Name of indicator	3.7 Copepod biomass
Type of Indicator	State indicator
Author(s)	Elena Gorokhova, Maiju Lehtiniemi, Solvita Strake, Jurate Lesutiene, Natalja Demereckiene and Laura Uusitalo
Description of the indicator	The indicator is based on the idea that zooplankton with a high mean size, i.e. copepods, would indicate good feeding conditions for zooplanktivorous fish as well as a high potential grazing on phytoplankton (e.g. Cardinale *et al*.2002, Rönkkönen *et al*.2004). The data for the indicator is obtained through routine zooplankton monitoring programs carried out in several Baltic Sea countries. Annual (once a year) sampling provides sufficient data for the calculation of the indicator, but a higher sampling frequency would probably be better due to decreasing the variation in the data. The minimum requirement for the taxonomic resolution in the sample analysis is to group level, meaning that copepods have to be counted as their own group. The indicator has a solid scientific basis and it addresses the importance of zooplankton as the mediator of energy from primary producers to fish. This indicator presents the status of the part of the zooplankton community i.e. copepods, which is the most important for maintaining good growth conditions for pelagic fish stocks. The indicator 'mean size vs. total stock' has partly the same function indicating good feeding conditions for zooplanktivorous fish although it does not separate between large sized cladocerans and copepods as the present indicator does.
Relationship of the indicator to marine biodiversity	The indicator reflects changes in the zooplankton community. These changes are indirectly related to changes in nutrient composition and directly related to fish communities, climate and phytoplankton community composition, and have direct impact on both phytoplankton communities and fish growth. The zooplankton community, and its dominant members the copepods, have a crucial role in the pelagic food web dynamics in transferring energy from primary producers to a form utilizable by fish. Zooplankton is affected by changes in primary production, indicative of eutrophication, and by changes in the structure and abundance of the fish community, indicative of overfishing (e.g. Adrian *et al*. 1999, Yan *et al*. 2008). Therefore, zooplankton lives between top-down and bottom-up dynamics, and can potentially yield a lot of information on the state and dynamics of the aquatic ecosystem (Jeppesen *et al*. 2011). Copepods are selective feeders. Thus the copepods species composition affects directly both the phytoplankton and zooplankton species composition and have a potential to affect the biodiversity in these communities.
Relevance of the indicator to different policy instruments	Through collaboration between MARMONI and the HELCOM CORESET project, the indicator has been agreed as a Candidate Indicator in the HELCOM CORESET of Biodiversity indicators (HELCOM 2013). Marine Strategy Framework Directive (MSFD) descriptors 1 Biodiversity, 4 Food web. HELCOM Baltic Sea Action Plan (BSAP) Ecological Objective: Viable population of species, Target: By 2021 all elements of the marine food webs, to the extent that they are known, occur at natural and robust abundance and diversity.
Relevance to commission decision criteria and indicator	1.2. Population size 1.2.1. Population abundance and/or biomass 1.6. Habitat condition 1.6.2. Relative abundance and/or biomass, as appropriate
Method(s) for obtaining indicator values	The indicator is based on zooplankton data obtained from routine zooplankton sampling (e.g. HELCOM COMBINE; HELCOM 1988). Copepod abundance is determined by light microscopy, either by traditional "manual" counting, or by an automatic image analysis method using a scanner and suitable software. Copepod biomass can then be estimated based on length measurements of individuals (automatic image analysis does this), or by using species and stages specific pre-established weight values (if sample analysis is done with 'manual' counting by a microscope).
Documentation of relationship between indicator and pressure	Zooplankton biomass correlates positively with phytoplankton biomass and hence with eutrophication; in particular, small-bodied, filter-feeding (microphagous) zooplankters increase with increasing eutrophication (Gliwicz 1969, Pace 1986, Hsieh *et al*. 2011). On the other hand, the large-bodied zooplankters, especially copepods, constitute the best-quality food items for the zooplanktivorous fish (e.g. Cardinale *et al*. 2002, Rönkkönen *et al.* 2004). Rönkkönen *et al.* (2004) reported that in the Gulf of Finland, herring growth correlates positively with the abundance of the marine copepod species *Pseudocalanus minutus elongatus*.
Geographical relevance of indicator	4. Baltic Sea wide
How Reference Conditions (target	Good Environmental Status is based on a reference period within existing time series that defines a reference state when the food web structure represented good fish feeding

<table>
<tr><td>values/thresholds) for the indicator were obtained?</td><td>conditions.

The reference period for the copepod indicator was selected when growth of zooplanktivorous fish (weight-at-age, WAA) and its population size were relatively high. Recently, Ljunggren et al. (2010) demonstrated that WAA could be used as a proxy for zooplankton food availability and related fish feeding conditions to fish recruitment in coastal areas of the northern and central Baltic Sea.

GES boundaries are set region-specifically (e.g. Gulf of Finland, Gulf of Riga, Gulf of Bothnia etc.).</td></tr>
<tr><td>Method for determining GES</td><td>GES is met when

– there is a high proportion of copepods, that efficiently graze on phytoplankton and provide good-quality food for zooplanktivorous fish, and

– the abundance of zooplankton is at the level adequate to support fish growth and exert control over phytoplankton production.

GES is determined for the copepod biomass in the zooplankton community.
GES-boundary (lower limit) for the open Gulf of Finland (MARMONI 4FIN-EST area) is >70 mg/m^3. The status for the assessment period 2010-2012 for this area is in GES, indicator value is 160.8 mg/ m^3. The reference periods considered where 1979-1987.</td></tr>
<tr><td>References</td><td>Adrian, R., Hansson, S., Sandin, B., DeStasio, B., Larsson, U. (1999) Effects of food availability and predation on a marine zooplankton community—a study on copepods in the Baltic Sea. Int Rev Hydrobiol 84:609–626

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