Monitoring Groningen Sea Ports

Non-indigenous species and risks from ballast water in Eemshaven and Delfzijl

Executive summary

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Aim and methods

International shipping comprises an environmental risk: import of ecosystem foreign, and potentially harmful and disease-causing organisms, called non-indigenous species (NIS). One of the main vectors of introduction of NIS in ports is discharged ballast water of ships.

Especially for the Wadden Sea, this can lead to large risks if NIS establish themselves permanently and become invasive.

The Waddenfonds project *'Demonstration of Ballast Water Treatment Barge "- A sustained protection of the ecosystem in the Wadden Sea against invasive alien species and pathogens"* was launched in 2013. Damen Green Solutions – coordinator- developed the 'Invasave', a ballast water treatment system on a mobile platform. The project had several additional research components related to the reduction of alien species introductions through ballast water in Dutch ports. One of these research components is attributed in report "Monitoring Groningen Sea Ports- Non-indigenous species and risks from ballast water in Eemshaven and Delfzijl".

Figure A. *Position of the two sampled ports in the Wadden Sea region.*

Wageningen Marine Research was asked to perform a baseline study in the port of Eemshaven and the port of Delfzijl (figure A), managed by the port authority Groningen Seaports (GSP), in order to describe the present species community, both indigenous and non-indigenous. The results and methodologies should be supportive for any future monitoring program.

In order to evaluate the potential contribution of ballast water with the introduction of NIS, ballast water species composition was identified and compared with the species assemblage in the receiving ecosystems- in this study the harbours of Groningen Seaports (Eemshaven and Delfzijl).

In addition, an assessment on the current risk of untreated ballast water in the ports of GSP and Wadden Sea was conducted. Based on the experiences during monitoring and analyses, best practices were evaluated in order to advise on future monitoring (what, where, when).

The monitoring approach was adapted from available HELCOM/OSPAR protocols and comprised sampling in various relevant habitats (sediments, water and hard substrates, including pontoons, pillars, quays and SETL plates). A variety of techniques was applied for sampling (Figure B). In June 2016, an inventory was made of the accessibility of the various substrates and a first selective monitoring was conducted. In September 2016, in both harbours replicated sampling was applied at all available substrates in order to account for variation in harbours due to harbour lay-out. Species presence and composition was analysed using classical taxonomical techniques. In a selection of samples, species were detected using DNA metabarcoding (resulting in eDNA profile) techniques.

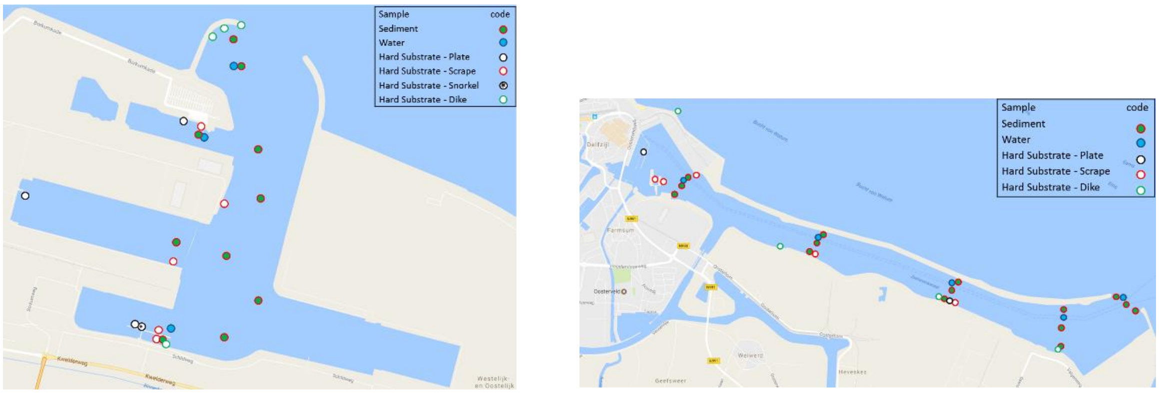

Figure B. *Sampling locations, substrates and methods for Eemshaven (left) and Delfzijl (right).*

In addition to the harbour sampling, ballast waters of three ships were sampled and species were analysed both by classical taxonomy and by eDNA profiles. The ballast waters of the ships simples were not treated, and originated from three different regions (Mediterranean, UK east coast, Rotterdam).

Results

A total of 344 species were identified in this survey (harbours and ballast waters combined), using both classical taxonomy and eDNA techniques. In the ballast water of three ships, a total of 88 species was found (both techniques combined), including 12 NIS.

In the harbour of Eemshaven a total of 262 species were found and in Delfzijl 202 species. In both harbours together, 332 unique species were identified, of which 47 are known non-indigenous species (NIS) (1 out of 7). In Delfzijl 31 NIS were found, in Eemshaven 39. Figure B shows the diagrams representing the unique and shared number of species per species status (indigenous/non-indigenous/unknown) per sampled system (Ballast waters, Eemshaven, Delfzijl). A review of all detected established NIS shows that vectors of introduction does not only include ballast water, but also other shipping vectors (hull fouling), as well as fisheries and aquaculture.

Some of the established NIS in the Wadden region were also found in this survey and included for example now-a-days- common species such as crabs *Hemigrapsus sanguineus* and *Hemigrapsus takanoi*, tunicates *Styela clava and Botrylloides violaceus and barnacles and worms Austrominius modestus, A. improvisus, and Ficopomatus enigmaticus*.

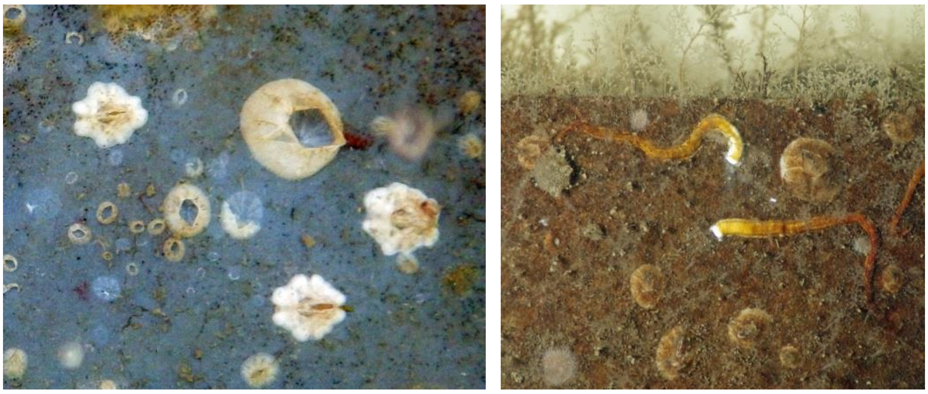

Photo A. Austrominius modestus *and (empty)* A. improvisus *(left piture) and* Ficopomatus enigmaticus *and* A. improvisus *found on plates. Pictures by Gittenberger.*

Photo B. *Crab species and established NIS since 1999/2000: Hemigrapsus sanguineus (left), Hemigrapsus takanoi (right). Pictures by Gittenberger.*

Monitoring data showed a difference in species composition between the harbours of Delfzijl and Eemshaven. This can be explained by their different characteristics, both with respect to environmental conditions such as a salinity, and harbour design, such as lay-out and construction materials used. The difference in harbour lay-out also necessitated a difference in sampling intensity and techniques between harbours, which may have added to the difference. In general, however, Delfzijl is a less biodiverse harbour, compared to Eemshaven.

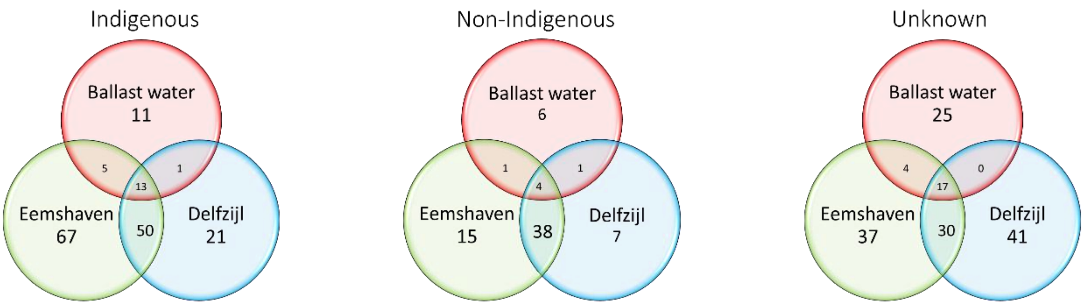

Figure C. *Diagrams representing the number of species detected in Ballast waters and the two harbours, divided by origin (indigenous/ non-indigenous/ unknown).*

Comparison and implications

Ballast water and harbours differ largely in species composition. Half of the species found in the ballast water were not observed in the much more intensely sampled harbours. Similarly, of the 12 NIS found, 6 were not yet reported from the Wadden region, or found in the harbours of GSP. The current analysis can, however, not answer the question whether the organisms found in the ballast water samples were viable individuals, eggs or larvae, or only cells (in eDNA) samples). The report provides a risk assessment of these 6 species. Some do have the potential to establish or spread themselves in the region. The Japanese mussel or Green mussel (*Arcuatula senhousia*), was detected in ballast water, and given its habitats requirements it is not unlikely that the species can establish in the Wadden Sea. It also depends on whether the DNA fragments originated from living eggs or larvae, or dead or non-viable cells. Field observations should confirm its presence. Regarding other NIS, such as *Hydroides elegans* and *Amphibalanus amphitrite* it is more likely to observe these species near cooling water discharge points first. Depending climate change, these species might established and spread along larger spatial scales, including the Wadden Sea. If these species pose a threat for populations of indigenous species is not known.

Since the limited sampling of three ships already comprised 6 potential new NIS, the risk of species introductions via ballast water is demonstrated. The research thus contributes to a better understanding of the presence of NIS in the sea ports of Delfzijl and Eemshaven, the potential contribution of NIS posed by untreated released ballast water and the potential risk that they may have for the Wadden Sea. As such, the results contribute to the demonstration of the value of ballast water treatment systems in a regional ecological context. This knowledge demonstrates the usefulness and necessity of the use of risk mitigation measures- and thus the use of the Invasave- as ballast water treatment system. These results are consistent with the described goals and activities in the program for the Waddenfonds.

Future monitoring

Given the objective to evaluate the best practices to advise on future monitoring (what, where, when), an overview is provided on the best practices. Results showed that sampling at various habitats and substrates, using multiple techniques complement each other in detecting the variety of species and NIS. Sampling water and hard substrates contributed to highest species detection, sampling sediment is of lesser importance.

Classical taxonomy techniques and eDNA (metabarcoding) used to identify species yielded a similar number of species but neither technique detected all species. It was the combination of techniques, as well as the sampling of multiple different habitats that resulted in the overall detection of species, both indigenous and non-indigenous. eDNA analysis is a rapidly developing technique, with many possibilities but also knowledge to gain and imperfections to be aware of. This makes it a suitable technique for monitoring species that are easily missed by classical methods and also for identification of life-stages that are hard to identify (eggs, juveniles) and damaged species. The viability of species detected with eDNA was not taken into account, and should be included in upcoming studies using eDNA.

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