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Note

Assessing the ecological status of Italian lagoons using a biomass-based index

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ABSTRACT

We compared the performance of abundance- and biomass-based M-AMBI in the 13 major Italian lagoons, using a benthic dataset constituted by 208 sampling sites. The relative importance of ecological groups changed when using abundance or biomass, sometimes leading to an improved ecological status classification. Being biomass more ecologically relevant than abundance, the adoption of a biomass-based index may better describe the ecological status of lagoons, where the community is naturally disturbed and dominated by tolerant and opportunist species.

Ecological indicators are an effective way to characterize marine ecosystem health, and their number is rapidly increasing (Borja et al., 2015). Among the biological quality elements highlighted by the European Water Framework Directive 2000/60/EC, benthic macrofauna is known to be probably the best effective indicator of pollution stress, as it shows predictive responses to different levels of anthropogenic impact. Based on the Pearson and Rosenberg (1978) paradigm several biotic indices have been proposed in recent years (Borja et al., 2015). The AZTI's marine biotic index (AMBI; Borja et al., 2000) and its multivariate version (M-AMBI; Muxika et al., 2007) are probably the most widely used benthic indices all over the world (Borja et al., 2015). In Europe many countries have officially adopted the index for the description of ecological quality of coastal waters (Bulgaria, France, Germany, Italy, Romania, Slovenia and Spain; Borja et al., 2009; Birk et al., 2012). AMBI relies on the calculation of the biotic coefficient, which is based in turn on the proportion of disturbance-sensitive taxa and is expressed on a continuous scale ranging from 0 (best status) to 7 (worst status: azoic). The AMBI approach follows a model (Grall and Glemarec, 1997) which categorizes benthic invertebrates into five ecological groups (from EG-I, sensitive, to EG-V, first order opportunists), depending on their dominance along a gradient of organic enrichment. Recently, Warwick et al. (2010) suggested to estimate AMBI using biomass (bAMBI) and production (pAMBI). This because in an assemblage the abundance of a species can be relatively a poor measure of its functional importance, particularly in stressed situations when the insensitive species tend to be small bodied opportunists (Warwick et al., 2010). Muxika et al. (2012) successfully assessed the proposed modification to AMBI along the Basque coast (northern Spain), showing that those AMBI modifications were highly correlated and thus useful to assess the benthic quality status, if boundaries between quality classes were re-determined. More recently, Mistri and Munari (2015) tested the performance of biomass-based AMBI (bAMBI and pAMBI) in transitional ecosystems, finding good agreement between the response of all biomass-based indices and disturbance expressed by the severity of pressures. The use of a biomass-based index for the assessment of the ecological quality status in transitional systems is not trivial, since several studies (Magni et al., 2009; Sigovini et al., 2013; Prato et al., 2014) suggested that the use of indices based on species tolerance/sensitivity need to be adapted where the community is naturally disturbed and dominated by small-sized opportunists. The use of biomass in calculating M-AMBI (M-bAMBI) was tested by Cai et al. (2014, 2015) in assessing the benthic status of Bohai Bay (north of China), a shallow water basin receiving industrial and municipal wastewater from coastal cities. Those authors found that M-bAMBI seemed more effective than M-AMBI in indicating human pressures of the Bay (Cai et al., 2015).

Since lagoons are often characterized by high benthic biomass (McLusky, 1989), and biomass is a measure of ecosystem functions (Warwick et al., 2010), in this note we explore the performance of M-bAMBI in the most important Italian lagoons, at which the disturbance status was known. We assembled a data set of macrofaunal counts from 13 large Italian lagoons (Fig. 1) occurring along a cline of 7° of latitude (between 45°44′N and 39°56′N). Along Italian coasts there are almost

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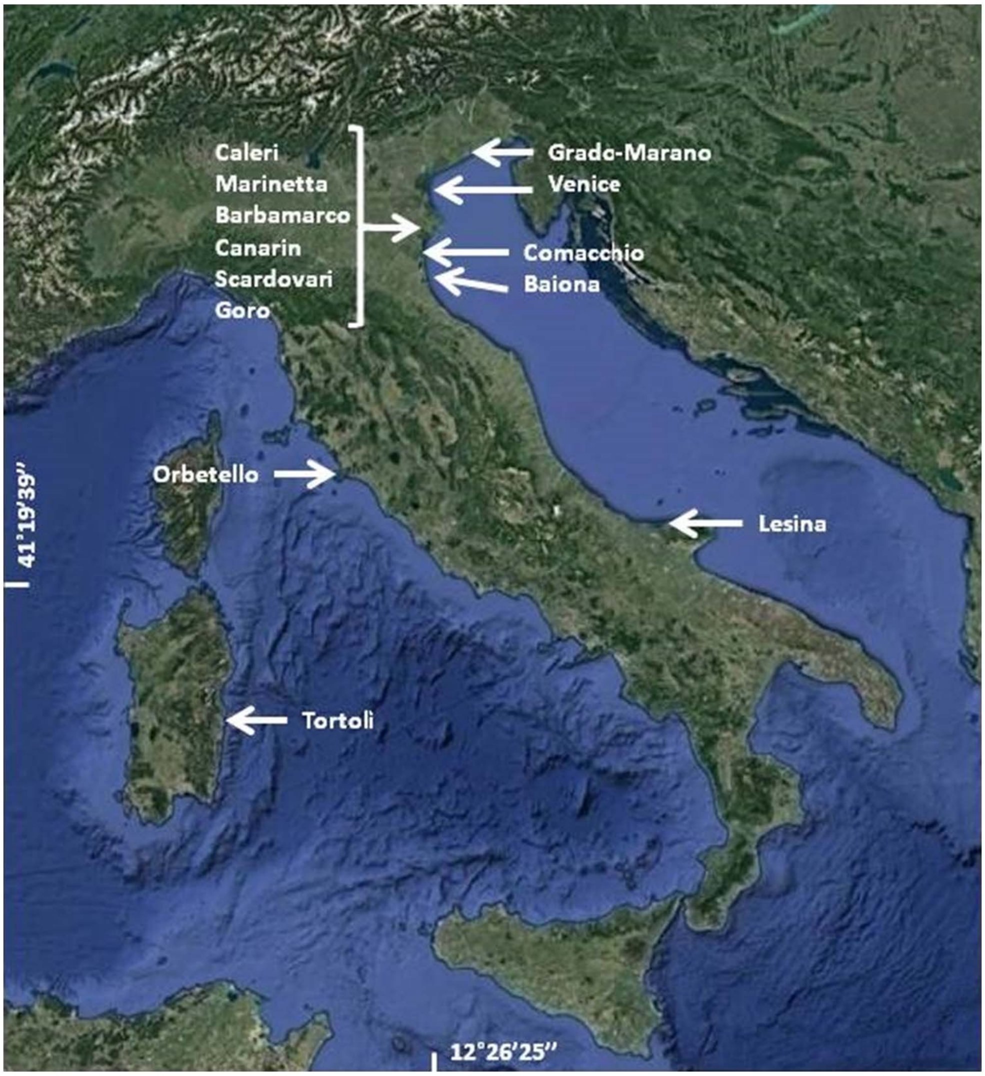

Fig. 1. Location of the studied lagoons in the Italian coast.

Table 1
Major geographical and ecological features of the 13 studied lagoons (mt: microtidal; nt: non-tidal; S: richness; H′: diversity; SD: standard deviation).

Lagoon	Latitude	Longitude	Area (km^2)	Mean depth (m)	Salinity	Typology	Sampling sites	Tot n samples	S (± SD)	H′ (± SD)
Grado Marano	45°42′N	13°20′E	160	1.5	Poly/euhaline	mt	21	21	25.6 ± 14.3	2.9 ± 1.0
Venice	45°24′N	12°19′E	500	2.5	Poly/euhaline	mt	20	43	18.4 ± 12.4	2.1 ± 0.6
Caleri	45°05′N	12°18′E	11	2.0	Meso/polyhaline	mt	4	8	14.0 ± 6.8	1.8 ± 0.6
Marinetta	45°03′N	12°21′E	10	0.8	Meso/polyhaline	mt	6	12	14.6 ± 4.1	1.3 ± 0.8
Barbamarco	45°00′N	12°27′E	8	0.8	Meso/polyhaline	mt	2	4	15.5 ± 8.7	1.6 ± 0.5
Canarin	44°55′N	12°29′E	10	0.8	Meso/polyhaline	mt	3	6	12.7 ± 2.3	2.0 ± 0.9
Scardovari	44°51′N	12°24′E	32	1.5	Meso/polyhaline	mt	5	10	22.3 ± 4.4	2.3 ± 0.5
Goro	44°49′N	12°18′E	37	2.0	Meso/polyhaline	mt	16	16	26.2 ± 6.3	1.9 ± 0.9
Comacchio	44°36′N	12°10′E	117	0.8	Euhaline	nt	4	22	9.6 ± 4.7	1.7 ± 0.7
Baiona	44°30′N	12°14′E	12	1.0	Polyhaline	mt	3	6	32.5 ± 3.5	3.0 ± 0.2
Lesina	41°52′N	15°26′E	51	0.8	Meso/polyhaline	nt	4	12	14.4 ± 4.3	2.3 ± 0.5
Orbetello	42°26′N	11°11′E	27	1.5	Polyhaline	nt	9	36	13.1 ± 6.6	2.0 ± 0.7
Tortolì	39°56′N	09°40′E	3	1.0	Poly/euhaline	nt	6	12	25.3 ± 8.5	3.1 ± 0.8

Table 2
Reference conditions for various lagoon typologies used in M-AMBI calculations. H′: diversity, S: richness.

Tidal range	Salinity	AMBI	H′	S
Not tidal	–	1.85	3.3	25
Microtidal	Oligo-meso-poly	2.14	3.4	28
Microtidal	Eu-iper	0.63	4.23	46

170 lagoons, but 140 of them have a surface area < 10 km^2. With the exclusion of Orbetello Lagoon and Stagno di Tortolì (Tyrrhenian Sea), all lagoons with area > 10 km^2 (e.g. Grado-Marano, Venice, Po Delta, Comacchio, Lesina) are located along the Western Adriatic coasts. Our data set comprises all main Adriatic and Tyrrhenian Italian lagoons (Caleri, Marinetta, Barbamarco, Canarin, Scardovari and Goro are those in the present Po Delta). In Table 1, major geographical and ecological features of the 13 lagoons are shown. A total of 103 sites, representative of the different habitats found within each lagoon, were sampled