

Name of indicator	1.3 Abundance and impact of non-native fish species (round goby example)
Type of Indicator	State indicator
Author(s)	Atis Minde, Eriks Kruze
Description of the indicator	Indicator reflects primary and secondary invasions of non-native species and is related to various pressures like shipping, ballast water discharge, climate change depending on introduction route of particular non-native species. Degree of impact of the non-native species on the native fish communities can be very different. Alien species can integrate in the native fauna without causing significant changes in the ecosystem or they can be ecologically aggressive and cause major changes in the natural food web structure and biodiversity in general. For example population of round goby can significantly decrease biomass of benthic mussels and other benthic invertebrates thus limiting food supply for other benthic fish in the Baltic like flounder and also competing with benthic feeding waterbirds. Thus, the increase of biomass of non-native species at the cost of decreasing abundance of local species shows loss of biodiversity and structural changes in the food webs.
Relationship of the indicator to marine biodiversity	The indicator describes relative abundance of particular non-native species within an area of concern and its impact on the biodiversity and food web at habitat/ecosystem level.
Relevance of the indicator to different policy instruments	Indicator can be applied for reporting on MSFD descriptors 1, 2 and 4. Indicator is related to HELCOM BSAP ecological objective: that habitats, including associated species, show a distribution, abundance and quality in line with prevailing physiographic, geographic and climatic conditions.
Relevance to commission decision criteria and indicator	1.1.1. Distributional range 1.2.1. Population abundance and/or biomass
Method(s) for obtaining indicator values	The values for this indicator are obtained from coastal fish monitoring using "coastal net series" -survey nets. WPUE (mean biomass per one sampling station in May and June) of round goby and native benthic fish species (in this case: flounder) are calculated. Only May and June data are used because it is the period of peak activity of round goby and catches of passive sampling gears (in this case bottom gillnets) are reflecting true abundance of the species. Ratio between biomass of round goby and flounder is calculated by dividing WPUE of round goby by WPUE of flounder.
Documentation of relationship between indicator and pressure	Invasion of round goby can have a great variety of both negative and positive effects on the marine habitat (Corkum <i>et al.</i> 2004). There are several articles that describe existing and possible competition between round goby and native fish species occurring in the same habitat and decrease of native species occurrence where strong populations of round goby have been established. Round goby can have a negative effect on native fish populations by feeding on their eggs (Chotkowski and Marsden 1999), feeding competition (Karlson et al 2007) and aggressive behaviour (Dubs and Corkum 1996). We can expect that populations of fish species that occupy the same habitat or have similar diet preferences will have an impact of increasing round goby population and their numbers and/or biomass will decrease. It is indicated that at least in one occasion abundance of round goby and flounder are negatively correlated (Karlson et al 2007).
Geographical relevance of indicator	2. Regional
How Reference Conditions (target values/thresholds) for the indicator were obtained?	Reference conditions for this indicator is a state of coastal ecosystem before establishment of round goby population. In Latvian case it is the natural state of coastal fish community before 2007.
Method for determining GES	This indicator could be used in various geographical regions. However, for calculation of this indicator, it is important to use only those native species that are historically characteristic and abundant in the habitat/ecosystem of concern and which occupy the same or similar ecological niche as the invasive fish species. One has to follow two steps to determine GES using this indicator. Step 1. It needs to be established whether or not there is a relationship between changes of invasive species and native fish biomass evident. If no relationship between invasive

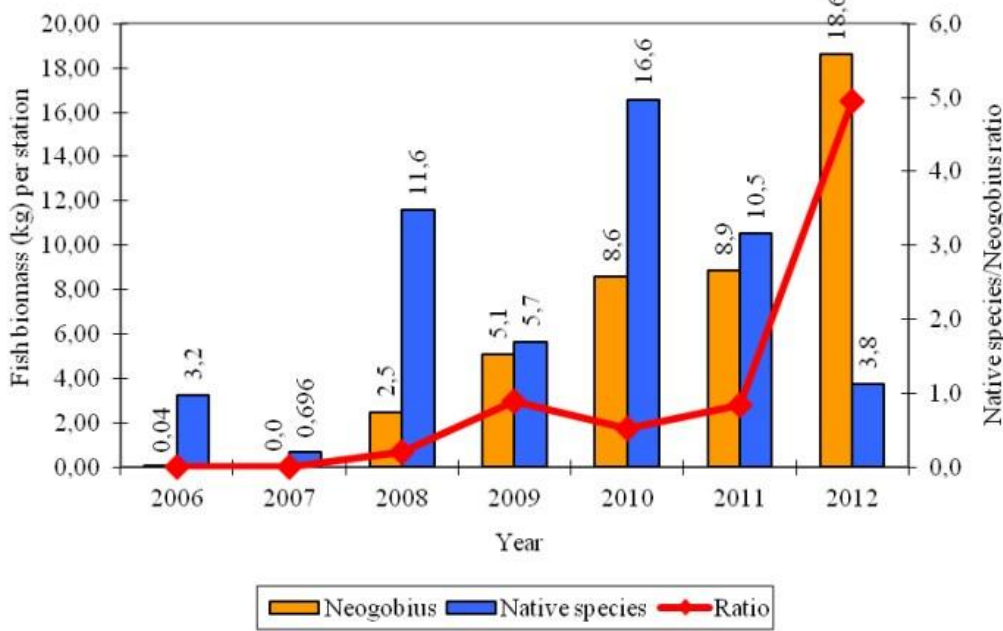
	species and native fish species biomass can be seen we consider habitat or ecosystem to be in GES. If this is the case there is no need to follow with step 2. Step 2. There is a likely relationship between invasive and native fish species. In this case if the correlation between invasive and native fish species is positive we also could consider the habitat/ecosystem to be in GES. However if the correlation is negative (and there is a clear biological explanation of that process) and we can see the values of invasive species/native species ratio increasing, we have to consider the habitat/ecosystem not in GES. In the current example we can see significant increase of round goby biomass in both areas – Liepāja and Pape. There is also clear decrease of flounder biomass within the period of round goby invasion and most possibly feeding competition is behind these changes. Thus we cannot consider that both areas are in GES.																																
References	Chotkowski, M.A. and Marsden, J.E. (1999). Round goby and mottled sculpin predation on trout eggs and fry: field predictions from laboratory experiments. <i>Journal of Great Lakes Research</i> 25: 26–35 Corkum L.D., Sapota M.R., Skóra K.E., 2004. The round goby, <i>Neogobius melanostomus</i>, a fish invader on both sides of the Atlantic Ocean, <i>Biological Invasions</i> 6: 173-181 Dubs, D.O.L. and Corkum, L.D. (1996). Behavioral interactions between round gobies (<i>Neogobius melanostomus</i>) and mottled sculpins (<i>Cottus bairdi</i>). <i>Journal of Great Lakes Research</i> 22: 838–844 Karlson, A. M. L., Almqvist, G., Skóra, K. E., and Appelberg, M. 2007. Indications of competition between non-indigenous round goby and native flounder in the Baltic Sea. <i>ICES Journal of Marine Science</i>, 64: 479–486																																
Illustrative material for indicator documentation	Liepāja <table><thead><tr><th>Year</th><th>Neogobius (kg/station)</th><th>Native species (kg/station)</th><th>Ratio</th></tr></thead><tbody><tr><td>2006</td><td>0.04</td><td>3.2</td><td>0.01</td></tr><tr><td>2007</td><td>0.0</td><td>0.696</td><td>0.0</td></tr><tr><td>2008</td><td>2.5</td><td>11.6</td><td>0.21</td></tr><tr><td>2009</td><td>5.1</td><td>5.7</td><td>0.89</td></tr><tr><td>2010</td><td>8.6</td><td>16.6</td><td>0.52</td></tr><tr><td>2011</td><td>8.9</td><td>10.5</td><td>0.84</td></tr><tr><td>2012</td><td>18.6</td><td>3.8</td><td>4.9</td></tr></tbody></table> Legend: Neogobius (orange bar), Native species (blue bar), Ratio (red line with diamond)	Year	Neogobius (kg/station)	Native species (kg/station)	Ratio	2006	0.04	3.2	0.01	2007	0.0	0.696	0.0	2008	2.5	11.6	0.21	2009	5.1	5.7	0.89	2010	8.6	16.6	0.52	2011	8.9	10.5	0.84	2012	18.6	3.8	4.9
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Figure 1. Ratio between native species and round goby biomass (WPUE)

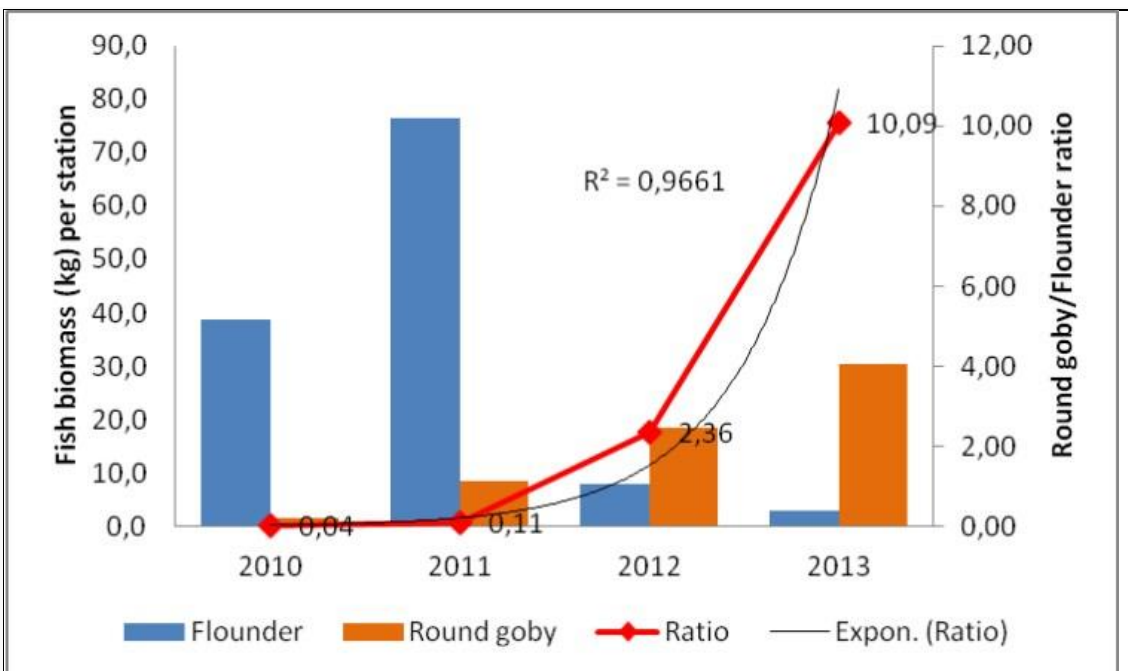


Figure 2. Ratio between round goby and flounder biomass (WPUE)

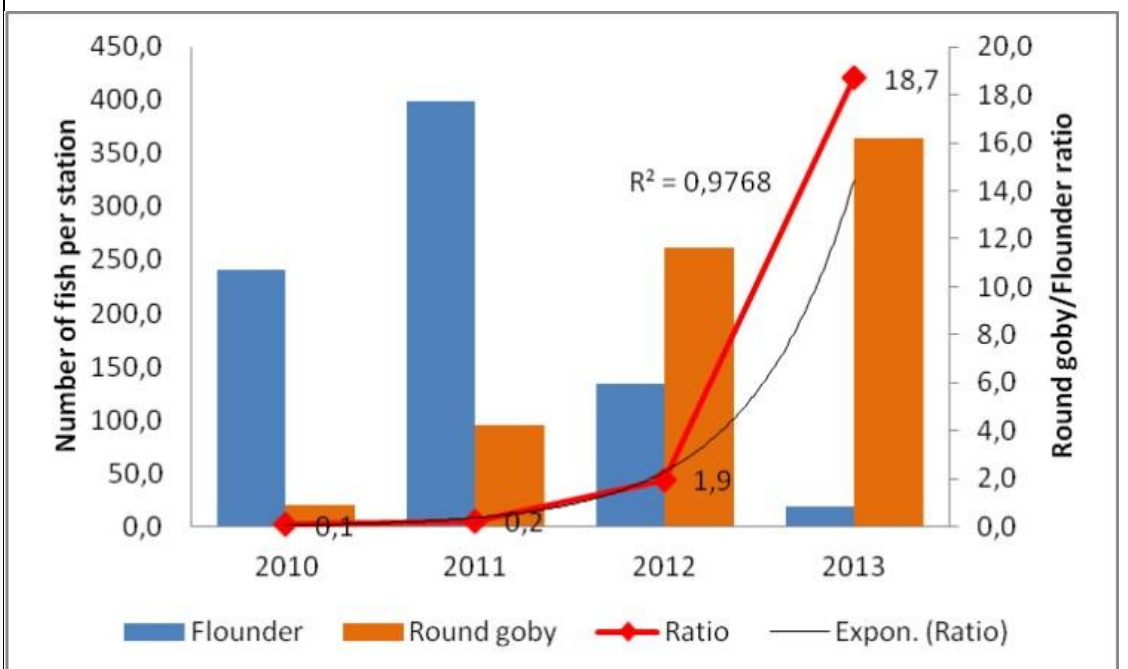


Figure 3. Ratio between total number of round goby and flounder (CPUE)