Project information

Project title

Shipping in polar waters: Introduction of marine invasive species through ballast water and biofouling

Year

2012/2013

Project leader

Inger Greve Alsos, Tromsø University Museum

Participants

Project leader

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Participants

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- Jamie Kirkpatrick: University of Tasmania
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- Slawek Kwasniewski: Polish Academy of Sciences

Flagship

Arctic Ocean - Technology and systems of agreements

Funding Source

Fram Centre NOK 900 000 Svalbards Miljøvernfond 2010/2011 NOK 650 000 Norwegian Polar Institute (internal) 2010 NOK 50 000

Summary of Results

The prevention of biotic invasion is a primary goal of environmental management. In the Arctic there is a need to better characterise present and future marine bioinvasion patterns and processes. In this project we investigate the biotic composition of ships' ballast water tanks travelling to Svalbard to evaluate the potential for invasive species to be transferred and introduced to the archipelago via ballast water discharge. We then augment this analysis with a vector based assessment of the entire Svalbard shipping network. This latter assessment is based on measures of environmental similarity between ports visited by ships within the Svalbard shipping network and Svalbard, and lists of known invasive species established at connected ports. Under this approach we evaluate species invasion risk both today and under predicted environmental conditions and shipping activities.

In an earlier project we sampled the ballast water tanks of eight bulk carriers discharging ballast water in Svalbard representing ca. 70 % of the range of vessels visiting the region. Details of the sampling process are detailed in a previous report (http://www.sysselmannen.no/Svalbards-miljovernfond/Nyhetsarkiv/Arktiske-blindpassasjerer-/). We used these samples to develop an understanding of the origin, type, and density of zooplankton organisms transferred to Svalbard. These three factors are critical to evaluating invasion risk. Samples contained a high number of larval organisms requiring both morphological and molecular methods to accurately identify organisms. Morphological identification revealed organisms from 18 higher taxa including species native and non-native to Svalbard. DNA barcode sequencing of 250 additional organisms currently being completed will improve the resolution of taxonomic information substantially. These data will provide insight into the effectiveness of ballast water exchange currently practiced by ships; risks posed by discharging un-exchanged ballast water in Svalbard, and the potential for transported ballast water species to survive under present and future environmental conditions.

The vector based assessment of the Svalbard shipping network revealed that the region is highly connected to a number of global ports. A smaller number of network components presently connect Svalbard to favourable environments that host known invasive biofouling species. Predicted sea surface warming would increase environmental similarity substantially between over 500 ports and Svalbard (Fig 1). A broadened shipping network would then connect Svalbard to a pool of around 150 known invasive ballast water and biofouling species with an increased likelihood of establishing around Svalbard if transported. The analysis demonstrates that the potential for marine species invasion in Svalbard is presently limited by low year-round temperatures, and restricted east-west shipping. Increasing ocean temperatures and any expansion within the shipping network will rapidly reduce these barriers to invasion.

This work represents the first assessment of marine species invasion risk to the European Arctic. Our data indicate that in the absence of focused preventative management, the risk of species invasion in Svalbard, and the wider Arctic, will become high over coming decades. Ballast tank sample data will uncover the type of organisms that may pose an invasion risk via ballast water discharge, while our vector based assessment provides a comprehensive evaluation of the magnitude of ballast water and biofouling risks based on the entire shipping network, and the way these risks will evolve over the remainder of this century.

Published Results/Planned Publications

Preliminary results from this project were published in a book of abstracts from the 2012 7th NEOBIOTA European Conference on Invasive Alien Species in Spain.

Two publications are planned from this project. The first reports results from the vector-based assessment of the Svalbard shipping network. This is nearing completion for submission. The second publication will focus on the risk of species invasion in Svalbard based on results of the ballast water sampling and resulting taxonomic work.

Communicated Results

Preliminary results from this project were presented in an oral presentation to the 7th NEOBIOTA European Conference on Invasive Alien Species in Spain.

Preliminary results were also communicated in the 2012 July edition of the Svalbardposten.

Interdisciplinary Cooperation

The project benefited from interdisciplinary cooperation in several ways.
Morphological taxonomic expertise was available through cooperation with researchers from Akvaplan Niva, and the Polish Academy of Sciences. DNA barcoding expertise was available to the project through cooperation with the Institute of Systematics and Ecology of Animals Siberian Russian Academy of sciences. We gained knowledge on ballast water regulations through collaboration with the Institute for Marine Research.

Budget in accordance to results

Funding from the Fram Centre directly helped with costs incurred for morphological taxonomic work, and DNA barcoding expenses. Furthermore, shipping traffic data for Svalbard which was essential to completing the vector based analysis was obtained using Fram Centre funding. Travel expenses associated with attending and presenting results of the work at the European Conference on Invasive Alien Species in Spain, and also for CW to attend a DNA barcoding course in Sweden were also provided by Fram Centre funding. Finally, salary for CW to undertake research, analysis, and ultimately, publication of the work was provided by the Fram Centre. Together, Fram Centre funding was essential to the completion the data analysis. As more ideas to publication content arose during the project, some more time and salary is needed to finish the publications.

If Yes

It helps press the need for developing ballast water treatment technology.

Conclusions

a) The project has refined directions for further research, and highlights areas which will increasingly require environmental management attention.

Firstly, the project indicates that current environmental management techniques of ships discharging ballast water are limited. Research focused on measuring the efficacy of ballast water exchange would uncover the extent to which this measure reduces invasion risk. The vector based assessment which we employed to evaluate invasion risks associated with the shipping fleet could readily be adapted to evaluate invasion risks associated with increasing and changing shipping traffic along the Northern Sea Routes, North East Passage, and North West Passage.

Secondly, the project provides the first perspective of how marine invasion risks may alter with predicted sea-surface warming. These results press the need for management measures that mitigate the increasing invasion risk over the remainder of this century. Management measures that will require consideration include how ballast water exchange is conducted, ballast water treatment technologies, and means to identify and reduce invasive biofouling.

b) One of the most important outcomes of the project will be the expected high resolution of taxonomic data. Previous studies of ballast water samples have been hampered by taxonomic difficulties. Poor taxonomic resolution limits the potential to accurately describe invasion risk. While the method we use is not novel, its application to the range of larval types and sizes we use it on has not been well demonstrated in this context. Similarly, efficient means to analyse potential invasion risk associated with ship traffic on a region-wide scale have been lacking. The method we use not only provides measures of risk for the shipping network today, but also forecasts the way in which risks will alter under future environmental and shipping conditions.