Name of indicator	## 3.9 Microphagous mesozooplankton 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 small-sized herbivorous zooplankton indicate a limitation in the ability of the zooplankton community to transfer energy from primary producers to higher trophic levels (HELCOM 2013, Gorokhova *et al*. in prep.). These small-sized zooplankters, i.e. microphagous mesozooplankton, include rotifers, non-predatory cladocerans, copepod nauplii, rotifers, tintinnids and protozoans. This indicator shows the changes in the zooplankton community structure related to eutrophication and gives a more detailed picture of the change in the species diversity in the zooplankton community compared to mean size vs. total stock indicator. 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. It is important that the zooplankton species composition in the samples is analysed to the highest taxonomic resolution possible (preferably to species level). The indicator has a solid scientific basis and it addresses the importance of zooplankton as the mediator of energy from primary producers to fish.
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 climate and phytoplankton community composition, and have direct impact on phytoplankton communities. Zooplankton has a crucial role in the pelagic food web dynamics: it transfers 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). Small-sized microphagous zooplankton feed mainly on phytoplankton, bacteria and detritus. Many of these organisms can reproduce rapidly due to parthenogenetic reproduction and will in optimal environmental conditions potentially reduce zooplankton biodiversity and evenness of the community. The species composition in the zooplankton community 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, 5 Eutrophication. 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). Individual numbers of species and life stages are counted using a microscope. Microphagous mesozooplankton biomass can then be estimated based on length measurements of individuals, or by using species and stages specific pre-established weight values.
Documentation of relationship between indicator and pressure	Eutrophication favours small-sized, filter-feeding phytoplankton and detritus production, which in turn favours microphagous zooplankton (Gliwicz 1969, Pace 1986, Hsieh *et al*. 2011). Climate change will increase the water temperature which will favour most of the microphagous zooplankters due to rapid parthenogenetic reproduction in optimal conditions (often warm water).
Geographical relevance of indicator	4. Baltic Sea wide
How Reference Conditions (target values/thresholds) for the indicator were obtained?	Good Environmental Status is based on a reference period within existing time series that defines a reference state when the food web structure was not measurably affected by eutrophication. The reference period for the microphagous zooplankton indicator was selected when GES for chlorophyll *a* concentrations and water transparency that have been specifically

	defined for the sub-basins of the Baltic Sea (HELCOM 2009) are met. GES boundaries are set region-specifically (e.g. Gulf of Finland, Gulf of Riga, Gulf of Bothnia etc.). GES-boundary (upper limit) for the open Gulf of Finland (MARMONI 4FIN-EST area) is < 143 mg/m^3. The status for the assessment period 2010-2012 for this area is GES, indicator value is 14,80 mg/ m^3. The reference periods considered where 1979-1982.
Method for determining GES	The reference period for the microphagous zooplankton biomass reflects a time period when effects of eutrophication are low, defined as 'acceptable' chlorophyll *a* concentration and hence eutrophication-related food web changes are negligible.
References	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. Gliwicz, Z.M. (1969) Studies on the feeding of pelagic zooplankton in lakes with varying trophy. Ekol. Pol., 17, 663–708. HELCOM (1988) Guidelines for the Baltic monitoring programme for the third stage. Part D. Biological determinants. Baltic Sea Environment Proceedings 27D: 1-161. HELCOM (2013). MSTS indicator description sheet. Downloadable from HELCOM web site:http://meeting.helcom.fi/c/document_library/get_file?p_l_id=80219&folderId=2289395&name=DLFE-54128.docx Hsieh CH, *et al*. (2011) Eutrophication and warming effects on long-term variation of zooplankton in Lake Biwa. Biogeosciences 8: 593-629. Jeppesen E, *et al*. (2011) Zooplankton as indicators in lakes: a scientific-based plea for including zooplankton in the ecological quality assessment of lakes according to the European Water Framework Directive (WFD). Hydrobiologia 676: 279-297. Pace, M.L. 1986. An empirical analysis of zooplankton community size structure across lake trophic gradients. Limnol. Oceanogr. 31: 45-55. Yan ND, *et al*. (2008) Long-term trends in zooplankton of Dorset, Ontario, lakes: the probable interactive effects of changes in pH, total phosphorus, dissolved organic carbon, and predators. Can. J. Fish. Aquat. Sci. 65: 862-877.