteristic species, Opportunistic species on rocky bottoms

Reference conditions were established on several criteria:

- a good representativity of **hard rocks** at the regional level (geologic maps)
- a good representativity of **seaweed beds** (cartographic studies by Ifremer, CEVA...), exploited algal biomass when existing, at the water body leve
- a good representativity of relatively sheltered, intertidal **shores with dominating seaweed communities** in the water body (sector studies)

The occurrence of a **large algal biomass** on a given site (global plant covering, 6 belts / bathymetric levels, estimation of canopy volumes from both the surface and the height (strata) of structuring species) (local monitoring data, *cf.* Ar Gall & Le Duff, 2011 *In situ* sampling procedure and quality index calculation for the EQ "intertidal seaweeds", CCO (Cover - Characteristic species - Opportunistic species),WFD - coastal waters - GIG NEA, 9 pp.): station level

- a **high specific diversity** in a site (both historical (*cf.* Dizerbo & Herpe, 2007. Checklist and repartition of seaweeds on French coasts of the Channel and of the Atlantic Ocean, including British Channel Islands. Eds. Anaximandre, 315 pp.) and recent monitoring data (*e.g.* REBENT Brittany): station level
- a putative **low pressure by human activities** (no local collect of seaweeds, no industrial pollution, no domestic pollution, few trampling, few disturbance due to fishing from the shore, low diffuse pollution / eutrophication): station level

Ireland & (UK) United Kingdom and - RSL = Rocky Intertidal Macroalgae - Reduced Species List (NEA 1/26; NEA 7)

Historic macroalgal species records from sites deemed as 'high quality' were used to set reference conditions. This approach used a combination of expert judgement and data from sites considered to be near pristine and free from identified pressures at the time of sampling. Algal communities at the sites and species richness totals had to reflect those of shores regarded as high quality according to expert opinion. A database of over 350 sites was used for the UK and IE.

Norway - RSLA = Macroalgae - Rocky Shore Reduced Species List with Abundance

Similar approach as UK and IE.

Portugal - PMarMAT = Marine Macroalgae Assessment Tool

(Perennial Intertidal Algae & Opportunistic macroalgae)

Reference conditions were established from historical (1960-1970's) and recent surveys, on non-affected by anthropogenic pressures and suitable for macroalgae colonization sites (Gaspar et al., 2012). Table 2.18 resumes de reference conditions (RF) to be applied for each indicator in Portugal.

Table 2.18PMarMat reference values.

PMarMAT indicator	Ref.Cond.
Taxa richness	≥ 28
Proportion Chlorophyta	≤ 0.10
No. Rhodophyta	≥ 18
ESG Group Ratio	≤ 2.00
Proportion opportunists	≤ 0.10
Coverage opport. (%)	≤ 0.10
Shore description	≤ 7

Subtidal Macroalgae

Sweden - Multi Species Maximum Depth Index (MSMDI)

The adjustment against a reference is done in the scoring system for each species and not for the whole index. The reference depth limit and the scoring boundaries are set for each species in each national type based on maximum depths or historical data and relations between depth distribution, secchi depths, chl a and nutrients. The final scoring boundary values are set by expert judgment. For a discussion on selection of reference depth limits see Carletti and Heiskanen 2009.

Norway - Multi Species Maximum Depth Index (MSMDI)

The historical Norwegian datasets are, mainly based on dredging and caution must be exercised. Hence, the historical data were used in combination with modeling (based on Secchi depths), present depth occurrence of the selected species in areas with low nutrient enrichment, and expert judgement to estimate reference depth limits for other water body types. The result is presented in the Table 2.19, Table 2.20 and Table 2.21. The High/Good boundary for depth limits of nine selected macroalgal species in each salinity regime is reported within the Swedish coastal water types. Information can be found at www.naturvardsverket.se/sv/Lagar-och-andra-styrmedel/Lag-och-ratt/Foreskrifter-och-allmanna-rad/Foreskrifter-utgivningsordning/.

Depth limits in NEA9 areas are defined by the only area for which historical data is available, i.e. Gullmar Fjorden, one profile in 1941 and two recent Norwegian surveys. The high-good boundary for depth limits of nine selected macroalgal species has been defined as a 17-33% deviation from the estimated reference levels. All depth limits are set by expert judgement for each of the nine selected macroalgal species since the few available data do not allow any good statistical treatment. Similarly, good-moderate boundaries have been set by expert judgement and represent a 42 to 50% deviation from reference levels.

Table 2.19 Estimated depth limits for NEA 9 – Skagerrak fjords – in Norwegian and Swedish waters. Historical data by M. Waern 1941 in Eriksson et al. 2002, recent data from Walday et al. 2001 is from Grenlandsfjord 1998-1999, Magnusson et al. 1992 is from Oslofjord 1990.

NEA 9 'Skagerrak fjords	Walday et al. 2001	Magnusson et al. 1992	Eriksson et al 2002	**NEW ref.**	High / Good	Good / Moderate
Survey nr:	1	2	3			
Species						
CHOCR		5	12.5	**12**	>10	7
FURLU		3	15	**15**	>12	8
HALSI			12.5	**12**	>10	7
LAMSA	7	12	10	**12**	>8	6
PHYP+COCTR	17	13	11	**14**	>10	8
RHOCO	12	10	15	**15**	>12	8
DELSA	17	11	16.6	**17**	>13	9
PHYRU	14	9	16	**16**	>13	8

In Table 2.20 the lower depth limits have been estimated based on Sundenes historical data sets (Sundene 1953) and several recent data sets. As for NEA9 both the reference values and the boundaries are based on expert judgements. The historical values from Sundene (1953) are based on dredging and are therefore not as reliable as recent surveys carried out by use of diving. Hence, the new estimated reference values are estimated somewhere between Sundenes findings and recent observations. For some species the recent findings of lower depth limits exceeds those found by Sundene. In these cases the recent finding has been used in estimating a new reference value. The High/Good boundaries vary between 18 and 37% of the estimated reference value and the Good/Moderate boundaries vary between 44 and 58% of the estimated reference values .

*Table 2.20 Estimated depth limits for NEA8- Skagerrak inner archipelago - in Norwegian and Swedish waters. (Walday et al. 2001 is from Grenlandsfjord 1998-1999, Magunsson et al. 1992 is from Oslofjord 1990, Pedersen et al., is from Chysochromulina surveys in 1988 and 1989, Moy et al. 2005 is from the Norwegian Coastal Monitoring Program from 1990-2005, Karlsson 1994 -1998 is from the Swedish coastal monitoring program from 1994-1998 and Sundene 1953 is from surveys in outer Oslofjord in 1947 to 1952. New reference is based on expert judgement and all these reports mentioned. * uncertainty of viability as dredging was used in collection the seaweeds.)*

NEA8 Skagerrak Inner Archipelag	Walday et al. 2001.	Magnusson et al. 1992	Pedersen et al. 1989	Moy et al. 2005	Karlsson 1994-98	Sundene 1953 *	**NEW ref.**	High / Good	Good / Moderate
Survey nr:	1	4	5	6	7	**8**			
Species									
CHOCR	10			8	10	15	**12**	>8	5
FURLU	12	6		3	12	20	**16**	>10	7
HALSI	4		6	8	10	5	**10**	>8	5
LAMSA	14	10	16	6	8	13	**16**	>10	7
PHYP+COCTR	20	12	20	16	9	35	**22**	>18	12
RHOCO	14			16	12	14	**16**	>12	7
DELSA	22	15	16	16	20	35	**25**	>18	12
PHYRU	16	14	16	14	18	20	**18**	>15	10

Within NEA10 there are several extensive monitoring programs both in Norway and in Sweden that have made it possible to determine a lower depth limits for the same species as in NEA8 and 9. Fredriksen and Rueness (1990) compared the data sets collected at the same stations examined by Sundene in 1947-1952, and used both dredging and diving. The conclusions were that the lower depth limits have been reduced since Sundenes explorations. Both these reports have been compared with recent registrations and new reference levels have been estimated for all species. Within the Coastal Monitoring Program (1990-) some scattered individuals are found even deeper than the new reference values, however, these lower depth limits represent individuals that may not survive the over wintering, hence not a reference level for healthy and reproductive species. The High/Good boundaries vary between 24 and 29% of estimated reference level and the boundary level of Good/Moderate between 40 and 50% of reference levels (Table 2.21).

*Table 2.21 Estimated depth limits for NEA10- Skagerrak exposed - in Norwegian and Swedish waters. (Moy et al. 2005 is from the Norwegian Coastal Monitoring Program from 1990-2005, Fredriksen & Rueness 1990 is from surveys on Sundenes (1953) location in 1989. Karlsson 1994 is from the Swedish coastal monitoring program from 1994-1998 and Sundene 1953 is from surveys in outer Oslofjord in 1947 to 1952. New reference is based on expert judgement and all these reports mentioned. * uncertainty of viability as dredging was used in collection the seaweeds.)*

NEA10 exposed	Skagerrak	Moy et al. 2005	Fredriksen & Rueness, 1990	Sundene 1953 *	Karlsson 1994-98	NEW ref.	High / Good	Good / Moderate
	Survey nr:	9	4	8	7			
Species								
CHOCR		18		18	16	**18**	>13	9
FURLU		13	14	20	14	**16**	>12	9
HALSI		14		8	10	**14**	>10	8
LAMSA		20	13	16	14	**16**	>12	9
PHYP+COCTR		30	18	35	16	**30**	>22	18
RHOCO		24		12	16	**16**	>12	9
DELSA		30	15	32		**30**	>22	18
PHYRU		29	27	27		**29**	>22	17

2.4. National boundary setting

Table 2.22. Explanations for national boundary setting of the national methods included in the Annex I of the EC Decision.

Member State/Method	Methodology used to set H/G boundary	Methodology used to set G/M boundary
Intertidal Macroalgae		
Spain (CFR)	Initially equidistant divisions showing slight (about 20%) deviations from reference conditions. Boundaries will be adjusted after the IC exercise.	Initially equidistant divisions showing slight (about 40%) deviations from reference conditions.
Spain (RICQI)	Equidistant division of the EQR gradient	Equidistant division of the EQR gradient
Spain (RSL)	Mid point between the upper and lower points of variance from adjacent quality clases. Boundaries may be adjusted after the IC exercise	Mid point between the upper and lower points of variance from adjacent quality clases.

Member State/Method	Methodology used to set H/G boundary	Methodology used to set G/M boundary
France (CCO)	Derived from metrics variability at near-natural reference sites and EQR boundaries derived from 1st IC exercise	Calibrated against pre-classified sampling sites (e.g. pre-classification based on expert judgement) and EQR boundaries derived from 1st IC exercise.
Ireland (RSL)	H/G boundary indicated by multi-variate analysis of large dataset, combined with expert judgement. Sub-metric EQRs normalised to equidistant boundaries.	G/M boundary indicated by multi-variate analysis of large dataset, combined with expert judgement. Sub-metric EQRs normalised to equidistant boundaries.
Norway (RSLA) for type NEA 1/26	Equidistant division of the EQR gradient	Equidistant division of the EQR gradient
Norway (RSLA) for type NEA 7	Equidistant division of the EQR gradient	Equidistant division of the EQR gradient
Portugal (PMarMAT)	Initially equidistant divisions showing slight (about 20%) deviations from reference conditions. Boundaries will be adjusted after the IC exercise.	Initially equidistant divisions showing slight (about 40%) deviations from reference conditions.
United Kingdom (UK RSL)	H/G boundary indicated by multi-variate analysis of large dataset, combined with expert judgement. Sub-metric EQRs normalised to equidistant boundaries.	G/M boundary indicated by multi-variate analysis of large dataset, combined with expert judgement. Sub-metric EQRs normalised to equidistant boundaries.
Subtidal Macroalgae		
Norway (MSMDI)	Boundaries are set at two levels, scoring boundaries for selected species and index boundaries. Scoring boundaries are set in relation to reference depth limits for each species based on expert judgement, index (mean score) boundaries are just an equidistant division of the EQR gradient into five classes.	Scoring boundaries are set mainly by expert judgment with aid from secchi depth and chl a relationships to nutrients.
Sweden (MSMDI)	Boundaries are set at two levels, scoring boundaries for selected species and index boundaries. Scoring boundaries are set in relation to reference depth limits for each species based on expert judgement, index (mean score) boundaries are just an equidistant	Scoring boundaries are set mainly by expert judgment with aid from secchi depth and chl a relationships to nutrients.

Member State/Method	Methodology used to set H/G boundary	Methodology used to set G/M boundary
	division of the EQR gradient into five classes.	

Spain - RICQI = Rocky Intertidal Community Quality Index

Table 2.23The metric scoring system of RICQI. Scores for bioindicator species SpBio (ESS: Ecological Status Similarity; PC: presence/absence of Cystoseira genus), morphologically complex algae MCA, species richness R (Ra: algal species; Rf: invertebrates species), and parameters related to faunal cover FC (Pf: ratio faunal cover to whole assemblage cover, Ch: herbivores cover; Cs: suspensivores cover).

RICQI index score system						
SpBio (ESS + PC = max. 0.5)	ESS	Score	**PC**	Score		
	Bad	0.10	present	0		
	Poor	0.20	absent	-0.05		
	Moderate	0.30				
	Good	0.40				
	High	0.50				
MCA (max. 0.20)	**MCA**	Score				
	0-15%	0.05				
	>15-30%	0.10				
	>30-45%	0.15				
	>45%	0.20				
R (Ra + Rf = max. 0.15)	**Ra**	Score	**Rf**	Score		
	0-10	0.02	0-5	0		
	>10-20	0.04	>5-10	0.01		
	>20-30	0.06	>10-15	0.02		
	>30-40	0.08	>15-20	0.03		
	>40	0.10	>20-25	0.04		
			>25	0.05		
FC (Pf + Ch + Cs = max. 0.15)	**Pf**	Score	**Ch**	Score	**Cs**	Score
	0-5%	0.03	0-5%	0	0-10%	0.05
	>5-10%	0.05	>5%	0.05	>10%	0
	>10-15%	0.04				
	>15-20%	0.02				
	>20-25%	0.01				
	>25%	0				
Ecological Quality	Bad	Poor	Moderate	Good	High	
RICQI (SpBio + MCA + R + FC)	0 - 0.2	> 0.2 - 0.4	> 0.4 - 0.6	> 0.6 - 0.8	> 0.8 – 1.0	

Table 2.24 Average cover (in %) of indicator species for each of the quality levels (high, good, moderate, and poor) differentiated in the nMDS ordination analysis on the basis of Bray-Curtis dissimilarity matrix calculated for 4th root-transformed data. A theoretical inventory, based on data of the area, prior to 1996, represents the bad conditions.

Species list	High	Good	Moderate	Poor	Bad
Bachelotia antillarum	-	-	-	0.6	6.3
Bifurcaria bifurcata	6.2	1.0	-	-	-
Boergeseniella thuyoides	2.4	-	-	-	-
Caulacanthus ustulatus	1.2	4.8	12.2	13.0	1.6
Ceramium botrycarpum	0.5	0.3	3.6	6.4	-
Ceramium ciliatum	0.5	1.6	10.5	10.5	1.3
Ceramium flaccidum	0.3	0.1	6.8	5.4	1.3
Chondracanthus acicularis	3.6	4.0	0.4	-	-
Chondria coerulescens	0.7	5.0	5.6	4.0	-
Chthamalus spp.	1.2	1.3	1.4	-	-
Cladophora lehmanniana	0.8	0.4	2.9	1.5	-
Cladostephus spongiosus	1.4	0.2	0.3	0.6	0.1
Codium decorticatum	0.3	10.7	5.6	0.6	-
Corallina elongata	37.3	51.8	54.5	6.3	-
Cystoseira tamariscifolia	5.8	-	-	-	-
Dictyota dichotoma	0.2	0.1	1.0	1.0	-
Falkenbergia rufolanosa	5.5	2.7	1.2	0.1	-
Gastroclonium reflexum	0.1	0.3	0.3	3.6	-
Gelidium spinosum	1.8	7.2	5.6	-	-
Gelidium pulchellum	0.1	1.9	1.0	1.1	-
Gelidium pusillum	-	0.1	1.6	38.2	48.5
Gymnogongrus griffithsiae	-	-	0.1	0.1	1.1
Hyale spp.	1.0	0.4	0.2	-	-
Hypnea musciformis	1.0	0.4	0.4	-	-
Jania rubens	3.7	0.7	0.1	-	-
Laurencia obtusa	7.9	0.7	-	-	-
Lithophyllum incrustans	10.7	7.9	1.1	-	-
Mesophyllum lichenoides	4.3	10.0	6.8	-	-
Mytilus galloprovincialis	0.5	0.7	2.1	8.6	0.5
Ophidocladus simpliciusculus	1.0	0.1	-	-	-
Paracentrotus lividus	3.5	0.3	0.3	0.1	-
Patella spp.	5.2	2.9	1.0	0.8	-
Plocamium cartilagineum	1.1	0.8	-	-	-
Polydora spp.	-	-	1.0	27.0	37.5
Polysiphonia atlantica	-	-	0.0	0.6	1.1
Pterosiphonia complanata	1.7	6.1	1.9	-	-
Pterosiphonia pennata	0.7	1.0	0.5	0.5	-
Ralfsia verrucosa	1.4	1.4	2.2	0.2	-
Stypocaulon scoparium	32.2	11.0	3.0	-	-
Ulva rigida	0.7	4.6	12.5	3.4	2.0

Conceptual model:

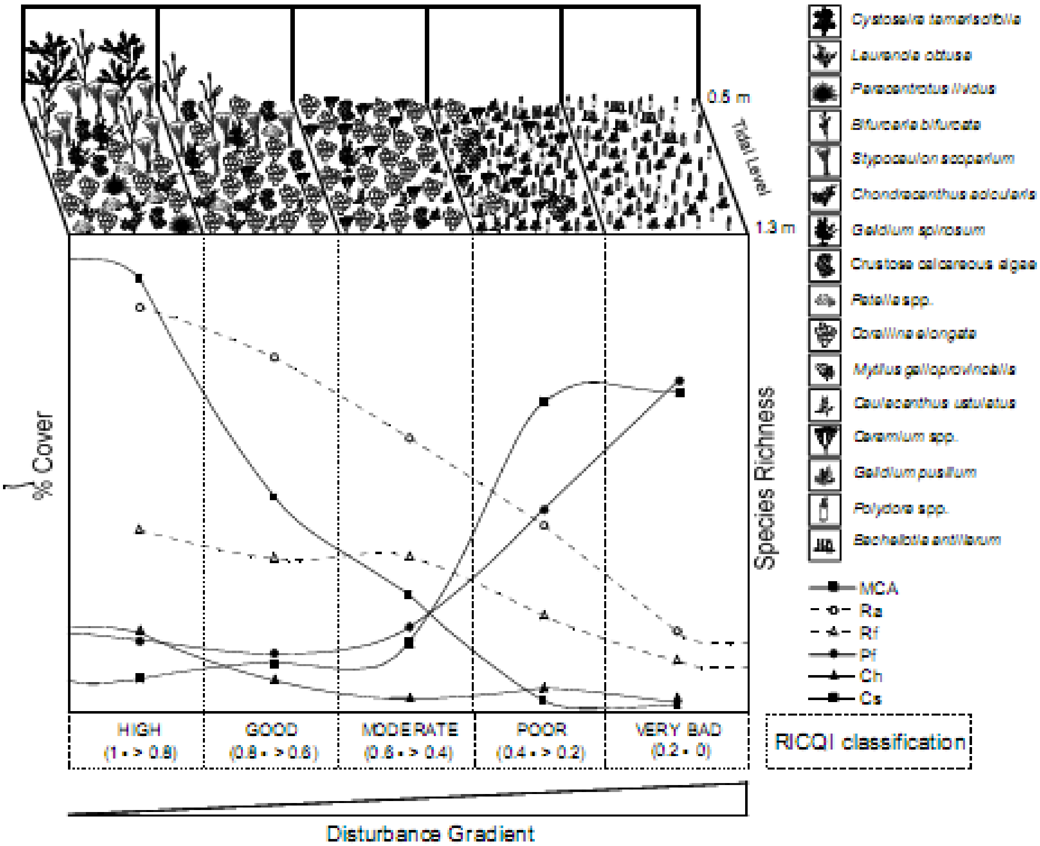


Figure 2.9 Conceptual model proposed for successional stages along gradient of increasing environmental disturbance and associated values of metrics included in the index. MCA: Morphologically complex algae; Ra: algal species richness; Rf: invertebrate species richness; PF: faunal percentage with respect to benthic community; Ch: herbivores cover; Cs suspensivores cover

Spain - RSL = Reduced Species List

The Ecological Quality Ratio (EQR) for the RSL index is calculated for each station considering the range of the different elements calibrated previously from Atlantic shores of Andalusia (Table 2.25) and the following equations proposed by Wells *et al.* (2008). Equation 5 was used when the value of the element increased with increasing EQR (species richness, proportion of red algae and proportion of ESG-I), while equation 6 was used when the value of the element decreased when EQR increased (proportion of green algae and proportion of opportunists).

Table 2.25The metric scoring system with classification status ranges for macroalgae species richness, red algae, ESG-I, green algae and proportion of opportunists.

	Bad	Poor	Moderate	Good	High
Common elements					
Corrected species richness	< 10	11 - 19	20 - 26	27 - 29	> 29
Number of red seaweeds	< 5	6 - 9	10 - 13	14 - 18	> 18
Proportion of green seaweeds	> 0.55	0.55 - 0.35	0.35 - 0.25	0.25 - 0.20	< 0.20
RSL - ecological					
Proportion of ESGI	< 0.15	0.15 - 0.25	0.25 - 0.35	0.35 - 0.40	> 0.40
Proportion of opportunists	> 0.30	0.30 - 0.15	0.15 - 0.10	0.10 - 0.05	< 0.05
EQR-RSL	< 0.20	0.20 - 0.40	0.40 - 0.60	0.60 - 0.75	> 0.75

(5) EQR = {((value – lower CR)/CW) x EQR BW} + lower EQR BR

(6) EQR = Upper EQR BR - {((value – lower CR)/CW) x EQR BW}

Where CR was the Class Range, CW the Class Width, BR was the EQR Band Range and BW was the EQR Band width.

The equivalence system between EQR and ES proposed by Bermejo *et al.*(2012) for the RSL underestimated the ecological status precluding the comparability between the obtained results due to differences in reference conditions. Thus, the ecological status classification of the different localities must be done according to Table 2.26 (resulting from the calibration between CARLIT and RSL in southern Spain; Bermejo *et al.*, unpublished) or the modification posed by the NEA-GIG.

Table 2.26 Proposed correspondence between ecological quality ratio (EQR) of RSL and ecological status class (ESC).

ESC	EQR RSL
High	1.00 - 0.70
Good	0.70 - 0.50
Moderate	0.50 - 0.40
Poor	0.40 - 0.20
Bad	0.00 – 0.20

(Ireland & (UK) United Kingdom - RSL = Rocky Intertidal Macroalgae - Reduced Species List (NEA 1/26; NEA 7)

For the H/G boundary of intertidal macroalgae communities a level of species richness (or total number of species recorded from a reduced species list) is used from which proportions of red, green and opportunist are calculated along with a ratio of ephemeral against perennial algae (ESG ratio). At reference conditions algal species richness, the proportion of red species and the ESG ratio should be high, and the proportion of green and opportunist species should be low. Reference conditions are based on historical and existing data and reports.

Class boundaries have been set based on historical reports and data along with expert judgement which show certain levels of species richness and community composition to correspond to distinct levels of pressure. The use of several community features allows for different responses to be picked up and allows for natural environmental conditions to be considered. Class boundaries for the RSL are shown in Table 2.27.

Table 2.27 Class boundaries for RSL

Class	Bad	Poor	Moderate	Good	High
EQR	0 - 0.2	0.2 - 0.4	0.4 - 0.6	0.6 - 0.8	0.8 - 1.0
Normalised Species richness	0 - 5	5 - 17	17 - 25	25 - 35	35 - 70
Percentage of greens	100 - 80	80 - 30	30 - 20	20 - 12	12 - 0
Percentage of reds	0 - 15	15 - 35	35 - 45	45 - 55	55 - 100
ESG ratio	0 - 0.2	0.2 - 0.7	0.7 - 0.8	0.8 - 1.0	1.0 - 1.2
Percentage of opportunists	100 - 50	50 - 25	25 - 15	15 - 10	10 - 0

Note: There are slightly different class boundaries for each of the three UK/IE RSLs, but a generalised set is shown here.

Work by Wells (2002) demonstrated anthropogenically induced changes to intertidal algal communities as a result of significant changes in the pollution loading and subsequent abatement of sewage pollution. These data provided a quantifiable pressure gradient from which to assess changes in macroalgae species richness and composition (Figure 2.10).

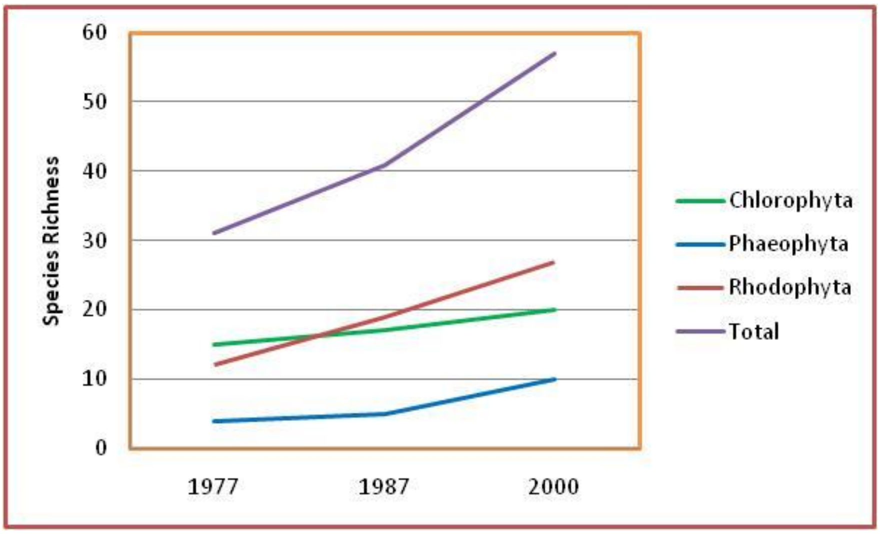


Figure 2.10 Numerical species richness for Joppa during 1977 and 1987 (Wilkinson et al unpubl.; Wells, 2002)

Species composition responded well to predictions. For WFD historical and current data were subjected to multivariate analysis which, along with expert opinion, allowed the derivation of boundaries. These were tested using the foregoing approach of Wells and Wilkinson. Their observations, along with similar findings from other sites, allowed the expected boundaries, as defined by expert opinion, to be refined against known values for a variety of shore types.

Norway - RSLA = Macroalgae - Rocky Shore Reduced Species List with Abundance

The Class boundaries for the different submetrics are shown in Table 2.25 and Table 2.26.

Table 2.28 Class boundaries for RSL in NEA 1/26 for Norway.

EQR	0,8-1,0	0,6 – 0,8	0,4 – 0,6	0,2 – 0,4	0 – 0,2
Quality Classes → / Parameters	High	Good	Moderate	Poor	Bad
Species richness adjusted	30 – 80	15 – 30	10 - 15	4 - 10	0 - 4
% number of Green Algae	0 - 20	20 – 30	30 – 45	45– 80	80 - 100
% number of Red Algae	40 – 100	30 – 40	22 – 30	10 – 22	0 - 10
ESG1/ESG2	0.8 – 2.5	0.6 – 0.8	0.4 – 0.6	0.2 – 0.4	0 – 0.2
% number of opportunistics	0 -15	15 - 25	25 – 35	35 – 50	50 - 100
Abundance Brown	90 – 450	40 – 90	25 - 40	10– 25	0 - 10

The class boundaries for RSLA-NEA 7 are somewhat different from those for RSLA in NEA – 1/26. The class boundaries were set according to the mean values for each submetric found in a nutrient pressure gradient, from bad to high.

Table 2.29 Class Boundaries for RSLA in NEA 7.

EQR	0,8-1,0	0,6 – 0,8	0,4 – 0,6	0,2 – 0,4	0 – 0,2
Quality Classes →	**High**	**Good**	**Moderate**	**Poor**	**Bad**
Parameters					
Species richness adjusted	30 – 65	20 – 30	12 - 20	4 - 12	0 - 4
% number of Green Algae	0 - 20	20 – 25	25 – 30	30 – 36	36 - 100
% number of Red Algae	40 – 100	30 – 40	21 – 30	10 – 21	0 - 10
ESG1/ESG2	1 – 1.5	0.7 – 1	0.4 – 0.7	0.2 – 0.4	0 – 0.2
% number of opportunistics	0 - 25	25 - 32	32 – 40	40 – 50	50 - 100
Abundance Green	1 – 14	14 – 28	28 – 45	45 – 90	90 - 300
Abundance Brown	120 – 300	60 – 120	30 – 60	15 – 30	0 - 15
Propotion of Brown	40 – 100	30 – 40	20 – 30	10 – 10	0 - 10

(PT) Portugal - PMarMAT = Marine Macroalgae Assessment Tool

(Perennial Intertidal Algae & Opportunistic macroalgae)

Table 2.30 Metrics and respective boundaries adopted by Portugal, and provides the way to go from the sum of scores to the EQS.

PMarMAT indicator	Bad	Poor	Moderate	Good	High
Taxa richness (*)	0 - 6	7 - 13	14 - 20	21 - 27	>28
Proportion Chlorophyta	>0.40	0.30 - 0.39	0.2 - 0.29	0.1 - 0.19	<0.10
No. Rhodophyta	0 - 3	4 - 8	9 – 12	13 - 17	>18
ESG Group Ratio	<0.24	0.25-0.49	0.50 - 0.99	1.00 - 1.99	>2.00
Proportion opportunists	>0.40	0.3 - 0.39	0.2 - 0.29	0.1 - 0.19	<0.10
Coverage opport. (%)(*)	>0.70	0.30 - 0.70	0.20 - 0.29	0.10 - 0.19	<0.10
Shore description	-	15 - 18	12 - 14	8 - 11	1 - 7
Corresponding Score to Metrics Class	0	1	2	3	4
Sum of Scores	**0 - 7**	**8 - 14**	**15 - 21**	**22 - 28**	**29 - 36**
EQR	**0 - 0.20**	**0.21 - 0.40**	**0.41 - 0.60**	**0.61 - 0.79**	**0.80 - 1**
EQS	**Bad**	**Poor**	**Moderate**	**Good**	**High**

Subtidal Macroalgae

(Se) Sweden & (NO) Norway - Multi Species Maximum Depth Index (MSMDI)

Scoring point (1, 0.8 or 0.6 in table above) is given (for each species) if max depth of the species is larger than boundary. I max depth is <= 0.6 boundary a score of 0.4 is given. If a species has disappeared due to anthropogenic reasons a score of 0.2 is given otherwise a missing species is not given any score. Index value is mean score for species found in a transect. The ecological status of a water body is assessed by comparing the average of all available MSMDI values against the boundaries for each status class. Status class boundaries are equidistant with a size of 0.2.

Taxon	Inner coastal waters NEA 8a+b			Fjords NEA 9			Outer coastal waters NEA 10		
	1	0.8	0.6	1	0.8	0.6	1	0.8	0.6
Chondrus crispus	8	5	3	10	7	4	13	9	5
Delesseria sanguinea	18	12	6	13	9	5	22	18	9
Furcellaria lumbricalis	10	7	4	12	8	4	12	9	5
Halidrys siliquosa	8	5	3	10	7	4	10	8	4
Phycodrys rubens	15	10	5	13	8	4	22	17	9
Phyllophora pseudoceranoïdes + Coccotylus truncatus	18	12	6	10	8	4	22	18	9
Rhodomela confervoides	12	7	4	12	8	4	12	9	5
Saccharina latissima	10	7	4	8	6	3	12	9	5

2.5. Results of WFD compliance checking

Table 2.31 List of the WFD compliance criteria and the WFD compliance checking process and results of the national methods (intertidal macroalgae) included in the Annex I of the EC Decision.

Intertidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
1. Ecological status is classified by one of **five classes** (high, good, moderate, poor and bad).	Yes for ES, FR, IE. NO, PT, UK
2. High, good and moderate ecological status are set in line with the WFD's **normative definitions** (**Boundary setting procedure**)	No for ES, FR, PT (preliminary equidistant division in five classes) Yes, for IE, NO & UK.
• Scope of detected pressures	See section on Pressures addressed
• Has the pressure-impact relationship of the assessment method been tested?	See section on Pressures addressed
• Setting of ecological status boundaries: methodology and reasoning to derive and set boundaries	See section on national boundary setting
• Boundary setting procedure in relation to the pressure: Which amount of data/pressure indicators have been related to the method and what was the outcome of the relation?	See section on Pressures addressed
• Reference and Good status community description: Is a description of the communities of reference/ high – good – moderate status provided? Not only a formula or an EQR value, but the range of values for the different parameters included in the method that result in high – good – moderate status	Yes for all methods. See sections on ecological characteristcs.
3. **All relevant parameters** indicative of the biological quality element are covered (see Table 1 in the IC Guidance). A **combination rule** to combine parameter assessment into BQE assessment has to be defined. If parameters are missing, Member States need to demonstrate that the method is sufficiently indicative of the status of the QE as a whole.	Yes for ES (Cantabria región), ES (Basque Country), FR, PT, NO No for ES (Andalusia region), IE, UK (do not include abundance). The 3 participants have provided justification for non-inclusion of abundance in the RSL tool. Abundance is covered by separate Intercalibrated tool NO has included some sub-metric that includes abundance of greens and browns in its RSL (IC phase 1) to be RSLA. The old RSL will still be used for IC- purposes.

Intertidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
• Complete list of biological metric(s) used in assessment	See section on BQE parameters
• Data basis for metric calculation: single sample in space or time for metric calculation or aggrega-ted data in space or time?	Single sample in space and time for the applica-tion of the methods but aggregated data from multiple sites for the assessment of the final quality at water body level.
• Combination rule for multimetrics	See section on BQE parameters
4. Assessment is adapted to **intercalibration common types** that are defined in line with the typological requirements of the WFD Annex II and approved by WG ECOSTAT	Yes for ES, FR, PT, within the type NEA 1/26-Biotype A2 Yes for IE, NO, UK, within the type NEA 1/26-Biotype B21 Yes for NO, UK, within the type NEA 7.
• Is the assessment method applied to water bodies in the whole country?	UK/IE - Yes
• Specify common intercalibration types	See section on typology
5. The water body is assessed against type-specific near-natural reference conditions	Yes for ES, FR, IE, NO, PT, UK
• Scope of reference conditions	See section on National reference conditions
• Key source(s) to derive reference conditions	See section National reference conditions
• Number of sites, location and geographical coverage of sites used to derive reference conditions	See section on National reference conditions
• Time period (months+years) of data of sites used to derive reference conditions	See section on National reference conditions
• Reference site characterisation: criteria to select them	See section on National reference conditions
• Is a true reference used for the definition of High status or an alternative benchmark estimation?	See section on National reference conditions
6. Assessment results are expressed as **EQRs**	Yes for ES, FR, IE, NO, PT, UK
7. Sampling procedure allows for **representative** information about water body quality/ ecological status **in space and time**	Yes for ES, FR, IE, NO, PT, UK.
• Has the uncertainty of the method been quan-tified and is it regarded in the assessment ?	Not direct assessment of the uncertainty, but all the methods has been tested against pressures obtaining adequate results.
• Specify how the uncertainty has been quantified and regarded	Not direct assessment of the uncertainty, but all the methods has been tested against pressures obtaining adequate results
8. All data relevant for assessing the biological **parameters** specified in the	Yes for ES (Cantabria region), ES (Basque Country), FR, PT, NO

Intertidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
WFD's normative definitions are covered by the **sampling procedure**	No for ES (Andalusia región), IE, UK (no abundance) – justification provided.
9. Selected taxonomic level achieves adequate **confidence and precision** in classification	Yes for, ES, FR, IE, NO, PT, UK
• Minimum size of organisms sampled and processed	UK/IE – all species from defined lists are registered qualitatively
• Record of biological data: level of taxonomical identification – what groups to which level	UK/IE – Mostly to species level, but some taxa to higher taxonomic levels, as defined in RSLs

Table 2.32 List of the WFD compliance criteria and the WFD compliance checking process and results of the national methods (subtidal macroalgae) included in the Annex I of the EC Decision.

Subtidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
1. Ecological status is classified by one of **five classes** (high, good, moderate, poor and bad).	Yes for NO, SE
2. High, good and moderate ecological status are set in line with the WFD's **normative definitions** (**Boundary setting procedure**)	Yes for NO and SE. Note: NO and SE boundaries are set at two levels, scoring boundaries for selected species and index boundaries. Scoring boundaries are set in relation to reference depth limits for each species based on expert judgment, index (mean score) boundaries are just an equidistant division of the EQR gradient into five classes.
• Scope of detected pressures	See section on Pressures addressed
• Has the pressure-impact relationship of the assessment method been tested?	See section on Pressures addressed
• Setting of ecological status boundaries: methodology and reasoning to derive and set boundaries	See section on national boundary setting
• Boundary setting procedure in relation to the pressure: Which amount of data/pressure indicators have been related to the method and what was the outcome of the relation?	See section on Pressures addressed
• Reference and Good status community description: Is a description of the communities of reference/ high – good – moderate status provided? Not only a formula or an EQR value, but the range of values for the different parameters included in the method that result in high – good – moderate status	Yes for all methods. See sections on ecological characteristic for details.
3. **All relevant parameters** indicative of the biological quality element are covered (see Table 1 in the IC Guidance). A **combination rule** to combine para-meter assessment into BQE assessment has to be defined. If para-meters are missing,	Yes with some limitations for NO, SE, as depth distribution of 3 to 9 common conspicuous perennial eutrophication sensitive represents both abundance and sensitive species.

Subtidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
Member States need to demonstrate that the method is sufficiently indicative of the status of the QE as a whole.	
• Complete list of biological metric(s) used in assessment	See section on BQE parameters
• Data basis for metric calculation: single sample in space or time for metric calculation or aggregated data in space or time?	Single sample in space and time for the application of the methods but aggregated data for the assessment of the final quality at water body level.
• Combination rule for multimetrics	See section on BQE parameters
4. Assessment is adapted to **intercalibration common types** that are defined in line with the typological requirements of the WFD Annex II and approved by WG ECOSTAT	Yes for NO, SE (national type specific)
• Is the assessment method applied to water bodies in the whole country?	No for NO. Different method in NEA 1/26 and 7
• Specify common intercalibration types	See section on typology
5. The water body is assessed against type-specific near-natural reference conditions	No for NO, SE (reference conditions based on historical, modelling and expert judgment) NO has some near ref.condition-sites for NEA10 and NEA8
• Scope of reference conditions	See section on National reference conditions
• Key source(s) to derive reference conditions	See section on National reference conditions
• Number of sites, location and geographical coverage of sites used to derive reference conditions	See section on National reference conditions
• Time period (months+years) of data of sites used to derive reference conditions	See section on National reference conditions
• Reference site characterisation: criteria to select them	See section on National reference conditions
• Is a true reference used for the definition of High status or an alternative benchmark estimation?	See section on National reference conditions
6. Assessment results are expressed as **EQRs**	Yes for NO, SE
7. Sampling procedure allows for **representative** information about water body quality/ ecological status **in space and time**	Yes for NO ,SE Note: For SE this presently differs between areas because demands in assessment method are hard to fulfill in some areas with today's monitoring data

Subtidal Macroalgae	
Compliance criteria	**Compliance checking conclusions**
• Has the uncertainty of the method been quantified and is it regarded in the assessment ?	Not direct assessment of the uncertainty, but all the methods has been tested against pressures obtaining adequate results. Yes for NO within the WISER-project (Mascaró *et al.* 2012)
• Specify how the uncertainty has been quantified and regarded	Not direct assessment of the uncertainty, but all the methods has been tested against pressures obtaining adequate results. For MSMDI uncertainty variation among diver,site,VB, year and regions has been tested and quantified (Mascaró *et al.* 2012)
8. All data relevant for assessing the biological **parameters** specified in the WFD's normative definitions are covered by the **sampling procedure**	Yes NO, SE
9. Selected taxonomic level achieves adequate **confidence and precision** in classification	Yes for NO, SE

General conclusion of the compliance checking:

Not all methods include abundance but clarifications provided by ES (Andalusía region), IE and UK supported that exception (see section on Required BQE parameters).

Some methods for intertidal macroalgae in rocky substrates were intercalibrated in IC1, according to different groups of countries (ES_PT; IE_NO_UK). At that phase, biogeographic and methodological differences (e.g. no abundance estimates in some methods) were the basis of the lack of agreement between national methods, and were also one of the reasons for defining "biotypes" all along the NEA coasts.

3. Results IC feasibility checking

3.1. Typology

Table 3.1 Common typologies

Common IC type	Type characteristics	MS sharing IC common type
CW-NEA 1/26 - Biotype A2	Established after the physicochemical and biological characterization of coastal areas all around NEA Region (Ramos *et al.*, 2012 and in preparation)	ES, FR, PT

CW-NEA 1/26 - Biotype B21	Established after the physicochemical and biological characterization of coastal areas all around NEA Region (Ramos *et al.*, 2012 and in preparation)	IE, NO, UK, FR
CW-NEA 5		DE (only 1 Member State)
CW-NEA 7		NO, UK
CW-NEA 8b	Water type 8 is now divided into subtype 8a and 8b due to different water masses in Skagerrak (mixed Baltic and North Sea Water) and Kattegat (mostly influenced by Baltic Water) See Annex I at the end of this report	DK, SE
CW-NEA 8a		NO, SE
CW-NEA 9		NO, SE
CW-NEA 10		NO, SE

Table 3.2 Feasibility checking of the national methods included in the Annex I of the EC Decision.

Method	Appropriate for IC types/subtypes	Remarks
ES1 – CFR intertidal and subtidal	CW-NEA 1/26 (biotype A2)	Method applicable also to subtidal areas
ES2 – RICQI intertidal	CW-NEA 1/26 (biotype A2)	
ES3 – RSL (Andalucía) intertidal	CW-NEA 1/26 (biotype A2)	
FR – CCO intertidal	CW-NEA 1/26 (biotype A2)	
PT – PMarMAT intertidal	CW-NEA 1/26 (biotype A2)	Is needed a RTL previously developed for each subtypological variant.
IE - RSL intertidal	CW-NEA 1/26 (biotype B21)	Method applicable to stable rocky substrata in UK & IE coastal waters
NO – RSLA intertidal	CW-NEA 1,26 (biotype B21)	Area south of Bergen and north of the Arctic Circle is not IC, as typology is different.
UK – RSL intertidal	CW-NEA 1/26 (biotype B21) CW-NEA 7	Method applicable to stable rocky substrata in UK & IE coastal waters
NO – RSLA intertidal	CW-NEA 7	Fjords (Norwegian national type H3 and M3) are IC with national type CW12 in UK.
NO – MSMDI subtidal	CW-NEA 8a, 9 & 10	Method only applicable on sampling localities with hard substrata.
SE – MSMDI subtidal	CW-NEA 8a, 8b, 9 & 10	Method only applicable on sampling localities with hard substrata.

Conclusion

Northeast Atlantic typologies (types/biotypes) for rocky coasts are shown in the table above. Due to preliminary results on IC phase 1 (IC1), an alternative division of the NEA region in biotypes was developed, aiming to provide objective and quantitative criteria that might justify the identification of groups of MS's sharing more similar CW conditions for the IC exercise of some biological component (e.g CW Macroalgae).

The analysis of biotypes was led by Spain (IH Cantabria), including two different steps. First, a preliminary proposal based on the physico-chemical characterization of CW along the NEA Region (cf. Ramos *et al.*, 2012) was developed, whose main results were the establishment of main gradients along this intercalibration region (Figure 3.1) based on different statistical thresholds.

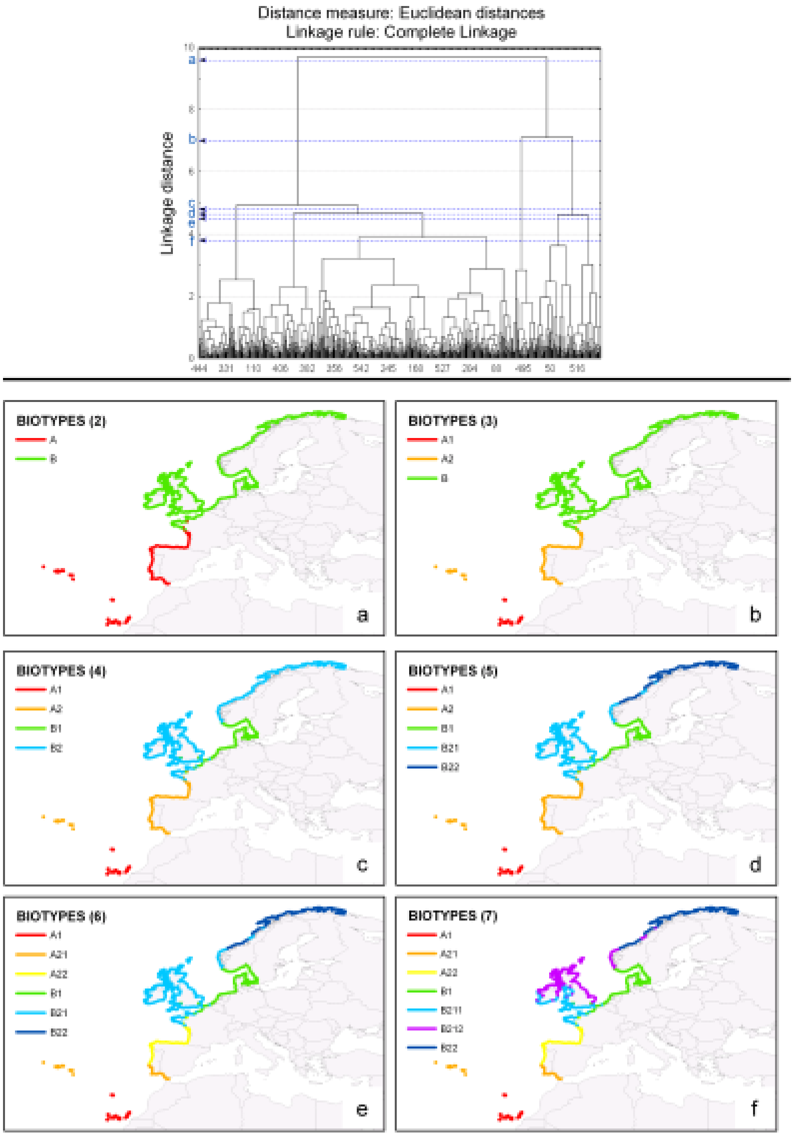


Figure 3.1 Division of the NEA region in biotypes.

Having in mind the similarity groups created by the biotypes' analyses along the whole NEA area (Ramos et al, 2012), the **IC2 exercise took into account the "conceptual framework" and main conclusions of that work to justify the division of the coastal waters previously included within Type CW NEA 1/26 in two geographic areas.** An important issue regarding this areal distribution is the position of the specific boundaries between the two biotypes (Figure 3.1). Coastal water constitutes a "continuous" in which we may/should identify "transition zones". Looking to different classifications proposed in several documents (e.g. OSPAR documents, Marine Strategy Directive, Ramos et al, 2012), we can observe that coastal areas along the English Channel occupy one of those strategic positions. So, they are normally "shared" by the Northern, the Southern and/or the North Sea areas (i.e. normative zones or types). Depending on restrictions of each distribution model we use, we may assign this singular coastal zone to different "types".

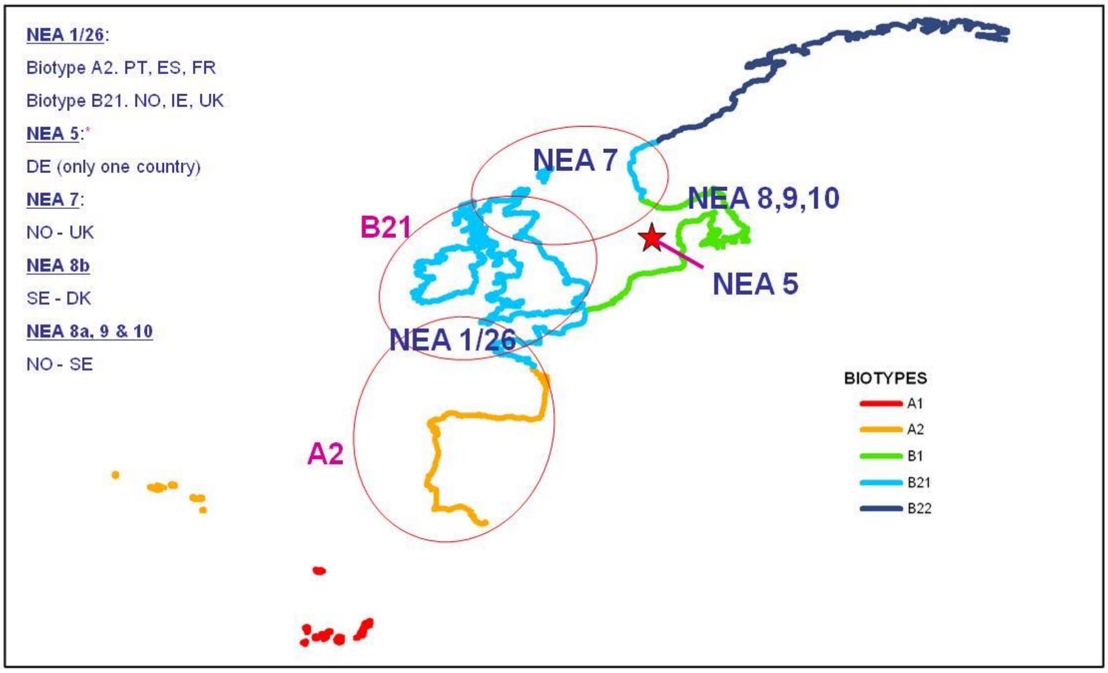


Figure 3.2 Types and subtypes adopted by the NEA GIG for the IC2 of CW Macroalgae.

A second step on the classification work was the biological validation of those biotypes according to the distribution of the most representative macroalga taxa (frequent, rare and absent species), included in 164 sites from 7 MS along the NEA (Ramos et al, submitted). Main results were presented at the ECSA50 Symposium. Following a similar statistical approach (Figure 3.3), the ordination analysis of those samples (MDS) show a clear gradient north-south. This way, sampling points belonging to Norway are located on the upper part of the MDS graph while Iberian Peninsula sampling points are located on the bottom. Besides, French sampling points are situated between those from the Iberian Peninsula and Ireland and UK islands, which ratify the "transitional character" of this area. This strong latitudinal gradient is specially caused by the orders Fucales and Laminariales, phaeophytes that dominated the northern area. By contrast, macroalgae that shows a higher presence in the southern area are mostly rhodophytes (*Caulacanthus ustulatus, Chondracanthus acicularis, Asparagopsis armata, Chondria coerulescens, Gymnogongrus spp., Gelidium pulchelum, Chondracanthus teedei* and *Boergeseniella thuyoides*).

In summary, part of the French coast is a transition zone between the northern and the southern type. The major part belongs to the southern type and a smaller northern part belongs to the northern type. For the IC2 purpose, taking also into account the assessment concept on the basis of the CCO method (FR), we agreed to include the data of the northern part in the dataset of the Biotype A2 for intercalibration purposes. However, also the comparability needs to be ensured between the northern part of France (still to be specified) belonging to biotype B21 and the countries included in biotype B21. So, the final biotypes considered for NEA 1/26 take into account two distinct areas:

1. Northern area (biotype B21), covering the intertidal of IE, NO, UK (for the current intercalibration), and FR (still to be compared)
2. Southern area (biotype A2), including the coasts of ES, FR and PT.

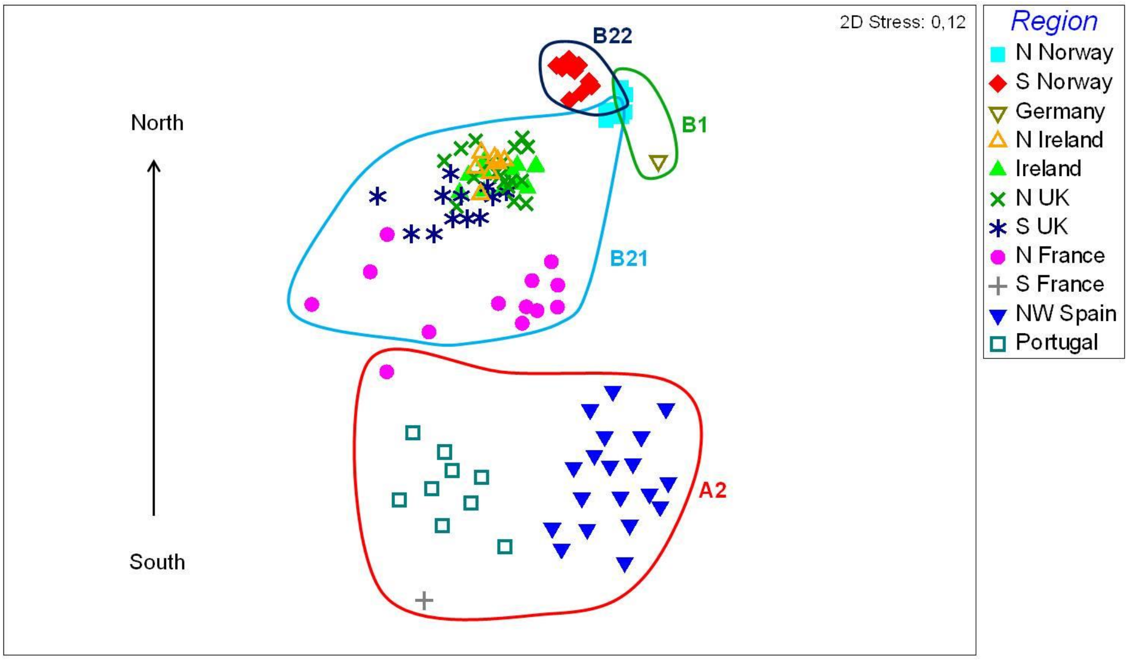


Figure 3.3. MDS analysis distribution of the different sampling stations according to their region. Source: Ramos et al., submitted.

As shown in section 4 and 5, this division has produced the best technically-sound EQRs adjustments between methods in this big coastal area.

Is the Intercalibration feasible in terms of typology?

The first impression from MS's concerning if IC is feasible in terms of typology is:

<u>NEA 1/26 intertidal</u>:

Biotype A2. PT, ES, FR – Yes

Biotype B21. NO, IE, UK – Yes

<u>NEA 1/26 subtidal</u>:

Biotype A2. ES, FR – Not within the IC2 due to the scarcity of potential common sites to be considered in time.

<u>NEA 5 intertidal and subtidal</u>:

DE – NO as there is only one MS involved for this element)

<u>NEA 7 intertidal</u>:

NO-UK - Yes

<u>NEA 8b subtidal</u>:

DK - SE – Yes, although finally the intercalibration in the IC2 have been not posible due to the differences in assesment concept.

NEA 8a, NEA 9 and NEA 10 subtidal:

SE - NO – Yes

3.2. Pressures adressed

Intertidal Macroalgae

A homogeneous system to evaluate pressures at the station level (site) was agreed by MSs (April 2011) and comparisons were carried out. The criteria used for pressure assessment is that approved in the NEA-GIG vegetation meeting carried out in Lisbon during the 6-7th of April of 2011. This system is based on a semi-quantitative assessment of 3 types of pressures (urban, industrial and diffuse discharges) in 4 levels (0- no pressure to 3- high pressure) and 3 integration systems (average, maximum or sum of the 3 types of pressures). See Table 3.3 for a more detailed explanation.

Table 3.3 System to evaluate pressures.

Urban Pressures		Distance (m)			
	Population equivalent	>500	500-100	100-50	<50
	<2000 PE	0	0	1	2
	2000- 10000 PE	0	1	2	3
	10k-150k	1	2	3	4
	>150k	2	3	4	4
Industrial Pressures		**Distance**			
	Population equivalent	>500	500-100	100-50	<50
	<2000 PE	0	0	1	2
	2000- 10000 PE	0	1	2	3
	10k-150k	1	2	3	4
	>150k	2	3	4	4
Diffuse					
	None	0			
	Low pressure	1			
	Medium	2			
	High	3			

In general, results showed that correlations were very variable between methods, but all of them might fulfil this requirement. After checking the response of each calculation rule, the **maximum pressure value** for each site seemed to respond in a more precise way for this analysis, justifying its use. The obtained regressions for all methods are shown below in detail (only sites considered within IC2 from each country/region).

Table 3.4 Pressures addressed by the national methods (intertidal macroalgae) included in the Annex I of the EC Decision.

Member State	Methods tested	Pressure	Pressure indicators	Amount of data	Strength of relationship (r or r2, p)
Intertidal Macroalgae					
Spain-Cantabria region (ES1)[1]	CFR	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	21 stations + 108 additio-nal stations used as ICM	See Figure below
Spain-Basque country (ES2)[2]	RICQI	Urban and industrial discharges, diffuse pollution	Semi Quantitative system agreed by MSs	66 stations (including temporal gradients)	See Figure below
Spain-Andalusi a region(ES 3)[3]	SRL	Urban and industrial discharges, diffuse pollution	Semi Quantitative system agreed by MSs	16 stations	See Figure below
France (FR)	CCO	Urban and industrial discharges, diffuse pollution	Semi Quantitative system agreed by MSs	8 stations	See Figure below
Ireland (IE)	RSL	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	62 stations	See Figure below
Norway (NO)	RSL	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	38 stations	See Figure below and document on comparisons between RSL and RSLA provided by NO

Member State	Methods tested	Pressure	Pressure indicators	Amount of data	Strength of relationship (r or r2, p)
Norway (NO)	RSLA	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	38 stations	See Figure below and Document on comparisons between RSL and RSLA provided by NO
Portugal [4] (PT)	PMarMat	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	18 stations	See Figure below
United Kingdom (UK)	RSL	Urban and industrial discharges, Diffuse pollution	Semi Quantitative system agreed by MSs	172 stations	See Figure below

[1] Previously tested in IC1 (Guinda *et al*., 2008)

[2] Previously tested in Díez *et al*. (2012)

[3] Previously tested in Bermejo *et al*. (2012)

[4] Individual metrics tested in Gaspar *et al*. (2012) and Neto *et al*. (2012)

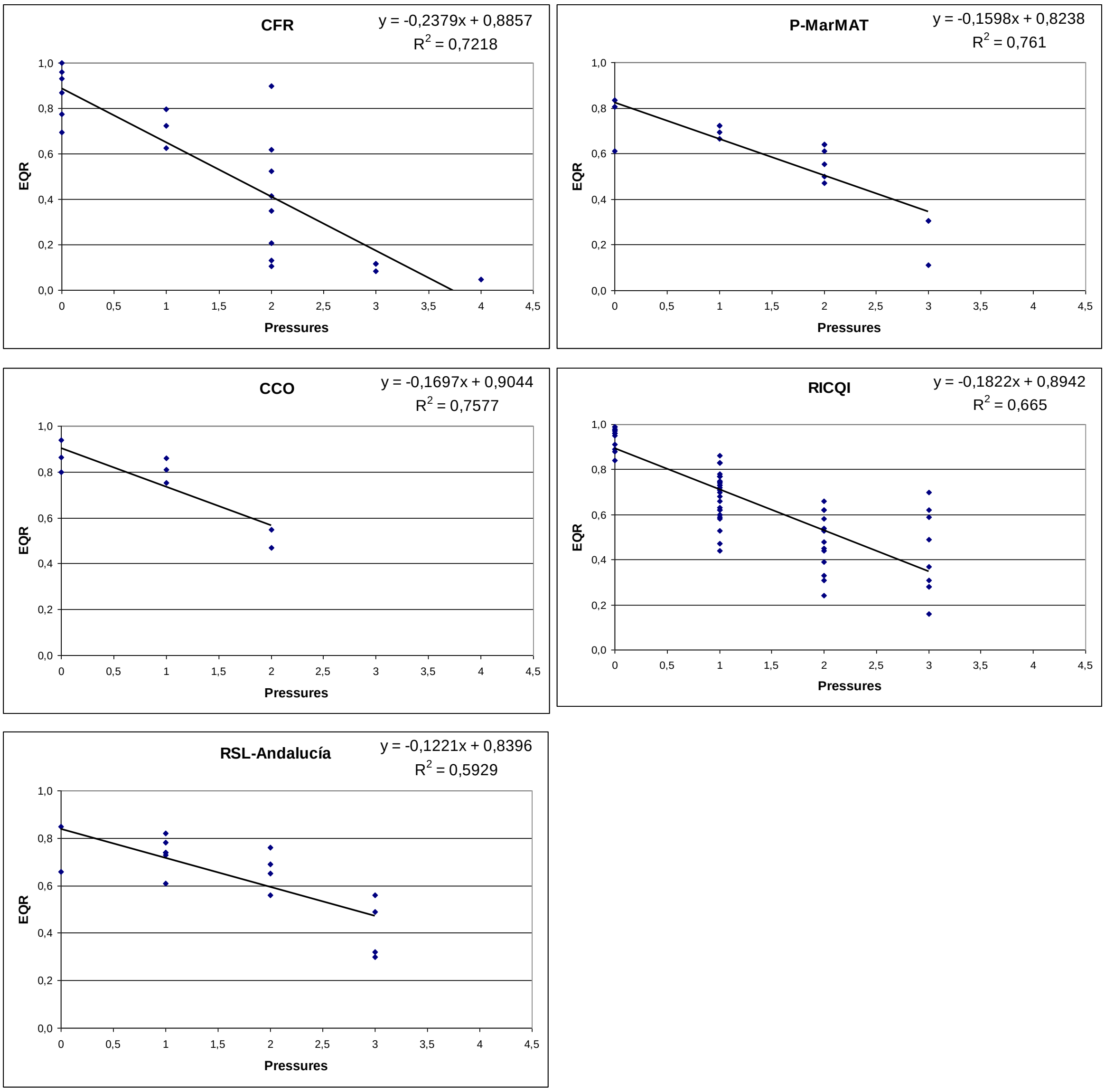


Figure 3.4 Relationships between national methods ands pressures

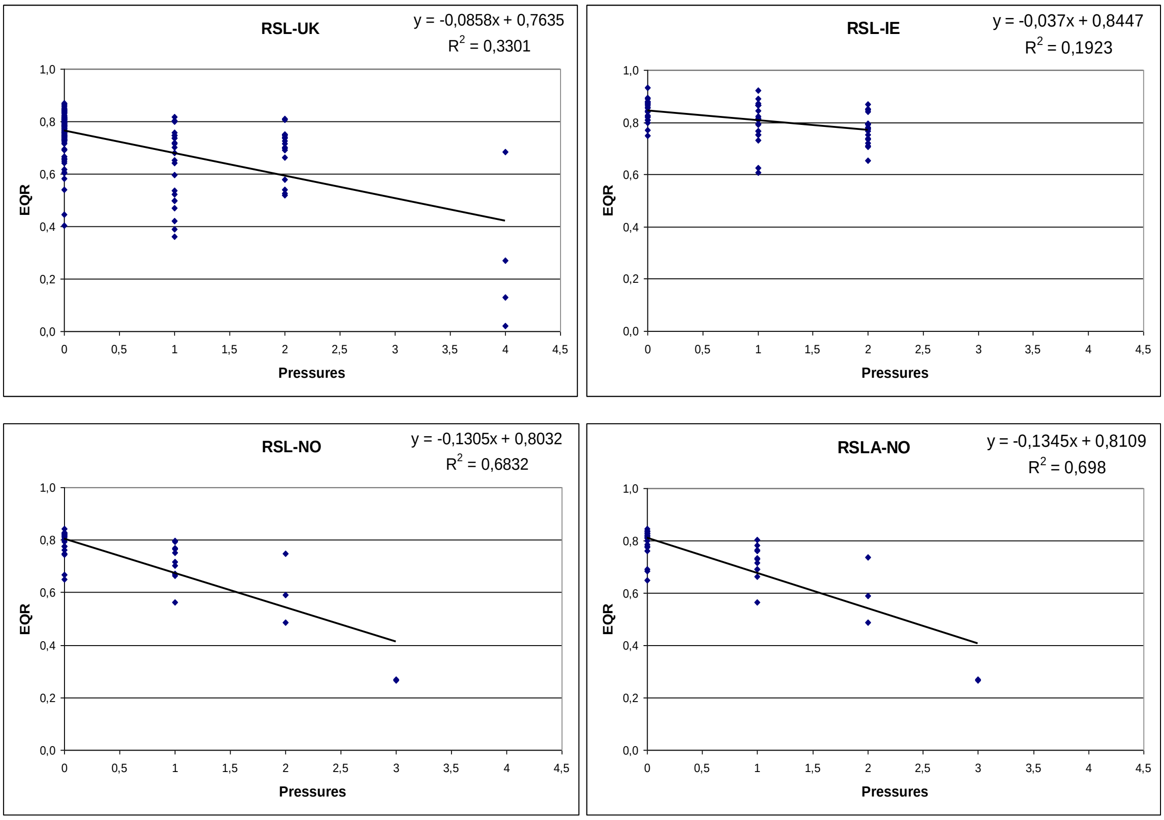


Figure 3.5 Relationships between national methods ands pressures

NO - RSLA

Norway have nutrient data for its sites and these were tested against the EQR-values calculated for NEA 1/26 and NEA 7 for both RSL and RSLA. During the intercalibration process a proxy for pressure were also estimated for all countries involved. This proxy was based on distance from cities, population and discharges and other criteria described in the Milestone report 4b. This was also tested against EQR-values for Norwegian sites.

The results show in general a good correlation between EQR-values and pressure. RSL and RSLA did show similar responses.

Testing all EQR against pressure in all water types showed a good correlation with all nutrients.The correlation coefficients are shown in Table 3.5. All show a negative response to nutrient increase. The strongest correlations were usually found for Total Nitrogen (TotN/l) and Ammonium (NH4) when testing NEA7 and NEA1/26 together. The same tests were also done against the Norwegian classification system SFT 97:3 which gave similar results but with slightly lower correlation coefficients (Figure 3.5).

Table 3.5 Multivariate correlation between EQR for RSL and RSLA against nutrient concentrations (A) and the Norwegian Classification system for ecological status 97:03 (B).

(A)

	EQR-RSL	EQR-RSLA
EQR-RSL		0,9551
EQR-RSLA	0,9551	
TotP/L	-0,8381	-0,8986
PO4-	-0,8135	-0,8925
TotN/l	-0,8686	-0,9277
NO3 + N02	-0,8200	-0,8756
NH4	-0,9309	-0,9585

(B)

	EQR-RSL	EQR-RSLA
EQR-RSL	1,0000	0,9551
EQR-RSLA	0,9551	1,0000
97:03 TotP/L	-0,6896	-0,7659
97:03 PO4-	-0,6763	-0,7891
97:03 TotN/l	-0,7728	-0,8181
97:03 NO3+NO2	-0,6831	-0,7578
97:03 NH4	-0,7910	-0,8605

There are 28 missing values.

The correlations are estimated by REML method.

The p-value for all correlations were <0.0001 ie. highly significative

The metrics response to the Proxy of pressure introduced by Spain showed also a good correlation with the RSL and RSLA. When running the test for only NEA1/26 the correlation were much unsure as most of the sites came from pristine or close to pristine conditions. The response of phosphate and nitrate+nitrite on EQR for NEA 7 and NEA1/26 is shown in Figure 3.6 and 3.7.

Table 3.6 Multivariate correlation between EQR for RSL and RSLA against a Proxy for pressure

	EQR-RSL	EQR-RSLA
EQR-RSL		0,9551
EQR-RSLA	0,9551	
Proxy Pressure	-0,8651	-0,8359

As nutrient pressure in NEA 7 are based on data set from a strong gradient, the dose – response for NEA 7 sites are quite good, but as seen for NEA 1/26, the nutrient data are from sites that are in high or good status. Hence the correlations for the Norwegian sites on pressure are not that good. The only significant correlation was shown for Phosphate on EQR (Figure 3.6). The correlation between Phosphate and the ICM was not significant. The nitrate + nitrite concentration showed a negative response on EQR, but it was not significant (Figure 3.7).

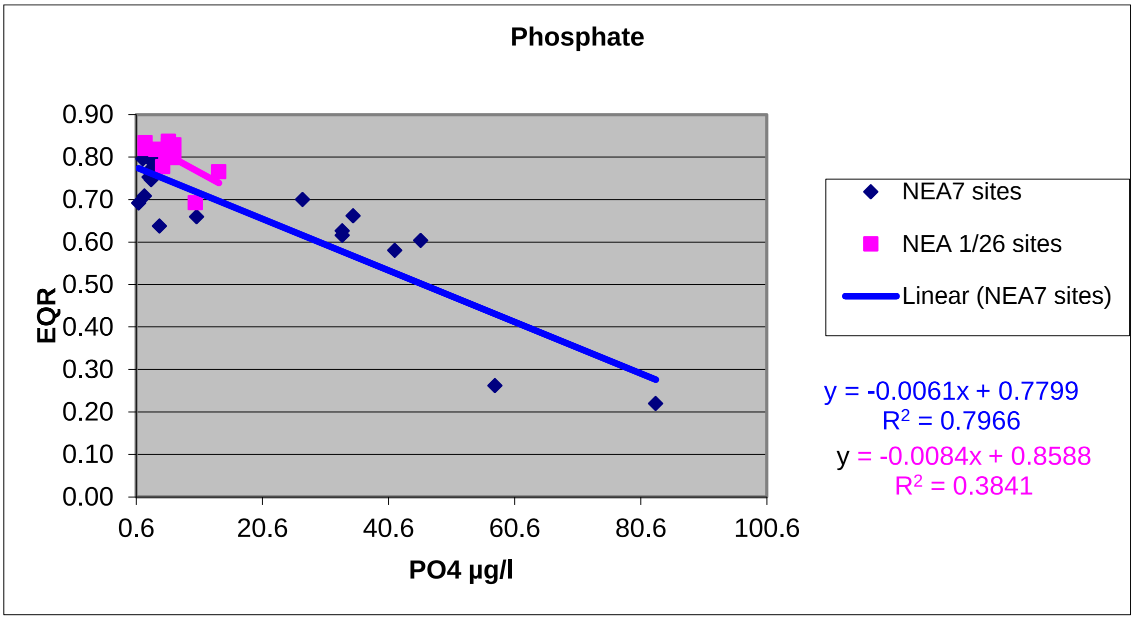


Figure 3.6 Correlation between Phosphate and EQR for NEA 7 (blue) and NEA 1/26- sites (purple)

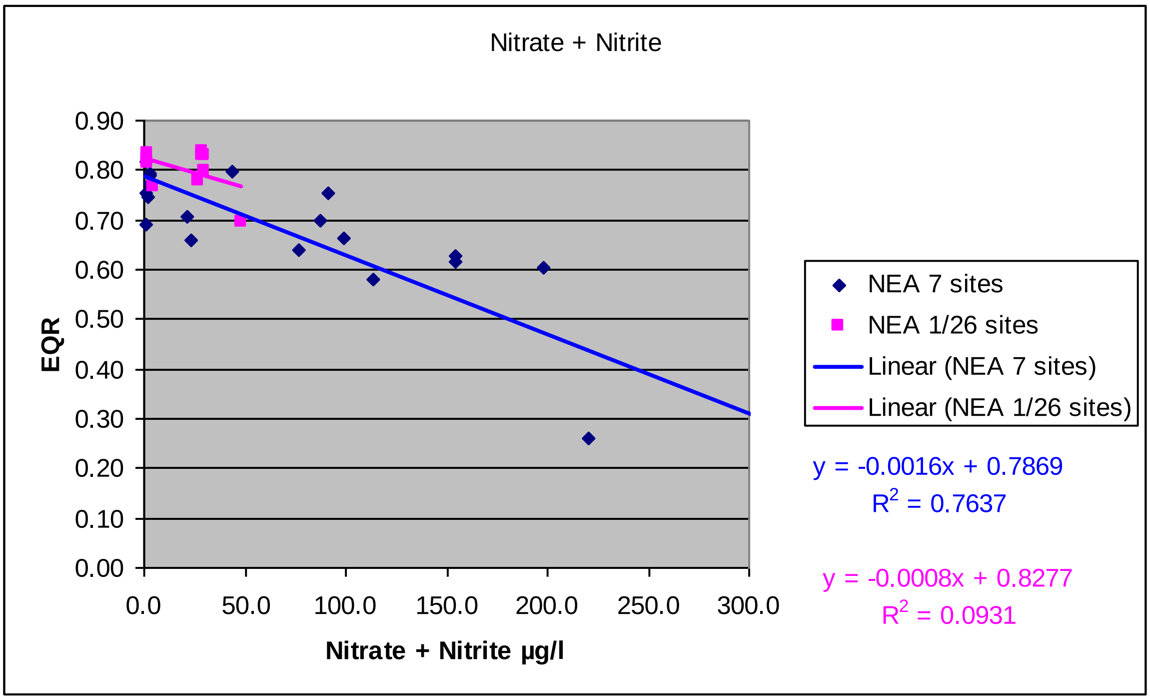


Figure 3.7 Correlation between Nitrate+Nitrite and EQR for NEA 7 (blue) and NEA 1/26- sites (purple)

Subtidal Macroalgae

Table 3.7 Pressures addressed by the national methods (subtidall macroalgae) included in the Annex I of the EC Decision

Member State	Metrics tested	Pressure	Pressure indicators	Amount of data	Strength of relationship (r or r2, p)
SUBTIDAL MACROALGAE					
NO (MSMDI)	MSMDI	Eutrophication	Nutrient concentration	30 water chemistry stations and 44 biological stations	R^2= 0.44, p<0.0001
SE (MSMDI)	MSMDI	Eutrophication	Nutrient concentration	64 biological stations, 10 water chemistry stations.	R^2 = 0.41, p< 0.0001

Sweden – Norway - MSMDI

It is a well-known fact that depth limit and abundance of seagrasses and macroalgae in deeper waters show significant responses to eutrophication pressure (Krause-Jensen et al. 2008). Since the method is based on these variables, there is a strong theoretical support for validation against a pressure.

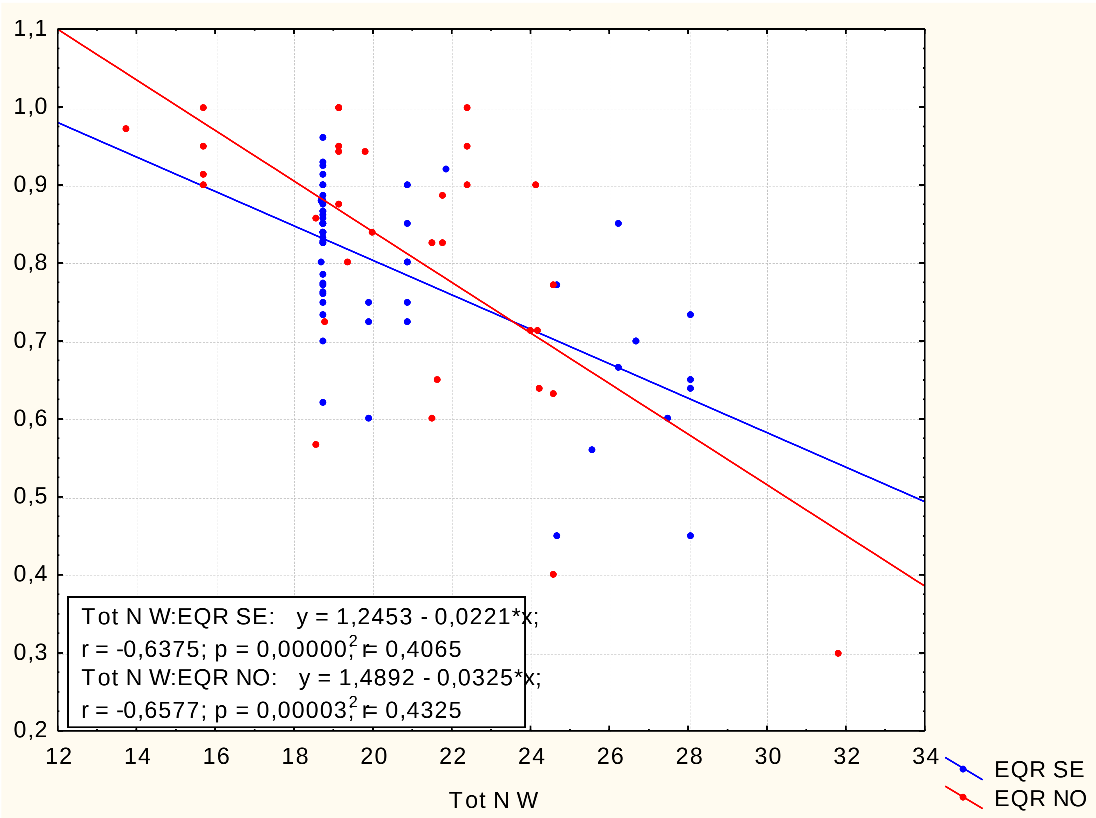


Figure 3.8 EQRs of the common SE – NO method MSMDI against winter values of total nitrogen 0-10 m

In the work phase 1 on Boundary Setting Protocol, there are data from Norway on the relation between nutrient load and secchi depth against lower depth limits of species used in the assessment method that can be used as a validation

The method relies on several studies on changes in depth distribution over time in different areas of Sweden (e.g. Eriksson et al. 1998, 2002, Kautsky et al 1986). In these studies changes in depth distribution are discussed in relation to eutrophication.

3.3. Assessment concept

intertidal Macroalgae		
Method	**Assessment concept**	**Remarks**
ES1 - CFR	Coverage of characteristic macroalgae (pre-defined list of species; biogeographic); Fraction of opportunistics; Richness of characteristic macroalgae species (see Juanes *et al*, 2008 and Guinda *et al.*, in preparation).	Assessment based on abundance of conspicuous patches of characteristic macroalgae.
ES2 – RICQI	Similarity between assessed sample and reference communities and presence of genus *Cystoseira*; morphologically complex macroalgae; species richness; and faunal cover (see Díez *et al.*, 2012).	Combined assessment of two distinct biological elements from rocky shores (macroalgae and macroinvertebrates), with different weights.
ES3 – RSL	Species richness (from a reduced species list), number of red seaweeds, proportion of green seaweeds, proportion of ESG I, proportion of opportunists species	Based on “presence” of specific macroalgae (RSL approach).
FR - CCO	Presence of characteristic species (pre-defined list of species; per seaweed belt), abundance, sensitive and opportunistic species	Number and list of characteristic species per belt adapted by coastal zone
IE - RSL	Based on qualitative registration of selected littoral species on hard substrate.	Based on “presence” of specific macroalgae (RSL approach)
NO - RSL	Based on qualitative registration of selected littoral species on hard substrate.	Based on “presence” of specific macroalgae (RSL approach).
NO - RSLA	Based on semiquantitative registration of littoral species on hard substrate where abundance of green and brown taxa are included as indicators of eutrophication pressure.	Based on “presence” of specific macroalgae (RSL approach). Abundance incorporated (Braun-Blanquet scale).

PT - PMarMAT	Based on qualitative registration of selected littoral species on hard substrate + abundance of eutrophication insensitive taxa	Combined assessment of "presence" of specific macro-algae (RSL approach) plus abundance of opportunistic spp.
UK - RSL	Based on qualitative registration of selected littoral species on hard substrate. Includes spp richness, proportions of reds, greens, opportunists, ESG ratio (seeWells et al, 2007).	Based on "presence" of specific macroalgae (RSL approach).

Is the Intercalibration feasible in terms of **assessment concepts?**

Conclusion

There were significant differences in the assessment concepts behind the methods involved in IC2, with several important consequences along the intercalibration process.

- The main difference in the assessment concept was due to the absence of abundance estimations in some methods: ES3 - IE – NO (RSL only) – UK). As stated in section on WFD compliance checking, this was one of the main reasons to launch the work on biotypes.
- Regarding the proposed metrics for estimation of richness, different approaches have been used (e.g. characteristic vs. opportunistic species, ESG ratios, species richness, proportion of reds, proportion of greens, proportion of opportunistic, etc). These could be summarized in: 1) the assessment of all the characteristic species within the site from a pre-defined list, and a "presence criteria" dependent on a minimum coverage (CFR- CCO), 2) the evaluation of all the identified species in a list (RSL & RTL-approaches) and 3) the presence of some indicator species (HDI, RICQI). Lack of homogenization in the maximum number of the assessed species considered by each method was an important difficulty to find a global ICM for the NEA region based on this indicator. After splitting up the NEA 1/26 on two biotypes, this problem persisted in the Southern area because of differences on assessment concepts between methods.
- Another worth mentioning difference between assessment concepts is that introduced by one method (ES2 RICQI), as it considers the combined assessment of two quality elements (macroalgae and invertebrates) from rocky shores, using different weights for both components. At this stage it is very difficult to predict if there would be either an increase or a reduction in the EQRs variability due to the addition of this complementary metric to the assessment of the macroalgae. However, all the macroalgae metrics, required by the WFD, are included in the ES2 method. Hence, it is compliant with the WFD and the obtained results in the IC show a suitable adjustment with the selected ICM.

Considering all the analysed factors and taking into account the different types and subtypes (biotypes) considered, the first impression is that feasibility of intercalibration in terms of assessment concepts is possible for the national method included in the Annex I of the IC exercise, due to similarity on tools.

See below the self-evaluation made by MS:

NEA 1/26:

Biotype A2. PT, ES, FR – Yes

Biotype B21. NO, IE, UK – Yes

NEA 7:

NO-UK - Yes

Subtidal Macroalgae		
Method	**Assessment concept**	**Remarks**
NO - MSMDI	Based on lower depth limits of 9 species on hard substrate identical to SE.	Hard substrate might be a limiting factor, Such stations are not included.
SE - MSMDI	Based on lower depth limits of 9 species on hard substrate identical to NO.	

Conclusion

Is the Intercalibration feasible in terms of assessment concepts?

The feasibility of intercalibration in terms of assessment concepts is possible because SE and No are using the same method

4. Collection of IC dataset and benchmarking

4.1. Dataset description

Table 4.1 Overview of the number of sites/samples/data values in the intercalibrated common types.

Member State	**Number of sites (stations) or samples or data values**		
	Biological data	**Physico- chemical data (Not used in the IC exercise)**	**Pressure data**
Type NEA 1/26 Biotype A2 Intertidal macroalgae			
Number of Member States: 3		Total number of sites:	
ES1 (CFR)	21 stations + 108 additional stations used as ICM (see table below)		21 stations + 108 additional stations used as ICM
FR (CCO)	8 stations		8 stations
PT: PMaRMAT	18 stations		18 stations

ES2-RICQI	66 stations (temporal gradients)	Available, but not used in the exercise	66 stations (temporal gradients)
ES3 (RSL)	16 stations		16 stations
Type NEA 1/26 Biotype B21 Intertidal macroalgae (jointly analysed with Type 7 for UK – NO)			
Number of Member States: 3		Total number of sites: 272	
IE – RSL	62 stations		62 stations
NO	38 stations (NEA 1/26 + NEA 7)		38 stations
UK – RSL	172 stations (NEA 1/26 + NEA 7)		172 stations
Type NEA 7			
Number of Member States: 2		Total number of sites: 29	
NO	20 station	20 (used in IC)	20 (used in IC)
UK	9 stations	9 (used in IC)	9 (used in IC)
Type NEA 8a, 9 and 10			
Number of Member States: 2		Total number of sites: 108	
NO	44 stations	30 stations	30 stations
SE	64 stations (including 8b)	10 stations	10 stations

4.2. Data acceptance criteria

Table 4.2 Overview of the data (intertidal macroalgae) acceptance criteria used for the data quality control.

Intertidal Macroalgae	
Data acceptance criteria	**Data acceptance checking**
Data requirements (obligatory and optional)	ES1: CFR - OK, Cover and species information ES2: RICQI - OK, Cover and species information. Additional invertebrate information. ES3: RSL - Andalucía- Species list & shores description Not abundance data FR: CCO - OK, Abundance and species information IE: RSL - Species lists and shore description (optional cover data) NO: RSL - Species list & shore description. Not abundance data. RSLA - OK , Species lists and abundance data PT: PMarMAT – OK, taxonomic composition from a RTL, and abundance as cover of opportunistic species UK: RSL Species list & shore description. Not abundance data.
The sampling and analytical methodology	ES1: CFR - OK (Juanes *et al.*, 2008; Guinda *et al.*, in preparation). ES2: RICQI – OK (Díez *et al.*, 2012). ES3: RSL - Andalucía- OK (Bermejo et al., 2012) FR: CCO - in accordance with national methods IE: RSL - in accordance with national methods NO – OK in accordance with national methods and ISO 9324 PT:_ PMarMAT - OK, in accordance with national methods, and similar to others from EU. UK: RSL – In accordance with national method
Level of taxonomic precision required and taxa lists with codes	ES1: CFR - OK, Characteristic macroalgae (pre-defined list of species) ES2: RICQI – OK. At species level using ERMS-WoRMS codes ES3: RSL - Andalucía- Predefined taxa list FR: CCO - Species/species group level IE: RSL - Species ID to common species list NO - OK (National nomenclature/algabase) PT:_ PMarMAT - OK, adapted to field survey, including perennial and annual species in a RTL UK: RSL – Mixed taxon level ID (mainly to sp) to defined geographic lists
The minimum number of sites / samples per intercalibration type	ES1: CFR- 21 stations + 108 additional stations used as ICM ES2: RICQI – 66 stations ES3: RSL-Andalusia region: 16 stations FR: CCO – 8 stations IE: RSL- 62 stations NO – RSL, RSLA, 38 stations (NEA 1/26 & NEA 7) PT:_ PMarMAT 18 stations

	UK: RSL 172 stations (NEA 1/26 & NEA 7)
Sufficient covering of all relevant quality classes per type	See Table below for the quality classes covered at each method.

Coverage per ecological quality class:

Only provided for intercalibrations of intertidal macroalgae in type NEA 1/26 Biotype A2 and B21

Table 4.3 Class levels achieved by each of the methods using IC data

Method	Ecological status				
	High	Good	Moderate	Poor	Bad
Type NEA 1/26 Biotype A2 Intertidal macroalgae					
FR: CCO	x	x	x		
ES: CFR	x	x	x	x	x
ES: RICQI	x	x	x	x	[1]
ES-And: RSL	x	x	x	x	
PT: PMarMAT	x	x	x	x	x
Type NEA 1/26 Biotype B21 Intertidal macroalgae					
IE: RSL	x	x			
NO: RSL	x	x	x	x	
NO: RSLA	x	x	x	x	
UK: RSL	x	x	x	x	x

[1]Absence of algae due to pressure

Table 4.4 Overview of the data (subtidal macroalage) acceptance criteria used for the data quality control.

Subtidal Macroalgae	
Data acceptance criteria	**Data acceptance checking**
Data requirements (obligatory and optional)	NO: OK SE: OK
The sampling and analytical methodology	NO: OK SE: According to national methods, OK
Level of taxonomic precision required and taxa lists with codes	NO: OK (National nomenclature/algabase) SE: OK (algaebase)
The minimum number of sites / samples per intercalibration type	NO: MSMDI,-2 stations SE: Min 3 stations for water body assessment
Sufficient covering of all relevant quality classes per type	NO: No, mostly Good and High Quality SE: No, dominance of high and good

4.3. Common benchmarck

The group has defined reference conditions for the Types NEA 1/26 Biotype A2 and B21 and Type NEA 7.

The group has performed continuous benchmarking for the Types NEA 8a, 9 and 10.

Reference conditions for the intertidal macroalgae of the Types NEA 1/26 Biotype A2 and Biotype B21 and Type NEA 7

- Common approach for setting reference conditions (true reference sites or indicative partial reference sites, see Annex III of the IC guidance):
  ES1 (CFR) - ES2 (RICQI) - ES3 (RSL) - FR (CCO) - IE (RSL) - NO (RSLA) - PT (PMarMAT) - UK(RSL): Only sites from each Member State/region where total absence of anthropogenic pressures were registered (pressure assessment procedure explained in section on pressures addressed) were selected as reference.

- Detailed description of reference criteria for screening of sites in near-natural conditions (abiotic characterisation, pressure indicators):
  ES1 (CFR) - ES2 (RICQI) - ES3 (RSL) - FR (CCO) - IE (RSL) - NO (RSLA) - PT (PMarMAT) - UK(RSL): Total absence of point urban and type-dependent industrial discharges at a certain distance of the site, according to a specific magnitude scale based on the 91/271 Urban Wastewater Treatment Directive (pressure assessment procedure explained in section on pressures addressed). No known outlet or industrial discharges in the vicinity and no aquaculture bins. However the aquaculture bins in NO are sometimes moved around from one site to another, but one aimed not to put benchmark station closer to fishfarm than at least 1-5 km depending on the main currents.

- Identification of the reference sites for each Member State in each common IC type.
  The specific x,y coordinates from all reference sites for each method in the IC have been included in the Common Database and they are sufficient to make a statistical reliable estimate:

  NEA 1/26:

  <u>Biotype A2</u>:

  ES1 (CFR) 6 reference sites

ES2 (RICQI) 13 reference sites

ES3 (RSL) 2 reference sites

FR (CCO) 3 reference sites

PT (PMarMAT) 5 reference sites

Biotype B21:

IE(RSL) 22 reference sites

NO(RSL) 17 reference sites

UK(RSL) 121 reference sites

NEA 7:

NO(RSLA) 5 reference sites

UK(RSL) 6 reference sites

The benchmark stations were chosen in 2009, however one Norwegian station was excluded (B10) as a fish farm bin had been located too close to the station. 6 benchmarking stations were then included from both nations.
Some reference sites have several applications corresponding to different years.

- Screen of the biological data for impacts caused by pressures not regarded in the reference criteria to make sure that true reference sites are selected: Ranges of variability of macroalgae community composition and abundance (except for ES3, IE, NO-RSL and UK) corresponding to that registered in undisturbed places.

- Detailed description of setting reference conditions (summary statistics used): Selection of sites complying with criteria. No statistics used.

5. Comparision of methods and boundaries

After checking for suitability of different alternative IC options tested by the NEA group (Milestone 6 report, Oct 2011 + ISPRA Workshop + JRC suggestions), MSs have agreed to follow Option 2 for all the three types/biotypes finally considered in the IC2 for intertidal macroalgae: Type NEA 1/26, biotype A2; Type NEA 1/26, biotype B21; Type NEA 7.

For subtidal macroalgae Option 1 is followed.

5.1. Type 1/26 biotype A2

5.1.1. IC option and common metrics

- IC option: Option 2 using a biological common metric
- Explanation for the choice of the IC option:

IC based on Option 2, including methods from MSs located within **NEA 1/26 biotype A2** (ES-FR-PT), using the **EQR value of the CFR index** as "Common Metric (ICM)".

- The differences in data acquisition:
  ES - FR - PT – Use of different metrics and sampling procedures (see sections on methods and sampling)
- Description of the IC Common metric:
  In this case, the EQRs of the CFR index applications were used as ICM. This approach was proposed by JOINT Research centre (JRC) because all MSs within Biotype A2 had in common the application of the CFR, in addition to their specific methods. In this way, it was possible to obtain a suitable boundary adjustment for all methods, including the national method of Spain (Andalusia region), which assessment concept differs from the others in this biotype (i.e. no abundance data).

5.1.2. Benchmarck standardization

The procedure followed the requirements of the Annex V of IC guidance. The benchmarking process was undertaken automatically using the Excel spreadsheets supplied by S. Birk and N. Wilby. IC Option 2 procedure was followed, using common reference sites for the type/biotype.

5.1.3. Results of the regression comparison

Correlation coefficient (r) and the probability (p) for the correlation of each method with the common metric (see Annex V of IC guidance) with an Ordinary Least Square regression.

NEA 1/26, biotype A2 (ES-FR-PT): CFR as ICM		
Member State/Method	**r**	**P**
PMarMAT vs. ICM (CFR)	0,932	<0.01
CCO vs. ICM (CFR)	0,873	<0.01
RICQI vs. ICM (CFR)	0,845	<0.01
RSL-And vs. ICM (CFR)	0,709	<0.01
CFR	ICM	

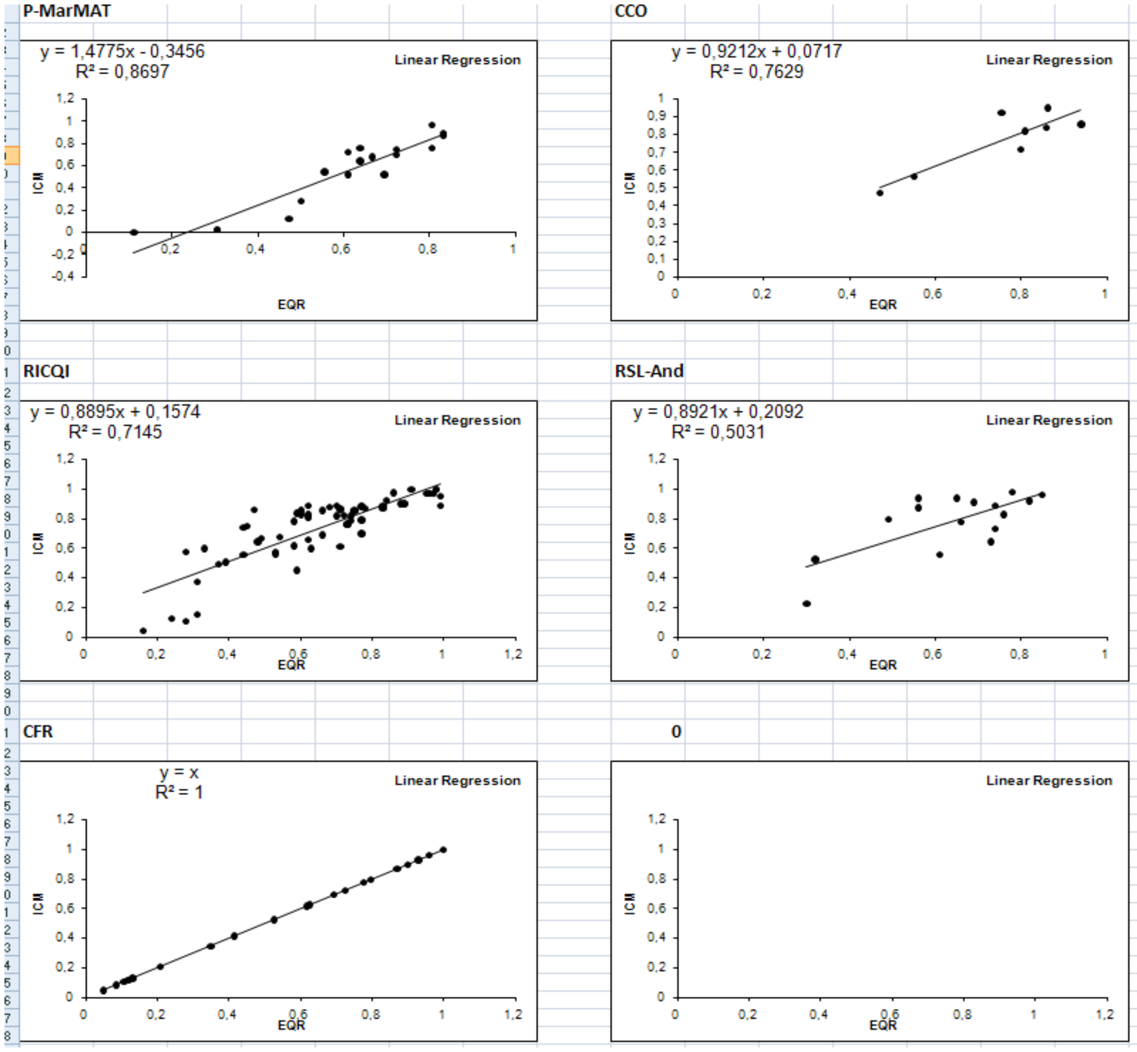


Figure 5.1 Relationships between the national methods and the ICM

All methods present a good correlation with the Pseudo-Common Metric, therefore all of them are included in the IC exercise.

The Pearson correlation coefficients fulfill the requirement that $r \geq 0.5$.

The slope of the regression fulfill the requirement that the slope should lie between 0.5 and 1.5.

The assumptions of normally distributed error and variance (homoscedasticity) of model residuals is met.

The Pseudo Common metric represent all methods ($r^2>0.5$, absolutely $r^2>0.3$).

Observed minimum r^2 is at least half of the observed maximum r^2.

Checking of methods comparability: No parameter fee statistical test have been performed in addition to the regression analysis

5.1.4. Comparability criteria

Assessing level of boundary bias

The benchmarking process was undertaken using the Excel spreadsheets supplied by S. Birk and N. Wilby, according to the procedures established in the Annex V of IC guidance. IC Option 2 procedure was followed, using common reference sites for the type/biotype and using the CFR index as Common Metric (ICM).

Not Adjusted					
	MarMAT	CCO	RICQI	RSL-And	CFR
H/G bias_CW	0,029	-0,033	-0,303	0,553	-0,274
G/M bias_CW	-0,284	0,051	-0,031	0,686	-0,226
intercept (c)	-0,346	0,072	0,157	0,209	0,000
slope (m)	1,478	0,921	0,890	0,892	1,000
slope manual					
Pearson's r	0,933	0,873	0,845	0,709	1,000
R^2	0,870	0,763	0,714	0,503	1,000
Adjusted					
H/G	0,800	0,800	0,820	0,750	0,810
G/M	0,610	0,600	0,600	0,480	0,600
H/G bias_CW	0,030	-0,033	-0,225	0,225	-0,236
G/M bias_CW	-0,247	0,051	-0,028	0,215	-0,215

Minor changes in some boundary (H/G-G/M) area required, within IC Type 1/26, biotype A2, for ES1 (CFR), ES2 (RICQI) and PMarMat. Significant changes (accepted by MS representatives) are needed in the case of ES3 (RSL-Andalusia)

In the case of IC for Biotype A2, a different analysis, "giving priority to specific methods to define the common view, dependent on their evaluation concerning the feasibility check", was proposed by JRC (Wendy Bonne). After a thoroughly analysis of this alternative approach, it was concluded that, according to final results obtained with both approaches, differences in assessment concepts between methods are more important than their specific pressure-response behaviour. Furthermore, for some methods, it is difficult to explain either some large ranges of variability or unexpected EQR values for a specific pressure value.

For that reason, bearing in mind that results were almost the same in both trials for all countries and it is not possible, at this stage, to know the actual ecological meaning of those slights changes on the EQRs, **it was decided to maintain the equal weight for all methods**.

5.2. Type NEA 1/26 B21

5.2.1. IC option and common metrics

IC option: Option 2 using a biological common metric

- Explanation for the choice of the IC option:
  IC based on Option 2, including methods from MSs located within **NEA 1/26 biotype B21** (UK-IE-NO), using the "Registered number of species" as "Common Metric (ICM)".
- The differences in data acquisition:
  All three nations use different species lists and the sampling method is also a bit different especially when it comes to the horizontal extension of the registered site/station. Physical description can be interpreted differently, but is based on the same principles by recording the physical characteristics on the sites.

  UK – RSL – Register species qualitatively only along a stretch of shore, the length of which may vary between sites.

  IE – RSL – Extract data from quantitative square frame registration. Uses 8 m shore line.

  NO – RSL – Extract data from semiquantitative registration of all species in a 10-15m belt.
- Description of the IC Common metric:
  In this case, the original number of registered species was used as ICM. The richness was not adjusted for the shoreline description, with the purpose of not introducing some national differences. Hence, no corrections were done on the ICM before benchmarking.

5.2.2. Benchmarck standardization

Benchmark standardization was applied by subtracting/adding differences found for the common metric in reference sites of the 3 Member States. Median values of the original number of registered species in the reference sites were calculated for each Member State. The ICM was normalized using the mean values of all 3 nations' median as "true value". Differences from the "true value" and national values were then subtracted or added to all the national values for the ICM-values resulting in the– BMICMs.

The regressions for ICM and EQR for the three nations also revealed a relatively weak correlation due to the fact that most of the sites were of High and Good status. UK which has some stations that are considered moderate or worse, shows a good correlation of 0.75 as opposed to the other two countries that have R^2 around 0.4 as shown in the figure below. The slopes are similar for all three nations and indicate a similar response of the EQR towards the BMICM.

5.2.3. Results of the regression comparison

Correlation coefficient (r) and the probability (p) for the correlation of each method with the common metric (see Annex V of IC guidance) with an Ordinary Least Square regression.

NEA 1/26, biotype B21 (UK-IE-NO): (based on medians)		
Member State/Method	**R^2**	**p**
IE-RSL vs ICM (Registered number of species)	**0.392**	**<0.01**
NO-RSL vs ICM (Registered number of species)	**0.417**	**<0.01**
UK-RSL vs ICM (Registered number of species)	**0.753**	**<0.01**

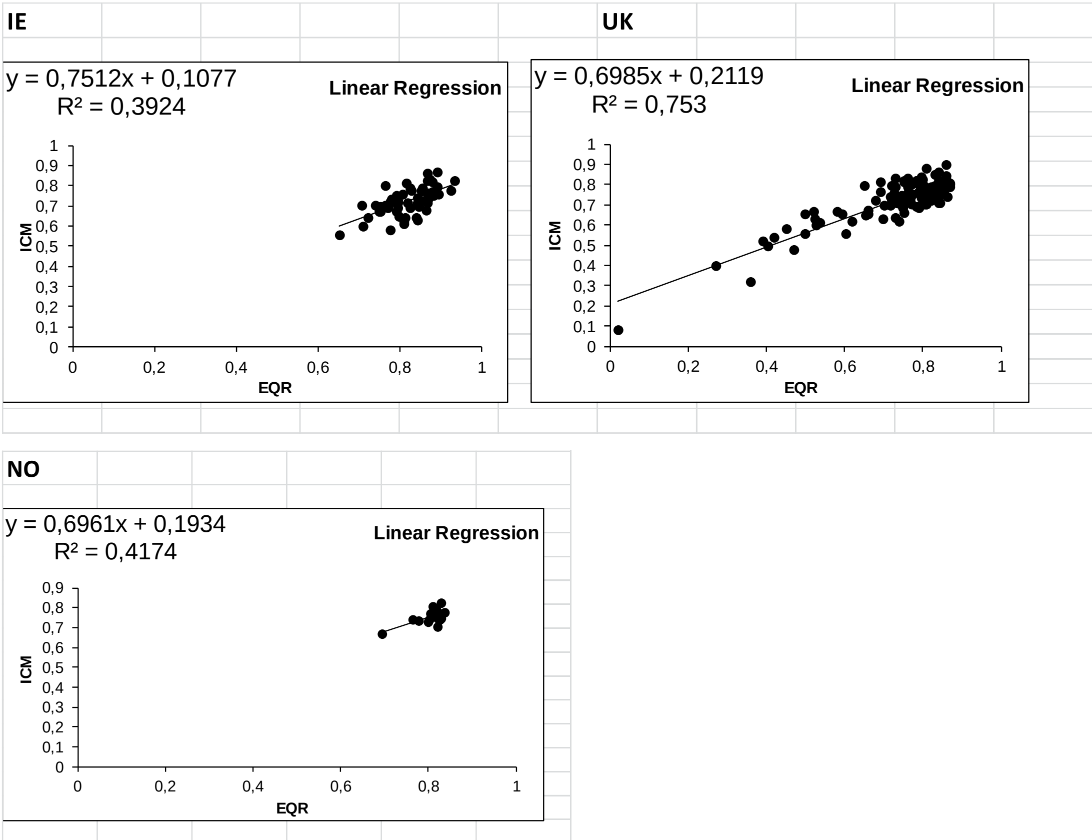


Figure 5.2 Regression of EQR against ICM (original species richness) for the three member states belonging to the Northern part of NEA 1/26 – IE, UK and NO. ICM is based on medians.

All methods present a good correlation with the Pseudo-Common Metric, therefore all of them are included in the IC exercise.

The Pearson correlation coefficients fulfill the requirement that r ≥ 0.5.

The slope of the regression fulfill the requirement that the slope should lie between 0.5 and 1.5.

The Pseudo Common metric represent all methods (r^2>0.5, absolutely r^2>0.3).

Observed minimum r^2 is at least half of the observed maximum r^2.

Checking of methods comparability: No parameter fee statistical test have been performed in addition to the regression analysis

Table 5.1 Regression data, bias and offset characteristics for the comparability checking for the Northern NEA 1/26 GIG countries i.e. IE, UK and NO. ICM is species richness. Based on medians for ICM calculation.

	IE	UK	NO
intercept (c)	0,108	0,212	0,193
slope (m)	0,751	0,698	0,696
slope manual			
Pearson's r	0,626	0,868	0,646
R^2	0,392	0,753	0,417
Median ICM	0,757	0,767	0,767
Offset	0,007	-0,003	-0,003
Offset manual			
Max	1,000	1,000	1,000
H/G	0,800	0,800	0,800
G/M	0,600	0,600	0,600
M/P	0,400	0,400	0,400
P/B	0,200	0,200	0,200
CM_Max +Offset	0,866	0,907	0,886
CM_H/G +Offset	0,715	0,767	0,747
CM_G/M +Offset	0,565	0,628	0,608
CM_M/P +Offset	0,415	0,488	0,468
CM_P/B +Offset	0,265	0,348	0,329
H width to Max	0,150	0,140	0,139
G width	0,150	0,140	0,139
M width	0,150	0,140	0,139
H/G bias	-0,028	0,024	0,004
G/M bias	-0,035	0,027	0,008
H/G bias_CW	-0,185	0,173	0,027
G/M bias_CW	-0,233	0,197	0,054
Check Sum H/G bias	0		
Check Sum G/M bias	0		

5.2.4. Comparability criteria

Assessing level of boundary bias

To test comparability among different indices an option 2 subtraction sheet provided by Sebastian Birk, was used to test the boundaries. The bias and offsets showed acceptable values and there were no need for adjustment in order to fulfill the requirement set in the protocol. These results are shown in tables and figures below.

	IE	UK	NO
H/G	0,800	0,800	0,800
G/M	0,600	0,600	0,600
	IE	UK	NO
Max	1,000	1,000	1,000
H/G	0,800	0,800	0,800
G/M	0,600	0,600	0,600
M/P	0,400	0,400	0,400
P/B	0,200	0,200	0,200
CM_Max +Offset	0,866	0,907	0,886
CM_H/G +Offset	0,715	0,767	0,747
CM_G/M +Offset	0,565	0,628	0,608
CM_M/P +Offset	0,415	0,488	0,468
CM_P/B +Offset	0,265	0,348	0,329
H width to Max	0,150	0,140	0,139
G width	0,150	0,140	0,139
M width	0,150	0,140	0,139
H/G bias	-0,028	0,024	0,004
G/M bias	-0,035	0,027	0,008
H/G bias_CW	-0,185	0,173	0,027
G/M bias_CW	-0,233	0,197	0,054
N of Bm sites	100		

	IE	UK	NO
H/G	0,800	0,800	0,800
G/M	0,600	0,600	0,600
	IE	UK	NO
Max	1,000	1,000	1,000
H/G	0,800	0,800	0,800
G/M	0,600	0,600	0,600
M/P	0,400	0,400	0,400
P/B	0,200	0,200	0,200
CM_Max +Offset	0,861	0,920	0,884
CM_H/G +Offset	0,714	0,773	0,745
CM_G/M +Offset	0,567	0,626	0,605
CM_M/P +Offset	0,420	0,479	0,466
CM_P/B +Offset	0,273	0,332	0,327
H width to Max	0,147	0,147	0,139
G width	0,147	0,147	0,139
M width	0,147	0,147	0,139
H/G bias	-0,030	0,029	0,001
G/M bias	-0,032	0,026	0,006
H/G bias_CW	-0,203	0,196	0,007
G/M bias_CW	-0,221	0,179	0,044
N of Bm sites	104		

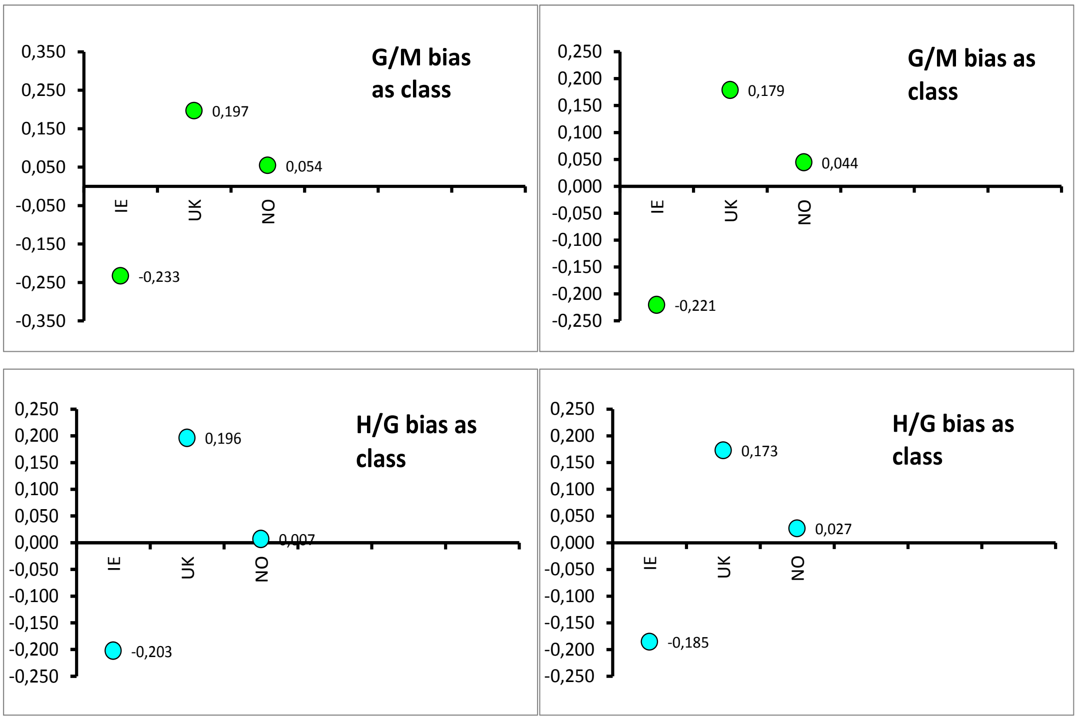


Figure 5.3 Class boundaries and adjustment made to fulfill bias and offset requirements among Northern GIG member states i.e. IE, UK and NO. ICM is species richness. Based on medians.

5.3. Type NEA 7

5.3.1. IC option and common metrics

- IC option: Option 2 using a biological common metric
- Explanation for the choice of the IC option:
  IC based on Option 2, including methods from MSs located within **NEA 7** (UK - NO), using the "Registered number of species" as "Common Metric (ICM)" see "Justification paper on RSL and RSLA in Appendix 2.
- The differences in data acquisition:
  NO – RSL/RSLA – Extract data from semiquantitative registration of all species in a 10-15m belt according to a reduced species list.

  UK – RSL – Register species qualitatively only along a stretch of shore, the length of which may vary between sites depending on local geographic features.
- Description of the IC Common metric:

In this case, the original total number of registered species was used as ICM. The richness was not adjusted for the shoreline description, with the purpose of not introducing some national differences. After benchmark standardization, the class boundaries were set equally within all classes for both NO and UK, i.e. 1.0, 0.8, 0.6, 0.4, 0.2 and 0.

5.3.2. Benchmarck standardization

Benchmark standardization was applied by subtracting/adding differences found for the common metric in reference sites of both Member States. Median values of the original number of registered species in the reference sites were calculated for each Member State. The median value for the UK and the NO benchmarking stations were 30 and 27 species, respectively. The ICM was normalized using the mean values of both nations' median as "true value". Differences from the "true value" and national values were then subtracted or added to all the national values for the ICM-values resulting in the– BMICMs (see document on RSL-RSLA). All the UK values were adjusted down by 1.5 species and all the ICM values for NO were adjusted 1.5 species higher. The new values became the benchmarked intercalibration common metric (BMICM). These benchmarked values were then used in Option 2 sub- form provided by Sebastian Birk.

After benchmark standardization there seems to be a very good coherence between the datasets from both UK and NO as shown in the figure below.

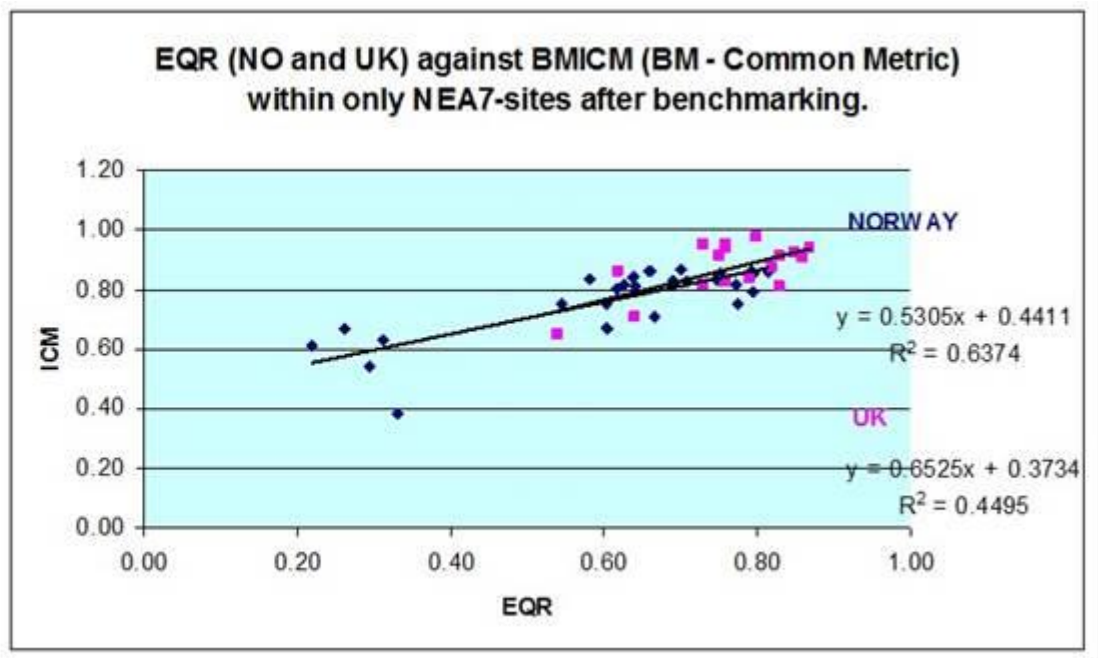


Figure 5.4 The EQR values for NO and UK plotted together against BMICM.

5.3.3. Results of the regression comparison

The relationship of the BMICM for NO and UK with national EQRs is shown in the figure below. Both have a slope >0,5 and r^2=0.64 and 0.45 for NO and UK, respectively. They were both significant ($p<0.01$).

Correlation coefficient (r) and the probability (p) for the correlation of each method with the common metric (see Annex V of IC guidance) with an Ordinary Least Square regression.

NEA 7 (NO-UK): (based on means)		
Member State/Method	**R^2**	**p**
NO-RSLA vs ICM (Registered number of species)	0.637	<0.01
UK-RSL vs ICM (Registered number of species)	0.450	<0.01

Regressions show the same slope and have R^2 >0.4, which is reasonable considering natural variation and are significant at <0.01

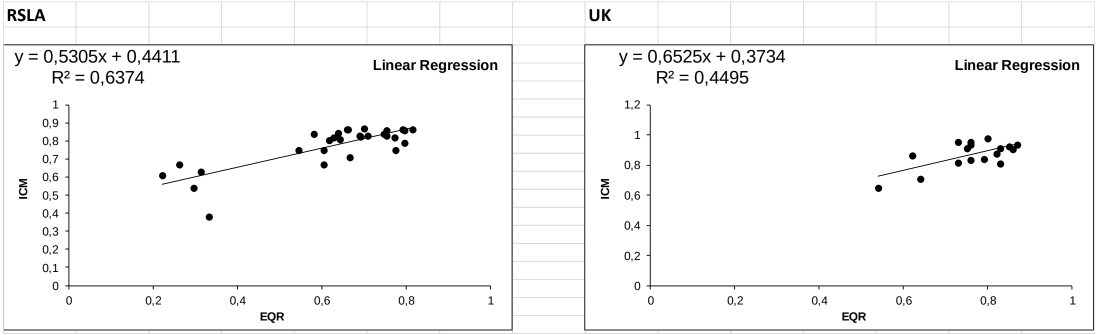


Figure 5.5 NEA 7 Norway's metric RSLA against BMICM to left and UK's RSL against BMICM to the right (from NEA-GIG database incl. new data from Norway of fall 2011.).

Table 5.2 Regression data, offset and bias-data for the two metrics.

	RSLA	UK
intercept (c)	0,441	0,373
slope (m)	0,530	0,652
slope manual		
Pearson's r	0,798	0,670
R^2	0,637	0,450
Median ICM	0,863	0,857
Offset	-0,003	0,003
Offset manual		
Max	1,000	1,000
H/G	0,800	0,800
G/M	0,600	0,600
M/P	0,400	0,400
P/B	0,200	0,200

	RSLA	UK
CM_Max +Offset	0,968	1,029
CM_H/G +Offset	0,862	0,899
CM_G/M +Offset	0,756	0,768
CM_M/P +Offset	0,650	0,638
CM_P/B +Offset	0,544	0,507
H width to Max	0,106	0,130
G width	0,106	0,130
M width	0,106	0,130
H/G bias	-0,018	0,018
G/M bias	-0,006	0,006
H/G bias_CW	-0,172	0,140
G/M bias_CW	-0,057	0,047
Check Sum H/G bias	0	
Check Sum G/M bias	0	

All methods present a good correlation with the Pseudo-Common Metric, therefore all of them are included in the IC exercise.

The Pearson correlation coefficients fulfill the requirement that r ≥ 0.5.

The slope of the regression fulfill the requirement that the slope should lie between 0.5 and 1.5.

The Pseudo Common metric represent all methods (r^2>0.5, absolutely r^2>0.3).

Observed minimum r^2 is at least half of the observed maximum r^2.

Checking of methods comparability: No parameter fee statistical test have been performed in addition to the regression analysis

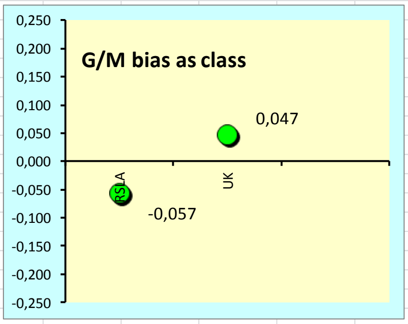
5.4. Comparability criteria

The option 2 subtraction sheet provided by Sebastian Birk, was used to test NO and UK boundary settings in NEA 7.

No adjustment of the class boundaries were needed as shown in the figure below.

	RSLA	UK
H/G	0,800	0,800
G/M	0,600	0,600

	RSLA	UK
Max	1,000	1,000
H/G	0,800	0,800
G/M	0,600	0,600
M/P	0,400	0,400
P/B	0,200	0,200
CM_Max +Offset	0,968	1,029
CM_H/G +Offset	0,862	0,899
CM_G/M +Offset	0,756	0,768
CM_M/P +Offset	0,650	0,638
CM_P/B +Offset	0,544	0,507
H width to Max	0,106	0,130
G width	0,106	0,130
M width	0,106	0,130
H/G bias	-0,018	0,018
G/M bias	-0,006	0,006
H/G bias_CW	-0,172	0,140
G/M bias_CW	-0,057	0,047
N of Bm sites	11	



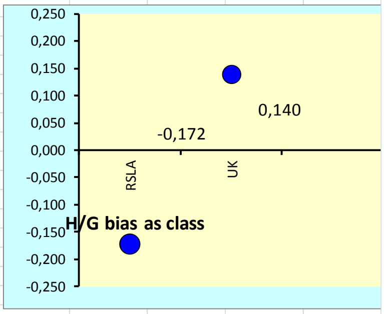


Figure 5.6 Differences in class boundaries for RSLA among UK and NO in NEA7.

NEA 7 –Checking the Norwegian RSLA a All methods present a good correlation with the Pseudo-Common Metric, therefore all of them are included in the IC exercise.

The Pearson correlation coefficients fulfill the requirement that r ≥ 0.5.

The slope of the regression fulfill the requirement that the slope should lie between 0.5 and 1.5.

The Pseudo Common metric represent all methods (r^2>0.5, absolutely r^2>0.3).

Observed minimum r^2 is at least half of the observed maximum r^2.

Checking of methods comparability: No parameter fee statistical test have been performed in addition to the regression analysis

All methods present a good correlation with the Pseudo-Common Metric, therefore all of them are included in the IC exercise.

The Pearson correlation coefficients fulfill the requirement that r ≥ 0.5.

The slope of the regression fulfill the requirement that the slope should lie between 0.5 and 1.5.

The Pseudo Common metric represent all methods (r^2>0.5, absolutely r^2>0.3).

Observed minimum r^2 is at least half of the observed maximum r^2.

Checking of methods comparability: No parameter fee statistical test have been performed in addition to the regression analysis against the Norwegian RSL

All the EQR for the Norwegian stations were analysed based on both RSL and RLSA. Their correlation was very good when we tested it earlier in 2011, but a bit more disturbance was incorporated when we added new data from the fall 2011. The result however still shows a very good correlation between the two metrics (Figure 5.7).

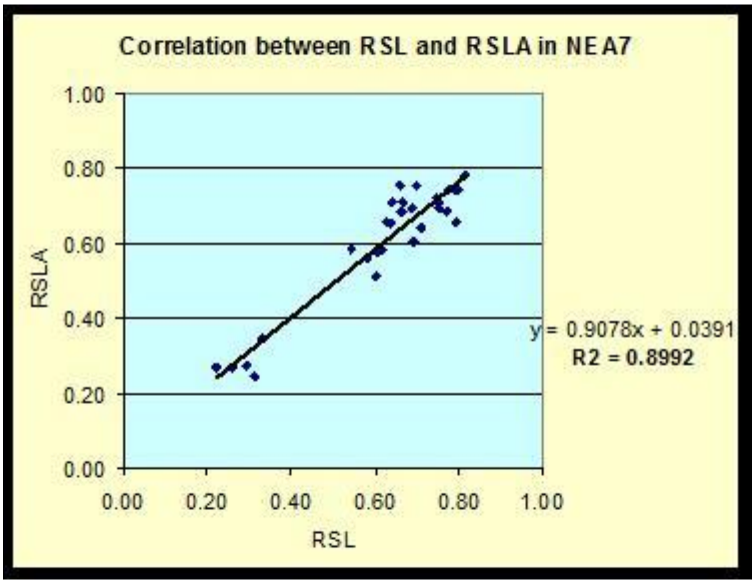


Figure 5.7 Bivariate fit for RSL against RSLA for all NEA7 stations in Norway.

5.5. Type NEA 8a,9, 10

5.5.1. IC option and common metrics

IC option: Option 1, as it is the same method for macroalgae, commonly developed partly on joint data from both Member States, the same reference depth limits, scoring boundaries and status class boundaries.

5.5.2. Benchmarck standardization

As this IC Option is an Option 1 with a common boundary setting, the common boundary setting procedure is described here. The check for regional differences using this common boundary setting procedure has been performed by continuous benchmarking. The EQRs of both Member States have been plotted against pressure and this resulted in insignificant differences, which mean that no regional differences have to be taken into account for the assessment in both Member States and that they can use the same references and boundaries.

Description of the common boundary setting procedure set for the common IC type NEA 8a, 9 and 10: In section on pressures addressed, a description is available for the depth distribution of macroalgae in Swedish and Norwegion sites in relation to Secchi depth and Total nitrogen concentration. Boundary depth limits have been set by expert judgement. No analysis has been reported on joint data from Norway and Sweden for a real common boundary setting.

5.5.3. Results of the regression comparison

Not needed for an Option 1 with a common boundary setting procedure

5.6. Comparability criteria

Not needed in an Option 1 with common boundary setting.

6. Final results to be included in the EC

6.1. Table with EQRs

Table 6.1 Overview of the IC results for the national methods included in the IC exercise.

Biological Quality Element		Macroalgae and Angiosperms	
Macroalgae: parameter intertidal or subtidal macroalgae rocky bottom Results: Ecological quality ratios of national parameter intercalibrated			
Type and country	**National parameter intercalibrated**	**Ecological Quality Ratios**	
		High-Good boundary	**Good-Moderate boundary**
Type NEA1/26 Biotype A2 intertidal macroalgae			
France	CCO - Cover, Characteristic species, Opportunistic species on intertidal rocky bottoms	0.80	0.60
Portugal	PMarMAT - Marine Macroalgae Assessment Tool	0.80	0.61
Spain (Cantabria)	CFR – Quality of Rocky Bottoms	0.81	0.60
Spain (Basque Country)	RICQI - Rocky Intertidal Community Quality Index	0.82	0.60
Spain (Andalusia)	RSL - Reduced Species List	0.75	0.48
Type NEA1/26 Biotype B21 intertidal macroalgae			
Ireland	RSL - Rocky Shore Reduced Species List Macroalgal Index	0.80	0.60
Norway	RSLA - Rocky Shore Reduced Species List Macroalgal Index	0.80	0.60
United Kingdom	RSL - Rocky Shore Reduced Species List Macroalgal Index	0.80	0.60
Type NEA7 intertidal macroalgae			

Norway	RSLA - Rocky Shore Reduced Species List with Abundance	0.80	0.60
United Kingdom	RSL - Rocky Shore Reduced Species List Macroalgal Index	0.80	0.60
Type NEA8a/9/10 subtidal macroalgae			
Norway	MSMDI – Multi Species Maximum Depth Index	0.80	0.60
Sweden	MSMDI – Multi Species Maximum Depth Index	0.80	0.60

6.2. Correspondence common types versus national types

Types NEA 1/26, NEA 7: No information provided

Types NEA 8a, 9 and 10: SE, NO, not applicable

Correspondence between common typology and national types in Kattegat and Skagerrak:

Common Type	Countries involved	National Name			Description
		SE	DK	NO	
NEA 10	SE NO	3		SK1	Skagerrak, outer coastal waters
NEA 9	SE NO	2		SK3	Skagerrak, fjords
NEA 8a	SE NO	1n		SK2	Skagerrak, inner coastal waters
NEA 8b	SE DK	1s,4,5,6	OW2		Kattegat

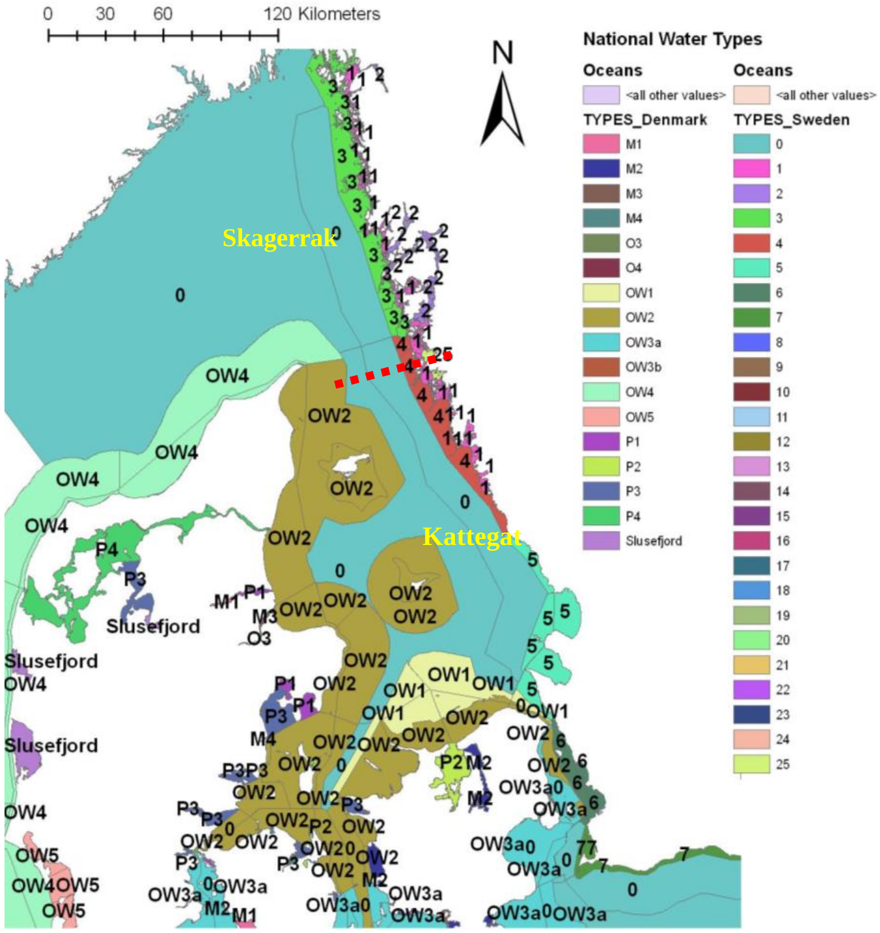


Figure 6.1 National typology for the Swedish and Danish Coastal Waters in Kattegat and Skagerrak. The red line suggest the division between Kattegat and Skagerrak where 8a is north of the line and 8b is south of the line.

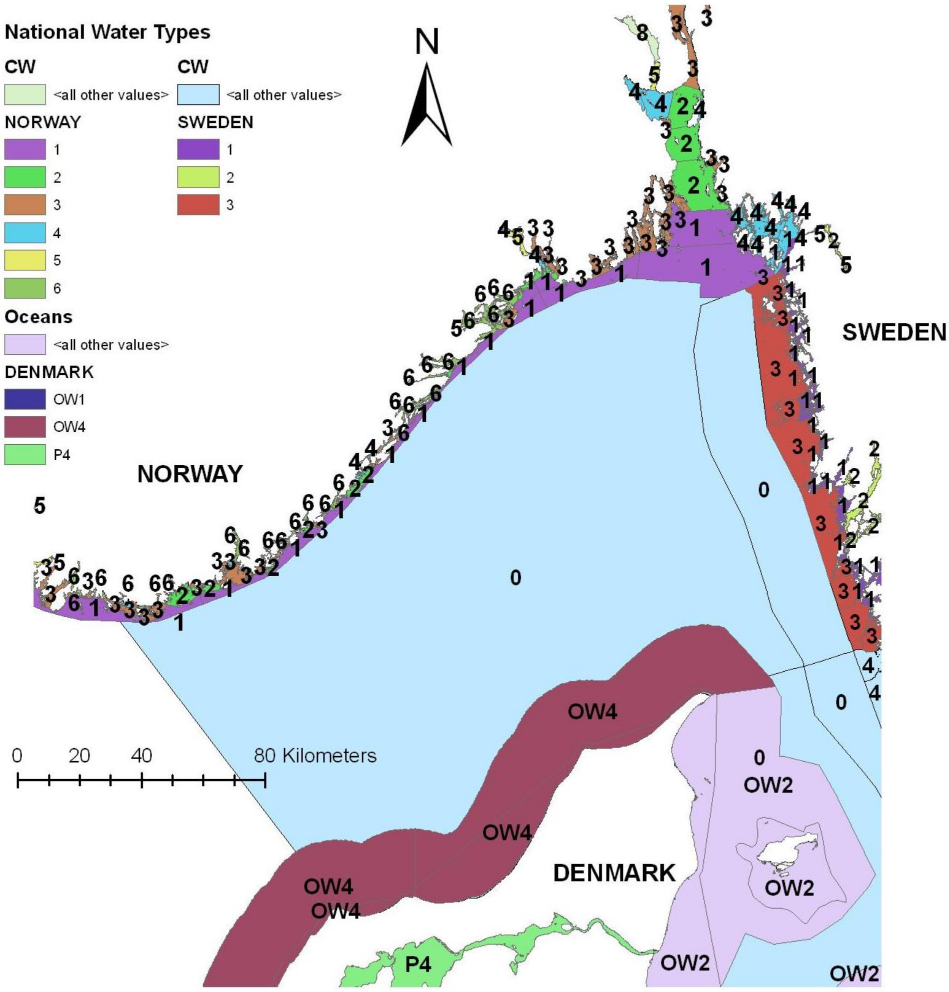


Figure 6.2 Water types in the Skagerrak for Norway, Sweden and Denmark (only OW4). Note that the annotations of the Norwegian and Swedish national types are different.

6.3. Gaps of the current intercalibration

- The intercalibratio for the common type NEA 1/26 subtidal (ES,FR) has not been possible due to the scarcity of potential common sites to be considered in time.
- The intercalibration for the Type NEA 5 (DE) has not been possible because there is only a MS involved in this type
- The Intercalibration for the common type NEA 8b subtidal has been not possible due to differences of assessment concept.

The first impression from MS's concerning if IC is feasible in terms of typology is:

<u>NEA 1/26 intertidal:</u>

Biotype A2. PT, ES, FR – Yes

Biotype B21. NO, IE, UK – Yes

NEA 1/26 subtidal:

Biotype A2. ES, FR – Not within the IC2 due to the scarcity of potential common sites to be considered in time.

7. Ecological characteristics

7.1. Description of reference or alternative benchmark communities

NEA 1/26, biotype A2:

ES (N. Spain): Cantabria (ES1- CFR) and Basque Country (ES2- RICQI)

In the coast of **Cantabria (CFR index),** the reference sites are characterized by high covers (>50%) and richness of large perennial macrophytes (e.g. Fucales, Laminariales, Gelidiales, Corallinales, Gigartinales, etc) and low covers (<10%) of opportunistic species (e.g. Ulvales, Ectocarpales, etc). *Cystoseira tamariscifolia, Bifurcaria bifurcata, Stypocaulon scoparium, and Gelidium spinosum* are the characteristic species of the lowest intertidal level (infralittoral fringe), while the mediolittoral fringe is characterized by *Corallina elongata*, which shares the substratum with caespitose forms, such as *Laurencia obtusa* and *Chondracanthus acicularis,* and crustose calcareous algae.

The reference sites from the **Basque Coast (RICQI index)** are characterized by the large perennial macrophytes, such as *Cystoseira tamariscifolia, Bifurcaria bifurcata, Stypocaulon scoparium, and Gelidium spinosum*, which occupy the lowest intertidal level (infralittoral fringe). The mediolittoral fringe is characterized by *Corallina elongata*, which shares the substratum with caespitose forms such as *Laurencia obtusa* and *Chondracanthus acicularis* and crustose calcareous algae. The invertebrates Patella spp. and *Paracentrotus lividus* are abundant. Species richness (>40), Morphologically-Complex Algae cover (>40-45%) and herbivorous cover show the highest values. These benchmark areas coincide with low values of: light extinction coefficient (<0.15), inorganic matter (<2 mg/l), turbidity (<0.5 NTU), organic matter (<1.5 mg/l), and total suspended solids (<4 mg/l) (for details, see Díez *et al*., 2012).

ES (SW. Spain): Andalusia region (ES3- RSL)

ES3 (SRL): Presence of macroalgae sensitive to pollution (e. g. Fucales, Gelidiales) and few opportunistic species, high proportion of ESG I species, high species richness.

FR (CCO)

Both the taxonomic diversity and the community structuration correspond globally to undisturbed conditions. Macroalgal covering is high at all bathymetric levels of the intertidal zone. Occurrence of characteristic species is important in each algal belt, whereas covering by opportunistic species is very low, in agreement with the lack of any apparent anthropic disturbance. Good cover and richness of characteristic Macroalgae sensitive to pollution (e.g. Fucales, Laminariales, Gelidiales, Corallinales, Gigartinales, etc) and low cover of opportunistic species (e.g. Ulvales, Ectocarpales, etc)

PT (PMarMAT)

Good cover and richness of Characteristic Macroalgae sensitive to pollution (e.g. Fucales, Laminariales, Gelidiales, Corallinales, Gigartinales, etc) and low cover of opportunistic species (e.g. Ulvales, Ectocarpales, etc); high proportion of ESG I taxa; high taxa richness.

<u>NEA 1/26, biotype B21:</u>

IE (RSL):

See UK.

NO (RSL):

Good cover and richness of Characteristic Macroalgae sensitive to pollution (e.g. Fucales, Laminariales, Corallinales, Gigartinales, etc) and low cover of opportunistic species (e.g. Ulvales, Ectocarpales, etc). Northern and southern species on their limit of distribution were not included in the RSL/RSLA and limited the geographical extention of intercalibration area

UK (RSL):

Diverse community of red, green and brown seaweeds with high levels of species richness. Cover variable depending on local physical conditions but species richness relatively constant temporally. Red species present as richest group along with a high proportion of long-lived spp. Opportunist and green species should constitute a lower proportion of the algae present.

<u>NEA 7:</u>

NO (RSL/RSLA):

Good Cover and richness of Characteristic Macroalgae sensitive to pollution (e.g. Fucales, Laminariales, Gigartinales, etc) and low Cover of opportunistic species (e.g. Ulvales, Ectocarpales, etc). Northern and southern species on their limit of distribution were not included in the RSL/RSLA and limited the geographical extention of intercalibration area

UK (RSL):

Diverse community of red, green and brown seaweeds with high levels of species richness. Cover variable depending on local physical conditions but species richness relatively constant temporally. Red species present as richest group along with a high proportion of long-lived spp. Opportunist and green species should constitute a lower proportion of the algae present.

7.2. Description of good status communities

<u>NEA 1/26, biotype A2:</u>

ES (CFR) : Disturbance-sensitive large perennial macroalgal taxa show moderate Covers (approximately below 40%) and richness, and there is an increasing presence low bearing and opportunistic macroalgae (approximately above 20%).

ES2 (RICQI): Wilst in **Good status** Cystoseira tamariscifolia is absent, cover of B. bifurcata, L. obtusa and C. acicularis decreases significantly, the calcareous C. elongata becomes dominant and S. scoparium and G. spinosum remain abundant, MCA cover decrease and species richness may be altered, in the **Moderate status** C. elongata remains dominant, showing its highest cover, the turfing algae Caulacanthus ustulatus and Ceramium spp. become abundant, L. obtusa and C. acicularis disappear, crustose calcareous algae show low cover and species richness and MCA decrease.

ES3 (RSL-And): Good status: There is a diverse community of red, green and brown seaweeds with a slight deviation from reference sites and with lower levels of species richness. Lower number of species richness from the reduced list. Macroalgal cover is variable depending on local physical conditions. Slight decrease in the number of red and brown seaweeds and a greater proportion of greens and short-lived species (ESGII). **Moderate status**: The effects of anthropogenic pressures on the seaweed assemblages are visible in part. A moderate number of macroalgal associated with undisturbed conditions are absent. There is a less diverse community of red, green and brown seaweeds. Significant proportion (< 25 %) of green algae. Macroalgal cover is variable depending on local physical conditions, but overall the coverage of very sensitive species is lower than that in good and high status. There is a decrease in the proportion of red species with a high number of short-lived opportunistic macroalgae.

FR (CCO): Good status: Both the taxonomic diversity and the community structuration remain good, but macroalgal covering tends to decline. Occurrence of characteristic species remains important in each algal belt, whereas covering by opportunistic species tends to increase, in agreement with a slight anthropic disturbance. **Moderate status:** Macroalgal communities are more sensitive to ecological changes and are submitted to defined anthropic pressure, under the form of either physical or chemical disturbance. Both the global covering of Phaeophyceae and the number of characteristic species per level are reduced, whereas the covering by opportunistic species becomes important.

PT (PMarMAT) Good status: There is a diverse community of red, green and brown seaweeds with a slight deviation from reference sites and with lower levels of species richness. Macroalgal cover is variable depending on local physical conditions. Slight decrease in the number of red and brown seaweeds, and a greater proportion of greens (up to 20%), short-lived species (ESG II) and opportunists. **Moderate status:** The effects of anthropogenic pressures on the seaweed assemblages are visible in part. A moderate number of macroalgal associated with undisturbed conditions are absent. There is a less diverse community of red and brown seaweeds. Significant proportion of green or opportunists algae (up to 30%). Macroalgal cover is variable depending on local physical conditions, but overall the coverage of very sensitive species is lower than that in good and high status. There is a decrease in the proportion of red species with a high number of short-lived opportunistic macroalgae.

NEA 1/26, biotype B21 and NEA 7:

NO- RSL/RSLA: Disturbance-sensitive macroalgal taxa show moderate covers and richness, and there is a moderate presence of opportunistic macroalgae.

As morphological pressures increase, the available intertidal habitat for suitable attachment of marine benthic algae decreases causing a decrease in levels of species richness and ESG ratio and a shift in the proportion of red and green species. These effects may also result from increased sediment deposition. With increased nutrient input the proportion of opportunistic macroalgae will increase and may restrict growth of other species causing a general decline in species richness. With further increasing in nutrient pressure there seems to be a shift in dominance from red and brown opportunistic taxa, to more green opportunistic taxa and a reduction in the larger brown perennials. Such shift is more prominent in more sheltered areas of NEA 2,6

IE (RSL): Slightly less diverse community of red, green and brown seaweeds. Cover variable depending on local physical conditions. Greatest reduction in red spp. and greater proportion of short-lived spp. present.

UK (RSL): Good status: Slightly less diverse community of red, green and brown seaweeds. Cover variable depending on local physical conditions. Greatest reduction in red spp. and a slightly greater proportion of short-lived spp. present.

Moderate status: There is a less diverse community of red, green and brown algae. Cover is variable depending on local physical conditions. There is a decrease in the proportion of red species, with a higher proportion of short-lived macroalgae. The community shows a greater dominance of green and opportunist species.

Reference conditions, High/Good and Good/Moderate boundaries are indicated for each metric indicator in the table below.

Method	Metrics	Reference Conditions	Boundaries	
			H/G	G/M
CFR	Cover CM Semiexp.	90	73	54
	Fraction Opp. (%) Semiexp.	5	12	19
	Richness CM Semiexp.	10	8	6
	Cover CM Exp.	70	57	42
	Fraction Opp. (%) Exp.	5	12	19
	Richness CM Exp.	7	6	4
PMarMAT	Sp. Richness	28	27	20
	Nº Rhodophyta	18	17	12
	Prop. Chlorophyta	0,1	0,1	0,2
	ESG Ratio	2,00	1,99	0,99
	Prop. Opp	0,1	0,1	0,2
	Cover Opp. (%)	0,1	0,1	0,2
	Shore Description	7	8	12
CCO*				

Method	Metrics	Reference Conditions	Boundaries	
			H/G	G/M
	Cover (%)	>75	NA	NA
	Nb Characteristic sp. (% max Nb)	>50	NA	NA
	Cover Opp. (%)	<5	NA	NA
RICQI	ESS	>0.5	0,4	0,3
	MCA (%)	>50	45	30
	Ra	>45	40	30
	Rf	>30	25	20
	Pf	>30	25	20
RSL-ES3	Corrected Sp. Richness		29	26
	Prop. Rhodophyta		18	13
	ESG Ratio		0,2	0,25
	Prop. Chlorophyta		0,4	0,35
	Prop. Opp		0,05	0,1
RSL-UK	Normalised sp. Richness		35	25
	% Chlorophyta		12	20
	% Rhodoohyta		55	45
	ESG Ratio		1	0,8
	% Opp		10	15
RSL-IE	Normalised sp. Richness		35	25
	% Chlorophyta		12	20
	% Rhodophyta		55	45
	ESG Ratio		1	0,8
	% Opp		10	15
RSL-NO	Sp. Richness Adj		30	15
	% nº Chlorophyta		20	20
	% nº Rhodophyta		40	30
	ESG Ratio		0,8	0,6
	% Opp		15	25
RSLA-NO 1/26	Sp. Richness Adj		30	15
	% nº Chlorophyta		20	30
	% nº Rhodophyta		40	30
	ESG Ratio		0,8	0,6
	% Opp		15	25
	Abundance Phaeophyceae		90	40
RSLA-NO 7	Sp. Richness Adj		30	20
	% nº Chlorophyta		20	25

Method	Metrics	Reference Conditions	Boundaries	
			H/G	G/M
	% nº Rhodophyta		40	30
	ESG Ratio		1	0,7
	% Opp		25	32
	Abundance Chlorophyta		14	28
	Abundance Phaeophyceae		120	60
	Prop. Phaeophyceae		40	30

* FR-CCO. Each metric constitutive of CCO do not have a specific quality gri ; however, the final CCO score does

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Annex

A. New typology in Skagerrak and Kattegat, WFD Intercalibration – 2nd phase – NEA-GIG

New typology in Skagerrak and Kattegat

WFD Intercalibration – 2nd phase – NEA-GIG

Author:

Are Pedersen

in collaboration with the macro-algae and angiosperm-, phytoplankton- and benthic fauna-groups among the Nordic countries within the NEA-GIG

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Request for dividing Kattegat and Skagerrak into two subtypes

Summary request

The Water Framework Directive defines several water types within the North Atlantic. The first attempts to divide the North Atlantic in similar types ended up in joining some types and separating others. NEA 8, 9 and 10 were separated from NEA 1 and 26 due to different hydrographical conditions. However, the Skagerrak and Kattegat were not separated. This has caused problems during the intercalibration process within this region as the difference among Skagerrak and Kattegat are in respect to salinity and to some extent wave height, even more different in the upper water column than the difference between Skagerrak and the North Sea.

After meetings among the Nordic countries, Denmark, Norway and Sweden have concluded that it would be better for the purpose of achieving a more solid intercalibration and harmonized metrics, to divide Skagerrak and Kattegat in two subtypological variants. This refers to the metrics phytoplankton and macro algae/Angiosperms. Geographically we suggest that the two variants are divided as done in HELCOM and OSPAR with a line stretching from Skagen in Denmark to Gothenburg in Sweden. This implies that Norway and Sweden will have the water types 8a, 9 and 10 in common, while Denmark and Sweden will only have water type 8b in common. Such subdivision will facilitate the standardization within the smaller subdivisions as this was impossible within the old NEA-8 due to total different hydrograhical conditions and habitats between the two subdivisions.

Background for the request

Today Norway, Sweden and Denmark share the water type of NEA 8. NEA 8 is described as the moderately exposed coastal areas. NEA 10 is defined as the most exposed areas of the coastline whereas NEA 9 is fjords, and both of these two water types are shared today among Norway and Sweden. Denmark does not have water types 9 and 10 (Table A.1 and see also figures A.5 and A.6 for further clarification).

Table A.1 The existing typology of the Skagerrak/Kattegat region with 3 water types. (Notice all the different national types that are included in NEA 8 for especially Sweden).

Common Type	Countries involved	National Name		
		SE	DK	NO
NEA 10	SE NO	3		Sk1
NEA 9	SE NO	2		Sk3
NEA 8	SE NO	1,4,5,6	OW2	Sk2

Today these water types extend from Lindesnes at the southern tip of Norway, through Øresund between Denmark and Sweden. At Lindesnes the salinity is about 30 as opposed to in Kattegat where the salinity in surface waters above the pycnocline usually varies between 17 and 25. The exposure, and consequently wave height, is also quite different along this stretch. There is however a distinct area where these physical characters changes considerably and that is between Skagen at the northern tip of Denmark and Gothenburg in Sweden – the natural separation line between Skagerrak and Kattegat. This is also used as a dividing line in HELCOM and OSPAR.

The changes in physical characteristics from southern Kattegat towards Skagerrak is thoroughly described in a report written for the Swedish Environmental Protection Agency (Naturvårdsverket) in Sweden by a group of international experts - SWEDISH ENVIRONMENTAL PROTECTION AGENCY, Report 5898 • West Coast Eutrophication.

The expert group consisted of:

Dr. Donald F. Boesch, Chair
University of Maryland Center for Environmental Science, Cambridge Maryland, USA

Dr Jacob Carstensen
National Environmental Research Institute, Aarhus University, Roskilde, Denmark

Dr. Hans W. Paerl
Institute of Marine Sciences, University of North Carolina, Morehead City North Carolina, USA

Dr. Hein Rune Skjoldal
Institute of Marine Research, Bergen, Norway

Dr. Maren Voss
Leibniz Institute for Baltic Sea Research, Warnemünde, Germany

Below is a section from the report on the physical characteristics of the area (with permission from the Swedish Environmental Protection Agency (Naturvårdsverket)):

"Geography and Bathymetry

The Swedish west coast faces the Öresund, Kattegat and Skagerrak (Figure A.1). These are three very different although connected water bodies. (Underlining done by Are Pedersen). The Skagerrak is part of the deep Norwegian Trench which is a glacially excavated valley that runs along the coast of Norway and connects the North Sea with the deep Norwegian Sea to the north. The Skagerrak is about 700 m deep in the inner (eastern) part and there is a steep slope from the Swedish Bohuslän coast down into the deep Skagerrak. The Kattegat and Öresund in contrast are shallow sea areas that connect the Skagerrak with the Baltic Sea. The Kattegat is a broad basin about 200 km long and 100 km wide. The boundary between Kattegat and Skagerrak is usually taken as a line from Skagen (north tip of Denmark) to the city of Göteborg on the Swedish coast."

"Circulation and Water Masses

The North Sea circulation is basically counter-clockwise (Figure A.2; Otto et al.1990). Atlantic water from the inflow across the ridge between Scotland and Iceland flows into the North Sea across the northern boundary between Scotland and Norway. (Some left out.) Much of the inflow in the Norwegian Trench continues into the Skager-rak where it circulates around and leaves on the northern side along the Norwegian Skagerrak coast.

There is also some inflow of Atlantic water through the (English) Channel that continues northeast along the European continent south of the Dogger Bank. This flow is the main seawater that receives the input of fresh water from the large European rivers including the Seine, Scheldt, Rhine-Meuse, Weser, and Elbe. The fresh water lowers the salinity and gives the flow a distinct characteristic as a coastal current that flows north as the Jutland Current along the western and northern coasts of Denmark."

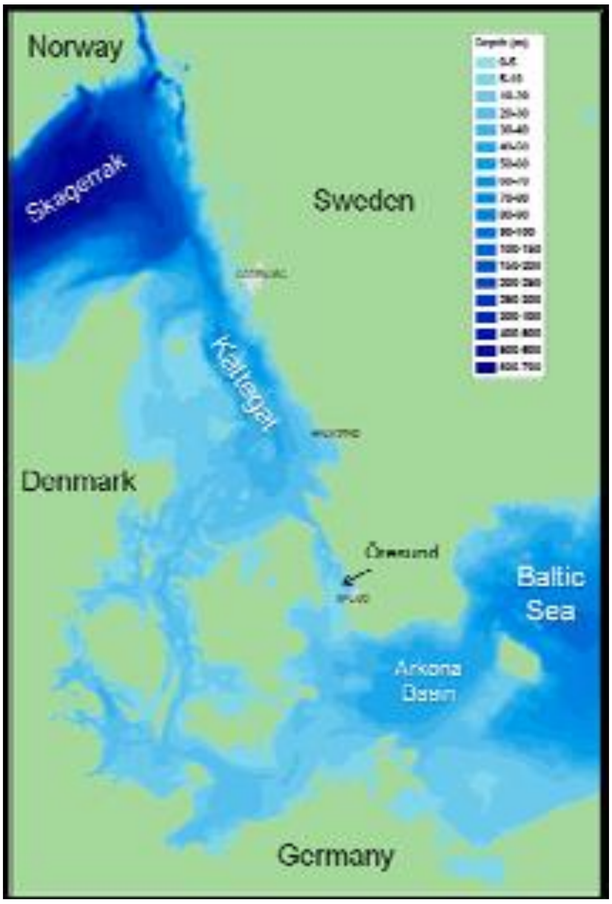

Figure A.1 Seas along the Swedish west coast.

"Roughly half of the total flow through the North Sea circulates through the Skagerrak (Skjoldal 2007).

<u>The Skagerrak experiences the confluence for four different water masses:</u>

- outflowing Kattegat surface water (KSW, which contains the Baltic outflow),
- water from the Jutland Coastal Current (Jutland coastal water),

- water from the central North Sea (CNSW),
- and Atlantic water (AW).

These water masses have different salinities and densities and when they meet in inner Skagerrak they can be layered one above the other. The least dense water is the Kattegat surface water, with an average salinity around 25 as it leaves Kattegat (Figure A.3). The next less dense is Jutland coastal water which has salinities typically around 32-33 as it passes off Skagen. The Central North Sea water contains some fresh water mixed in from the coastal zones and typically has salinities between 34.5 and 35, while the Atlantic water has salinities >35.

In the inner Skagerrak these water masses are typically stacked above each other, although there can be short-term and spatial variation in this pattern. The outflow from Kattegat continues north along the Swedish Bohuslän coast, overlying Jutland water, central North Sea and Atlantic water masses. Through mixing and entrainment, this buoyant coastal current increases its salinity as it continues north into the wide bight of the outer Oslofjord, where it is deflected and flows as the Norwegian Coastal Current along the Norwegian Skagerrak coast and then farther north along the Norwegian west coast. It has been shown that by the time the current passes Arendal, about half way along the Norwegian Skagerrak coast, most of the Jutland water can be accounted for as being present in the deeper part of the upper 30 m of the water column (Skjoldal et al. 1997, Aure et al. 1998).

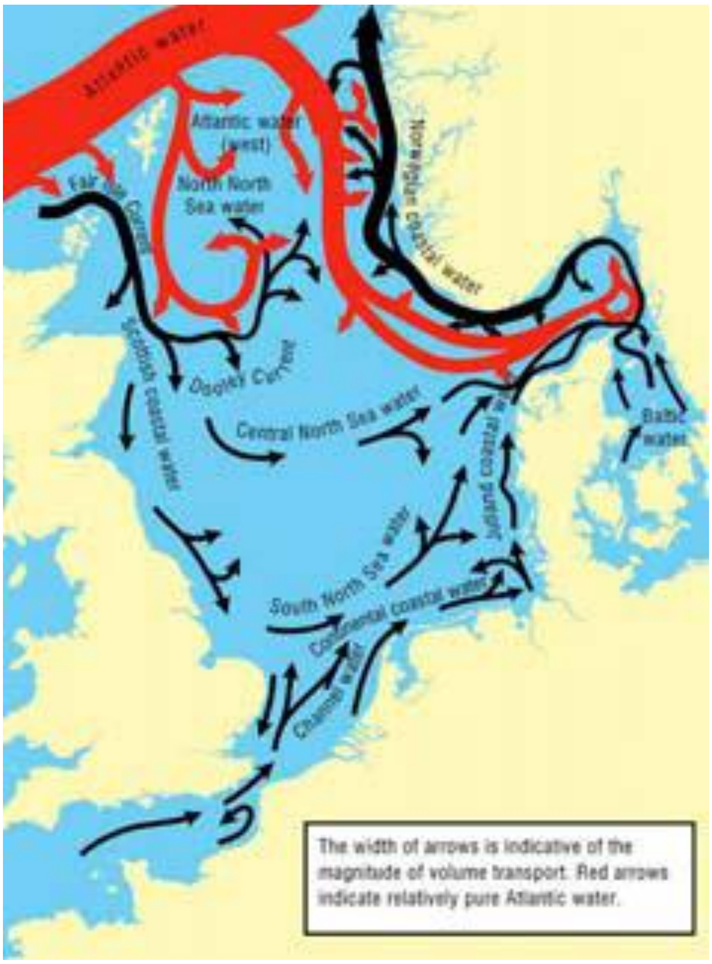

Figure A.2 General circulation in the North Sea

The circulation in the Kattegat is typical estuarine with low-salinity water flowing out from the Baltic Sea as an upper layer, while saltier water flows south as a deeper layer. A large fraction of the deeper water is gradually entrained into the upper layer as it penetrates south through the Kattegat. The upper and deeper layer is usually separated by a pronounced density gradient, or pycnocline. The salinity of the Baltic water in the Arkona Basin is about 8 on average as it approaches the Belts and Öresund. Salinity increases to about 20 in the southern Kattegat. On the further passage north through Kattegat, the salinity of the upper layer increases to an average of about 25 south of Læsø. This corresponds to an entrainment of an amount of water about twice the Baltic outflow, resulting in an increase in the net volume flow by a factor of about 3. In the frontal area north of Læsø, where high salinity Skagerrak water is subducted as a bottom current, surface salinities can rapidly change 5 to 10 due to the mixing of different water masses.

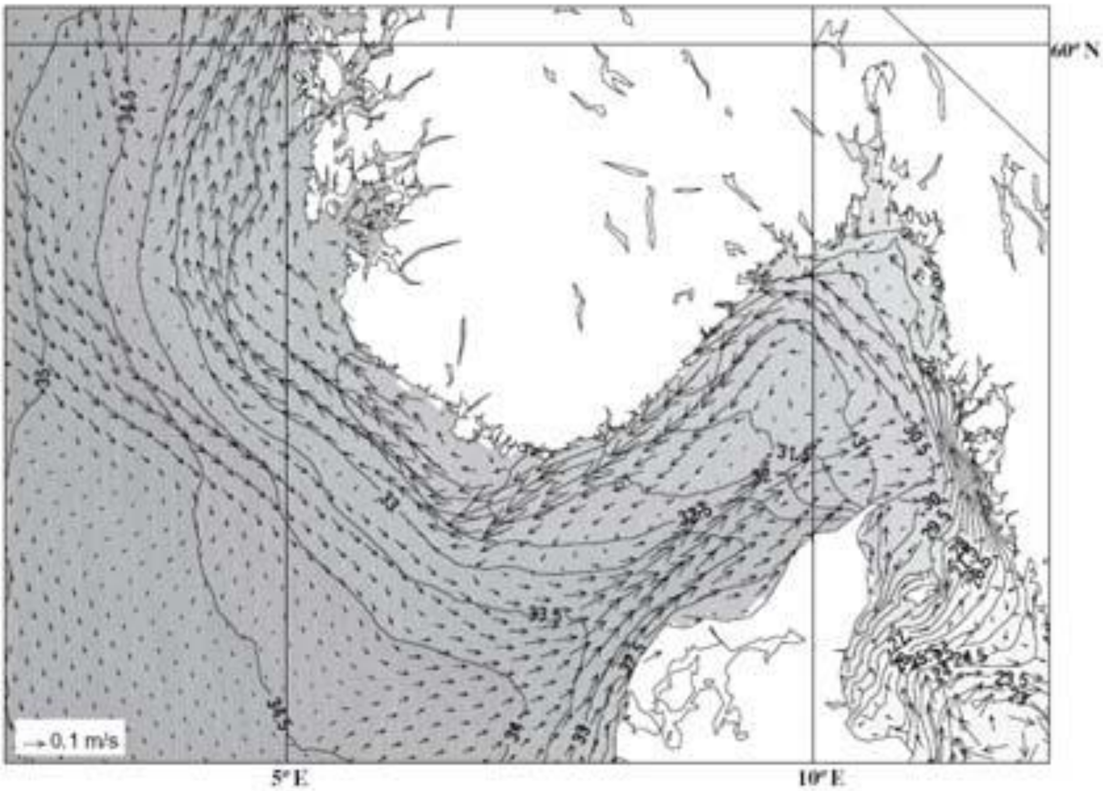

Figure A.3 Annual (1998) mean of salinity and currents in the surface 5 m for the Skagerrak-northern North

Sea region as modeled by Albretsen (2007).

The coastal waters (defined as waters within the baseline) have been divided into regions based on typology according to the methodology given by the EU Water Framework Directive. The typology is based mainly on water salinity, exchange and residence time, and bottom substrate. The areas are from south to north: the coast along the Öresund, the coast along southern Kattegat including Skälderviken and Laholm Bay, the coast along northern Kattegat, the coast along Skagerrak, and the fjord systems north of Gøteborg including Havstensfjord and Gullmarfjord."

Dahl et. al (2003) has clearly shown the drop in average salinity (0-5m) from the end of the Baltic Sea through Öresund and Kattegat out towards Skagerrak during a winter and a summer periode (Figure A.4). It verifies the significant spatial gradient and differences in salinity from the Baltic Sea to Skagerrak and validates the suggested division of Skagerrak and Kattegat's surface waters.

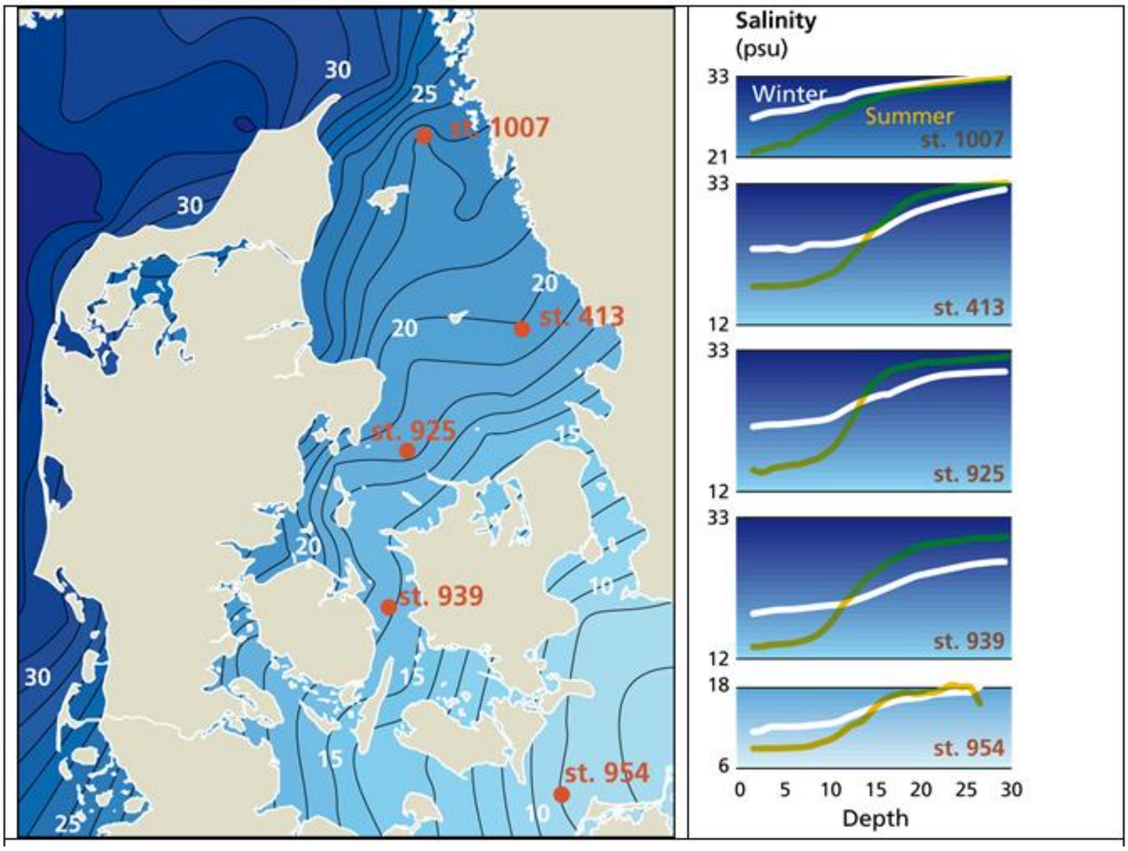

Figure A.4 Left: Yearly average surface salinity from 0-5m depth and selected water chemistry sampling stations from the national monitoring programme. Right: Salinity profiles from selected sampling station average from two half year seasons, winter (October-March) and summer (April-September. From Dahl et al 2003.

Summary of the Nordic countries national typology

The expert panel divides the Swedish West Coast into different water types based on the physical characteristics mentioned above according to the guidelines in the WFD. The West Coast is divided up from South to North in four different water types. The Swedish national water types from south to north are:

Type 6. Öresund Coast

Type 5. Southern Halland and northern Öresund

Type 4. Kattegat, outer parts

Type 3. Skagerrak, outer parts

Type 1 (archipelagos, inner parts) and 2 (fjords) are types with various type of exposure inside type 3 and 4. All these water types are shown in Figure A.5 below.

The Danish typology is also shown in the section on correspondence common types versus national types of this report, and shows the presence of two main types of outer coastal water types one on each side of Jylland – OW4 on the western side and OW2 in Kattegat. It is separated at Skagen (the division also used in OSPAR) and the type OW2 represents the NEA-8b water type. For the Swedish coast the type 4, 5 and 6 will represent NEA-type 8b. Denmark and Sweden are developing specific tools/indices to deals with a gradient of salinity within their water type 8b. The boarder between NEA- and BALTIC-GIG is between water types OW2 and OW3a, and 6 and 7, within Danish and Swedish waters respectively.

The Norwegian typology describes 5 water types in the Skagerrak region. The outer exposed water type 1 is the same type as NEA-10 and the Swedish type 3. This is a relative homogenous water type even if there is a distinct east-west gradient in different physical characteristics (section on correspondence common types versus national types of this report,). The Norwegian type 2 coincides with the suggested water type NEA-8a which is similar to the Swedish water type 1. The Swedish type 2 and the Norwegian type 3 are fjords and defined as NEA-9 (Figure A.6). Hence, Sweden and Norway still have the same typology as suggested in phase I of the intercalibration, however, with a restriction of the southern extent to the Skagerrak-Kattegat border.

The water types OW4 is different from the water found along the Swedish and Norwegian coast in the Skagerrak region and have water characteristics that resembles the water coming from the German bight. Hence should not be considered as NEA-10, but more like 1/26c.

The expert panel is of the opinion that one should separate between the water type found in Kattegat and the water types found in Skagerrak.

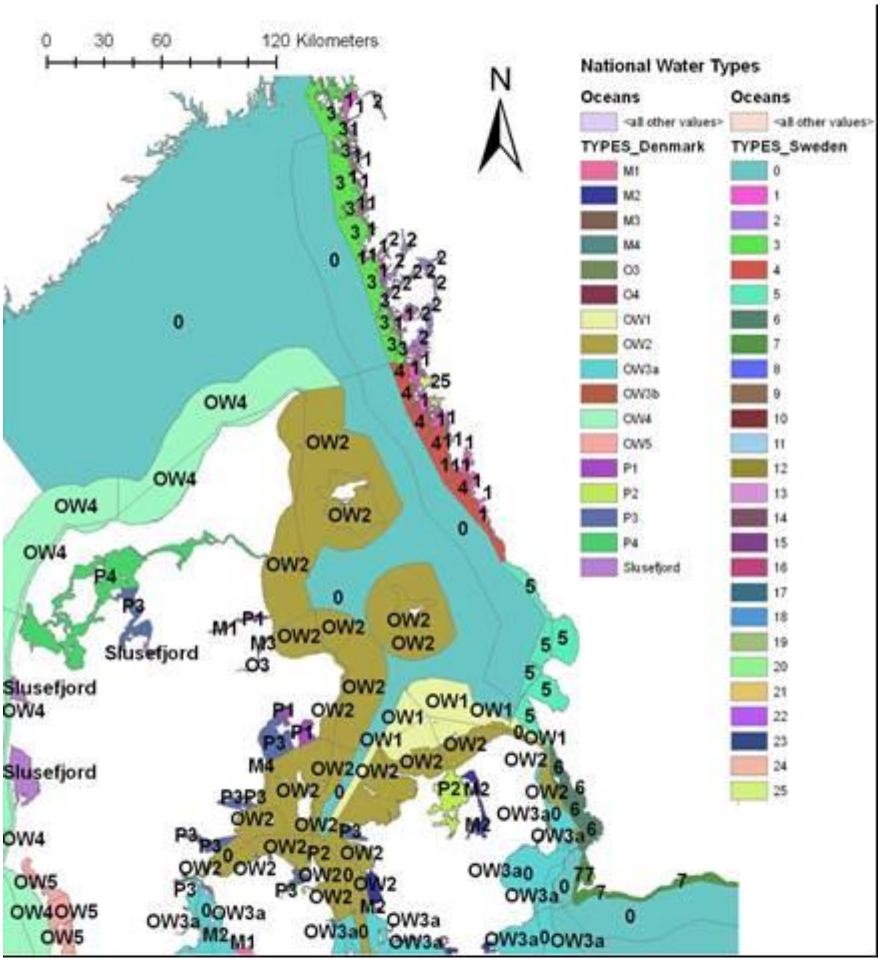

Figure A. 5. National typology for the Swedish and Danish Coastal Waters in Kattegat and Skagerrak. The red line suggest the division between Kattegat and Skagerrak where 8a is north of the line and 8b is south of the line.

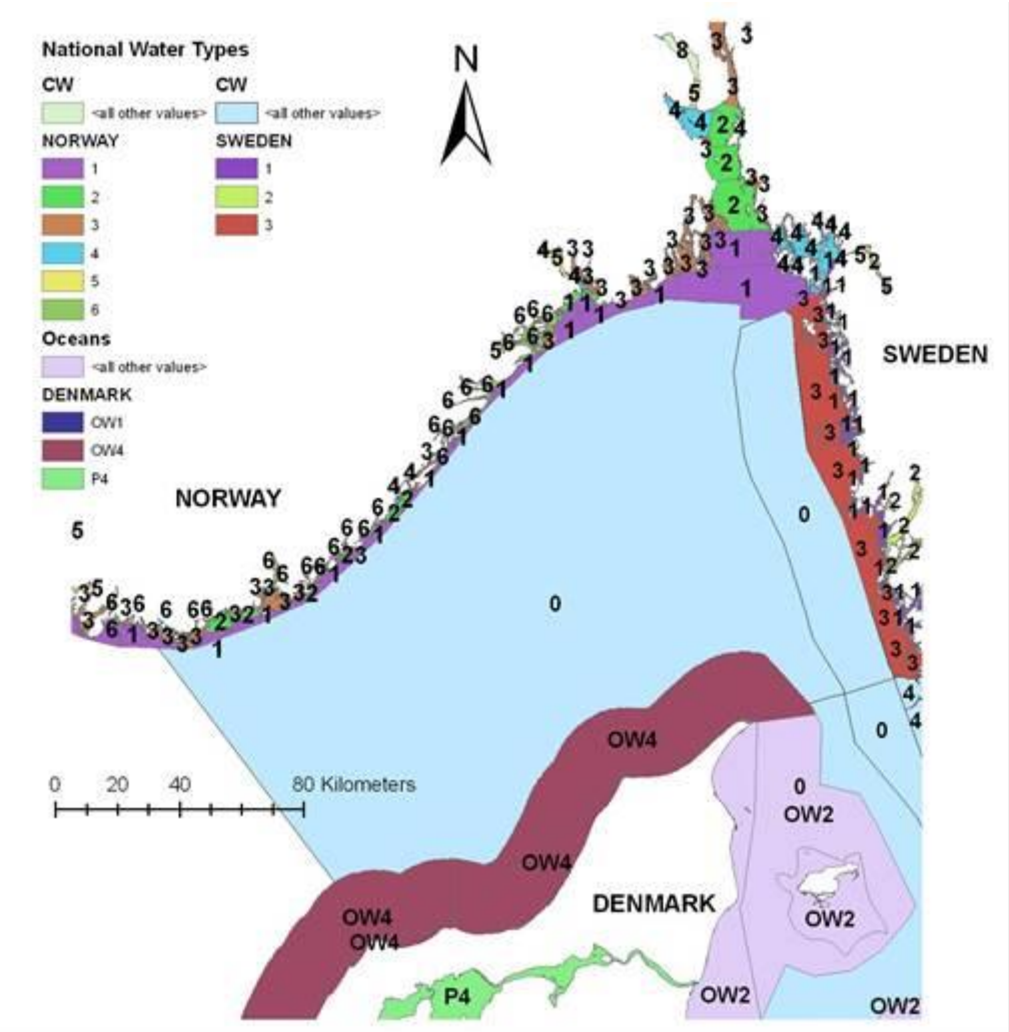

Figure 6. Water types in the Skagerrak for Norway, Sweden and Denmark (only OW4). Note that the annotations of the Norwegian and Swedish national types are different.

Nordic water types shared within the NEA-GIG

Figures A.5 and A.6 above show the complexity of the national typology for the Skagerrak and particularly for the Kattegat. The national types and the new common types according to suggested typology are shown in the table below (table 2). Norway and Sweden will share all three water types, but Sweden and Denmark will only share one common water type i.e. NEA 8b. Notice that the salinity in the surface water is quite different among type 8a and b where as the bottom waters has a more similar salinity (outline in blue).

The NEA and BALTIC GIG are separated by the national watertypes 6 and 7 on the Swedish coast and OW2 and OW3a

Table A.2 New suggestion of Swedish, Norwegian and Dannish water types within the Nordic countries and one shared with other European countries. (Salinities from

Gustavson 2000, cited in Naturvårdsverket report 5898 and slightly modified by Mats Blomqvist, Hafok)

Common Type	Countries involved	National Name			Upper Layer salinity	Deep water salinity	Exposure
		SE	DK	NO			
NEA 10	SE NO	3		Sk1	25- 30	32-35	Exposed
NEA 9	SE NO	2		Sk3	25- 30	32-35	Sheltered
NEA 8a	SE NO	1*		Sk2	25- 30	25-30	Moderately exposed
NEA 8b	SE DK	1*, 4, 5, 6	OW2		10- 25	18-30	Moderately to sheltered

* The Swedish national type 1 is for phytoplankton split in one northern and one southern subtype. The boundary is the same as suggested here between 8a and 8b.

The Danish Skagerrak coast should continue to be a subtype (1/26d) of type 1/26 (OW 4 in figure A.5 and A.6). The Danish Skagerrak coast is very different from the Norwegian and Swedish Skagerrak coasts. The Danish Skagerrak coast (OW4) is much more shallow and sandy and the coastal water is primarily dominated by the Jutland current, which makes it more similar to the Danish North Sea with a little higher salinity (1/26c). The Danish Skagerrak coast is therefore more related to type 1/26 hence should stay as 1/26d.

BQE within the new suggested typology

The main differences among Skagerrak and Kattegat are within the physical /chemical characteristics of the surface waters. Hence we suggest that this new suggested typology should regard the BQE: Macroalgae, Phanerogame and Phytoplankton. The benthic fauna is not that affected by the differences in surface waters and the intercalibration in phase two have been planned by three countries for moderately exposed coastal water – (the old NEA8) using data from accumulation bottoms below the halocline. However for the other BQE a separation of Skagerrak and Kattegat seems appropriate as the surface water in these two regions are quite different.

The North East Atlantic water types

Spain and Portugal have also performed some statistical tests with the purpose to determine if one can extract different physical and ecological subtypological variants within the typology along the NEA-GIG (Ramos *et al.* 2011). So far has only analysis of the physical classification for the whole North East Atlantic Coastline been performed.

The shore line have been divided up in stretches of 40km and data for the main physical characteristics for temperature (SST), salinity, light attenuation (PAR), wave heights, and tidal range have been tested with different combinations. Not all tests show similar patterns, but to support the fact that Kattegat and Skagerrak have quite different salinity regimes, a figure from the work is shown in Figure A.7. The figure shows that the surface water salinity in Kattegat is different from all other regions. In addition was wave hight also different among Kattegat and Skagerrak and based on these two factors we recommend that the Kattegat is separated from Skagerrak and that they form two separate subtypological variant.

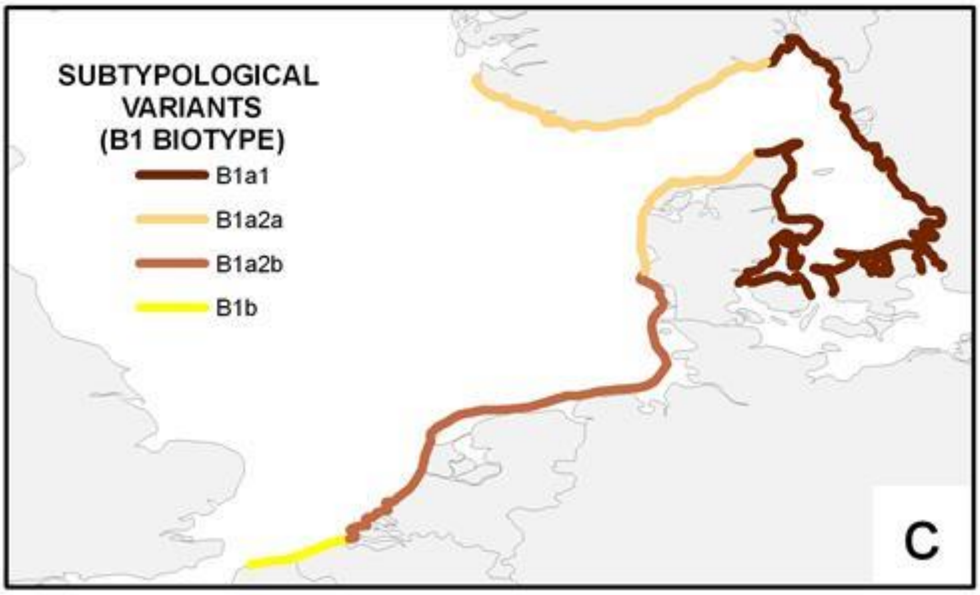

Figure 7. Classification obtained after applying the second physical classification (c) B1 biotype (four subtypological variants). Source: Ramos et al., 2012.

Previous demarcation of the typology for phytoplankton was described in part 3 to the technical report on intercalibration during the first phase. Here the NEA-types for especially Type 1,26 was divided up in different subtypes. This was shown in figure 2.4.2 on page 162 of the 1st IC technical report. Unfortunately the identification of NEA types 8,9 and 10 are wrongly displayed in this figure as NEA 10 is supposed to be the exposed areas of the Skagerrak and Kattegat as opposed to NEA-8 that was supposed to be the more sheltered areas and more inshore for the NEA-10, similar to NEA 1 and NEA 2,6. NEA 9 is the fjords only found in Sweden and Norway.T his is not correctly displayed in the technical report where it only NEA 10 is sheared between Sweden and Norway an NEA 8 only between Sweden and Denmark. NEA-8 is only in the Kattegat area and not found in Norway. This is not correctly displayed and may cause some confusion. The more correct typology is presented in table 1 with reference to the NEA typology and the national water types.

Ramos, E, Juanes, JA., Galván, C., Neto, J., Melo, R., Pedersen, A., Scanlan, C., Wilkes, R., van den Bergh, E., Blomqvist, M., Karup, H.P., Heiber, W., Reitsma, J, Ximenes, M.C., Silió, A., Méndez, F, González, B. 2012. Coastal waters classification based on physical attributes along the NE Atlantic region. An approach for rocky macroalgae potential distribution. Estuarine, Coastal & Shelf Science, 112: 105-114.