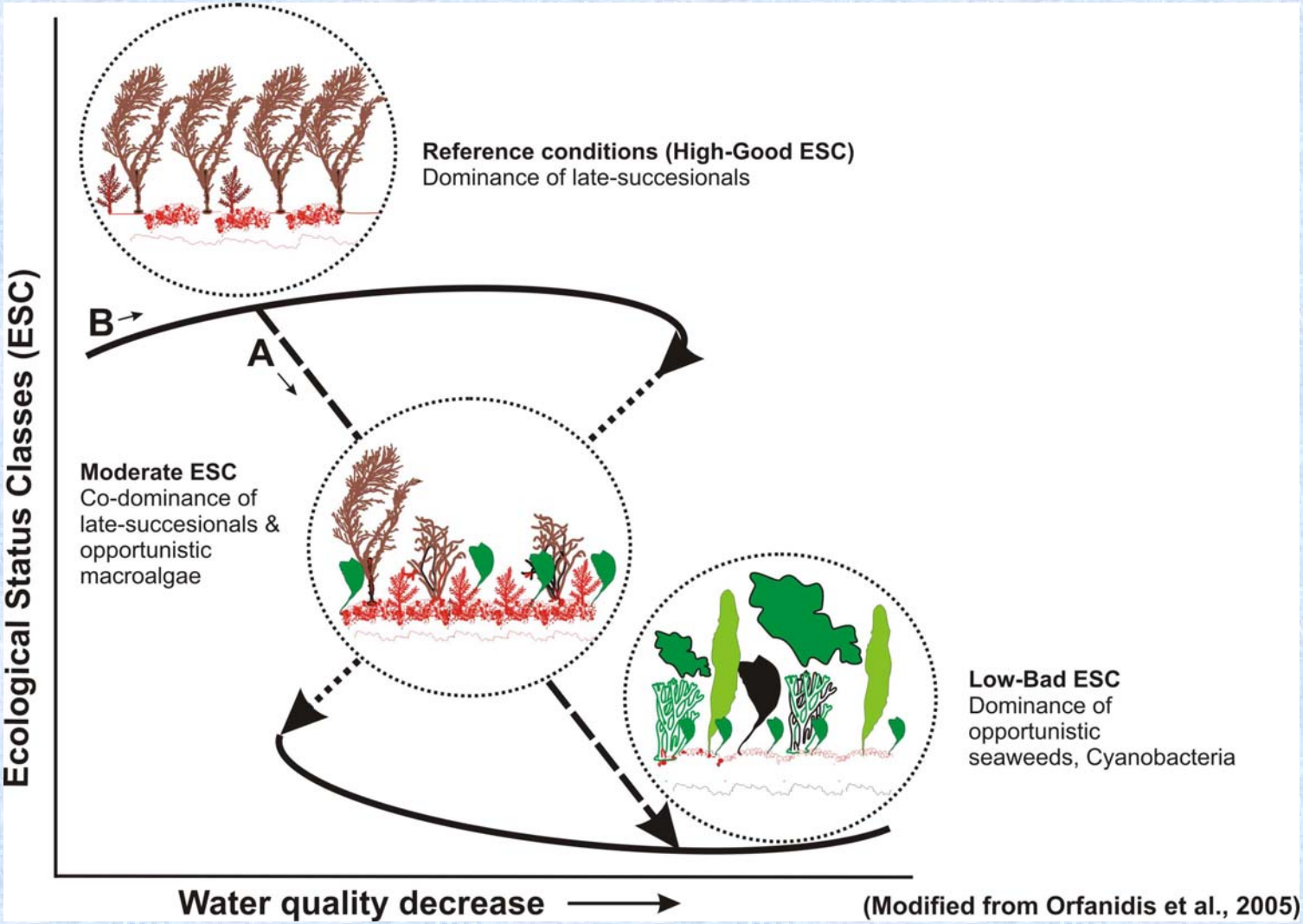
Ecological Evaluation-EEI Index

A biotic index for the implementation of WFD

by Sotiris Orfanidis (November 2007)

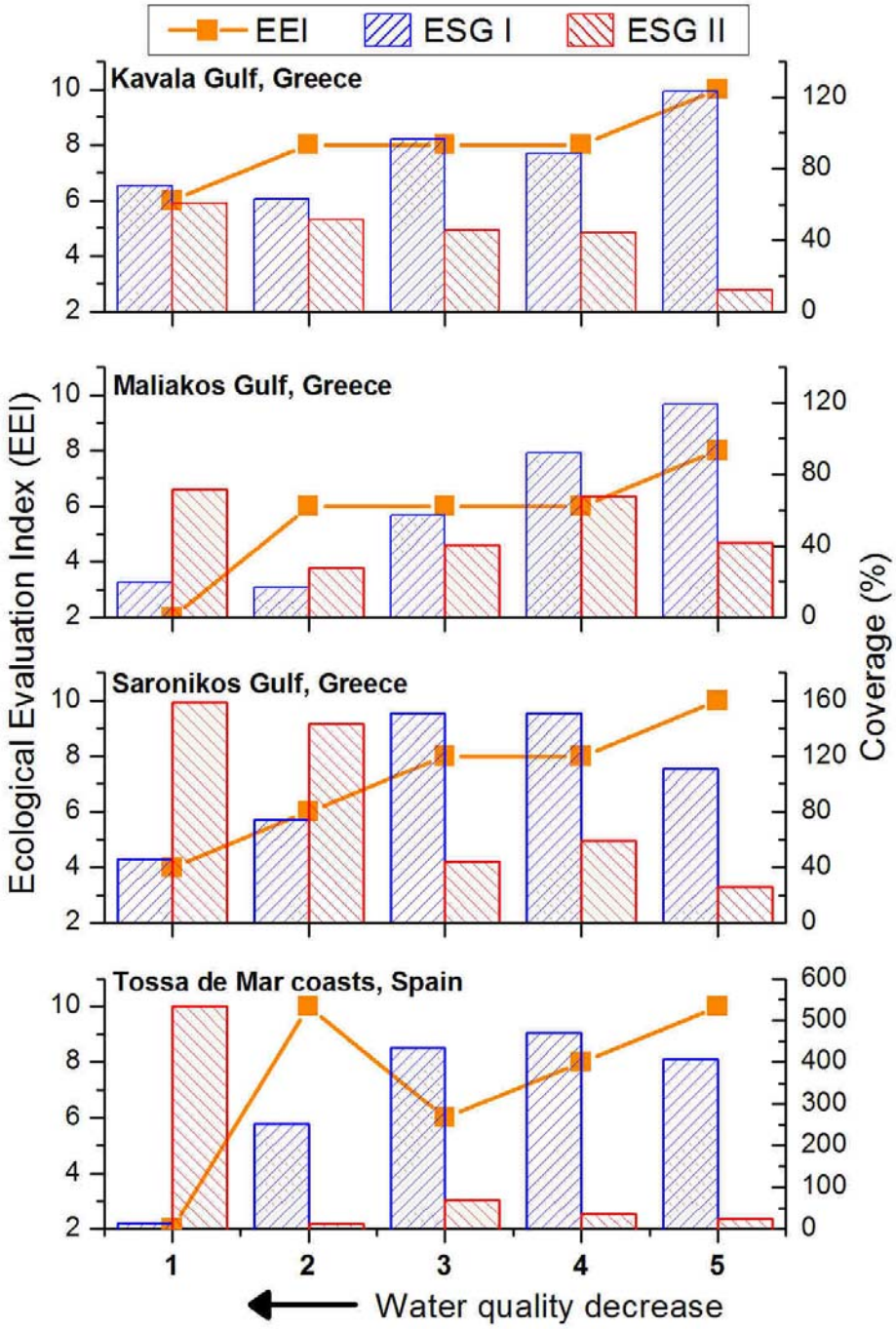
THE CONCEPT

The concept of the EEI is based on the obvious and universal pattern that “anthropogenic disturbance, e.g. pollution-eutrophication, shifts the ecosystem from pristine to degraded state, where opportunistic species are dominated” (see Figure). This pattern can be explained from the species competition abilities and is in accordance to *r*- and *K*-selection theory. Marine benthic macrophytes (seaweeds, seagrasses) were used as bio-indicators of ecosystem shifts, from the pristine state with late-successional species (Ecological State Group I) to the degraded state with opportunistic species (ESG II).



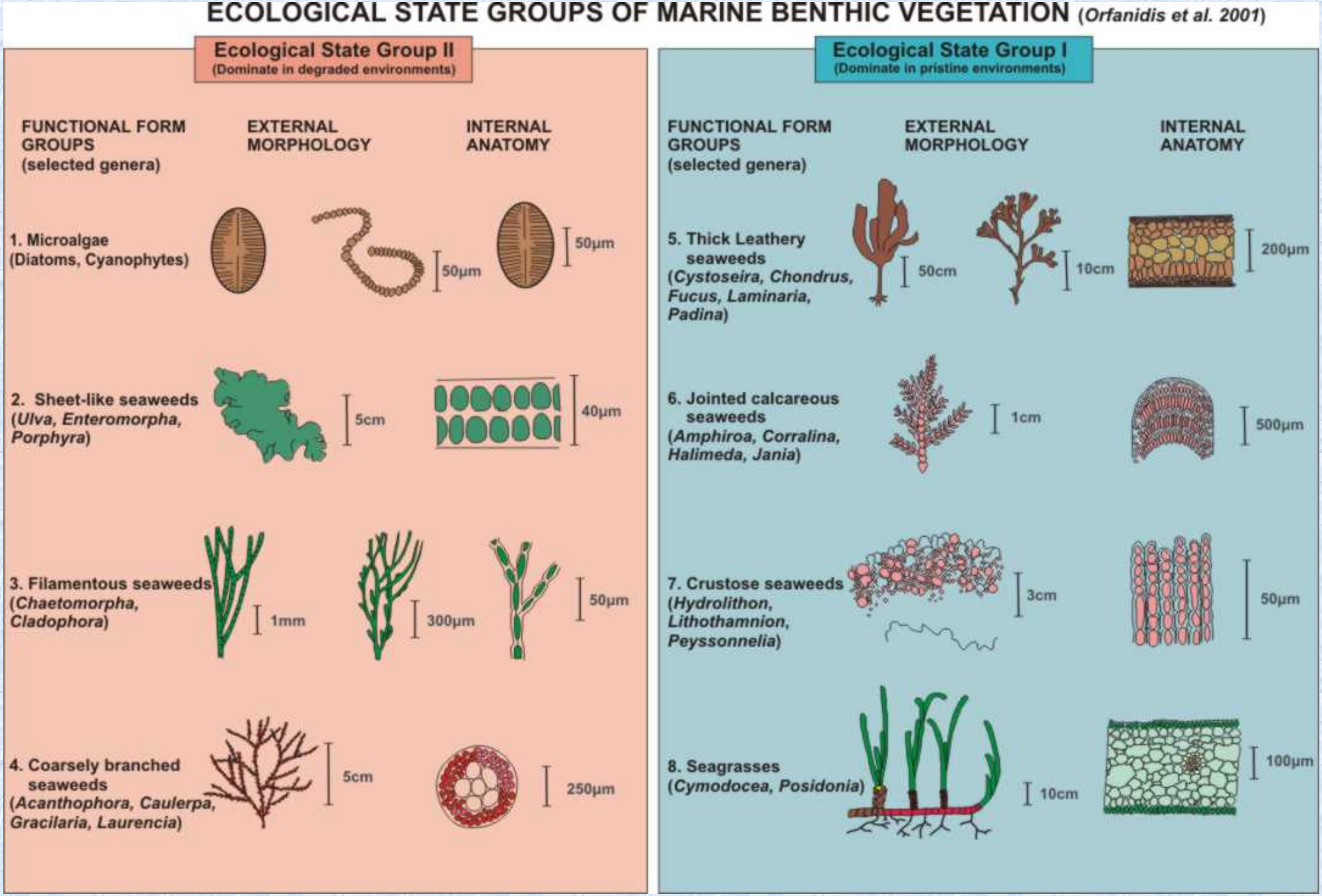
WHY TO USE EEI

The EEI is a number ranging from 2 to 10 or from 0 to 1, classifying the transitional and coastal waters in five Ecological Status Classes, from high to bad. This new index is in accordance to European Water Framework Directive (2000/60/EC) and can be a valuable tool for water managers giving them possibilities to compare, to rank and to set management priorities at different spatial scales, e.g. local, national, international. See Figure for implementation of EEI across water quality gradients in different rocky Mediterranean coastal waters: Kavala and Maliakos Gulfs (Orfanidis and Panayotidis, 2005), Saronikos Gulf (Panayotidis et al., 2004), Tossa de Mar coasts (Arévalo et al., 2007).



HOW TO USE EEI

Early vs. late-successional species



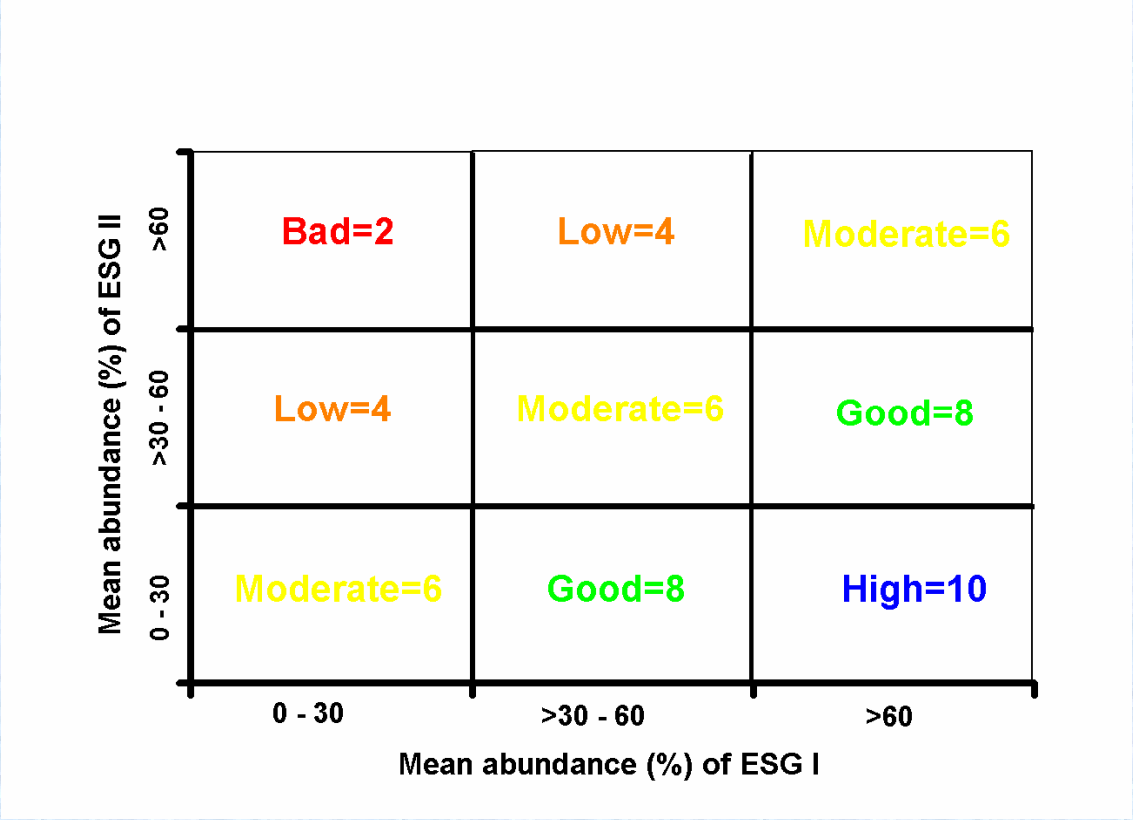
(Macrophyte graphs are not original and were based on diverse sources)

HOW TO USE EEI

Matrix and numerical scoring systems of EEI

A. The original EEI

The average absolute abundance (%) of ESG I and II are cross compared in a matrix to determine the Ecological Status Class of a Site in a range of five classes from high to bad. A numerical scoring system corresponds the ESC in a numerical value, the EEI. EEI values higher than 6 indicate sustainable ecosystems of good or high ESC, whereas EEI values lower than 6 indicate that the ecosystems should be restored to a higher ESC. For a spatial scale weighted EEI see the example in the next page.

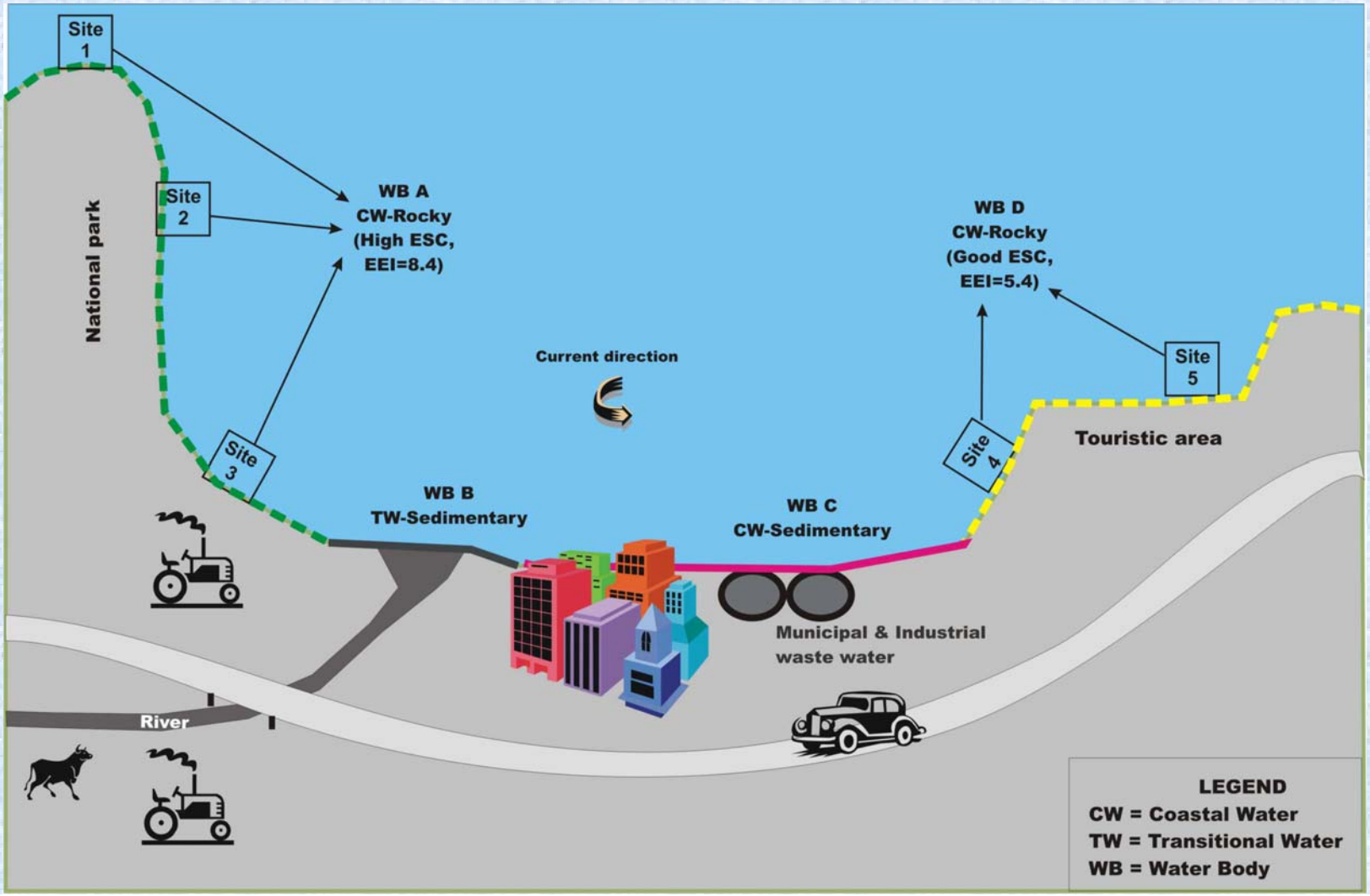


B. The EEI can be transformed in accordance to the Ecological Quality Ratios of WFD:

$$EEI_{EQR}=1.25x(EEIvalue/RCvalue)-0.25,\ RC=10$$

HOW TO USE EEI (A water quality assessment in the spatial scale of Km's)

A hypothetical coastal line (see Figure) is divided in four Water Bodies (WB), three coastal (A, C, D) and one transitional (B). Whereas WB C is sedimentary, WBs A and D are rocky. Within each rocky WB two or more permanent sites being apart in a distance of Km's with well developed (climax) macrophyte community were sampled. A quantitative destructive sampling strategy is recommended (3 samples per site, per season). The mean absolute coverage (%) of ESG I and II of samples in the sites 1, 2 and 3 of WB A was: site 1 (140 and 20), site 2 (70 and 25) and site 3 (80 and 50). This corresponds to high (EEI 10), high (EEI 10), and good (EEI 8) ESCs for areas covering 20, 40 and 40% of WBs coastline, respectively. EEI for whole WB is: EEI = (10 x 0.2) + (10 x 0.4) + (8 x 0.4) = 2 + 4 + 3.2 = 9.2, which corresponds to High ESC. The mean absolute coverage (%) of ESG I and II of samples in sites 4, 5 of WB D was 36 and 90, 45 and 50, respectively. This corresponds to low (EEI=4) and moderate (EEI=6) ESC for areas covering 30 and 70% of WBs coastline, respectively. EEI of whole WB is: EEI = (4 x 0.3) + (6 x 0.7) = 1.2 + 4.2 = 5.4, which corresponds to Good ESC.



Basic literature

1. Orfanidis, S., Panayotidis, P., Stamatis, N. (2001). Ecological evaluation of transitional and coastal waters: A marine benthic macrophytes-based model. **Mediterranean Marine Science** 2 (2): 45-65.
2. Orfanidis, S., Panayotidis, P., Stamatis, N. (2003). An insight to the ecological evaluation index (EEI). **Ecological Indicators** 3 (1): 27-33.
3. Panayotidis, P., Montesanto, B., Orfanidis, S. (2004). Use of low-budget monitoring of macroalgae to implement the European Water Framework Directive. **J. Applied Phycology** 16: 49-59.
4. Orfanidis, S., Panayotidis, P. (2005). Implementation of Water Framework Directive (WFD) for coastal waters by using the Ecological Evaluation Index-EEI: the case of Kavala's and Maliakos Gulfs, Greece. **Proceedings 12th Panhellenic Congress Ichthyologists, Drama, Greece**, pp. 237-240 (In Greek with English summary).
5. Orfanidis, S., Stamatis, N., Tsiagga, E. (2005). Ecological status assessment of Delta Nestos Lagoons by using biological and chemical indicators in agreement to Water Framework Directive (WFD 2000/60). **Proceedings 12th Panhellenic Congress of Ichtyologists, Drama, Greece,** pp. 245-248 (In Greek with English summary).