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Vessel traffic in the Canadian Arctic: Management solutions for minimizing impacts on whales in a changing northern region

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ABSTRACT

Warming weather conditions in the Arctic are already resulting in changes in both sea ice extent and thickness. The resulting extended 'open water' season has many implications for vessel traffic and marine life. For example, an increase in vessel traffic due to ice-free waters will most likely lead to an increased risk of impact on cetaceans through increased noise pollution, strike risk for some cetacean species, and the possibility of exposure to chemical pollutants. The objective of this study was to pre-empt a predicted increase in vessels by investigating and exploring possible management scenarios, with the aim of mitigating negative impacts on locally important species such as bowhead and beluga whales. Utilizing insights gained from established vessel management schemes in more southerly regions, this paper evaluates the current suite of tools being implemented and their appropriateness for implementation in a more extreme Arctic environment.

1. Introduction

The Arctic Ocean and surrounding seas have had relatively modest levels of shipping in the past, primarily confined to the ice-free or reduced-ice summer season (Huntington, 2009). However, due to a warming climate, sea ice extent and volume is declining in all months of the year (Pongolini et al., 2017), and the continued reduction of ice cover based on predictive models has led many to anticipate a significant impact on shipping activities in the Arctic (Pizzolato et al., 2014). Loss of ice cover, coupled with growth in industrial development in the Arctic (Huntington et al., 2015), is making it an increasingly desirable and accessible destination (Allen, 2014), leading to greater integration with the global economy (Reeves et al., 2012) and a projected increase in vessel traffic (Reeves et al., 2014). The number of vessels which are heading to or from Arctic ports are increasing (Reeves et al., 2012). This includes vessels transiting navigationally constrained waters in both the Northwest Passage (Canadian Arctic) and the Northern Sea Route (Russian Arctic) while serving oil and gas exploration areas in the Beaufort and Chukchi Seas (Allen, 2014; Pongolini et al., 2017) and mining operations in Alaska (Huntington et al., 2015). In addition, cruise ships, military vessels, research boats, and support vessels for resource extraction, are all predicted to become more common in the region (Reeves et al., 2012) due to the longer ice-free season. The bulk of vessel traffic growth will likely occur in the ice-free months of summer and autumn; changes in freeze-up and break-up timing may extend these seasons (Huntington et al., 2015). This may also reduce the need for ice-breaker escorts during these months; however, winter traffic is still expected to require significant icebreaker capacity (Bourbonnais and Lasserre, 2015).

1.1. The side effects of increasing vessel activity

Until very recently the Arctic has functioned as an acoustic refuge from industrial noise (Diachok and Winokur, 1974), and is significantly quieter than non-Arctic areas due to the seasonal presence of sea ice and lack of shipping and industrial activity (Insley et al., 2017). Many studies have speculated that the introduction of anthropogenic noise to the Arctic soundscape, which will inevitably lead to masking and disturbance, could be one of the greatest long-term threats to marine mammals living within this region (Reeves et al., 2012). This is because sound is vital to the survival of marine mammals as they use it to detect and navigate their environment, locate predators and prey and communicate with one another (Huntington et al., 2015; McWhinnie et al., 2017). One of the primary concerns is that an increase in low frequency

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chronic noise emitted from vessels may have wide ranging masking effects on cetaceans (McKenna et al., 2012; Erbe et al., 2016; Dunlop, 2016). Whales are also at risk of ship strikes, which is recognized by the International Whaling Commission as a global threat to numerous species of cetaceans because being struck by a vessel may result in significant injury or even mortality (Reimer et al., 2016). In addition, through increased vessel traffic cetaceans may face a greater risk of being exposed to vessel-generated oil spills or marine discharges such as oily water, wastewater, ballast water or garbage (Hoekstra et al., 2002, 2003; Huntington et al., 2015).

1.2. Arctic cetaceans

While climate change has caused dramatic shifts in northern sea ice regimes, the marine mammals that reside in Arctic waters have now attained a globally iconic status as they reflect the dangers of global warming (Meek et al., 2011). Arctic marine mammals are a particular conservation concern for multiple reasons, including their importance in subsistence culture and economy in northern hunting communities and their role within Arctic ecosystem functions (Reeves et al., 2012, 2014). Living resources such as whales have long been managed and utilized by indigenous communities, with ice cover previously being used to assist in the protection of some of these 'stock' species (Fernandez et al., 2016). Three species of cetacean are endemic in Arctic waters: bowheads (*Balaena mysticetus*), narwhals (*Monodon monoceros*), and belugas (*Delphinapterus leucas*) (Reeves et al., 2014), although only two of these species (belugas and bowheads) are found within our area of interest, the Beaufort Sea.

Belugas are the most numerous of Arctic whales: globally there are thought to be at least 150,000 belugas composed of at least 20 sub-populations (or 'stocks') (Reeves et al., 2014). Despite their overall numbers, some sub-polar populations, such as the St. Lawrence stock, are known to be in serious trouble. The St. Lawrence stock is currently listed as Threatened under Canada's Species at Risk Act (DFO, 2012) and Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC, 2014). Despite the application of protective measures, this population has shown no sign of recovery. This has mostly been attributed to the impact of anthropogenic activities within their environment and their exposure to environmental contaminants (Gervaise et al., 2012; Mosnier et al., 2015). One of the largest stocks spends its summer further north in the Beaufort Sea and is thought to comprise of almost 40,000 individuals (Reeves et al., 2014). Belugas are known to be sensitive to certain types of noise. For example, in Arctic regions they have been observed fleeing ice breakers and using alarm vocalization in response to distant ships (Cosens and Dueck, 1993; Reeves et al., 2014). They have, however, also been shown to become habituated to 'less-threatening' vessel noise and are found in busy waterways such as the St. Lawrence estuary.

Globally, the number of bowheads, comprised of four sub-populations, is thought to number over 18,000 animals (George et al., 2004), with some populations such as those in Bering-Chukchi-Beaufort Seas (the BCB population), having recovered to the point where they are now listed as a species of Least Concern by IUCN (IUCN, 1996). Two of the four sub-populations, the Okhotsk Sea and the Svalbard-Barents Sea populations, however, have not shown such recovery success and are red-listed as Endangered and Critically Endangered, respectively, by IUCN. All populations of bowheads are migratory to some degree although the extent of this movement varies regionally (Reeves et al., 2014). Studies have shown bowheads to be relatively sensitive to industrial activity, exhibiting avoidance responses to noise sources such as ships and seismic surveys at low received levels (Richardson et al., 1999; McDonald et al., 2012; Blackwell et al., 2013, 2015). Therefore, it is very likely that increased industrialized vessel traffic will increase the risk of harm to bowhead whales (Reeves et al., 2012). Alaskan subsistence hunters have already helped provide evidence of the bowheads susceptibility to ship strikes through the documentation of scars and wounds consistent with ship strikes on harvested individuals (George et al., 1994; Reeves et al., 2012). Indirect evidence that large vessels will also prove hazardous for bowheads can be derived from studies such as those conducted by Moore et al. (2004) on their close relatives, the North Atlantic Right Whale (*Eubalaena glacialis*). North Atlantic right whales are found in the heavily trafficked waters of eastern North America and their numbers have shown little recovery since their take by commercial whaling was prohibited in 1935 (Reeves et al., 2012; Kraus et al., 2016). This is in direct contrast to the BCB population of bowheads and Southern right whales (*Eubalaena australis*) (Bannister, 2001) that have seen their numbers increase steadily over the past few decades. Thus, there would appear to be sufficient evidence to raise concern over the future of BCB bowhead whale population, given the predicted increase in Arctic vessel traffic.

1.3. Implications for conservation and management of marine mammals

Marine mammal species in the Arctic, including beluga and bowheads, are top multi-level consumers within these ecosystems and have an integral role in sustaining high latitude ecosystems (Meek et al., 2011). As such, any increase in vessel traffic has implications, not only for conservation of these species, but also for the human indigenous communities that depend on these mammals for fundamental nutritional needs and their heritage and cultural identity (Meek et al., 2011; Reeves et al., 2012; Fernandez et al., 2016). Historically, marine mammal conservation initiatives have typically resulted in permanent or semi-permanent spatially-defined coastal regions under the implicit assumption that the target species would continue to aggregate within their known habitat distribution and utilize important areas within their range such as migratory corridors, calving ground or foraging sites (Reimer et al., 2016). However, any increase in underwater noise from the likes of vessel traffic could result in animals changing migration patterns or regional residency, becoming less predictable, and the abandonment of previously important areas (Findley and Vidal, 2002). In addition, as marine mammals also respond to environmental changes, migration patterns, or regional residency can become less predictable, thus conventional protection measures (e.g. spatially fixed regions such as marine reserves) may fail to provide sufficient protection (Reimer et al., 2016). In the Arctic, this could reduce the success rate of local subsistence hunters (Reeves et al., 2012) or force them to travel farther (Huntington et al., 2015). Another major criticism of marine reserves generally, and particularly several of those established for marine mammals, is that they represent "paper parks" that provide a false sense of conservation achievement (Hooker and Gerber, 2004).

Marine Protected Areas (MPAs) are a common generic term for different types of marine reserves that aim to protect and conserve associated flora and fauna within an area. MPAs and other marine planning tools can be used to mitigate a suite of threats via area based management schemes (Wright et al., 2011). Hoyt (2009) suggested that MPAs devised to protect marine mammals would require targeted management measures that would aim to address marine mammals and ecosystem threats either as part of the MPA itself or through existing laws and regulations. Therefore MPAs could potentially act as a legislative tool for countries to protect whales from the impacts of shipping. MPAs have been effectively used around the world to create sanctuaries from fishing (Côté et al., 2001), but their use for vessel management is not well documented. However, a placed-based tool for protecting whales from ships may be one of the few policy measures that a country can implement to physically protect whales from the presence and impacts of vessels within their habitats. Furthermore, when an area is designated as an MPA, it is set aside for some form of conservation, which can prove very restrictive for some activities within the area depending on the conservation needs and goals of that MPA. Therefore careful consideration must be given to the design, size, goals and management of MPAs, especially those in remote areas such as the Arctic where enforcement issues can arise (Nyman, 2016).