Name of indicator	3.1 Phytoplankton species assemblage clusters based on environmental factors
Type of Indicator	State indicator
Author(s)	Bärbel Müller-Karulis, Iveta Jurgensone, Ieva Bārda
Description of the indicator	Indicator based on 7 summer phytoplankton species clusters obtained with a cluster analysis. Most clusters appeared at all stations at each sampling occasion, if a cluster was absent, it was assigned a biomass of 0. Relationships with environmental factors were tested with GAM models. Dominant species in each cluster and cluster dependencies on environmental factors are: Cluster 1 – wide range of species from different taxonomical groups representing high biodiversity, however in very low abundance Cluster 2 – cluster is more associated with stability of water column Cluster 3 – consists of tolerant species occurring all year around, including species *Aphanizomenon flos-aquae* Cluster 4 – consist of species complex, indicating high nutrient concentrations. One of included species is *Eutreptiella spp*., which could be indicator of bad environmental state Cluster 5 – included opportunistic species *Skeletonema costatum*, which might indicate eutrophication Cluster 6 – species complex is dominating by the flagellates characteristic in the Gulf of Riga during summer season Cluster 7 – cluster coherent with nutrient loads Within the framework of the MARMONI project, we tested existing clusters within the last 4 year data and their relation with nutrient loads. The clusters 1 and 7 were the only clusters showing significant link with nitrogen/phosphorus loads in perennial perspective.
Relationship of the indicator to marine biodiversity	Indicator reflects on eutrophication and indirectly on biodiversity.
Relevance of the indicator to different policy instruments	MSFD descriptors 1 and 5
Relevance to commission decision criteria and indicator	1.6.2. Relative abundance and/or biomass, as appropriate 1.6.3. Physical, hydrological and chemical conditions 1.7.1. Composition and relative proportions of ecosystem components (habitats and species)
Method(s) for obtaining indicator values	Species grouping into different clusters was done at genus level based on log (biomasses) of all genera found in 185 phytoplankton samples collected in June – September in the Gulf of Riga between 1993 and 2008. Similarities between samples were expressed as Euclidean distances between genera biomass. Ward's minimum variance method, an agglomeration method that aims to minimize the variance within clusters, was used to group species into clusters. Relationships with environmental factors were established for the log+1 transformed biomass of each cluster. Sampling month was included as a factor in the analysis. All statistical methods are part of the R libraries (clustering according to hclust, general additive models according to mgcv (Hastie & Tibshirani 1986)).
Documentation of relationship between indicator and pressure	Relationship between nutrient loads and clusters have been found. The Cluster 1 increases when N/P loads decrease (Fig.1), while the proportion of the Cluster 7 increases with an increase of N/P loads (Fig.2).
Geographical relevance of indicator	2. Regional
How Reference Conditions (target values/ thresholds) for the indicator were obtained?	Phytoplankton clusters reflect the influence of eutrophication (Cluster 7) and biodiversity (Cluster 1). The reference conditions were estimated taking into account the period of 1993-2012, when maximum biodiversity (Cluster 1) and at the same time minimum eutrophication (Cluster 7) were recorded. It was estimated during the period of 2007-2009 (Fig.3).

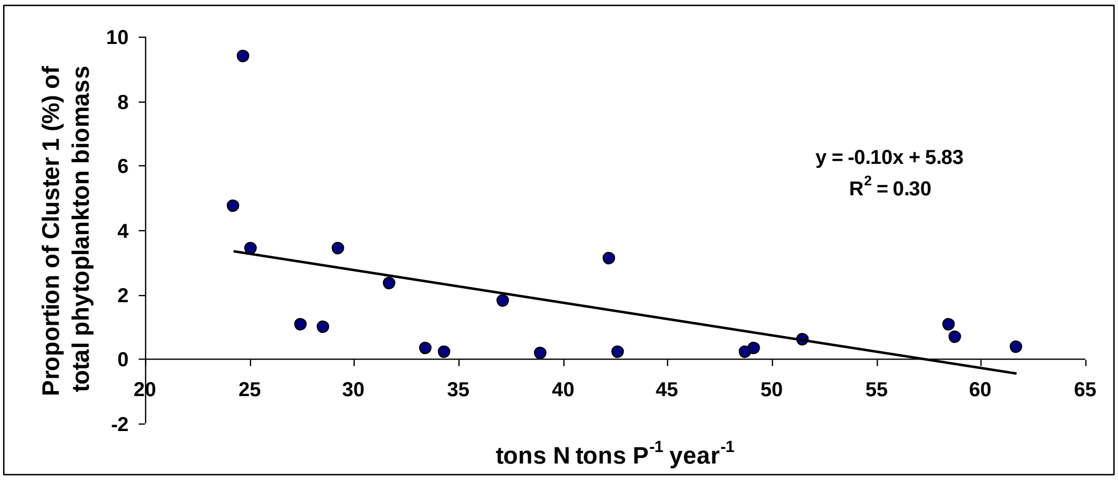
<table>
<tr><td></td><td>Reference threshold was determined for Cluster 7, which should not exceed 2% of the total phytoplankton biomass.</td></tr>
<tr><td>Method for determining GES</td><td>GES value has been determined from reference threshold. Respectively, GES value for Cluster 7 is +50% of reference conditions, that is 3% from phytoplankton total biomass.</td></tr>
<tr><td>References</td><td>Hastie, Trevor, and Tibshirani, R. 1986. Generalized Additive Models (with discussion). Statistical Science Vol 1, No 3, 297-318</td></tr>
<tr><td>Illustrative material for indicator documentation</td><td>


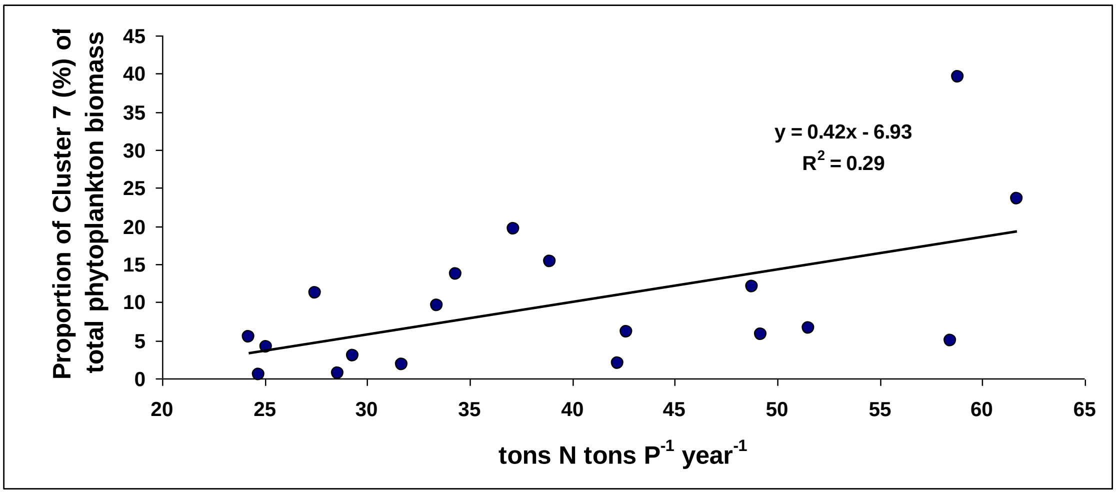
Figure 1. Cluster 1 relation with N/P loads in the Gulf of Riga


Figure 2. Cluster 7 relation with N/P loads in the Gulf of Riga
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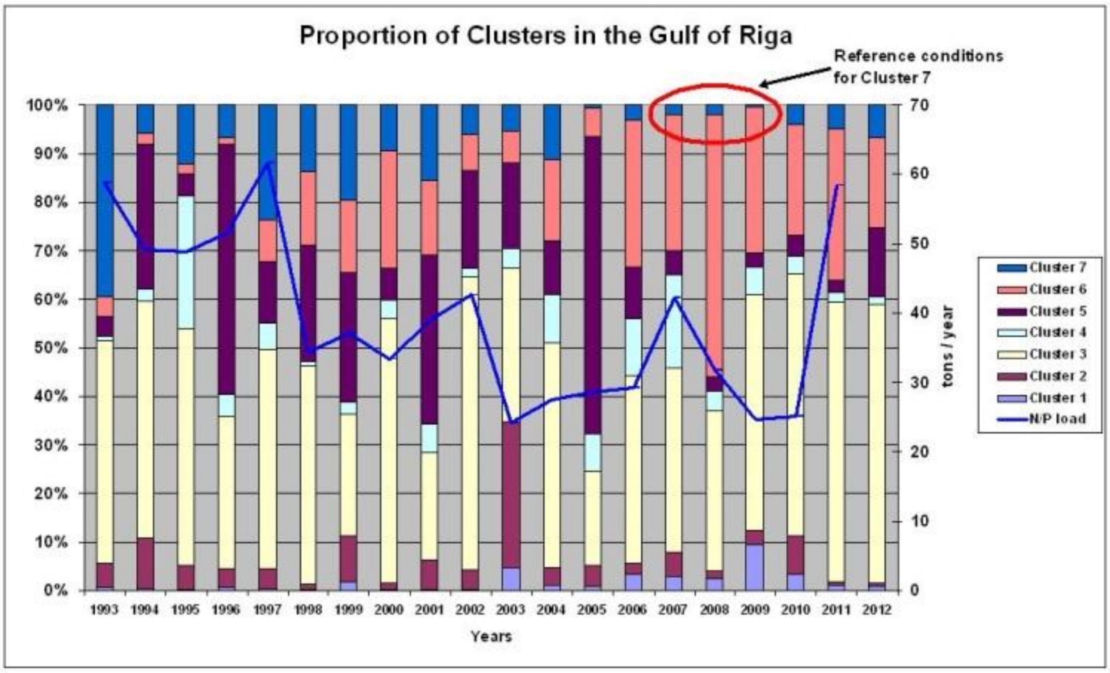

Figure 3. Clusters distribution in the Gulf of Riga