SOFT BOTTOM BENTHIC INDICATORS

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Abstract

Based on real values and/or ranges of values, the benthic parameters of the number of species (S), the abundance (N), the Shannon-Wiener community diversity (H), the "key species" and the trends of these parameters, were tested as possible indicators to assess the state of the ecosystem. Ranges of the benthic indicators in Greek waters and the conditions under which each parameter should be evaluated are given. A classification scheme of marine ecosystem health is proposed.

Keywords : benthic, indicators, Greek waters

Indicator "Number of Species"

As tested in Greek waters the number of species in a benthic assemblage decreases with depth and varies with the sediment type increasing in mixed sediments comparing to muds. Also one of the central patterns in biodiversity, noted universally, is that the number of species increases with the area sampled. Figure 1, based on aggregated data collected from 9 stations, over 3 years, in Geras Gulf (2) shows such a trend.

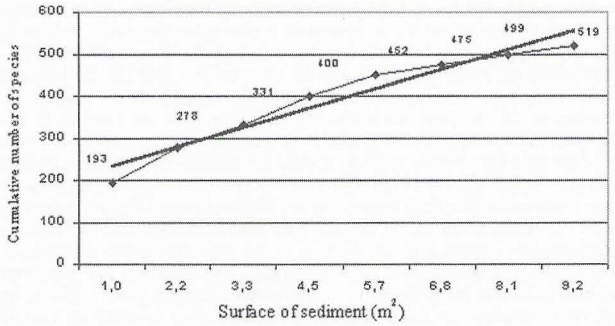

Figure 1 : Increase in number of species with sampling effort

Based on data collected over a variety of soft bottom habitats in Greek waters it appears that number of species, in undisturbed area ranges between 22 and 165 species per $0.1m^2$, depending on depth and type of substratum. The number of species (S) can be a reliable measure of environmental stress provided that it is used when comparing benthic communities :

a) occurring within **a well defined sampling unit** (standard $0.1m^2$)

b) from samples collected with the **same gear** (standard grab $0.1m^2$, mesh sieve 0.5mm)

c) at the **same depth range and sediment type** (ranges to be defined per Sea).

d) The species identification is being done at the same taxonomic level (4 major groups or all groups).

Indicator "Abundance (N)"

The abundance of benthic organisms in a given area is too variable and cannot be used as a reliable measure of environmental stress. On the other hand, trends in abundance of "key species", if well defined, would be a good indicator.

Indicator "Key species"

Based on a synthesis of reviews on the subject and on the data of Saronikos Gulf (1,3,4) the following table shows the zones of pollution with the respective key species.

Table 1. Key species, indicative of the degree of environmental disturbance

I. Zone of maximal pollution	Azoic
II. Highly polluted zone	Opportunists: *Capitella capitata, Malacoceros fuliginosus, Corbula gibba*
III. Moderate polluted zone	Opportunists: *Chaetozone sp, Polydora flava, Schistomeringos rudolphii, Pseudopolydora antennata, Cirriformia tentaculata*
IV. Transitional zone	Tolerant species: *Paralacydonia paradoxa, Protodorvillea kefersteini, Lumbrineris latreilli, Nematonereis unicornis, Thyasira flexuosa*
V. Normal zone	Sensitive species ex. Syllis sp.

The key species characterising a pollution gradient may be different when different geographical areas are examined.

Indicator "Community diversity (H)"

The Shannon-Wiener Index (5) of community diversity in Greek waters has been calculated to range between 1,12 to 6,81, if calculated on pooled data. However, if calculated on a standard sampling unit ($0.1m^2$) the maximal value is 5,76 bits/unit. Figure 2 shows the variation of H in 116 sites all over Greece. Certainly community diversity is lowered by severe pollution stress compared with control areas or years. Values lower than 1,50 bits per unit have been calculated at the badly polluted areas of Saronikos Gulf (zone I), between 1,5 and 3 for highly polluted areas of Thermaikos and Saronikos (zone II), 3-4 for moderately polluted (zone III) areas, 4-4,6 for transitional zones (zone IV) and over 4,6 for normal zones. The maximum values of H coincide with the pristine areas of Sporades marine park, Kyklades plateau, Rhodes isl., Ionian Sea and Petalioi Gulf Aegean) : 6,81 bits per unit.

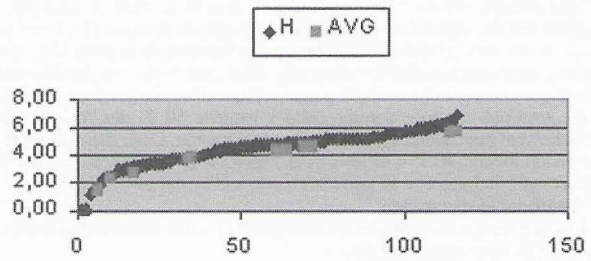

Figure 2 : Distribution of community diversity (H) over 116 Greek sites. AVG : H/0.1m²

The range of the Shannon Diversity index should be used as a tool of pollution evaluation, taking into account not only the substrate and depth of the given area but also the regional standards of the case area. Also when evaluating H, one should take into account separately its two components together with the faunistic data, in order to detect extreme abundance of opportunists indicating disturbance. In Greek Waters based on the community diversity index alone, 5 classes of community health can be arbitrarily defined :

Class I : H<1,5 : Azoic to very highly polluted
Class II : 1,5 <H<3 : highly polluted
Class III : 3<H<4 : moderately polluted
Class IV : 4<H<4,6 : for transitional zones
Class V : H>4,6 : normal

All the above described benthic indicators were used to efficiently describe the state of the marine ecosystem in Saronikos Gulf, receiving the domestic and industrial effluent of Athens. Based on data collected between 1974 and 1999, though sparse in time, all of the above classes of community diversity were recognised at least over time.

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