Abundance and distribution of the Zebra mussel (Dreissena polymorpha)

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Photo by Kristiina Könönen

Key message

The Zebra mussel has become a part of the Baltic coastal ecosystem in many areas around the Baltic Sea, but the distribution is patchy, partly depending on the availability of suitable habitats and limited to areas of less saline water.

Zebra mussels may have adverse economic impacts on the coastal industries and ecological impacts on the coastal habitat structure

Results and assessments

Dreissena polymorpha is an invasive species which has established in several parts of the Baltic Sea. It originates from the Ponto-Caspian region and has been introduced to the Baltic Sea via ship ballast water. The species is present in coastal areas in most of the countries surrounding the Baltic proper (Fig. 1.), but the distribution can be patchy as the mussel requires suitable habitat for attachment. For example, in Denmark and Sweden the species is found from freshwaters and there is only one marine observation from outside Stockholm.

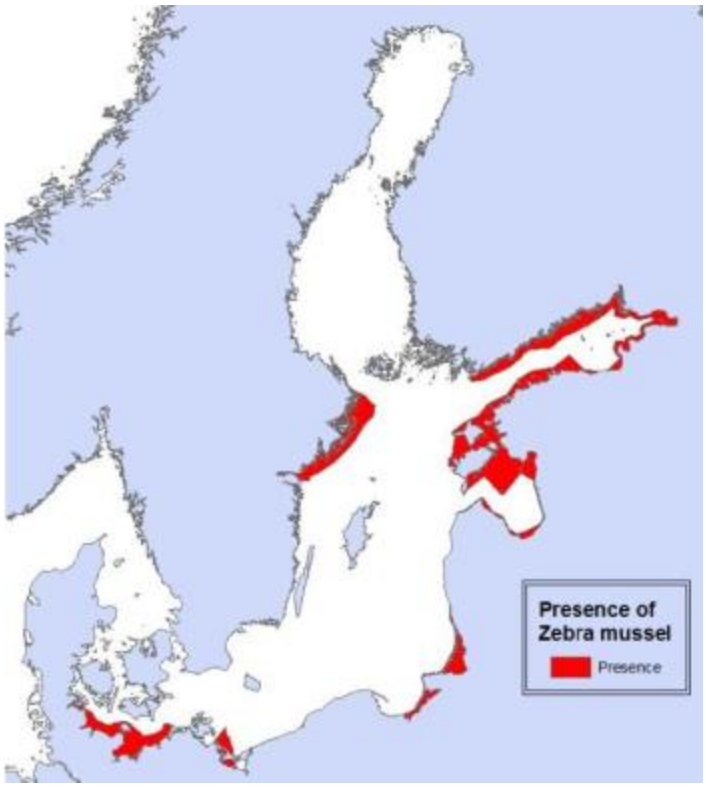

Figure 1. Presence of Dreissena polymorpha in different coastal areas in the Baltic (Source: HELCOM List of non-indigenous species). Note that the distribution in the Gulf of Riga and Swedish Baltic Proper are limited to more freshwater parts.

The species may, in favorable conditions, form large aggregations. Examples of dense aggregations exist from the Szczecin lagoon in Germany (860 - 10.000 ind m^{-2}) (Radziejewska et al. 2009) and up to 3.000 ind m^{-2} in Neva estuary, eastern Gulf of Finland (Orlova & Panov 2004). In the Curonian Lagoon, *D. polymorpha* is the dominant species (mean wet weight biomass 880 g m^{-2} , 86% of total), forming mussel beds over approximately 23% of the Lagoon's bottom area (Leppäkoski et al. 2002). Conversely, only a few individuals were found in Stockholm archipelago, Sweden, in the 1960s (von Proschwitz 1992). In 2007, Gradin & Larson found up to 7000 ind m^{-2} in lake Ekoln while there was much less in lake Mälaren and Hjälmaren. In the Eastern Gulf of Finland biomasses as large as 3000 g ww m^{-2} were found in the outer Neva Bay in 2000-2001 and 2004-2005 (Orlova et al. 2006). The species dominates the local stony and mixed bottoms communities by 96% coverage.

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In the Polish marine areas *Dreissena polymorpha* is present in two sub-basins: Szczecin and Vistula Lagoons connected to the Baltic Sea (Jażdżewski and Konopacka 2002).

Szczecin Lagoon. The first records of a large population of *D. polymorpha* in Szczecin Lagoon are from the end of the 19th century. In the 1950s a large and stable population of zebra mussels was found to overgrow the whole water body; average density reached 15,400 ind. m^{-2}, but the density varied across the lagoon depending on the bottom structure (hard, soft), slope and other factors (Stanczykowska et al. 2010). According to Wiktor (1969) maximum density attained 114.000 ind. m^{-2}. In the 1970s and 1980s, much lower densities were recorded in the southern part of the lagoon. Increasing concentrations of nutrients from a chemical plant in the town of Police were the most probable reason for the decline (Stanczykowska et. al. 2010). Nearly 90% of the individuals were clustered in a comparatively small area covering approx. 10% of the bottom surface in the Polish part of the lagoon. About 91.000 tons were concentrated in close communities and shoals on slopes of shallows (occupying about 46 km^2 of the surface); about 20000 tons live dispersed in the remaining area (500 km^2) of the Polish part of the Szczecin Lagoon.

Vistula Lagoon. According to Żmudziński (1957) *D. polymorpha* was a common species in Vistula Lagoon and the Vistula Delta already in the 50's. More recent publication of Ezhova et al. (2005) and Lewandowski (2004) shows that the distribution and densities have not changed radically - this means that the population belongs to the stable category. *D. polymorpha* is still abundant mainly in the southwestern region where it dominates in terms both biomass and abundance, but in general the population density is lower there than in the Szczecin Lagoon (ca. 100 ind. m^{-2}). The aggregations do not form compact shoals, and the bivalves were distributed along the shoreline to a depth of 1-2 m (Stanczykowska et al. 2010).

More information of the distribution, impacts and biology is found on (1) the DAISIEweb site for *Dreissena polymorpha* and the associated fact sheet, (2) the NOBANIS web site or (3) the Baltic Sea Alien Species Database.

Figure 2 Distribution of Zebra Mussel according to the DAISIE fact sheet (green is native range, red introduced).

Role in food web

Zebra mussel is an important prey item for demersal fish and mussel-feeding birds. As a result of its behavior to produce agglomerates on the littoral sea floor, it has greatly altered the structure of benthic habitats.

Documented impacts

Due to the tendency to form dense aggregations, *D. polymorpha* has caused significant economic losses for electric power generation and drinking water treatment facilities by clocking their water intake pipes and other structures (MacIsaac 1996). In US until 2004 Zebra mussels had caused estimated costs of $267 million for electric generation and water treatment facilities (Connelly et al. 2007).

Photo by Katriina Könönen

Policy relevance

This indicator adds supplementary information to the assessment of Good environmental status regarding the HELCOM Baltic Sea Action Plan (BSAP, HELCOM 2007) and the qualitative descriptor 2 'Non-indigenous species' of the EU Marine Strategy Framework Directive (Anon. 2008, 2010). This indicator could also be useful to the suggested supportive indicator biopollution level index, where newly introduced species and species with a changed invasiveness/impact during the assessment period will be assessed, as abundance and distribution is included in the index.

The Baltic Sea Action Plan does not directly have an ecological objective for the distribution and abundance of non-indigenous species. The management objective 'No new introductions of non-indigenous species' addresses the new introductions and the ecological objective 'Thriving communities of plants and animals' addresses the whole community. Nonetheless, this indicator gives essential background information for the other HELCOM indicators and supports risk assessments of NIS in the region.

Metadata

Data source: In the HELCOM Ballast Water Road Map, HELCOM HABITAT and MONAS were requested to compile a list of non-indigenous, cryptogenic and harmful native species in the Baltic Sea by the end of 2008. The list is a living document which has been edited in various HELCOM subsidiary bodies, expert workshops and projects. Since 2008 the list has been modified by HELCOM HABITAT (11/2009 and 12/2010), HELCOM MONAS (12/2009), the HELCOM HOLAS project and, most recently, by the HELCOM CORESET project.

The presence and absence of NIS in the assessment units is confirmed by experts and non-confirmed presence or absence is also shown. The list contains references to justify the information, but quite often the justification is made by expert judgement.

The Baltic Sea area was divided into 60 areas and each expert noted the presence or absence of each NIS. Presence is a sign of the species ever being found in the area. It does not indicate that it is still present and does not indicate the abundance.

Monitoring of non-indigenous species: Data is collected from all sources of information, from research studies and national monitoring.

Experts of the HELCOM CORESET project have recommended to regularly monitor ports and areas of intensive ship traffic in order to follow the effectiveness of the IMO Ballast Water Convention.

Quality information: Data is variable in time and space, sometimes anecdotal, but even without full coverage of information the quality of information received from research studies is reliable. The list of presence from the expert group is not totally substantiated with references, and need to be complemented with that.

References

Anon. (2008) Directive 2008/56/EC of the European Parliament and the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, L 164/19, 25.06.2008.

Anon. (2010): Commission decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU). OJ L 232/14, 2.9.2010.

Connelly, N. A, O'Neill, C. R., Knuth, B. a, & Brown, T. L. (2007). Economic impacts of zebra mussels on drinking water treatment and electric power generation facilities. Environmental management, 40(1), 105-12. doi:10.1007/s00267-006-0296-5

Ezhova E.E., Żmudziński L., Maciejewska K. 2005. Long-term trends in the macrozoobenthos of the Vistula Lagoon, southeastern Baltic Sea. Species composition and biomass distribution. Bull. of the Sea Fish. Inst. 1 (164), 2005: 56-73.

Grandin U. & D. Larson. 2007. Dykinventering av vandrarmussla i Mälaren och Hjälmaren. Rapportering av uppdrag 216 0634 (del 2) från Naturvårdsverket. Department of Environmental Assessment, Swedish University of Agricultural Sciences, Uppsala. Report 2007:27. ISSN 1403-977X. 17 pp.

HELCOM (2007) Baltic Sea Action Plan. Helsinki Commission. Available at: www.helcom.fi.

Jażdżewski K., Konopacka A. 2002. Invasive Ponto-Caspian species in waters of the Vistula and Oder basins and of the southern Baltic Sea. In: Leppäkoski E., Gollasch S., Olenin S. (eds) Invasive Aquatic Species of Europe. Kluwer Acad. Publ., Dordrecht, Boston, London: 384-398.

Leppäkoski, E., Gollasch, S., Gruszka, P., Ojaveer, H., Olenin, S. & V. Panov. 2002. The Baltic—a sea of invaders. Can. J. Fish.Aquat. Sci. 59: 1175–1188.

Lewandowski K. 2004. Mięczaki (Mollusca) w dorzeczach Wisły i Odry. [Molluscs in the catchment basins of the Vistula ad the Oder] Biuletyn Monitoringu Przyrody 5: 5-9.

MacIsaac HJ (1996) Potential abiotic and biotic impacts of zebra mussels on the inland waters of North America. American Zoologist 36:287–299

Orlova, M. I. & V. E. Panov. 2004. Establishment of the zebra mussel, *Dreissena polymorpha* (Pallas), in the Neva Estuary (Gulf of Finland, Baltic Sea): distribution, population structure and possible impact on local unionid bivalves. Hydrobiologia. 514: 207-217.

Orlova MI, Telesh IV, Berezina NA, Antsulevich AE, Maximov AA & Litvinchuk LF (2006) Effects of nonindigenous species on diversity and community functioning in the eastern Gulf of Finland (Baltic Sea). Helgoland Marine Research 60: 98-105.

Radziejewska, T., Fenske, C., Wawrzyniak-Wydrowska, B., Riel P., Wozniczka A., & P. Gruszka 2009. The zebra mussel (*Dreissena polymorpha*) and the benthic community in a coastal Baltic lagoon: another example of enhancement? Marine Ecology. 30: 138-150. doi:10.1111/j.1439-0485.2009.00313.x

von Proschwitz T. 1992. Sample from Stockholm archipelago from the 1960-ies, verified 1992 by, Museum of Natural History, Stockholm, Sweden.

von Proschwitz T. 2006. Guide till Sveriges stormusslor (Göteborgs Naturhistoriska Museum),http://www.nrm.se/download/18.6409b1b7109b4fb7d2180002080/Vandrarmussla.pdf

Stanczykowska A., Lewandowski K., Czarnoleski M. 2010. Distribution and densities of *Dreissena polymorpha* in Poland – past and present (in) The Zebra Mussel in Europe, Gerard van der Velde, Sanjeevi Rajagopal and Abraham bij de Vaate (Eds) ISBN 978-3-8236-1594-1

Wiktor J. 1969. Biologia *Dreissena polymorpha* (Pall.) i jej ekologiczne znaczenie w Zalewie Szczecińskim [The biology of *Dreissena polymorpha* (Pall.) and its ecological importance in the Szczecin Lagoon]. Stud. Mat. MIR Gdynia Ser A 5: 1-88.

Żmudziński L. 1957. Zoobentos Zalewu Wiślanego [Zoobenthos of Vistula Lagoon] Pr. Mor. Inst. Ryb., 9, 453–500.

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