SVALBARDS MILJØVERNFOND

Arctic stowaways: the potential for species introduction to occur in Svalbard associated with shipping

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Overview

In 2011, a Svalbard Environmental Protection Fund project began work assessing the risk of non-native species introduction to Svalbard in association with shipping. Work was done on-board coal ships arriving to Svea, Longyearbyen, and Barentsburg ports, and on a variety of cruise, cargo, research, and private vessels arriving to the Longyearbyen Bykaia over the summer period. This year saw the first field season and data collection for the project completed. Analyses are now taking place, and will result in recommendations to the Governor about the effect of existing regulations and/or the need for further development of management strategies to maintain rigorous protection of the Svalbard marine environment.

Background

The impact caused by introduced species exists as one of the most serious pressures on the natural environment today. Within the marine environment, it is rarely possible to eradicate non-native species once they have been introduced. The key to the management of marine invasive species therefore, is prevention of introduction. However, invasive species are often inadvertently introduced to new environments in association with human activities, such as by being transferred in ships' ballast waters, or by attaching to ship hulls. By these means, marine species which would otherwise not be able to cross natural barriers to dispersal may *stowaway* on ships, and invade new habitats. Shipping is responsible for the introduction of a number of particularly invasive species worldwide. Accordingly, management of invasive species needs to begin with the prevention of species introductions by shipping.

Shipping to Svalbard has expanded widely over recent decades. Ships now visit more areas on the Archipelago more often than ever before. The risk of shipping transferring non-native species to the region is currently unknown, and there is particular concern that a number of non-native/invasive species found in the coastal waters of nearby regions may be introduced. No true alien marine species have been recorded as established in the high-Arctic as yet, but there is some evidence that newly established mussels (*Mytilus edulis*) in Svalbard may be linked to ship traffic. With climate warming, however, a range of species may be expected to establish. In 2011 researchers from UNIS, Tromsø Museum, the Institute of Marine Research, and the University of Tasmania investigated the potential for shipping to facilitate species introduction to Svalbard, and the risk of impact any introduced species would have to the region.

Ballast water sampling

Coal ships travelling to collect coal from Svea, Barentsburg, and Longyearbyen in 2011 came from the Netherlands, Portugal, and the United Kingdom. Vessels travelled fully ballasted to Svalbard, collecting ballast in the port of origin. When taking on ballast water, any organisms in the water column may be taken on board as well. This can include organisms as small as viruses, bacteria and phytoplankton, through to fish. Some of the vessels travelling to Svalbard exchanged ballast in the open ocean as a means to limit the chance of species introduction to local Svalbard ports: by discharging ballast water collected from coastal ports and taking on oceanic ballast, many of the original coastal organisms are either discharged or killed; the newly collected oceanic organisms pose less of a threat to coastal regions. By taking samples of ballast water from the ballast water tanks of coal ships arriving to Svea, Barentsburg and Longyearbyen (Table 1), we were able to assess the number of organisms that can survive transport in ballast water tanks, and the type of organisms collected. We focussed on the larger zooplankton, finding high densities of live organisms present (between 5 – 3000 organisms/m^3).

Table 1. Number of ships sampled per location in Svalbard, and ballast water origin.

	Svea	*Longyearbyen*	*Barentsburg*
Number of ships sampled	5	1	2
Ship origin / ballast water up-take	Netherlands	Portugaul	Netherlands / UK
Mid-ocean ballast exchange	5	-	-
Volume (m^3) ballast discharge	604 000	140 000	35 000

We have so far identified up to 18 distinct taxa in the zooplankton samples collected. Samples were dominated by copepods, but also included many shrimps, krill, crabs, arrow worms, water fleas, isopods, barnacles, and mussels. Many of the organisms collected by ships that had exchanged ballast water mid-ocean are already present in the waters around Svalbard as native species, as ships usually exchanged ballast water off the mid-coast of Norway where many of the same species exist. Expert taxonomists are currently further identifying all organisms collected so we can determine which species are being introduced to Svalbard. This is a vital step: if we know what non-native species are arriving, we can better determine the threat they pose to the Svalbard environment.

Of course many of the organisms that are transported here cannot survive in the Svalbard environment. The temperature difference between Portugaul and Svalbard is great, as is the difference in salinity levels between some of the ports (e.g. the near fresh-water port of Turneuzen in the Netherlands) and the Svalbard fjords, and these differences prove lethal to many species. However, some species – particularly those that have become invasive in other regions worldwide – have a wide tolerance of environmental conditions, and their capacity to establish in Svalbard cannot be ruled out. We undertook experiments on some of the organisms in the UNIS laboratory to determine whether they could survive in local fjord water. Organisms collected from ships' ballast

water tanks were kept alive and then placed into small aquaria filled with local fjord water from Adventfjorden, Van Mijenfjorden, or Grønfjorden. We kept these at a constant typical (~5°) temperature, and monitored the organisms to see whether they could survive over a period of 10 days. Organisms that were collected from mid-ocean exchanged ballast water almost always survived in high numbers, as did some examples that were sourced from the United Kingdom and Dutch ports.

Together these data show that a range of species are introduced every summer in ships' ballast water to Svalbard. Many of these are native to Svalbard, and, accordingly, can survive well upon being discharged. Other organisms are almost certainly not native to Svalbard, and show signs of being able to tolerate the Svalbard conditions. Further work being undertaken will assess whether these may pose a threat. The presence of coastal organisms (crabs, isopods) in ballast water that had undergone mid-ocean exchange demonstrates that this form of regulation is less than 100% effective.

Figure 1. Ballast water sampling in Barentsburg

Biofouling inspections

This season, we also inspected the underwater surface of vessel hulls at the Longyearbyen bykaia. Organisms that attach to a surface will grow on all vessel hulls, and mobile organisms may live amongst these. Known as 'biofouling,' these organisms may be dislodged when ships berth, or may even reproduce, and become introduced to the local environment. The degree of biofouling on a vessel is related to a number of factors including the time since they were last painted with antifouling, the vessel's average speed, the time a vessel will usually layover in a port, and the extent to which vessels have travelled through ice. Other research has shown that fouling species will tend to aggregate in certain 'niche' areas of a vessel hull, such as on thruster covers, around the rudder and propeller, and on bulbous bows. These are areas that are often not painted with antifouling, and are also protected from the strong laminar flow exerted when vessels are underway. We used an underwater remotely operated vehicle (ROV) with a mounted video camera to get an underwater view of these parts of vessel hulls.

The ROV proved to be a useful tool for rapid inspection in an environment where SCUBA diving is logistically prohibitive. We were able to inspect the hulls of 12 vessels berthed in Longyearbyen, including a range of cruise and expedition ships, research and cargo vessels, and private yachts. Unfortunately we missed several appointments with larger cruise ships due to the unseasonal arrival of sea ice in the summer preventing their visit to Longyearbyen, and also due to the sedimentation of the port environment. The surveys showed that most vessels inspected were clean of substantial

fouling, but a few vessels were heavily fouled. Analysis of this footage, which is underway, will give us an idea of the type of organisms travelling on vessel hulls.

In addition we collected data on vessel characteristics for a larger number of vessels. This information will be linked to the hull inspections to determine those indicators of extensive biofouling. Most vessels arriving in Longyearbyen were repainted with antifouling regularly, and this almost certainly accounts for the general low incidence of fouling. Preliminary analyses suggest that those vessels that have longer layover periods and have not been recently painted with antifouling are most heavily fouled. In addition, the effect of ice scouring does not appear to reduce fouling in most niche areas.

The preventative management of species introductions via biofouling is challenging, and while there are moves worldwide to introduce measures to reduce the risk of transfer, efforts are hampered by a lack of knowledge, and the availability of time-and-cost effective technologies. Elsewhere in the world (e.g. sub-Antarctic New Zealand) vessels must undergo a biofouling inspection prior to visiting a region, which may involve contracting SCUBA divers to assess hull condition. We believe the use of an ROV would be advantageous in such a setting.

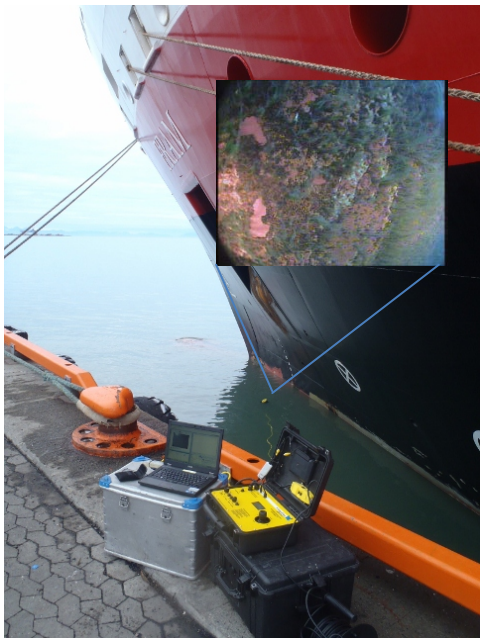

Figure 2. Undertaking an inspection of the MS Fram's hull at the Longyearbyen Bykaia in 2011 with the ROV. Inset is a picture recorded of growth on the hull.

Conclusions

The 2011 summer saw a successful start to the project in spite of the many logistical challenges presented. We will now build upon the season's work with detailed analyses of collected ballast water organisms and vessel hull footage, so we can work towards a comprehensive risk analysis. We are very grateful for the funding received from the Svalbard Environmental Protection Fund that permitted this work.