Name of indicator	2.3 Beach wrack Macrovegetation Index (BMI)
Type of Indicator	State indicator
Author(s)	Kaire Torn, Georg Martin, Madara Alberte
Description of the indicator	Indicator is based on the structure of macrovegetation of beach wrack. Representativeness of beach wrack data reflecting the biodiversity of macrovegetation in coastal area was tested during the study. Differences between submerged macrovegetation in coastal area and beach wrack samples were the smallest in July (table 1, Suursaar *et al.*, 2014). Compared to commonly used monitoring methods (Torn & Martin, 2011), BMI is easy to use and cost-effective. BMI was developed during a case study on data collected from northern Gulf of Riga (Baltic Sea) and tested in southern part of the Gulf of Riga. Indicator is based on relationship between eutrophication and species diversity in benthic vegetation. Index was developed based on presumptions: 1) key species (*Fucus vesiculosus, Furcellaria lumbricalis, Zostera marina, Charophyceae)* of the area were considered as valuable species for forming healthy communities, and 2) species richness of the community will shift toward increase in species number of filamentous algae due to disturbance e.g. eutrophication impact. This method can be recommended for the areas which are not affected by strong tides and currents or frequent extreme storm events.
Relationship of the indicator to marine biodiversity	Indicator reflects the diversity of macrovegetation species and abundance of community forming species.
Relevance of the indicator to different policy instruments	MSFD descriptor 1
Relevance to commission decision criteria and indicator	1.6. Habitat condition 1.6.2. Relative abundance and/or biomass, as appropriate 1.7. Ecosystem structure 1.7.1. Composition and relative proportions of ecosystem components (habitats and species)
Method(s) for obtaining indicator values	Beach wrack samples were collected from three transects parallel to the shoreline in each study area during July 2011-2013. The samples were collected using a 20 cm × 20 cm metal frame at a distance of 1 m from each other. The freshest beach wrack (i.e., the closest wrack band to the water edge) was always chosen for sampling. The collected material was packed and kept frozen. In the laboratory, the species composition of the sample was determined. In laboratory occurrence of all species, abundance of key species *(Fucus vesiculosus, Furcellaria lumbricalis, Zostera marina*, charophytes) and total biomass of the sample were determined. As wrack specimens were often fragmented and detailed identification was impossible, the morphologically very similar species were treated as one group. Based on formula (1) index was calculated for all samples. Average index value is used. The equation for calculation of BMI is: $BMI= (1-P_{ks})/(1+P_{ks})x(N_f/N),$ (1) where P_{ks} is the proportion of key species (expressed as part per hundred), N_f means species number of filamentous algae, and N means total number of macrophyte taxa.
Documentation of relationship between indicator and pressure	The index value can vary between 0 and 1, lower values show higher status of benthic biodiversity (better condition of valuable species). In the northern Gulf of Riga, lower index values (higher status of biodiversity) were detected in areas were water transparency was higher and nutrient concentrations were lower. Pearson correlations between the index values and pressure indicators were computed. Statistically significant relationships between index and water transparency (Secchi depth), BSPI (Baltic Sea Pressure Index) and total nitrogen were found in the northern Gulf of Riga (table 2, figure 1), whereas chlorophyll *a* showed a significant relationship with index values in the southern part of the Gulf (table 3, figure 2).
Geographical relevance of indicator	2. Regional
How Reference Conditions (target values/thresholds) for the indicator were obtained?	The reference conditions for the BMI, required for establishing GES boundary, were determined based on expert judgement and current data (index values determined in the MARMONI pilot area). The index value can vary between 0 and 1, lower values show higher status of benthic biodiversity (better condition of valuable species). The best possible BMI value (BMI=0) was set as reference condition. In case of reference conditions, the majority of vegetation biomass belongs to the valuable key species and the species number of filamentous algae is negligible.

Method for determining GES

GES (Good Environment Status) level was set by using concept of acceptable deviation from the reference conditions (European Commission, 2000). Quite a similar approach has been used in assessment method for the ecological status of Estonian coastal waters, using submerged aquatic vegetation and following the requirements of EU Water Framework Directive (WFD) (Torn and Martin, 2011, 2012). According to OSPAR Common Procedure for Identification of the Eutrophication Status of the Maritime Area, the acceptable deviation from reference conditions can be restrictive (15%), intermediate (25%) or non-restrictive (50%) (Andersen *et al*., 2006). In the current study, intermediate (25%) deviation from the reference conditions was used as GES boundary (BMI values 0.25).

References

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Illustrative material for indicator documentation

Table 1. Differences of species occurrence and abundance between submerged vegetation in coastal area and data from beach wrack in three studied areas, ANOSIM test R values are shown. The R value of less than 0.25 indicates that the separation between groups is negligible; the R value of 0.5 to 0.75 shows overlapping but clearly differentiable groups, and the R value over 0.75 indicates well separated groups.

Month	Area	R	p %
May	Kõiguste	0.150	1.50
May	Orajõe	0.469	0.01
May	Sõmeri	0.356	0.03
July	Kõiguste	0.127	2.20
July	Orajõe	0.300	0.05
July	Sõmeri	0.214	0.30
Sept.	Kõiguste	0.332	0.01
Sept.	Orajõe	0.444	0.01
Sept.	Sõmeri	0.270	0.02

Table 2. Results of Pearson correlation analysis between BMI (Beach wrack Macrovegetation Index) and selected eutrophication variables, data from northern Gulf of Riga. Statistically significant relationships ($p < 0.05$) are in bold.

Environmental variables	R
BSPI	**0,78**
Secchi (m)	**-0,87**
Ntot (µmolN/l)	**0,63**
Ptot (µmolP/l)	0,04

Table 3. Results of Pearson correlation analysis between BMI (Beach wrack Macrovegetation Index) and selected eutrophication variables, southern Gulf of Riga. Statistically significant relationships ($p < 0.05$) are in bold.

Environmental variables	R
Chl *a*	**0,83**
Secchi	-0,69
Ntot	0,48
Ptot	0,32

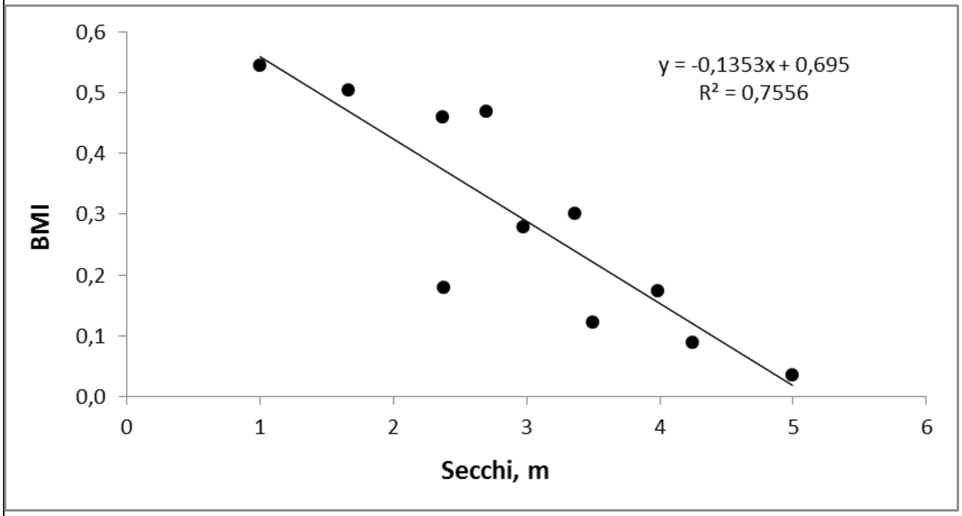

Figure 1. Relation between BMI and water transparency (Secchi depth) based on data from northern Gulf of Riga, 2011-2013.

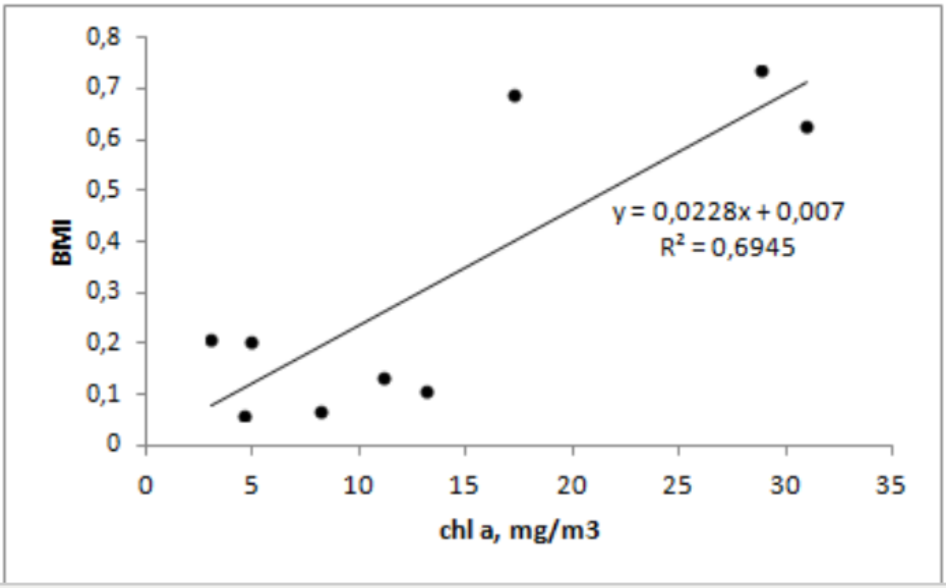

Figure 2. Relation between BMI and chlorophyll *a* based on data from southern Gulf of Riga, 2012-2013.