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Non-native species risks to the Arctic

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Summary
The ICES Working Groups on Ballast and Other Shipping Vectors (WGBOSV) and Introduction and Transfers of Marine Organisms (WGITMO) have identified non-native species issues in the Arctic as an emerging priority. Few systematic biodiversity surveys have been conducted in the Arctic historically, thus we have little knowledge about the presence or impact of non-native species in this region. Global climate change and increased resource exploitation are expected to increase risk of non-native species introductions in the near future, by a variety of human-mediated and natural pathways. WGBOSV and WGITMO members have begun a variety of research projects to quantify risks of non-native species in the Arctic and to evaluate potential management strategies.

Introduction
Biological introductions are defined as the introduction of plants, animals or micro-organisms to a location outside of the natural range of the species. Biological introductions can be deliberate or accidental. There are many synonyms for an introduced species (nonindigenous, non-native, exotic, alien) but when an introduced population becomes abundant and profoundly impacts the physical, chemical and/or biological aspects of the host environment, it is called invasive (see Richardson et al. 2011). In many cases, non-native species are intentionally introduced for human benefit (as food crops, livestock, pets, etc.) but accidental introductions of invasive species can negatively impact ecosystems through predation, competition, parasitism and habitat change and are recognized as a pervasive mechanism of global change and extinction. The biological introduction process can be divided into four basic stages: arrival, survival, establishment and spread. At each stage physical, chemical and/or biological barriers serve to 'filter' the number of individuals surviving to the next stage. Human transport vectors, such as commercial shipping, aquaculture and live trade imports, allow species to circumvent many geographic barriers between native and non-native ranges. Most aquatic non-native species (ANS) introductions have occurred in temperate latitudes where human activity is greatest; however, as few systematic surveys have been conducted in the Arctic historically, we have little knowledge about the presence or impact of ANS in this region. Global climate change and increased resource exploitation are expected to increase human activities in the Arctic, resulting in higher risk of ANS introductions in the near future. Shipping is not the only possible pathway to result in spread of ANS through, and to, Arctic seas as aquaculture and ranching activities, incremental spread from fishing activities, and exploitation of mineral resources are likely to feature in ANS spread. In addition natural spread by warm currents and by rafting is likely to enable range extensions of many species in both the North Atlantic and North Pacific oceans.

WGBOSV and WGITMO Activities
Since 2013, WGBOSV and WGITMO have shared a joint term of reference to investigate and report on new developments in non-native species issues in the Arctic. To date, the majority of this work has been undertaken by Canada, Norway and the Netherlands, with the interest and support of many ICES member countries.

In Canada, a number of research and monitoring initiatives have recently been conducted to examine the current and future risk of ship-mediated ANS in the Canadian Arctic, including a risk assessment to identify high-risk recipient ports, and high-risk shipping pathways, based on level and type of shipping activity,

environmental similarity between source and destination ports, and the number of high-impact AIS in source ports for ships entering Arctic waters (Chan et al. 2013). In addition, biological sampling of ballast water and hulls of ships arriving to major Arctic ports was conducted to determine identity of, and probability of arrival for, potential ANS. In many cases, collected specimens were juvenile forms and it was not possible to confidently identify individuals to the species level. Molecular tools are now being utilized in an attempt to better identify collected specimens. Biodiversity surveys have also been initiated at primary shipping locations to monitor for the introduction of non-native species and to improve baseline knowledge on the distribution of Arctic taxa (Goldsmit et al. 2014).

Norway is actively working on research related to full-scale, pilot-scale and lab-scale land-based and shipboard testing of different ballast water management systems (BWMSs). On-going research projects include examination of water quality variations on biological treatment efficiency, by-product formation and toxicity during ballast water management operation, rapid analysis methods for microplankton 10-50μm in size, studies of algae <10μm in size and pathogenic bacteria in ballast water after treatment, resilience and resistance of fresh water organisms subjected to BWMS testing, real-time monitoring with flow cytometry, risk assessment and UV-resistance of organisms from the Arctic.

In the Netherlands, Wageningen UR has initiated a research programme on sustainable Arctic development. One of these projects looks at the development of a cumulative environmental risk assessment methodology to quantify the effects of activities (profit) on the ecosystem in reconciliation with people and planet (TripleP@Sea). Research was done to investigate the potential risks of ballast water treatment in the Arctic regions. It could be concluded that even though not much is really known, there is a risk for ballast water efficacy and systems that use active systems might pose an environmental threat. Laboratory studies on the effect of low temperatures on BWMSs with active substances are ongoing in collaboration with Canada.

Finally, a database has been established as a single repository for information on ANS introduction histories, recipient regions, taxonomy, biological traits, impacts and other pertinent information (AquaNIS; http://www.corpi.ku.lt/databases/index.php/aquanis). Currently populated with data for ANS introduced to marine, brackish and coastal freshwaters of Europe, work is ongoing to expand the database for neighboring regions, including the Arctic.

Conclusions

With rapid and complex environmental change in the Arctic, there is a need to understand: 1) Which ANS are being transported to the Arctic; 2) Which species are likely to survive there; 3) What impact might be predicted by establishment of new species; 4) How and where should we monitor for new occurrences; and 5) How can we reduce the risk of new introductions?

References

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