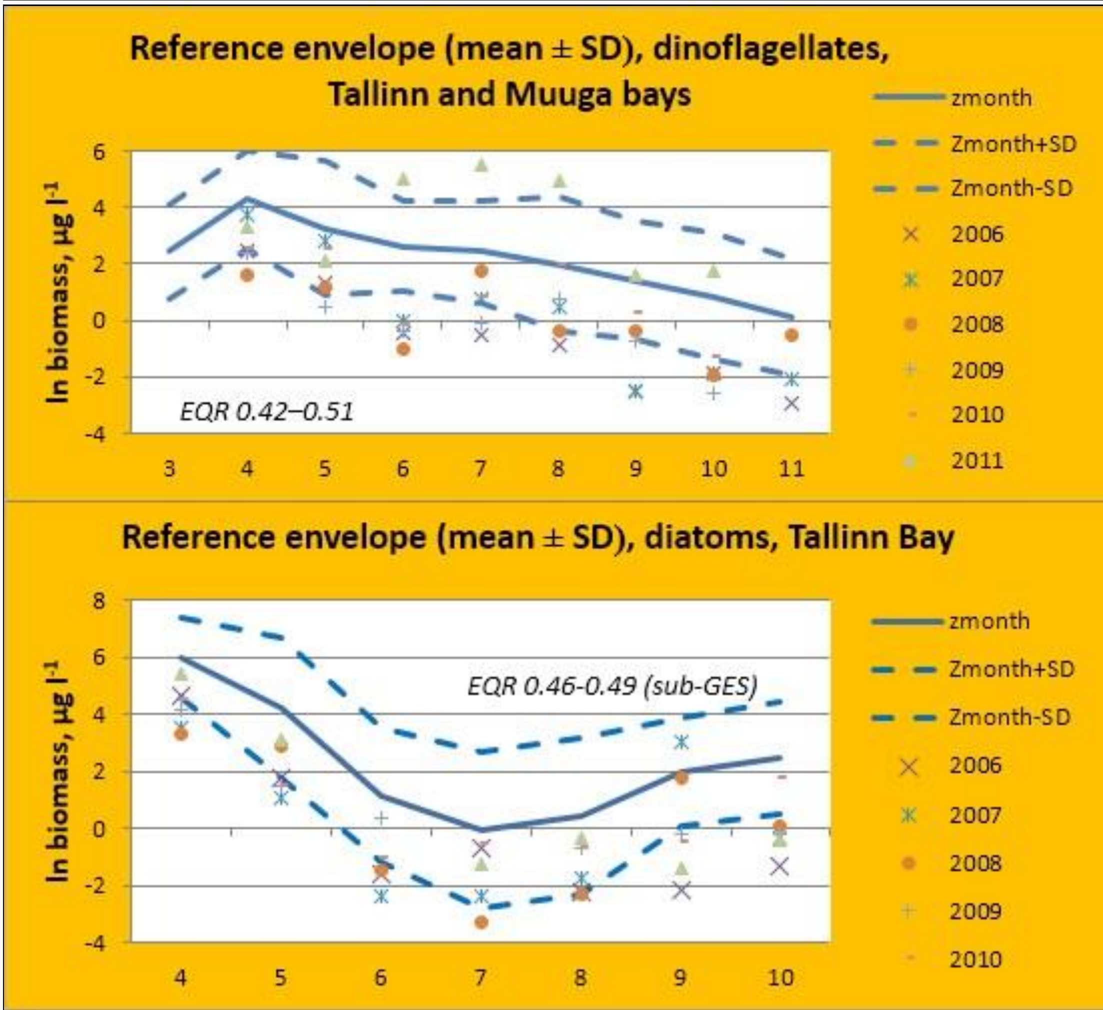
Name of indicator	3.2 Seasonal progression of phytoplankton functional groups
Type of Indicator	State indicator
Author(s)	Andres Jaanus
Description of the indicator	A shift in phytoplankton functional groups may affect ecosystem function in terms of the carbon available to higher trophic levels or settling to the sediments. The succession of functional groups can provide an index that represents a healthy planktonic system, with a natural progression of dominant functional groups throughout the seasonal cycle. Deviations from the normal seasonal cycle (such as a too high or too low biomass, or the absence of some dominating phytoplankton group(s)) indicate an impairment in environmental status. This indicator has been originally proposed for British coastal waters (Devlin *et al*., 2007).
Relationship of the indicator to marine biodiversity	Phytoplankton encompasses a huge range of taxonomic and functional diversity linked closely to the health of marine ecosystems.
Relevance of the indicator to different policy instruments	Marine Strategy Framework Directive (MSFD) descriptors 1 (1.6.1., 1.6.2. and 1.7.1 according to the Commission Decision), 4 (4.3.1) and 5 (5.2.4). HELCOM Baltic Sea Action Plan (BSAP). Water Framework Directive (WFD).
Relevance to commission decision criteria and indicator	1.6. Habitat condition 1.6.1. Condition of the typical species and communities 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	Principle: The process of establishing phytoplankton group reference growth curves for marine water bodies was originally described by Devlin *et al.* (2007). Type- or site-specific seasonal growth curves have been designed for each dominating phytoplankton group. Phytoplankton counts (wet weight biomass values) are averaged over months, and monthly mean and standard deviations (SD) are calculated for each functional group. A process of normalization, transformation and calculation of a monthly Z score (-2...+2) establishes comparable seasonal distributions for each functional group for a sampling year. A positive Z score indicates that the observation is greater than the mean and a negative score indicates that the observation is less than the mean. Indicator value: Data points are calculated by subtracting the long-term overall mean/SD value from the monthly mean value for a certain year. The score is based on the number of data points from the test area which fall within the acceptable deviation range set for each monthly point of the reference growth curve. Percentage-based thresholds are established for each functional group to determine class boundaries (EQR values) for the assessment of the ecological status. Indicator present status: The present status of the indicator was calculated for the years 2006–2011, based on monitoring data from Tallinn and Muuga bays (southern Gulf of Finland). Sample analysis and data preparation: The data required by this indicator is attained by quantitative phytoplankton analysis (cf. HELCOM 2014). Measurements of biomass (rather than abundance) were used, since they can readily be translated into understanding biogeochemical cycles, they link to eutrophication, and are considered to give a more accurate depiction of the phytoplankton community. Wet weight biomasses of four major functional groups, including cyanobacteria, dinoflagellates, diatoms and the autotrophic ciliate *Mesodinium rubrum* are averaged for each month over a sampling year. Skewed data is accounted for by the transformation of phytoplankton biomass on a natural log scale (ln bm). Type-specific reference curves are established (mean and ±acceptable deviations). Quality assurance: The methods of collection, counting and identification should be unified between all laboratories sharing the same assessment area. Sampling: The time-scale for data sets should be at least 10 years to create type- or site-specific reference growth curves and the frequency of sampling at least once a month during the vegetation period.
Documentation of relationship between indicator and pressure	In the original publication (Devlin *et al*., 2007) a risk assessment of different water bodies was made based on nutrient availability, production and disturbance. As a result, a ´risk´ status was allocated to each coastal water type. The threshold values (reference curves) must be validated by testing them against a range of data from sites of different levels of impact. For that the data from different type areas representing waterbodies with pristine conditions to very disturbed ones should be collected with sufficient frequencies (at least once a month) throughout the vegetation period. After that the assessment could be made

	whether the reference growth curves for low, medium and high risk waterbodies are comparable in term of percentage counts falling within the predefined growth envelopes.
Geographical relevance of indicator	2. Regional
How Reference Conditions (target values/thresholds) for the indicator were obtained?	Generic reference curves were established for each coastal water type or open sea basin. Yearly and monthly means and standard deviations of phytoplankton counts (wet weight biomass values) were calculated for each functional group. The acceptable deviation from monthly mean values in Estonian marine areas is ±standard deviation. The same procedure was followed in testing sampling data from other areas of the Baltic Sea (Latvian, Finnish and Polish coastal waters). A process of normalization and calculation of Z scores makes the seasonal growth curves of different functional groups comparable. Z scores of zero illustrate that the monthly sample approaches the overall mean for that sampling period. Positive and negative values indicate greater and lower values than the overall mean, respectively. The score was based on the number of data points from the test waterbody which fell within the acceptable deviation range set for each monthly point of the reference growth curve.
Method for determining GES	GES is tentatively determined with 2/3 (EQR=0.67) values falling inside ±standard deviation from monthly mean log-normalized biomass values of each functional group. This index is applicable for coastal and open sea waters of the Gulf of Finland. The index has been preliminarily tested in the Gulf of Riga and in the southern Baltic Sea, with no conclusions as yet about the applicability in these sub-regions. Separate GES-boundaries might need to be set for different areas depending on the test results.
References	Devlin, M., Best, M., Coates, D., Bresnan, E., O'Boyle, S., Park, R., Silke, J., Cusack, C. & Skeats, J. 2007. Establishing boundary classes for the classification of UK marine waters using phytoplankton communities. Marine Pollution Bulletin 55, 91–103. HELCOM 2014. Manual for Marine Monitoring in the COMBINE Programme of HELCOM. Part C, Programme for monitoring of eutrophication and its effects. Annex C-6, Guidelines concerning phytoplankton species composition, abundance and biomass; pp. 285–300. Last updated: 17.1.2014. Available at http://helcom.fi/action-areas/monitoring-and-assessment/manuals-and-guidelines/combine-manual
Illustrative material for indicator documentation	 Examples of reference growth curves. Monthly averaged normalized biomass values (Z_{month}),

	acceptable deviations (Z_{month}±SD) and test values for the period 2006–2011 in the southern Gulf of Finland (Tallinn Bay). Using a 5-year moving average, the number of observations falling inside reference envelope (monthly mean ±SD) is 42–51 % depending on algal group and test period. Applying the GES boundary of 67%, this means that the area does not reach GES.