ECOLOGY

# Beach wrack macrovegetation index for assessing coastal phytobenthic biodiversity

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**Abstract.** The EU Marine Strategy Framework Directive (MSFD) requires assessment of environmental status in relation to changing human pressures. In this study taxonomic composition of beach wrack is proposed as an indicator for the assessment of coastal sea benthic macrovegetation biodiversity within the context of the MSFD. Based on the relationships between eutrophication metrics and taxonomic structure of benthic vegetation, the Beach Wrack Macrovegetation Index (BMI) was developed and tested as a case study of the northern Gulf of Riga (Baltic Sea). The index showed a higher benthic biodiversity in areas with higher water transparency, lower nutrient concentrations, and lower Baltic Sea Pressure Index values. Compared to commonly used metrics, the BMI is an easy-to-use and cost-effective method, which can be further incorporated within a citizen science project. The method can be recommended for the areas that are not affected by strong tides or persistent currents. Boreal summer is the preferred season for sampling because then the impact of hydrodynamic effects on the structure of stormcast is the lowest.

**Key words:** biodiversity indicator, macrovegetation, stormcast, MSFD, Baltic Sea.

## 1. INTRODUCTION

The EU Marine Strategy Framework Directive (MSFD) requires the Member States to develop marine strategies for their seas for performing initial assessments of the state of the marine environment. Thus, it is required that the Member States define Good Environmental Status (GES) for their national marine waters, establish environmental indicators, and set targets as well as respective monitoring programmes (European Commission, 2008). One of the aims of the MSFD is to assess and maintain biological diversity of marine areas. The significance of biodiversity is emphasized by its role in supporting the capacity of the ecosystem to adapt to changing conditions. A positive relationship between the number of species and ecosystem stability over time is commonly noted (e.g. Naeem and Li, 1997; Worm et al., 2006). Thus, the maintenance and protection of species diversity is also connected with the preservation of the valuable environments that serve as a habitat for different species and populations (HELCOM, 2009).

Measurements and assessments of the status of biodiversity have been of interest to ecologists for a long time and a large number of metrics and indices have been developed (Shannon, 1948; Simpson, 1949; Southwood and Henderson, 2000; Desrochers and Anand, 2004; Magurran and McGill, 2011; Birk et al., 2012). Although species richness is the most widely used measure of biodiversity, the assessment of biodiversity also encompasses diversity within species and between species as well as of ecosystems (e.g. communities, habitats, landscapes) (Cochrane et al., 2010; Magurran and McGill, 2011). Due to various technical and historical reasons, some extensive gaps in knowledge on the assessment of marine biodiversity can be noted for the Baltic Sea, but also globally. In fact, no commonly stipulated procedures and methods currently exist for the assessment of marine biodiversity. For instance, the assessment methods based on macrovegetation communities in coastal seas are especially limited (Ojaveer et al., 2010; HELCOM, 2012). Therefore, novel and cost-effective methods are needed to assess the biological diversity of coastal areas.

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Traditional monitoring and assessment methods require special equipment (e.g. boat, diving gear) and skilled personnel for SCUBA diving (e.g. Bäck et al., 2002; Torn and Martin, 2012). We intended to develop and test an alternative, cost-effective method based on beach wrack sampling for the assessment of near-coastal benthic biodiversity. Beach wrack (also called stormcast or beach strand) is formed from detached macrovegetation that is washed ashore and accumulates on the beach. The wrack line is a strip of debris that usually runs parallel to the edge of the water and marks either the high tide or storm swash line. Its abundance and composition usually depend on the exposure relation to hydrodynamic agents as well as on the substrate of the beach (e.g. Orr et al., 2005).

In order to test the suitability of the method based on beach wrack and to assess the effect of hydrodynamic forces on the formation of beach wrack, a pilot study was carried out from April to October 2011 with macrovegetation sampling frequency once a month (Suursaar et al., 2014). It appeared that analysis of beach wrack composition and the sampling of the macro-vegetation community of the seabed using traditional methods (such as SCUBA diving or using underwater video techniques) generally yielded very similar results. This indicated the possibility of using beach wrack for assessing the taxonomic composition of the adjacent sea area. Compliance between the samples of beach wrack and submerged vegetation is hydrodynamically possible in case the alongshore currents are weak and the material on the beach originates in the adjacent sea

areas. Although higher wave events had a significant effect on the thickness and the amount of the beach wrack, the hydrodynamic conditions had not any significant influence on the species number (Suursaar et al., 2014).

The aim of the current study is to proceed with the development of the new methodology for assessing the status of biodiversity of near-coastal benthic communities based on macrovegetation from beach wrack, compliant with the requirements of the EU MSFD (European Commisssion, 2008). In this study, the Beach Wrack Macrovegetation Index (BMI) and the corresponding area adjusted (local) boundary for GES are presented. Also, the variability of the BMI index in relation to different pressure indicators is tested.

## 2. MATERIAL AND METHODS

### 2.1. Study sites

Benthic macrovegetation sampling was performed in four study sites located in the practically tideless, brackish and shallow northern Gulf of Riga (Fig. 1). In three areas (Kõiguste, Sõmeri, Orajõe) the material was collected in three consecutive years (2011–2013). At a fourth, Tahkuranna site, the sampling was performed in 2012–2013. Locations were selected to cover the gradient of anthropogenic impact with exposure conditions typical for the Gulf of Riga. Selected data on the study sites and the main characteristics of the coastal waters used in index validation are presented in Table 1.



**Fig. 1.** Location of the study sites in the northern Gulf of Riga, Baltic Sea.

**Table 1.** Characteristics of the study sites: significant wave height (Hs; 2011–2013 mean), historical range of sea level (SL) variations (Suursaar et al., 2002, 2012), Baltic Sea Pressure Index (BSPI) values, depth of the water chemistry station, salinity, water transparency, total nitrogen (TN) and total phosphorus (TP) concentration (2011–2013 average, period May–September; ±SD: *n* = 12 (Kõiguste, Sõmeri), *n* = 26 (Tahkuranna), *n* = 24 (Orajõe))

| Area | Coordinates | Hs, m | SL, m | BSPI | Station depth, m | Salinity | Secchi depth, m | TN, $\mu molN\ L^{-1}$ | TP, $\mu molP\ L^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|
| Kõiguste | 58°22′N, 22°59′E | 0.29 | 2.8 | 48 | 13 | 5.51±0.35 | 4.2±0.8 | 23.81±6.41 | 1.52±0.28 |
| Sõmeri | 58°21′N, 23°44′E | 0.36 | 3.3 | 47 | 10 | 5.14±0.40 | 3.5±0.6 | 28.11±7.58 | 1.60±0.29 |
| Tahkuranna | 58°14′N, 24°25′E | 0.39 | 3.9 | 55 | 6 | 4.40±0.53 | 1.3±0.5 | 40.50±2.82 | 1.44±0.50 |
| Orajõe | 57°57′N, 24°23′E | 0.46 | 3.6 | 51 | 10 | 4.36±0.46 | 2.5±0.2 | 32.72±4.50 | 1.14±0.58 |

While the Kõiguste, Sõmeri, and Tahkuranna study sites are located at the semi-embayed or moderately exposed parts of the northern Gulf of Riga, the Orajõe site is characterized by a more exposed and straight coastline. The Tahkuranna site is situated in Pärnu Bay, which is severely eutrophicated due to the nutrient inflow from the Pärnu River. Kõiguste, Sõmeri, and Orajõe are influenced by a diffused nutrient load from more distant or offshore regions of the Gulf of Riga (Kotta et al., 2008; Torn and Martin, 2012).

As mixed bottom substrates (consisting of sand, gravel, and boulders) prevailed in all study sites, both soft- and hard-bottom macrophyte species were present. In the shallow areas of Kõiguste and Sõmeri, various species of charophytes, vascular plants, and the bladder wrack *Fucus vesiculosus* L. occurred. In deeper areas, red algae such as *Furcellaria lumbricalis* (Hudson) J. V. Lamouroux and *Polysiphonia fucoides* (Hudson) Greville comprised the major part of the vegetation coverage. In shallow parts of Tahkuranna, charophytes and filamentous green algae *Cladophora glomerata* (L.) Kütz. dominated. During previous studies conducted in this area *F. vesiculosus* and *F. lumbricalis* were occasionally found. At Orajõe the coverage of *F. vesiculosus* and *F. lumbricalis* was low and the abundance of filamentous green algae was higher compared to Kõiguste and Sõmeri (Suursaar et al., 2014).

### 2.2. Data collection

Beach wrack samples were collected from three transects on the shore placed in line and parallel to the shoreline in each study site in July 2011–2013. The distance between the transects was about 60 m and the length of a single transect was 5 m. Five samples were collected from each transect. 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 cast to the shore (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 samples was determined. As wrack specimens were often fragmented and detailed identification was impossible, morphologically very similar species were treated as one taxonomic group. The filamentous brown algae *Ectocarpus siliculosus* (Dillwyn) Lyngbye and *Pilayella littoralis* (Linnaeus) Kjellman were not separated. All characeans except *Tolypella nidifica* (O. F. Müller) Leonhardi were determined as *Chara* spp. Vascular plants with similar morphology such as *Zannichellia palustris* L., *Ruppia maritima* L., and *Stuckenia pectinata* (L.) Börner were treated as one taxon. The biomasses of *F. vesiculosus*, *F. lumbricalis*, *Zostera marina* L., and *Chara* spp. and the rest of the sample were separated and weighed after drying at 60 °C to constant weight. Biomass (grams dry weight) was calculated per square metre (g dw m$^{-2}$).

Species accumulation curves were used (with PRIMER 6.0 software; Clarke and Gorley, 2006) to calculate the minimum suitable sample sizes. For all areas 15 replicates were used as the maximum sample size. Replicates were permuted randomly 999 times. Asymptotic Michaelis–Menten richness estimator was applied, which is assumed to have the highest precision (Canning-Clode et al., 2008).

The BMI was validated against the pressure gradient using Pearson correlation analysis in the statistical program of STATISTICA (StatSoft, Inc., 2013). To indicate the intensity of anthropogenic pressures, the water transparency, Baltic Sea Pressure Index (BSPI) (HELCOM, 2010), and nutrient content in seawater were used (Table 1). Before running correlation analysis, the data were tested for normality and homogeneity of variances using the Kolmogorov–Smirnov test and Levene's test, respectively. The information about water transparency and seawater samples for nutrient content were collected at the water chemistry monitoring stations adjacent to the sampling sites (2–5 km from the shoreline, depending on the bottom slope) to represent the May–September period of each year. Water transparency was measured by Secchi disc. The seawater samples were frozen immediately for further laboratory analyses.

Total nitrogen and total phosphorus concentrations were measured in the laboratory with a continuous flow automated wet chemistry analyser Skalar SAN$^{plus}$.

The BSPI is a spatial presentation of anthropogenic pressures to the Baltic Sea. The method, originally developed by experts of the HELCOM HOLAS project, combines the influence of 42 pressure metrics that cover a large range of anthropogenic impacts, including for example shipping, harbours, population density, and nutrient load. The BSPI values are assigned to every 5 km × 5 km spatial grid unit. A higher BSPI value indicates a higher overall pressure (HELCOM, 2010).

The general effect of hydrodynamic forces on the accumulation of beach wrack in the study sites was described previously by Suursaar et al. (2014). In order to assess the impacts of the hydrodynamic effect on the BMI and its components (e.g. proportion of habitat-forming species, number of filamentous taxa and all taxa), field measurements and hydrodynamic modelling were carried out. The data on waves and currents were obtained using a Doppler effect-based oceanographic instrument RDCP-600 manufactured by Aanderaa Data Instruments. It was deployed to the seabed at Sõmeri (measuring from 13 June 2011 to 2 September 2011), Kõiguste (2 October 2010 to 11 May 2011), and near Kihnu Island (10 September 2012 to 14 March 2013). In order to obtain hydrodynamic forcing data in other years, as well as at Orajõe and Tahkuranna locations, the wave parameters were calculated using a locally calibrated SMB-type wave model (Suursaar, 2013). Nearshore currents and sea-level variations were calculated using a 2D hydrodynamic model (Suursaar et al., 2002, 2012). Wind stress for forcing the models was calculated from the wind data measured at the Kihnu meteorological station (Fig. 1). The station is centrally located on Kihnu Island between the four study sites and it offers hourly data on offshore wind conditions (Suursaar, 2013). During the previous test study, the calculations were made for three time periods, averaged over the time periods 10, 20, and 30 days before the beach wrack sampling date. However, there was no significant difference between the selected averaging lengths (Suursaar et al., 2014). For this study, sea level and wave heights were calculated for each location 10 days prior to each beach wrack sampling date. The possible relationships were tested using Pearson correlation analysis in the program STATISTICA. The data was tested for normality before running correlation analysis using the Kolmogorov–Smirnov test.

## 2.3. Index development

The newly developed BMI utilizes the data on the taxonomic composition of macrovegetation found in beach wrack (Eq. (1)). The following assumptions were made: (1) the main habitat-forming species are valuable species for forming healthy communities and (2) species richness of a community will shift toward higher proportion of the species number of filamentous algae due to nutrient enrichment. In general, the species that form complex habitats are important keepers of bio-diversity due to the large number of other species that they serve or harbour (Vuorinen et al., 2015). In the Baltic Sea, such special, structuring species are large perennial macroalgae on hard bottoms and eelgrass and charophytes on soft substrates (Schramm, 1996; HELCOM, 2009). For the studied geographical region, *Fucus vesiculosus*, *Furcellaria lumbricalis*, *Zostera marina*, and *Chara* spp. were considered as valuable habitat-forming species. High nutrient loads have a negative effect on the abundance of the perennial and other sensitive species with large thalli, which may lead to reduced number or disappearance of these species in the community (Wallentinus, 1979; Viaroli et al., 1996; Karez et al., 2004; Kotta and Möller, 2014; Torn et al., 2014). Therefore the ratio of the number of filamentous algae to the number of macrophyte taxa was also included into the index:

$$\text{BMI} = \frac{1 - P_{vs}}{(1 + P_{vs})\, N_f / N}, \qquad (1)$$

where $P_{vs}$ is the proportion of the biomass of valuable habitat-forming species in the total biomass, $N_f$ is the number of the taxa of filamentous algae, and $N$ represents the total number of macrophyte taxa.

The reference conditions for the BMI, required for establishing the GES boundary, were determined based on expert judgement and current data. The index value can vary between 0 and 1; lower values show a higher status of benthic biodiversity and more favourable conditions for valuable species. The BMI value zero was set as the reference condition when most of the vegetation biomass is formed by valuable species and the number of filamentous algal taxa is negligible.

The GES level was set using the concept of acceptable deviation from the reference conditions (European Commission, 2000). Quite a similar approach was used in an assessment method for the ecological status of Estonian coastal waters, which is based on submerged aquatic vegetation and follows the requirements of WFD (Torn and Martin, 2011, 2012). According to the 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 deviation from the reference conditions was used as the GES boundary (BMI value 0.25). The BMI was calculated with an accuracy of two decimal places.

## 3. RESULTS

### 3.1. Application of the BMI in the study areas

In all study areas, taxonomic richness increased as a function of sampling effort (Fig. 2). The speed of the increase gradually slowed down before reaching a saturation 'plateau'. The area with the highest taxon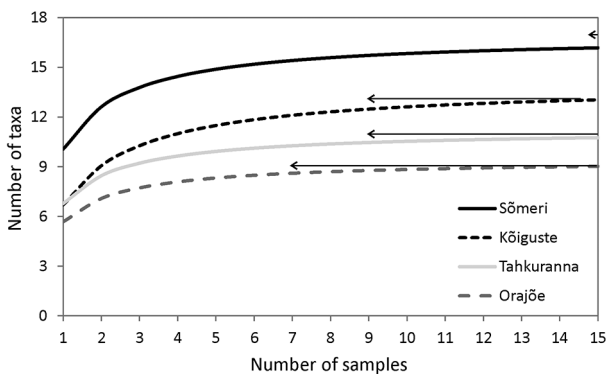omic diversity showed the largest bias between the real and the estimated number of taxa as data from 2012 showed. For bias lower than 5%, the minimum sample size was 15 at Sõmeri, 9 at Kõiguste and Tahkuranna, and 7 at Orajõe. Therefore the minimum number of replicate samples for biodiversity assessment was chosen to be 15 for all the studied areas.

The good environmental status level (BMI ≤ 0.25) was achieved at Kõiguste during the whole study period (Fig. 3). The BMI values were much higher at Tahkuranna and Orajõe, where the proportion of the main habitat-forming species was very low (generally less than 2%) and more than half of the recorded taxa belonged to the group of filamentous algae. The year 2012 was exceptional as then the share of habitat-forming species was over 60% in several replicate samples from Orajõe.

### 3.2. Relationships between the BMI and environmental variables

In the northern Gulf of Riga, lower index values (or higher status of biodiversity) were calculated for the areas where water transparency was higher and nutrient concentrations were lower. Pearson correlations between the index values and pressure indicators were found to be statistically significant in the case of transparency (Secchi depth), BSPI, and total nitrogen (Fig. 4). The correlation between the index and total phosphorus was low and statistically not significant. We did not find any
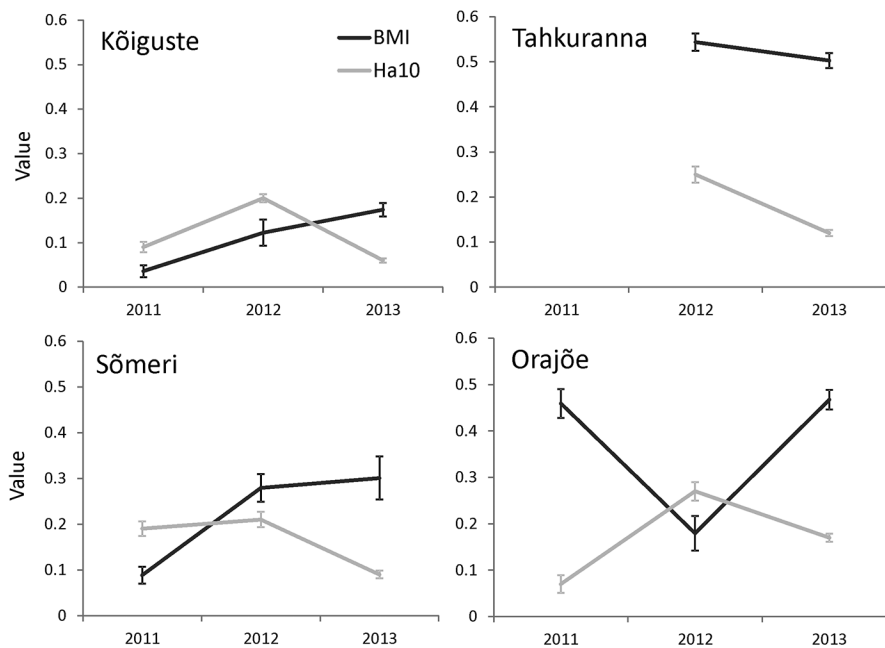
**Fig. 2.** Taxon accumulation curves based on data from July 2012. Fifteen replicates were collected from each area and permuted randomly 999 times. The curves were plotted using the Michaelis–Menten richness estimator. The ordinates marked with arrows indicate the maximum number of taxa and the length of the arrow (abscissa) shows the corresponding 5% bias for each location.

**Fig. 3.** Interannual variability of the BMI (average values of 15 replicate sample and standard error are shown) and wave height (Ha10; average values of hourly wave hindcasts and standard errors 10 days prior to beach wrack samplings).
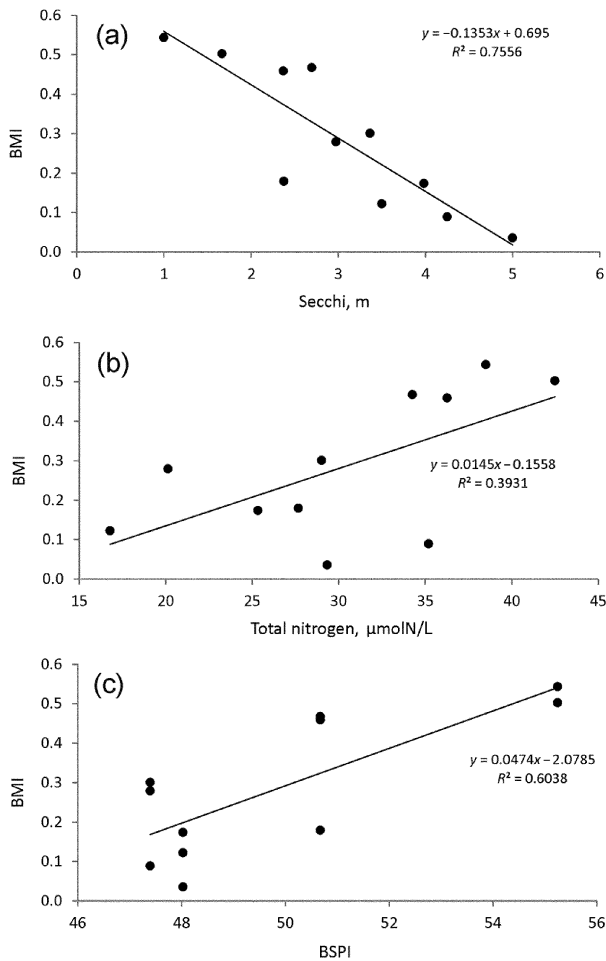
**Fig. 4.** Relationships between the BMI and the environmental variables from the northern Gulf of Riga in 2011–2013. Average values of 15 replicate samples were used for the calculation of the BMI. Average values of Secchi depth (a) and total nitrogen (b) represent the period of May–September of each year; BSPI (c) represents the cumulative anthropogenic pressure to a 5 km × 5 km spatial unit (HELCOM, 2010).

considerable effect of wave activity on the performance of the BMI during the summer period. Based on the data collected from three years and four study sites, the relationships between wave height and BMI, as well as its components (proportion of valuable habitat-forming species, total number of taxa, and the number of filamentous taxa) were statistically not significant ($p > 0.05$) (Fig. 3).

For illustrating the application of the index, the newly found BMI values were assigned to the study locations and further interpolated along the Gulf of Riga coastline (Fig. 5) on the basis of the regression between the BSPI and the BMI values (Fig. 4c).

# 4. DISCUSSION

The newly developed and tested indicator BMI is meant to meet the requirements of the EU MSFD. Varying between 0 and 1, the lower BMI values are set to show a higher status of the benthic biodiversity. The BMI value of 0.25 was set as the GES boundary for our test sites, but we admit that in other regions the thresholds can be somewhat different. Among the four study areas, the BMI indicated GES only at Kõiguste during our study period. At Sõmeri, GES was not reached in 2012 and 2013, but the differences between the BMI values and the GES targets were relatively small. The BMI values were higher at Tahkuranna and Orajõe, where the proportion of valuable habitat-forming species was low and the majority of the taxa were filamentous. This phenomenon could be explained by the proximity to significant human-mediated pressure sources, such as the town of Pärnu, a harbour, and the mouth of the Pärnu River.

Coastal areas represent high biological diversity of species. The loss of key habitat-forming species will lead to a detritus-based system with the dominance of annual filamentous algae and higher plants on soft substrates. The biodiversity will be lowered in terms of species, functions, and habitats (Gunderson and Pritchard, 2002). Therefore, elevated importance was given to the species richness and evenness of this group of vegetation in the developed index. Increased abundance of annual filamentous algae promoted by nutrient enrichment is a widely described phenomenon in the Baltic Sea (Karez et al., 2004; Kuuppo et al., 2006; Torn and Martin, 2012). As the decrease of the richness of sensitive species with large thalli (e.g. perennials, charophytes) coincides with nutrient enrichment (e.g. Wallentinus, 1979), the ratio of the number of filamentous taxa to macrophyte taxa was added to the calculation formula of the BMI. Thus, the developed indicator reflects both the proportion of the community-forming species and the adverse role of the filamentous taxa.

The abundance of drifting species as well as beach wrack is governed by the availability of biomass on the seafloor and physical forces such as wind, currents, and wave action (Norkko et al., 2000; Orr et al., 2005). The effect of currents, sea-level variations, and wave activity was surveyed previously in the northern Gulf of Riga during the vegetation season (April to October) in 2011 (Suursaar et al., 2014). The alongshore currents fluctuated back and forth without any long-term pattern. Obviously, the absence of strong tidal or seasonal currents and the infrequent occurrence of any other kind of persistent circulation ensure that the material on the beach originates in the adjacent sea areas. Despite the lack of tides, meteorologically induced high sea level events occurred rather periodically, every 10–30 days. As a rule,
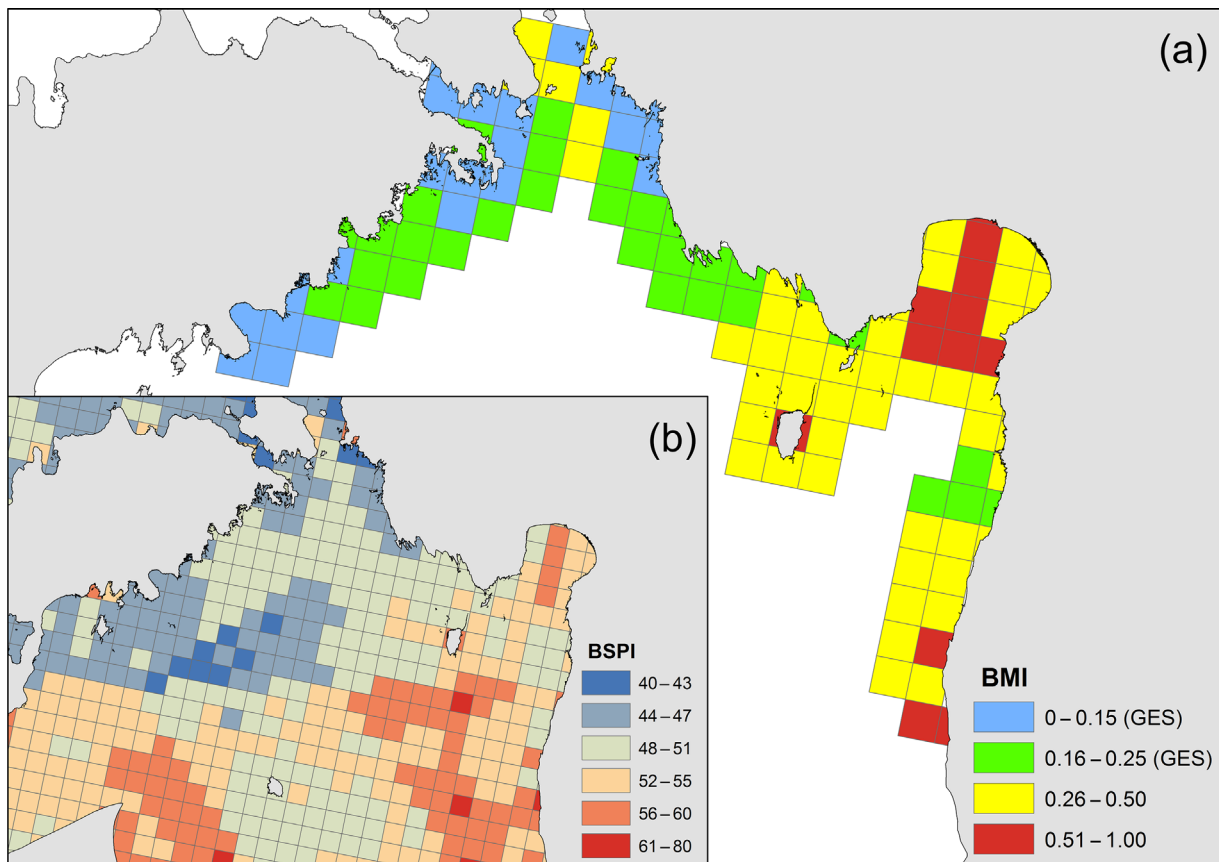
**Fig. 5.** An example of the application of the BMI along the Gulf of Riga coastline (a). The values at the four study locations are based on beach wrack sampling data (average values from 2011–2013). The interpolation to the larger area is based on the regression (Fig. 4c) between the BSPI values (b; HELCOM, 2010) and the BMI.

in late autumn and during ice-free winters such events are both more frequent and violent. Although high wave events tended to increase the amount of beach wrack, quite suitably for the BMI, the hydrodynamic conditions did not have any noteworthy influence on the number of taxa in it (Suursaar et al., 2014). Owing to the long-term wind statistics and configuration of the Gulf of Riga, in the annual course the northward current was slightly prevailing at Orajõe and Tahkuranna and the north-easterly current at Kõiguste. At Sõmeri, both directions were more or less in balance (Suursaar et al., 2012). Hence, the material in the beach wrack may still originate in a somewhat larger area than just the hydrobiological sampling site itself. A comparative study performed in our study areas showed a very good fit between the taxonomic composition of beach wrack and the actual phytobenthic communities located in the vicinity of the wrack collection sites (Suursaar et al., 2014). Moreover, based on the updated data from 2011–2013, the effect of hydrodynamic forces on the BMI or its components was found to be small. During summer months, the strong wave events are rare in the described areas. Hence,

beach wrack sampling is suitable for the areas where wrack is trapped due to the regular hydrodynamic activity and not much influenced by strong tides, currents, or extraordinary storm events.

Ideally, all indicators used for assessing the status of the environment should be straightforward, relatively inexpensive to measure, and sensitive to anthropogenic pressures on the system. They should also respond to stress in a predictable manner, have a known response to disturbances, and be integrative with other indices as well as exhibit low variability in response (Kuuppo et al., 2006). We tested relationships of several environmental predictors with the BMI. For instance, an elevated nitrogen concentration and light reduction had a significant impact on the distribution of macrovegetation in the studied areas. However, regarding natural variability, there were some differences between the test sites. Interannual variability was the highest at Orajõe. The specificity of that study site involves an exposed straight coastline, which does not trap the material in the same way as is characteristic of the other, more enclosed bays with a rough substrate (e.g. Kõiguste and Sõmeri).

Otherwise, the variability of the BMI performance between the years was small in all the study sites (except Orajõe).

The determination of reference conditions and acceptable deviations from the reference conditions are not mandatory in the methodology set for assessment purposes in the MSFD (European Commission, 2010). Still, the concepts of reference condition and acceptable deviation were used in our case for setting the GES boundaries with the purpose of better harmonization between the existing, WFD based, methods used for the assessment of the ecological status of coastal waters in Estonia. Paradoxically, in the conditions of increased data demand for fulfilling various new legislative tasks (e.g. MSFD, WFD), many countries are reducing their budgets for monitoring, which in turn calls for looking for more cost-effective ways of data collection (Lampadariou et al., 2005; Borja and Elliot, 2013). Indeed, beach wrack sampling is cost effective compared to many commonly used monitoring methods (Torn and Martin, 2011; Suursaar et al., 2014). As diving is time consuming and expensive, only a limited number of diving transects are sampled during traditional monitoring campaigns. However, the small number of transects may not be sufficient for adequately assessing the biodiversity of large and heterogeneous marine areas. Data obtained from beach wrack material potentially cover a larger area compared to the data collected by traditional methods (Suursaar et al., 2014). This is quite convenient, as providing assessments for wider marine areas is the actual purpose of the MSFD. The method is so easy to use that in the future it can be even conducted as a project of citizen science, which is a semi-scientific or scientific work undertaken by the members of the general public in collaboration with professional scientists (e.g. Osborn et al., 2002; Hand, 2010).

## 5. CONCLUSIONS

The study demonstrates that beach wrack sampling can be considered as an alternative cost-effective method for describing the taxonomic composition in the nearshore areas and for assessing the status of biological diversity of littoral benthic communities. Validation of the index showed that anthropogenic impacts can be detected through the use of the BMI. The proposed method is simple, easy to use, and can be recommended as a part of citizen science projects. Although it has been developed and tested in the northern Gulf of Riga, this index can be applied for other sea areas where suitable conditions occur (in our case, the practically tideless sea area with weak currents and without extreme storm events). It is recommended that the applicability of the method should be further tested in a broader marine scale.

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# Mereheidise indeks rannikumere põhjataimestiku bioloogilise mitmekesisuse hindamiseks

## Kaire Torn, Georg Martin ja Ülo Suursaar

Euroopa Liidu merestrateegia raamdirektiivi kohaselt peavad liikmesriigid hindama mereala keskkonnaseisundit ja inimtegevusest tulenevat mõju merekeskkonnale. Üheks keskkonnaseisundi hindamise osaks on mere bioloogilise mitmekesisuse arvestamine. Käesolevas artiklis on tutvustatud uut bioloogilise mitmekesisuse hindamise indikaatorit – põhjataimestiku mereheidise indeksit (BMI) –, mis põhineb lainetuse poolt rannale uhutud vetikate ja kõrgemate taimede taksonoomilisel koosseisul. Uurimistöö käigus testiti indeksit Liivi lahe põhjaosas neljal uurimisalal. BMI põhjal oli põhjataimestiku koosluste bioloogiline mitmekesisus suurem hea vee läbipaistvuse, madalamate toitainete kontsentratsioonide ja Läänemere koormusindeksi (BSPI) väärtuste korral. Varasemate meetoditega võrreldes on mereheidisel põhinev indikaator lihtne ja odav. Meetod sobib kasutamiseks eelkõige piirkondades, mis ei ole loodetest ega hoovustest tugevalt mõjutatud. Sobivamaks proovivõtu perioodiks põhjapoolkeral on suvi, kuna hüdrodünaamiliste tegurite mõju heidise liigilisele struktuurile on siis väikseim.