

# CFR index

## “Quality of Rocky Bottoms”

(Continuous EQR Scale)

<http://cfr.ihcantabria.com>

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## 1) General information:

**Acronym:** CFR

**Method name:** *Quality of Rocky Bottoms*

**Original name:** *Calidad de Fondos Rocosos*

**WISER ID:** 185

**GIG:** NE Atlantic

**Category:** Coastal Waters

**BQE:** Macroalgae (intertidal and subtidal)

**Country:** Spain

### Scientific literature:

- Guinda, X., J.A. Juanes, A. Puente, 2014. The CFR index: A validated method for the assessment of macroalgae according to the European Water Framework Directive. *Marine Environmental Research*, 102: 3-10.
- Guinda, X., A. Gracia, A. Puente, J.A. Juanes, Y. Rzhanov and L. Mayer, 2014. Application of landscape mosaics for the assessment of subtidal macroalgae communities using the CFR index. *Deep-Sea Research Part II: Topical Studies in Oceanography*, 106: 207-215.
- Guinda, X., J.A. Juanes, A. Puente & J.A. Revilla, 2008. Comparison of two methods for quality assessment of macroalgae assemblages, under different pollution types. *Ecological Indicators*, 8 (5): 743-753.
- Juanes, J.A., X. Guinda, A. Puente & J.A. Revilla, 2008. Macroalgae, a suitable indicator of the ecological status of coastal rocky communities in the NE Atlantic. *Ecological Indicators*, 8 (4): 351-359.

## 2) Description of the method:

$$CFR = 0.45 * C + 0.35 * F + 0.2 * R$$

**C:** Coverage of “Characteristic Macroalgae” (Table 1)

**F:** Fraction of opportunistic species (Table 1)

**R:** Richness of “Characteristic Macroalgae” →

“Abundance”

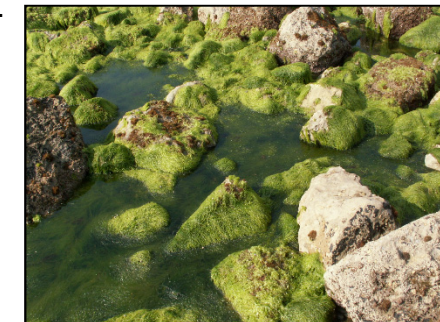
“Composition”

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*

Table 1. List of characteristic and opportunistic macroalgae identified on the coast of Cantabria\*

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



\* Encrusting species are not considered for the CFR index

### 3) Necessary information:

The following information is required to apply the index at each coastal station\*:

- % Coverages of macroalgae. It is not necessary to estimate the coverage of all the species, only global coverages for “Characteristic macroalgae” and “Opportunistic macroalgae” are needed.
- Number of “Characteristic macroalgae” species with coverage values ca.> 1%.

\* The index can be applied independently to different stations in the intertidal and/or the subtidal zone, using the corresponding scoring systems (see section 4). Establishment of standardized “depth zones” (5-15m, 15-25m) are based on previous information on macroalgae distribution (Guinda *et al.*, 2012). Further integration methods at the location level or the water body level are required.

Guinda, X., J.A. Juanes, A. Puente and B. Echavarrri-Erasun. 2012. Spatial distribution pattern analysis of subtidal macroalgae assemblages by a non-destructive rapid assessment method. *Journal of Sea Research*, 67: 34-43.

#### 4) Reference conditions:

Reference conditions (RC) were established combining expert judgment and cumulated frequency distribution curves of data obtained at **pristine zones**, for each of the types of intertidal and subtidal areas.

Metric	RC	Flat	Steep	Shallow	Deep
		intertidal (slope<20°)	intertidal (slope>20°)	subtidal (5–15 m)	subtidal (15–25 m)
<b>C: Coverage of CM (%)</b>	RC <sub>1</sub>	90	70	90	70
<b>F: Fraction of Opportunistics (%)</b>	RC <sub>1</sub>	5	5	2	2
	RC <sub>0</sub>	40	40	30	30
<b>R: Richness of CM</b>	RC <sub>1</sub>	10	7	6	6

RC<sub>1</sub> and RC<sub>0</sub> : Reference Conditions for High and Bad Status respectively.

## 5) Indicators description:

### **C: Coverage of “Characteristic Macroalgae”**

% Total Coverage of characteristic macroalgae populations (CM).

### **F: Fraction of opportunistic species**

Relative coverage of opportunistic species with respect to the total vegetated surface, according to:

$$F = \left( \frac{O}{(C + O)} \right) \times 100 \quad \left\{ \begin{array}{l} \text{F: Fraction of Opportunistics (\%)} \\ \text{O: Coverage of Opportunistics (\%)} \\ \text{C: Coverage of CM (\%)} \end{array} \right.$$

### **R: Richness of “Characteristic Macroalgae”**

Number of CM species with a significant coverage (ca. >1%)



## 6) How to apply the index:

### 6.1. General aspects

**Field surveying:** Visual estimation of % coverage of CM, % coverage of opportunistic species and number of CM species. Non-destructive qualitative assessment.

**Surveyed area:** Variable (10-100 m<sup>2</sup> aprox.). Intertidal stations only from low to middle intertidal.

**Survey month(s):** June to September

**Survey period for Intertidal zone:** Preferably during spring low tides

**Nº survey occasions:** 1 per sampling season

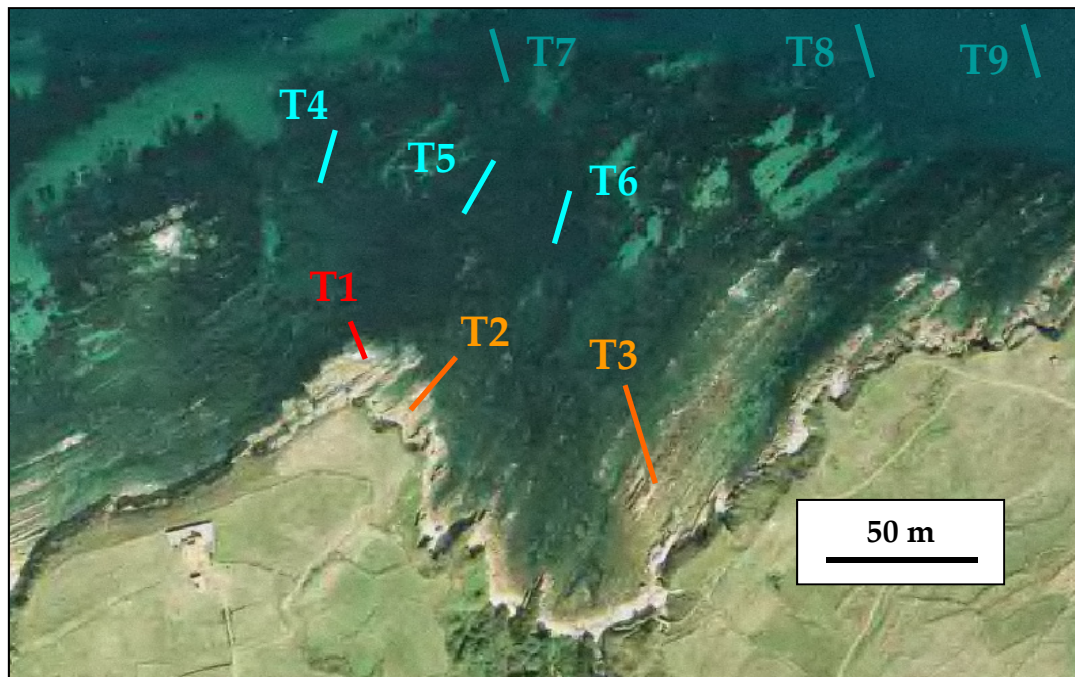
**Recommended Nº of replicates per site:** 3 replicates per assessed level: Intertidal, 5-15m, 15-25m.

**Taxonomical level:** Based on a predefined, well-established list of "Characteristic" and "Opportunistic" macroalgae for each biogeographical region (see Table 1), identified to the higher possible taxonomical level (e.g. *Gelidium corneum*, Ceramiales, etc.)

## 6.2. Location of the transects

Transects should be located on stable rocky substrates, suitable for macroalgae colonization:

- **Intertidal** predefined transect belts (e.g. 10 m width) from mid-intertidal to low-intertidal.
- **Subtidal** predefined transect belts (e.g. 2-5 m x 25 m) at homogeneous depths



(see next slide for types)

**T1:** Steep intertidal

**T2:** Flat intertidal

**T3:** Flat intertidal

**T4-T6:** Shallow subtidal 5-15m

**T7-T9:** Deep subtidal 15-25m

### 6.3. Identification of intertidal/subtidal types:

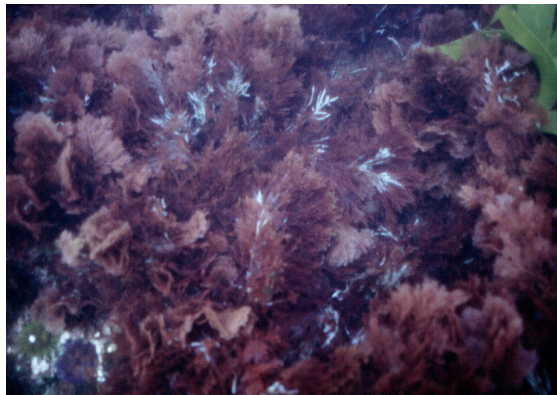
Flat  
Intertidal  
(slope  $<20^\circ$ )



Steep  
Intertidal  
(slope  $>20^\circ$ )



Shallow  
subtidal  
(5 – 15 m)

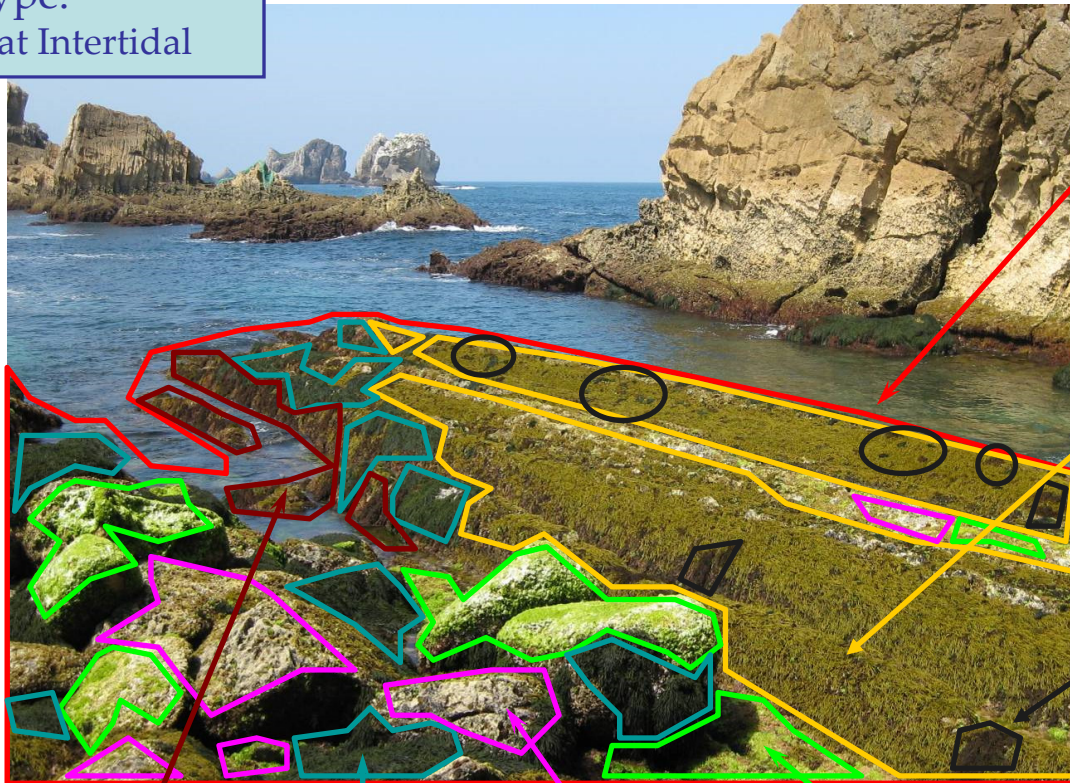


Deep  
subtidal  
(15 – 25 m)



## 6.4. Visual estimation of coverage values

Type:  
Flat Intertidal



Surveyed area  
(80 m<sup>2</sup>)

*Bifurcaria bifurcata*  
32 m<sup>2</sup>=40%

*Stypocaulon scoparium*  
1 m<sup>2</sup>=1.25%

*Gelidium spp.*  
10 m<sup>2</sup>=12.5%

*Codium tomentosum*  
15 m<sup>2</sup>=19%

*Corallina sp.*  
4 m<sup>2</sup>=5%

*Ulva/Enteromorpha spp.*  
10 m<sup>2</sup>=12.5%

## 6.5. Obtention of indicators values

### ➤ C: Coverage of CM

<i>Bifurcaria bifurcata</i>	40%
<i>Codium tomentosum</i>	19%
<i>Gelidium spp.</i>	12.5%
<i>Corallina sp.</i>	5%
<i>Stypocaulon scoparium</i>	1.25%
<b>Total.....</b>	<b>77.75%</b>

### ➤ F: Fraction of Opportunistics

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

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

### ➤ R: Richness of CM

Nº of CM with coverage >1%: 5

## 6.6. Score assignment

### C: Coverage of CM

If  $C > RC^*$ , then  $C_{score}=1$

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

\*RC=Reference conditions according to section 4

### R: Richness of CM

If  $R > RC^*$ , then  $R_{score}=1$

If not,  $R_{score} = \frac{R}{RC^*}$   $\xrightarrow{\text{R}_{score} \text{ for } R=5}$   $\frac{5}{10} = 0.5$

\*RC=Reference conditions according to section 4

### F: Fraction of Opportunistics

If  $F < RC^*$ , then  $F_{score}=1$

If  $F > RC_0^*$ , then  $F_{score}=0$

\*RC and  $RC_0$ =Reference conditions according to section 4

If not,  $F_{score} = \frac{RC_0^* - F}{RC_0^* - RC^*}$   $\xrightarrow{\text{F}_{score} \text{ for } F=13.8}$   $\frac{(40 - 13.8)}{40 - 5} = 0.748$

## 6.7. CFR index value calculation

$$\text{CFR} = 0.45 \cdot C + 0.35 \cdot F + 0.2 \cdot R$$

Scores:

$$\left. \begin{array}{l} C = 0.864 \\ F = 0.748 \\ R = 0.5 \end{array} \right\} \rightarrow \text{CFR} = 0.75$$

## 6.8. EQR and Ecological Quality Status assignment

$$\text{CFR} = 0.75 \rightarrow \text{EQR} = 0.75 \Rightarrow \text{Status: } \mathbf{Good}$$

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*