Biotic indices comprising one or more biotic metrics represent an effort to describe different and complex aspects of benthic communities or other biological organisational levels. For instance, in the formula generating a single numerical output that leads one to a particular conclusion, e.g., the Ecological Evaluation index (EEI-c) (Orfanidis et al., 2001, 2011). The EEI-c, inspired by the ‘alternative stable stages’ (Holling, 1973) and r, K selection (MacArthur & Wilson, 1967) theories, is a functional biotic index based on the well-known pattern where anthropogenic stress, for example eutrophication, shifts the ecosystem from being pristine, where late-successional mostly K-selected macroalgae are dominant, to a degraded state, where opportunistic, mostly r-selected nitrophilous macroalgae are dominant (Odum, 1985).

The EEI-c has been adopted in the Mediterranean Sea to assess the Ecological Status Classes (ESC) of coastal waters using photophilic benthic macrophytes as quality elements (Orfanidis et al., 2011). Here we tested the variation of photophilic macroalgae functional metrics (unit richness, % coverage, Shannon-Weaver index) to the urban stress index (Figure 3). Also, the basic classification scheme of the ESC’s of EEI-c is confirmed.

Results

Based on the functional metrics examined, the EEI-c index was able to classify the sampling sites into “High” (48%), “Good” (27%), “Moderate” (16%), “Low” (7%), and “Bad” (2%) ESC’s (Figure 1). 

In Figure 2, the sampling sites groups across the Mediterranean Sea on ESG level is presented. A gradient change from less to highly degraded sites is indicated. Redundancy Analysis (RDA) showed a negative correlation of the biotic index EEI-c to the index MA-LUSI and to the urban stress index (Figure 3). The results showed a non-linear correlation to the stress index MA-LUSI; highest correlations (R2>60) were detected for EEI-c values obtained from samplings combining two (summer and autumn or spring and autumn) or three (spring, summer, autumn) seasonal timepoints in the Aegean Sea (Figure 5). The Index MA-LUSI showed a high non-linear correlation (R²=0.8) with EEI-c (Figure 4).

The variation of EEI-c based on seasonal data, either separate or combined, was studied in the Aegean (Kavala and Saronikos Gulfs) and Adriatic (Slovenian and Albanian coasts) Seas. The results showed a non-linear correlation to the stress index MA-LUSI; highest correlations (R²>60) were detected for EEI-c values obtained from samplings combining two (summer and autumn or spring and autumn) or three (spring, summer, autumn) sampling seasons in the Aegean Sea (Figure 5).

Conclusions

This functional and broad spatial approach confirms that macroalgal communities, even when sampled not evenly, can be a valuable quality element of the anthropogenic stress and water quality, supporting thus the implementation of the Water Framework (WFD) and Marine Strategy (MSFD) EU Directives in the whole Mediterranean Sea scale.

References


