Name of indicator	4.11 Age/sex ratio of waterbird species (ARI/SRI)
Type of Indicator	State indicator
Author(s)	Ainars Auniņš, Leif Nilsson, Andres Kuresoo, Leho Luigujõe, Antra Stīpniece
Description of the indicator	This indicator consists of two single species indicators reflecting population condition of particular species. Separate indices are calculated for age ratios and sex ratios. Indices are calculated for all species holding considerable populations in the Baltic Sea in any of the seasons where they have sex and/or age specific differences in plumage that are distinguishable using the selected data collection method. The aim of these indicators is to give early warning on negative demographic processes going on in the population of the particular species. The age ratio indicator serves as a proxy to information on productivity and age specific survival of the species. These indices are known to be more sensitive and able give earlier warning than changes in the species abundance. Age ratio indicator is calculated separately for each of the following species: *Cygnus olor, Melanitta fusca, Melanitta nigra, Clangula hyemalis, Bucephala clangula, Somateria mollissima, Polysticta stelleri, Aythya marila, Phalacrocorax carbo*. National indicators may have a subset of the species listed above. Sex ratio indicator is calculated separately for each of the following species: *Melanitta fusca, Melanitta nigra, Clangula hyemalis, Bucephala clangula, Somateria mollissima, Polysticta stelleri, Aythya marila*. National indicators may have a subset of the species listed above.
Relationship of the indicator to marine biodiversity	The indicator reflects status (population condition) of important components of the marine biodiversity. The indicator gives an early warning on negative demographic processes going on in the population.
Relevance of the indicator to different policy instruments	MSFD descriptor 1 (species level – population condition, demographic characteristics, habitat level - condition of typical species and communities). HELCOM CORESET (general agreement for the need of this indicator at least for Long-tailed Duck *Clangula hyemalis*).
Relevance to commission decision criteria and indicator	1.3. Population condition 1.3.1. Population demographic characteristics (e .g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates) 1.6.1. Condition of the typical species and communities
Method(s) for obtaining indicator values	Field data collection**:** There are several options for data collection depending on target species. For *game species*, data can be collected from game bags by identifying sex and age of the birds shot. For *non-game species* or *game species that are rarely shot* or to *collect data outside the hunting season*, photographs from random flocks of birds (or random single birds) can be taken using high resolution DSLRs with long lens (focal length 300mm and more). Data can be collected during other data collection events carried out for collection of abundance data. Boat or ground counts are most suitable for collection of data for sex and age ratio, however it needs additional person for collection of images. Organising separate ground surveys is feasible while separate boat surveys for sex/age data collection might be cost ineffective. The obtained images are processed providing figures for flock size, number of adult birds, number of juvenile/immature birds and their sexes where appropriate (K. Larsson pers.comm.). Indicator calculation**:** The *age ratio* is calculated as proportion of juveniles in the postbreeding population. If young females are inseparable from adult females in images, the age ratio is calculated dividing juvenile males with number of adult males. The *sex ratio* is calculated dividing number of females with number of males.
Documentation of relationship between indicator and pressure	This indicator is more sensitive to short term changes such as problems with productivity or survival of young during the breeding season than abundance indicators (either in breeding or nonbreeding seasons). Biased sex proportions in the population suggest either different mortality of sexes or that sex ratio of hatched chicks is biased. Decreasing female proportion in a population suggests higher mortality of females, usually due to increased predation during breeding season. Lehikoinen *et al.* (2008) has shown that population decline of Eider has been accompanied by increasing male bias in the population that can be explained by increased female

	mortality during breeding season as a result of increased predation by both native (White-tailed Eagle) and invasive alien species (American Mink). Biased sex ratios of declining waterbird populations have been reported also for Scaup (Afton, Anderson 2001) and Stellers Eider (Flint *et al.* 2000). Decreasing proportion of young (1st year) birds shows reduced breeding performance of the species. The pressures associated with this are predation, insufficient food stocks, contamination of food sources, habitat loss, coastal development.
Geographical relevance of indicator	3. National waters 4. Baltic Sea wide
How Reference Conditions (target values/thresholds) for the indicator were obtained?	Target sex ratio indicator value for monogamous species is 1 as the breeding potential of such species is maximal when the sex ratio is equal (Nunney 1999). GES thresholds should be put on both sides of the target value. The actual GES threshold for each species still needs to be defined. Meanwhile trend based GES reference conditions can be used - if there is a significant trend in sex ratio and the actual indicator values are driving away from the GES target value, the indicator cannot be at GES. Target age ratio indicator value is species specific. The actual GES targets and boundaries have not been set. Meanwhile trend based GES reference conditions can be used - if the trend in the proportion of young in the population is negative, the indicator cannot be at GES.
Method for determining GES	Currently species specific GES levels have not been set. The GES target for sex ratio has been set at value where a monogamous population theoretically has maximal breeding potential (Nunney 1999). However, more ecological studies are needed to set species specific GES boundary values on both sides of the target value. While precise GES levels cannot be set, an existence of a trend where indicator values are driving away from the target, suggests that the indicator can be considered as not being at GES. More ecological studies are needed to set species specific GES targets and boundary values for age ratio. While precise GES targets and levels cannot be set, a negative trend in juvenile proportion in the population suggest that the indicator can be considered as not being at GES.
References	Lehikoinen A., Christensen T. K., Öst M., Kilpi M., Saurola P., Vattulainen A. 2008. Large-scale change in the sex ratio of a declining eider *Somateria mollissima* population. Wildlife biology 14: 288-301. Flint P.L., Petersen M.R., Dau C.P., Hines J.E., Nichols J.D. 2000. Annual survival and site fidelity of Steller's Eiders molting along the Alaska Peninsula. Journal of Wildlife Management 64: 261 - 268. Nunney L. 1999. The effective size of a hierarchically structured population. Evolution 53: 1 - 10. Skov. H., Heinänen S., Žydelis R., Bellebaum J., Bzoma S., Dagys M., Durinck J., Garthe S., Grishanov G., Hario M., Kieckbusch J.J., Kube J., Kuresoo A., Larsson K., Luigujõe L., Meissner W., Nehls H.W., Nilsson L., Petersen I.K., Roos M.M., Pihl S., Sonntag N., Stock A., Stipniece A., Wahl J. 2011. Waterbird Populations and Pressures in the Baltic Sea. Nordic Council of Ministers, Copenhagen, 201 pp.

Illustrative material for indicator documentation

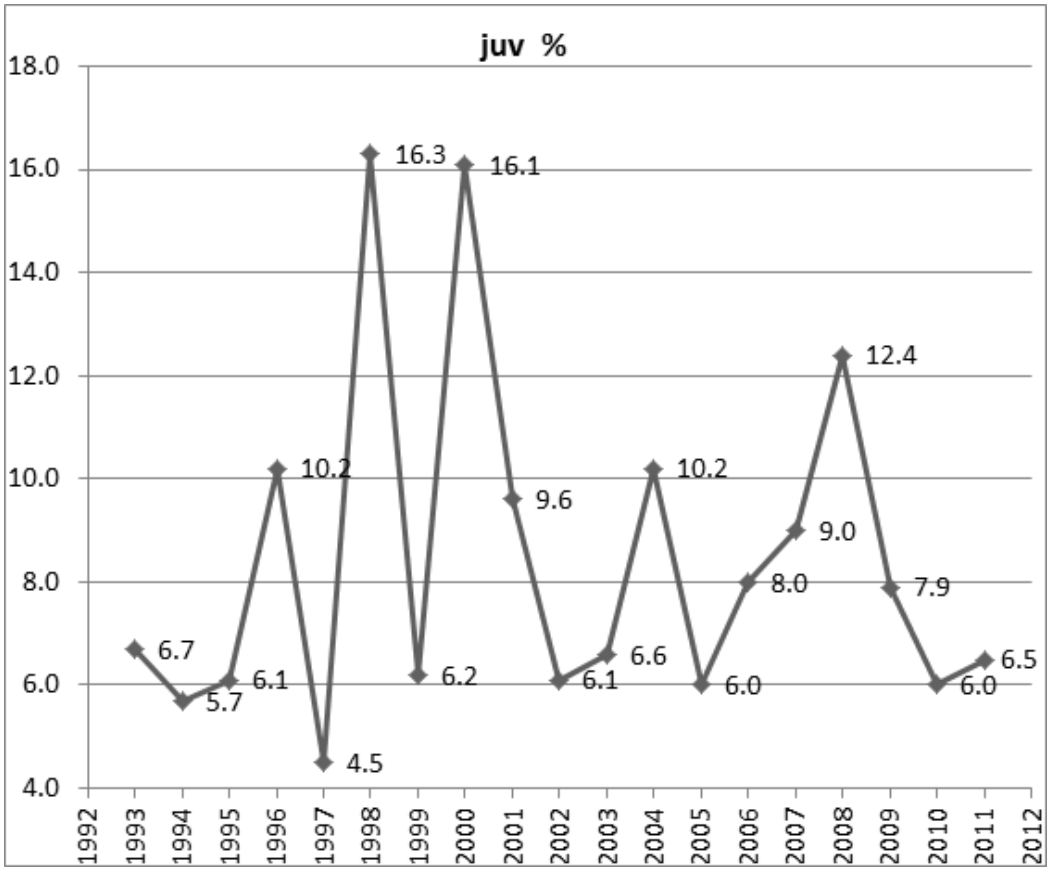

Figure 1. Example draft ARI indicator. Age ratio indicator (% juv birds) calculated for the wintering population of the Mute Swan *Cygnus olor* in Estonia 1992-2012