Marine Policy 97 (2018) 72–81

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Tourist vessel traffic in important whale areas in the western Canadian Arctic: Risks and possible management solutions

William D. Halliday[a,b,*], Pierre-Louis Têtu[c], Jackie Dawson[c], Stephen J. Insley[a,b], R. Casey Hilliard[d]

[a] Wildlife Conservation Society Canada, Whitehorse, Yukon Territory, Canada
[b] Department of Biology, University of Victoria, Victoria, British Columbia, Canada
[c] Department of Geography, Environment and Geomatics, University of Ottawa, Ottawa, Ontario, Canada
[d] Institute for Big Data Analytics, Department of Computer Science, Dalhousie University, Halifax, Nova Scotia, Canada

ARTICLE INFO

Keywords:
Beluga whale
Bowhead whale
Corridor
Marine protected area
Passenger vessel
Pleasure craft

ABSTRACT

Vessel traffic has been increasing rapidly in the Arctic, and within the Canadian Arctic, tourist vessels are the fastest growing maritime sector. Vessel traffic can cause a variety of impacts on whales, including ship strikes and acoustic disturbance. Here, the overlap between tourist vessels (e.g., pleasure craft/yachts and passenger vessels/cruise ships) and whale concentration areas is assessed within the Inuvialuit Settlement Region of the western Canadian Arctic. Different management measures which could be used to reduce impacts on whales are also assessed. Passenger vessels have had a relatively constant overlap with whale concentration areas through time, whereas pleasure craft have had a recent and rapid increase. Passenger vessels may have a greater impact on whales, compared to pleasure craft, since they are larger and travel faster. Excluding vessels from the two marine protected areas in the region would have no impact on whales within concentration areas, since vessels would likely just be displaced to adjacent areas with similar whale concentrations. Restricting vessels to the Canadian government's proposed low-impact corridor may reduce impact slightly, but creating a corridor completely outside of the known whale area could more significantly reduce the potential impact of vessels on whales in those areas. Restricting vessel speed within whale areas would also reduce the impact of passenger vessels, but would not likely reduce the impact of pleasure craft. Overall, a combination of management measures may be the best way to reduce impacts on whales in concentration areas.

1. Introduction

Vessel traffic can pose serious threats to whales. Vessels can directly strike whales [1], cause acoustic disturbance [2] or behavioural disturbance [3], increase stress levels [4], and can also pollute the waters where whales live [5]. Many populations of whales live in constant contact with vessels, and are therefore constantly at risk [6]. Other populations, such as those in remote areas, can be under reduced threat, but may have seasonal threats [7,8]. Although the overall contact with vessels is reduced for these populations, the overall risk may be greater since these whales are not as acclimated to vessels [e.g., [8,9]].

Three different management measures are typically used for decreasing the risks of vessels to whales [10]: 1) keeping vessels away from whales, either through ship routeing measures or exclusion zones; 2) restricting vessel speed, which reduces risks of ship strikes and can lower noise pollution; 3) using marine mammal observers or other forms of monitoring for whales near vessels, combined with altering vessel behaviour if whales are nearby (e.g., changing course, stopping engine). For example, adjusting the vessel corridor in the Roseway Basin of Canada to avoid the Right Whale Conservation Area was assessed to reduce the risk of ship strikes for North Atlantic right whales by 62% [11]. For another example, the Port of Vancouver (Canada) recently enacted an 11-knot slow-down in Haro Strait, reducing the amount of time when foraging by southern resident killer whales would be impacted by ~10% [12]. Management schemes that use multiple measures, such as an exclusion zone with a slow-down around it, may be more effective than any single management measure [10,13–15].

In the Arctic, vessel traffic volume has been steadily increasing over the past few decades, due to the greater access enabled by decreased sea ice in the summer, as well as improved technologies [16–20]. Additional vessel traffic will lead to further overlap between vessels and Arctic whales [8]. This issue is especially important because, due to the

* Corresponding author at: Wildlife Conservation Society Canada, 169 Titanium Way, Whitehorse, Yukon Territory, Canada Y1A 0E9.
E-mail address: whalliday@wcs.org (W.D. Halliday).

https://doi.org/10.1016/j.marpol.2018.08.035
Received 16 July 2018; Received in revised form 29 August 2018; Accepted 29 August 2018

relative remoteness of the Arctic, many management tools available in non-Arctic regions will not be as effective [10]. For example, any management measure requiring enforcement will be less effective simply because there are fewer enforcement vessels in the Arctic with a much greater distance to patrol, although enforcement might be aided by ship tracking technology such as AIS (automatic identification system), on which some vessels are required to transmit. Moreover, whales are also a subsistence food source for Indigenous people in many Arctic communities, and these communities typically want vessels to stay out of important whale areas (e.g., [21]). The remoteness of the Arctic also means that the distribution and abundance of whales are not as well understood [22]. Even if mariners intend to avoid key whale areas, information on these whale areas may not be available to them. The harsh and unpredictable environmental conditions also demand flexibility in route planning, so avoiding whale areas may sometime be impossible even if those areas are known.

The Polar Code was recently implemented by the International Mariners Organization (IMO) in an attempt to make vessel traffic in the Arctic safer [23]. The Polar Code applies to all ships certified under SOLAS (International Convention for the Safety of Life at Sea) [24], which includes cargo vessels 500 gross tons or more, and all passenger vessels with greater than 12 passengers. The Polar Code does not apply to pleasure craft, fishing vessels, military vessels, and any other vessels not covered by SOLAS [25]. Most of the Polar Code is aimed at ensuring that vessels traveling in the Arctic meet certain standards and make appropriate voyage plans. However, Chapter 11 (Voyage Planning) of the Polar Code states that mariners should take into account current information and measures to be taken, relevant routeing systems, speed recommendations, and vessel traffic services relating to areas with higher densities of marine mammals, including seasonal migration areas. Mariners are to follow national and international laws and guidelines related to reducing impacts of vessels on marine mammals. However, as stated earlier, the particulars of where marine mammals congregate or migrate in the Arctic is not well understood, except for a few well studied populations [22], such as the Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) [26,27] and Beaufort Sea beluga whales (*Delphinapterus leucas*) [28]. These two populations of whales make for a good case study of how vessel traffic interacts with key areas for these whales, given that these areas are known. Both of these whale populations have historically spent their winters in the Bering Sea and southern Chukchi Sea, and then migrate to the Beaufort Sea in the summer [26–28]. Much of their summer core use areas are in the eastern Beaufort Sea in the western Canadian Arctic (Fig. 1).

Vessel traffic has been increasing in the Canadian Arctic over the past three decades, and is three times higher now than it was in the 1980s [16,17,20]. The vessel types increasing the most are pleasure craft and passenger vessels [16,17,20]. Passenger vessels mostly comprise cruise ships and expedition-style tour vessels, and are defined under SOLAS as any vessel carrying 12 or more passengers [24]. Pleasure craft include the full spectrum of privately owned vessels used for pleasure, but most are private yachts that can range in size from very small to quite large. Both of these vessel classes are often destinational, and may spend time exploring and seeking out areas with more marine wildlife, although passenger vessels may spend more time transiting. These vessels may therefore cause greater disturbance to whales than other types of maritime traffic in the Arctic on the basis of proximity. Voluntary management measures, such as exclusion zones around whale areas, may not be effective for these vessels since they are actively seeking out marine mammals, and often have marine mammal observers on board who direct the ship towards marine mammals rather than away from marine mammals.

This study explores the potential impact of tourist vessel traffic (pleasure craft and passenger vessels) on whales in the western Canadian Arctic. The overlap between tourist vessel traffic and whale concentration areas in the Inuvialuit Settlement Region is examined, and three different management measures for reducing impacts of tourist vessels on whales are also explored. These measures include exclusion zones in marine protected areas, vessel routeing (i.e. corridors), and vessel slowdowns.

2. Methods

2.1. Study area

This study focuses on the Inuvialuit Settlement Region (ISR) in the western Canadian Arctic, which extends from the border between Yukon and Alaska in the west to the border between Northwest Territories and Nunavut in the east (Fig. 1). The western Canadian Arctic is the summer range for bowhead whales (*Balaena mysticetus*) and beluga whales (*Delphinapterus leucas*). The Ecological Atlas of the Bering, Chukchi, and Beaufort Seas [29] was used to identify high concentration areas for bowhead and beluga whales, and spatial data for both species was obtained from this atlas. Female beluga whales with calves tend to congregate in the Mackenzie River Estuary [30,31], while subadults and males tend to spend time throughout the ISR [28,32]. The high concentration area at the Mackenzie River Estuary is used for this study, which covers an area of 33,556 km^2. The Tarium Niryutait Marine Protected Area (TNMPA), created in 2010 through a partnership with Fisheries and Oceans Canada and the Inuvialuit people, lies within the beluga congregation area in the Mackenzie River Estuary, was designated specifically for beluga whales, and covers an area of 1750 km^2. However, much of the beluga concentration area lies outside of the MPA, with only 5% protected by the TNMPA (Fig. 1). Bowhead whales use areas near the shelf break throughout the eastern Beaufort Sea and Amundsen Gulf, likely where upwelling creates large and rich foraging areas [27]. Three main foraging areas exist for bowhead whales throughout the ISR at Atkinson Point, Cape Bathurst, and Cape Parry [26,27,33], for a total area of 15,410 km^2. The bowhead foraging area at Cape Parry overlaps with a small corner of the Anguniaqvia Niqiqyuam Marine Protected Area (ANMPA) (Fig. 1), which was created in 2016, and protects just 0.3% (43 km^2) of the total bowhead concentration area. The ANMPA is quite large (2361 km^2), but was not designated specifically for bowhead whales, but rather for Arctic char, cod, beluga whales, seals, polar bears, and sea birds.

2.2. Vessel traffic analyses

Multiple analyses were conducted on vessel traffic data, with the goal of describing trends in vessel traffic through time, overlaps with whale concentration areas, and vessel speed within whale concentration areas. The potential effectiveness of three management measures that could be used to reduce risk to whales was examined: marine protected areas, shipping corridors, and vessel slow downs. Two separate databases were used for these analyses. First, a database of vessel tracks through the Canadian Arctic from 1990 to 2015 was used, which has been fully described in previous publications [16,17,20], and henceforth referred to as the Canadian Coast Guard dataset. Briefly, this database was created using Canadian Coast Guard data for the NORDREG Zone, based on position reports from individual vessels transiting through the NORDREG Zone. These vessel points were then converted into tracks using a least cost path approach. The vessel track data were used for the analysis of vessel traffic through time and overlaps with whale concentration areas. The second dataset is a series of vessel tracks from satellite AIS data from ExactEarth (Cambridge, Ontario, Canada) from 2012 to 2017. Satellite AIS data were used to examine vessel speed.

First, trends in vessel traffic through time were examined using vessel tracks from the Canadian Coast Guard dataset from 1990 to 2015. The total distance traveled by all vessels within each vessel class during each year was calculated, and trends through time were analyzed using linear regression in R (package: stats; function: lm; [34]), with distance traveled as the dependent variable and year as the