

Vessel needs, preferences, and restrictions related to minimizing risk to whales without compromising vessel operations and the safety of navigation

By

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ABSTRACT

New approaches to large whale conservation make use of autonomous underwater vehicles (AUVs such as ocean gliders) to acoustically detect whales in near real-time, and send ‘whale alert’ information on whale locations to the bridge of commercial vessels to help mitigate vessel strikes to whales. A non-compliant or uninterested commercial fleet may be a barrier to achieving such conservation goals. Thus, understanding the needs, preferences, and restrictions of the shipping industry in the development phase of such new conservation initiatives may result in improved effectiveness. Here I report on a survey questionnaire designed to determine mariner knowledge and awareness of endangered whales and existing conservation measures, and the receptivity of the mariners to near real-time conservation technology on the bridge. The survey, distributed by the Shipping Federation of Canada, yielded 43 responses. The majority of respondents were interested in receiving more information on endangered whales and conservation measures in the eastern Canada and US-Gulf of Maine regions (72% and 79%, respectively). Eighty-four per cent of respondents indicated a preference for receiving information via Navigational telex (Navtex), and 79% listed Navtex as a “not disruptive” means of receiving near real-time whale alerts. Seventy-two per cent of respondents also listed Automatic Identification Systems (AIS) as “not disruptive”, though only 58% identified AIS as a preferred format of receiving whale alerts. Based on the questionnaire findings, mariners appear to be moderately receptive to receiving near real-time whale alerts on the bridge. To better understand the mariner willingness to participate, research should consider defining the response required of mariners when receiving such alerts. The results of this study suggest that future conservation programs should use communication formats that are most familiar to mariners and are least disruptive to the bridge protocols; i.e., Navtex and AIS.

Keywords: Conservation, baleen whales, North Atlantic right whale, Northwest Atlantic, commercial shipping, mariner, receptivity, passive acoustic monitoring

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LIST OF ABBREVIATIONS

AIS: Automatic Information Services

ATBA: Area To Be Avoided

AUV: Autonomous Underwater Vehicle

CCG: Canada Coast Guard

DMA: Dynamic Management Area

ESA: Endangered Species Act

GPS: Global Positioning System

IMO: International Maritime Organization

IUCN: International Union for Conservation of Nature

IWC: International Whaling Commission

MCTS: Marine Communication and Traffic Services

MPA: Marine Protected Area

MSR: Mandatory Ship-position Reporting

Navtex: Navigational Telex

Notmar: Notice to Mariners

PAM: Passive Acoustic Monitoring

SARA: Species At Risk Act

SFC: Shipping Federation of Canada

SMA: Seasonal Management Area

TSS: Traffic Separation Scheme

VHF: Very High Frequency

1. INTRODUCTION

1.1 Anthropogenic threats to baleen whales

The life histories, ecological requirements, and behaviours of baleen whales result in their exposure to various anthropogenic threats. Baleen whales are large, long-lived organisms, with life spans ranging between 40 and 100 or more years (Ramp et al. 2015). Many species are slow to reach reproductive maturity and do not produce offspring on an annual basis (Clapham et al. 1999). These life history characteristics result in slow population growth rates and stunted population recovery when their numbers are reduced by anthropogenic threats as is observed among many baleen whale species (Clapham et al. 1999). The longevity of baleen whales allows individuals and populations to be chronically exposed to anthropogenic threats, and to experience the introduction of new threats during one's lifetime. Additionally, throughout their migration, whales can experience a multitude of threats which may be compounding and thus increasingly detrimental to survival. Most species of baleen whale do not commonly aggregate in large pods, but instead travel alone or in small groups of two to six individuals. The transient and secluded nature of these whales causes members of the population to be potentially exposed, simultaneously, to several threats over a large geographic region.

Despite attempts to mitigate and reduce anthropogenic threats to whales, some threats continue to hinder the recovery of endangered species and the prosperity of populations. The two most prominent threats to baleen whales are entanglement in commercial fishing gear and collisions with commercial vessels (Clapham et al. 1999; International Whaling Commission 2012; Van der Hoop et al. 2012b). Both entanglement and collisions are threats resulting from industrial activities, and both can cause substantive, potentially lethal injuries to individual whales resulting in population suppression or, historically, depletion as observed in some baleen whale species (Van der Hoop et al. 2012b). However, baleen whales are not ubiquitously subject to these threats, nor are they uniformly threatened by commercial activities. Some species are more prone to industry-driven threats, due to their habitat requirements and behaviours (Van der Hoop et al. 2012a). While both of the above threats are considerable impediments to large whale survival and population recovery for endangered species, the latter issue, vessel strikes, has commonly been the focus of much research.

The risk of death as a result of vessel strikes to whales is a function of probability and consequence. That is, the probability that whales and vessels occur in the same space at the same time, and the severity of the resultant vessel strike that depends primarily, but not solely, on vessel speed (Vanderlaan & Taggart 2007; Vanderlaan et al. 2008; Conn & Silber 2013). The vessel strike issue has been recognized by the International Whaling Commission (IWC) as a worldwide threat to large whales, and a leading cause of whale mortality (International Whaling Commission 2012). The issue has been studied in the Northern and Southern Hemispheres in both the Atlantic and Pacific Oceans (Van Waerebeek et al. 2007). In all regions, vessel strikes have been identified as a significant conservation issue for several large whale species (International Whaling Commission 2012), although the severity of the issue varies depending on resident populations and their conservation status. Moreover, vessel strikes in the Northern Hemisphere, particularly in the North Atlantic, have been well-documented and addressed in the literature relative to the Southern counterpart (Van Waerebeek et al. 2007). In the Northwest Atlantic, where six species of baleen whale can be found at certain times of the year, vessel strikes continue to emerge as a leading cause of mortality and population suppression (Van der Hoop et al. 2012a) despite the implementation of several conservation measures.

1.2 Baleen whales of the Northwest Atlantic

Many species of baleen whale are known to make annual migrations, travelling between high latitude feeding grounds and low latitude breeding grounds (Ramp et al. 2015). In the Northwest Atlantic, six species of baleen whale make such a migration to feed on dense aggregations of zooplankton and small fish between the months of May and December (Clapham et al. 1999; Caldwell et al. 2010). These species include the blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), minke (*Balaenoptera acutorostrata*), sei (*Balaenoptera borealis*), and North Atlantic right (*Eubalaena glacialis*, hereafter right) whale. Conservation measures for baleen whales should simultaneously consider the shared traits of baleen whales, in addition to distinct life history characteristics, ecological requirements, and population statuses of individual species.

Baleen whales of the Northwest Atlantic are afforded varying levels of protection throughout their migratory range, as the population status among species differs between Canadian and American waters. In Canada, only blue and right whales are listed as endangered under the Species At Risk Act (SARA) (Beauchamp et al. 2009; Brown et al. 2009), and fin whales are listed as a species of special concern. In the United States, blue, fin, humpback, right, and sei whales are listed as endangered under the Endangered Species Act (ESA) (Lowry et al. 2007). Despite these discrepancies, conservation measures in both nations are largely focused on protecting the endangered right whale above all other species. While these measures are implemented for the recovery of the right whale, they are expected to afford some protection to other baleen whale species primarily through a reduction in risk (Vanderlaan et al. 2008; Brown et al. 2009). Regardless, the right whale focus is not unjust, as this species is widely accepted as one of the most endangered baleen whale worldwide (Brown et al. 2009). While vessel strikes are a risk for all baleen whales, and strikes involving large whales are relatively common in the Northwest Atlantic (Henry et al. 2012; Van der Hoop et al. 2015), on a per capita basis, the impacts of strikes are of greater consequence for the historically depleted right whales (Vanderlaan & Taggart 2007).

In 2013, the best estimate of catalogued right whales was 522 individuals according to the North Atlantic Right Whale Consortium, and the population is estimated to be increasing at a rate of 2.6% per year (Waring et al. 2013; Pettis & Hamilton 2014); however, right whales are still susceptible to population-level impacts given their life history traits, ecological requirements, and behaviours. The right whale commonly makes use of the coastal zone for both nursery habitat and feeding grounds, and thus experiences considerable spatial and temporal overlap with commercial activities that are concentrated in coastal areas (Brown et al. 2009). It is therefore not surprising that existing conservation measures in the Northwest Atlantic have been implemented for the protection and recovery of this endangered species.

1.3 Existing conservation measures

Over the past decade, conservation biologists and practitioners have collaborated with government, industry, and various publics to implement several conservation measures, with varying efficacy,

in the Northwest Atlantic to reduce the risk of vessel strikes to right whales. In Canada, these measures have included the designation of conservation areas, the designation of critical habitat areas, amendments to International Maritime Organization (IMO) Traffic Separation Schemes (TSS), and a voluntary Area To Be Avoided (ATBA) sanctioned by the IMO (Appendix 1) - (Brown et al. 2009; Vanderlaan & Taggart 2009). In the USA, conservation measures have additionally included a Mandatory Ship-position Reporting (MSR) system, mandatory vessel-speed restrictions, and Seasonal and Dynamic Management Areas (SMAs, DMAs respectively) (Vanderlaan & Taggart 2009; Silber et al. 2015; Van der Hoop et al. 2015). Many of these measures have been successful in reducing collision risk to right whales through altering the probability of co-occurrence in time and space, or by reducing the lethality of strikes, as was expected of vessel speed restrictions (Vanderlaan & Taggart 2009; Van der Hoop et al. 2014). However, some of these measures, including speed restrictions, have not been successful in achieving compliance amongst vessel operators, perhaps due to insufficient notice or a lack of punitive action, thus hindering their ability to reduce risk (Silber et al. 2014). The degree of success across conservation measures is not equivalent, as each of these measures commonly relies on a cooperative and compliant fleet.

Compliance can be determined by several factors including the severity of consequences for non-compliance; awareness and knowledge of regulations; and the costs and benefits of compliant behaviour (Kuperan & Sutinen 1998; Nkonya et al. 2008; Keane et al. 2008). The fleet and, more generally, the shipping industry can experience considerable costs via complying with regulations prescribed for the protection of baleen whales. There are dollar values associated with rerouting ships and reducing speeds to comply with conservation demands, and these values should not be overlooked. Despite these costs, some conservation measures in the Northwest Atlantic have been effective in reducing collision risk to baleen whales, and right whales in particular, due to a highly compliant fleet and cooperative industry. Mariners respect the ocean: it is how they earn a living. Beyond this, there is respect for the ocean's beauty and its biodiversity. If conservation information is presented as a collaboration between industry and conservation practitioners, mariners may be more likely to comply with new measures.

The IMO-sanctioned voluntary ATBA in Roseway Basin has seen considerable success, achieving a 71% compliance rate within the first five months of implementation and reducing the probability of lethal strikes to right whales by 82% (Vanderlaan & Taggart 2009). Similarly, changes made to the Grand Manan TSS by the IMO and Canada in 2003 result in an estimated 90% reduction in the probability of vessel strikes in the outbound shipping lane (Vanderlaan et al. 2008). However, other conservation measures, particularly those implemented with few implications for industry, have not been effective in reducing collision risk or strike mortality. For example, the designation of right whale critical habitats, which do not carry implications for industry, have not resulted in a significant reduction to ship strike mortality (Mullen et al. 2013). Baleen whale conservation issues are, first and foremost, issues that result from industrial activities, and it is therefore not surprising that conservation measures which consider industry are most effective in reducing risk. Nevertheless, the commercial shipping industry is inherently peripatetic and the effectiveness of existing conservation measures is hindered by their contrastingly stationary approach to management of whale species that are also inherently peripatetic.

1.4 Management problem

As technology advances and the ability to reduce collision risk via near real-time alerts on whale locations comes to fruition, it is critical that new management regimes address the needs and restrictions of industry when it comes to baleen whale conservation. Management in this case refers to the actions taken to change behaviours and attitudes of the fleet members with respect to baleen whale conservation. While near real-time alerts are likely to improve conservation through the distribution of updated and current information, the ability of large commercial vessels to respond immediately can be limited by safety considerations schedules, the need to maintain efficiency in shipping, and budgetary considerations. Management must consider these limitations while concurrently recognizing the challenges of protecting whales given their ecological requirements and behaviours, especially as distributions and movements change over time. Since whale distributions are heavily influenced by the availability of food (Davies et al. 2013), and prey species are subject to environmental stressors and change, the distributions of whales may change as prey species adapt or acclimate to seasonal or climate variations in their environment. Therefore, the risk of vessel strikes is likely to persist and may worsen as whale movements and aggregations

become less predictable. Further, not all whales make use of known critical habitats, and individuals may use those habitats differentially throughout a feeding season, thus being protected differentially throughout their migratory range. Vessel strikes continue to be an issue in marine management – thus the need to address the problem via improved and adapted management.

Addressing this persistent risk via the distribution of near real-time information on whale locations will require an understanding of the mariner's needs and preferences when it comes to receiving those alerts. The effectiveness of management, and therefore the effectiveness of conservation, may be improved by first gaining this understanding. Accordingly, this may allow for the tailoring of science and conservation technologies to better meet the requirements of industry. While current management regimes governing the industry regarding baleen whales have resulted in considerable success, the context and conditions of those regimes continues to change as industry and marine systems change. Management must therefore respond to those changes, and continually seek to improve effectiveness, consequently achieving conservation goals.

1.5 Emerging conservation technologies

The commercial shipping industry and large whale conservation programs have been successfully co-existing in the Northwest Atlantic since the early 2000's (Brown et al. 2009), although these programs, plans, and policies have traditionally resulted in permanent, spatial conservation measures concentrated in the coastal zone (Risch et al. 2014). Conservation measures in place in the Northwest Atlantic were implemented under the assumption that whale populations would continue to aggregate in particular geographic regions and make use of defined migration corridors. In Canada, no conservation measures seek to relay near real-time information to mariners regarding the locations of large whales; endangered or otherwise. In the USA, near real-time information on right whale presence is available to mariners in the port of Boston and Massachusetts Bay shipping terminals via acoustic auto-detection buoys (Duff et al. 2013). As whales respond to environmental change and migration patterns become less predictable over time (Ramp et al. 2015), it is of particular importance that large whales are protected throughout their range.

During periods of intense feeding when whales are present in the Northwest Atlantic, individual movements mirror the movements and availability of food across regions (Brown et al. 2009). Therefore, as prey aggregations shift in response to environmental change, whales are likely to follow and potentially move away from existing spatially explicit conservation areas. Further, there are large portions of whale migrations, including migration patterns and potential aggregation areas, which remain unknown despite research efforts dedicated to understanding large whale life histories and ecology (Jacobsen et al. 2004; Brown et al. 2009). Near real-time measures may improve the effectiveness of large whale conservation, as it is more adaptable than existing spatially fixed measures and can adequately respond to changes in whale aggregations. Moreover, such measures may provide protection to whales that do not make use of particular geographic regions. Near-real time conservation may be achieved by linking acoustic monitoring to vessel communication technology.

All baleen whales produce various vocalizations, presumably for acoustic communication with conspecifics (Edds-Watson 1997). In recent years, scientists and researchers have been addressing large whale conservation issues with acoustic science (Gillepsie et al. 2009; Stimpert et al. 2011; Risch et al. 2014). Passive Acoustic Monitoring (PAM) makes use of acoustic technology and processing systems to classify species and habitat using identifiable sounds. Traditionally, PAM devices collect and store data that cannot be analyzed or applied to real-life problems until such devices are recovered (Baumgartner et al. 2013). While these data have considerable application in solving conservation problems, they are not applicable in real-time and do not sufficiently address the disconnect between the mobile shipping industry, mobile whales, and stationary whale conservation measures, as is true of the Northwest Atlantic. To address this issue, Baumgartner et al. (2013) proposed the use of autonomous underwater vehicles (AUVs, e.g., ocean gliders) to not only collect acoustic information, but to also process, classify, and report acoustic detections of baleen whales in real-time. When paired with communication technologies used by the commercial shipping fleet, bringing information on baleen whale locations to the bridge in near real-time can be imagined.

Master mariners, meaning certified operators of commercial vessels, regularly receive land-based information on navigational hazards, weather conditions, and other marine activities. Communications are made through several different media, which are used variably by mariners depending on region, navigational conditions, voyage purposes, and onboard communication technologies. These media include internationally recognized technologies such as Very High Frequency (VHF) radio, the Automatic Identification Systems (AIS), and Navigational Telex (Navtex) (Appendix 2). In addition, domestic media used in Canada include Marine Communications and Traffic Services (MCTS), a program governed by Canada Coast Guard (CCG) that communicates with mariners and fleets through VHF and Notices to Mariners (Notmar), bridge placards, and navigational charts (Appendix 2). Each of these media represents a channel through which mariners can be contacted and information can be funnelled. While some of these media are inappropriate for communicating near real-time information obtained from acoustic monitoring devices, others may feasibly be used to transfer information on whale locations from ocean gliders to the bridge. What remains unknown is whether or not mariners are willing to use such near real-time information if received on the bridge to improve conservation, or the means by which mariners might prefer to receive such information given particular navigational operations and safety standards. Understanding the receptivity of mariners to near real-time information, in addition to the needs and preferences of receiving that information, may be critical to the implementation of near real-time conservation.

1.6 Implementing near real-time conservation

Implementing new conservation measures is a complicated process as regulators, authorities, politicians, and scientists come together in an effort to reasonably and effectively address conservation problems. Bringing near-real time conservation via whale location alerts to the bridge will require cooperative policy-makers, but it is also dependent on a cooperative fleet that is receptive to the emerging technology and further participation in conservation. Thus, having a better understanding of the needs, preferences, and restrictions of fleet members may strengthen relationships with those developing the new conservation measures, in addition to providing new information that may ease the uptake of those measures by industry. An important first step to gaining this understanding is to determine the baseline knowledge and awareness of target groups,

since target groups are essential to producing desired conservation outcomes (Aipanjiguly et al. 2003).

Knowledge of conservation problems can be highly related to support for conservation solutions (Aipanjiguly et al. 2003) or linked to the likelihood of individuals acting in favour of the environment (Jensen 2002; Kollmuss & Agyeman 2002), that includes conservation. Thus, mariners who are more knowledgeable, or at a basic level, are aware of endangered species and their conservation, may be more likely to comply with conservation initiatives. Similarly, knowledgeable mariners may be more receptive to new conservation technologies and programs, as they may possess greater sympathy for such issues, although perception of environmental issues can be more important than factual information in determining behaviour (Lepesteur et al. 2008). Consequently, it may be less important that mariners correctly identify endangered species, but more so that mariners generally perceive that some species are endangered and conservation measures are in place for their protection. Moreover, behavioural intention to act is jointly determined by personal attitudes and the perception that others believe in certain behaviours (Aipanjiguly et al. 2003). If mariners transiting the Northwest Atlantic perceive that other mariners and the regulating authorities expect compliance with conservation measures, and believe in their purpose and effectiveness, mariners may be more likely to act in favour of conservation. Understanding the relationships between awareness, knowledge, and behaviour is critical to ensuring that the desired behaviours of target groups are obtained through strategic conservation programs. Establishing sympathy for conservation may be a primary step in improving mariner receptivity to future conservation programs, which in turn may be strengthened if conservation planners first consider the preferences and needs of target groups.

When conservation programs are being developed, and the goals are being set, the preferences and values of the target audience should be considered, since that audience is typically a driver of the expected conservation action (Ressurreicao et al. 2012). Since the success of conservation depends on changes in human behaviour, it is intuitive to consider the needs and preferences of target groups who are most affected by conservation programs and whose action is needed for program success. Further, understanding the needs and preferences of target groups, like mariners, may

indicate the receptivity of those groups to new conservation programs. In this case, mariners who do not feel they need information on whale locations or who prefer more permanent, print-based media for receiving information, may be less receptive to implementing near real-time conservation technologies in their bridge protocols. The implementation of near real-time conservation will require a cooperative and receptive fleet that is willing to continue its active participation in conservation initiatives. Thus, understanding the ways by which conservation planners can ease the uptake of new technologies and protocols on the bridge may be essential to creating conservation programs that are well-received by industry.

1.7 Research questions

To address the conservation management problem, wherein baleen whale conservation must be improved and adapted to appropriately reflect the preferences, needs, and restrictions of the shipping industry to effectively make use of near real-time technologies, the following overarching research question was asked:

Are mariners receptive to the implementation of near real-time conservation technologies to reduce lethal strikes to baleen whales in the Northwest Atlantic?

To better address the primary question, the following secondary questions addressing (1) mariner knowledge of and interest in baleen whale conservation and (2) the receptivity of mariners to implementing near real-time conservation technologies on the bridge must be answered:

1. To what extent are mariners aware of the endangered status of baleen whales and existing conservation measures in the study region, and are they interested in learning more?
2. Are mariners able and willing to incorporate near real-time alerts into bridge planning and, if so, what format would mariners prefer to receive those alerts?

2. METHODOLOGY

2.1 Research questionnaire

A survey questionnaire was developed to better understand (1) the mariner awareness of endangered whales and existing conservation measures in the Northwest Atlantic, (2) the mariner preferences with respect to receiving near real-time alerts on whale locations, and (3) the mariner needs and restrictions when incorporating such alerts into bridge planning and protocols.

The questionnaire was fronted by an information sheet and consent form (Appendix 3), and comprised 10 questions in various formats including dichotomous (yes/no) options including a Likert scale question, a Guttman scale question, and opportunities for participants to respond with candour (Appendix 4). The first four questions of the survey gave an indication of the respondent demography via their role within the industry and their familiarity with the study region based on how often their ship(s) navigate the Gulf of St. Lawrence, the Scotian Shelf, the Bay of Fundy, and the Gulf of Maine. These questions included:

1. I represent (select one): a fleet or a single vessel
2. Which of the following regions do you or your vessel(s) navigate annually?
3. If you represent a single vessel, how many trips annually does your vessel make through any or all of the regions identified above?
4. If you represent a fleet, how many of your vessels annually navigate any or all of the regions identified above?

The fifth and sixth questions were designed to estimate the mariner awareness of whale conservation and their interest in learning more about conservation. The response options for question five included all six species of baleen whale and one species of toothed whale found in the Northwest Atlantic. The not at risk, toothed whale species was included to deter respondents from mindlessly selecting all species. These questions were used to address the first research sub-question, “To what extent are mariners aware of the endangered status of baleen whales and

existing conservation measures in the study region, and are they interested in learning more?”, and included:

5. a) To your knowledge, which of the whales below are considered as endangered?
 b) If you are not aware of endangered whales, would you be interested in receiving such information in the future?
6. Are you aware of any of the following measures on the east coast of Canada and or/ the USA-Gulf of Maine that may help reduce ship strikes to large whales?

The remaining four questions were designed to determine the mariner receptivity to receiving near real-time alerts, and their preferences with respect to when and how those alerts should be received. These questions were used to address the second research sub-question, “Are mariners able and willing to incorporate near real-time alerts into bridge planning and, if so, what format would mariners prefer to receive those alerts?”, and included:

7. When would you need information on whale locations in order to help you avoid collisions with whales?
8. If you were provided with near real-time information on whale locations during a voyage, in what format would you prefer to receive the information?
9. How disruptive would near real-time information be to bridge protocols if received in one or more of the following formats?
10. How much would you or your corporation be willing to spend for the technology to enable you to receive real-time whale location information on the bridge?

The questions included options for receiving whale alerts that are currently available, currently under development, or currently unavailable to mariners. Participants were asked to select their preferred method of receiving location alerts and to then rank the disruptiveness of each method to bridge operations; methods included VHF radio, MTCS, AIS, Navtex, mobile applications

(apps), and web pages. Question 10 was intended to gauge how willing the industry might be to fund the implementation of conservation technologies.

The questionnaire was expected to take no more than 10 minutes for participants to complete. The questionnaire was distributed on behalf of the research team by the Shipping Federation of Canada (SFC), and thus the mariners defined in this study were SFC Members whether they be agents, owners, or operators. The unique partnership with SFC allowed the questionnaire to potentially reach hundreds of individuals via their SFC Membership, as well as via email forwarding on the part of primary email recipients, sending the questionnaire through their respective channels of communication to vessel operators. As a result of this distribution method, however, the exact number of individuals who received the questionnaire remains unknown and therefore a response rate cannot be estimated. The SFC currently has 77 Members who are associated with 174 contacts to which the questionnaire was distributed, although more individuals may have received the survey as these contacts include other company representatives, fleet managers, and vessel operators. The SFC forwarded the survey to the above constituents on three occasions over an eight week period (June through August 2015). During this time, respondents were able to return the surveys to the SFC via email, fax, or land mail, which were then anonymously forwarded to the research team via email. Upon receiving the completed surveys, the responses were coded using a simple numbering system that allowed for the quantitative analysis of responses. Qualitative, open responses to questions were recorded and, when applicable, sorted into categories of similar responses to be analyzed semi-quantitatively.

2.2 Statistical analyses

Survey responses were primarily converted to a per cent score to reflect the proportions of different responses. Prior to this conversion, response frequencies were compared using a chi-square test (Minitab Ver. 17) to determine whether response proportions for each question were statistically different from the expectation of equal proportions. Where statistical differences were found, Fisher's exact test, appropriate for small sample sizes, was used for pairwise comparisons of proportions within each question as necessary; i.e., to determine the statistical differences between

pairs of categorical responses to individual questions. Responses from participants who identified either as a representative of the fleet or as a representative of a single vessel were aggregated due to the small sample size.

3. RESULTS

A total of 43 completed questionnaires were received by the SFC and forwarded to the research team. Although respondents were not asked to divulge personal or population demographic information, they were asked to identify as being either a representative of a single vessel or a fleet. Significantly large proportions of respondents (93%, $p= 0.000$) identified as representing a single vessel and 86% ($p= 0.000$) of indicated that they annually navigate the Gulf of St. Lawrence. The Scotian Shelf, Bay of Fundy, and Gulf of Maine regions of interest in this study were identified as regions annually navigated by 16%, 5%, and 12% of respondents, respectively, and 7% indicated that they did not navigate any of the aforementioned regions annually.

3.1 Knowledge and awareness

Each whale species listed on the questionnaire was identified as endangered according to the respondents' knowledge in a minimum of four responses. The majority of respondents (72%) correctly identified the right whale as an endangered species (Figure 1). The right whale was correctly identified more often than all other species, except the blue whale ($p= 0.000$). Blue, humpback, and fin whales were also frequently identified as endangered species (56%, 33%, 30%, respectively) compared to the remaining options, although only the blue whale was identified significantly more often than pilot, minke, sei, and fin whales ($p= 0.000$). Forty-two per cent of respondents selected at least one incorrect option when identifying whales considered to be endangered, according to Canada's listings. Under the SARA, only right and blue whales are listed as endangered, while fin whales are listed as a species of special concern. It is unknown whether respondents identified endangered species based on SARA or ESA listings. Under the ESA, all response options except the pilot whale are considered to be endangered. When asked whether respondents would be interested in receiving information on endangered whales in the future, had they not been previously aware, 79% ($p= 0.000$, $\chi^2= 40.7907$, $df= 2$) of respondents answered

“yes” and 7% of respondents answered “no”, while 14% of respondents did not reply to this question.

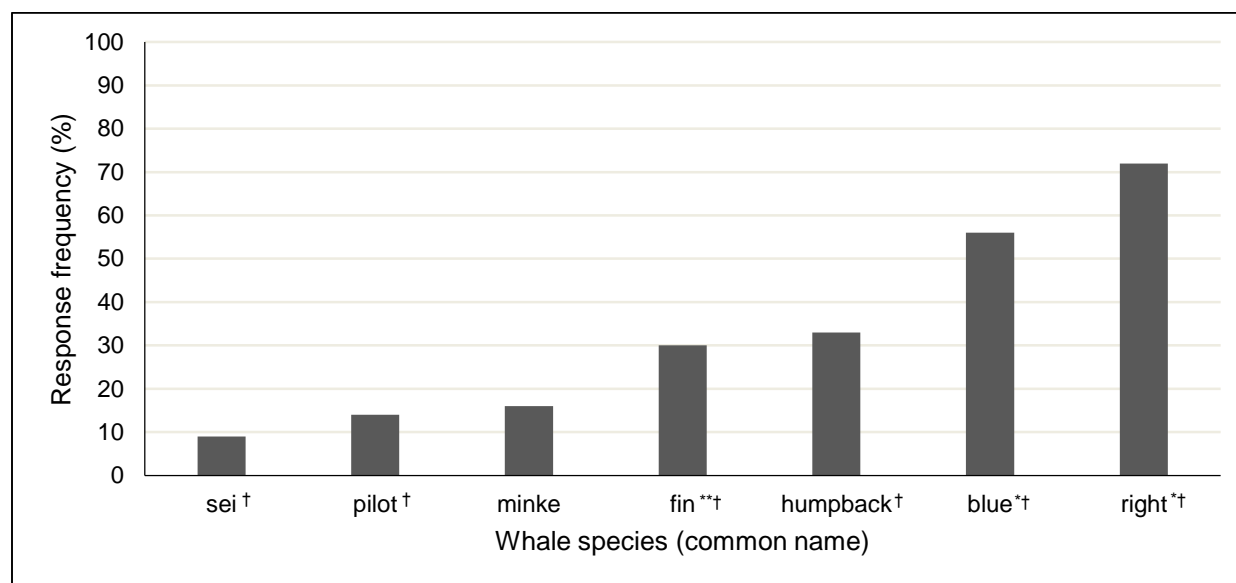


Figure 1. Bar chart showing the per cent response of mariners identifying whale species that they considered to be endangered. Superscripted bars indicate endangered (*) or special concern (***) in Canada (SARA) and endangered (†) in the USA (ESA).

Most respondents were aware of conservation measures implemented on the east coast of Canada and (or) the USA-Gulf of Maine to help reduce ship strikes to whales (Figure 2). The most well-known conservation measures were Marine Protected Areas (MPAs; 86%). Respondents indicated an awareness of MPAs more often ($p < 0.01$) than all conservation measures, with the exception of Areas To Be Avoided (ATBA) that were selected by 84% of respondents and significantly more often ($p < 0.02$) than all remaining options. Approximately half the respondents indicated they were aware of Traffic Separation Schemes (TSS) and conservation areas (60%, 51%) as conservation measures. Respondents indicated that the most common means by which they had become aware of the various conservation measures included bridge placards (79%) and navigational charts (74%). Both communication media were selected significantly more often ($p = 0.000$) than all remaining options, except Notice to Mariners (Notmar). However, Notmar was also a common means of gaining awareness (58%). When asked whether respondents would be interested in receiving advisory information in the future, had they not been previously aware of measures, 72%

($p= 0.000$, $\chi^2= 29.6279$, $df= 2$) indicated “yes”, 9% indicated “no”, and 19% did not respond to this question.

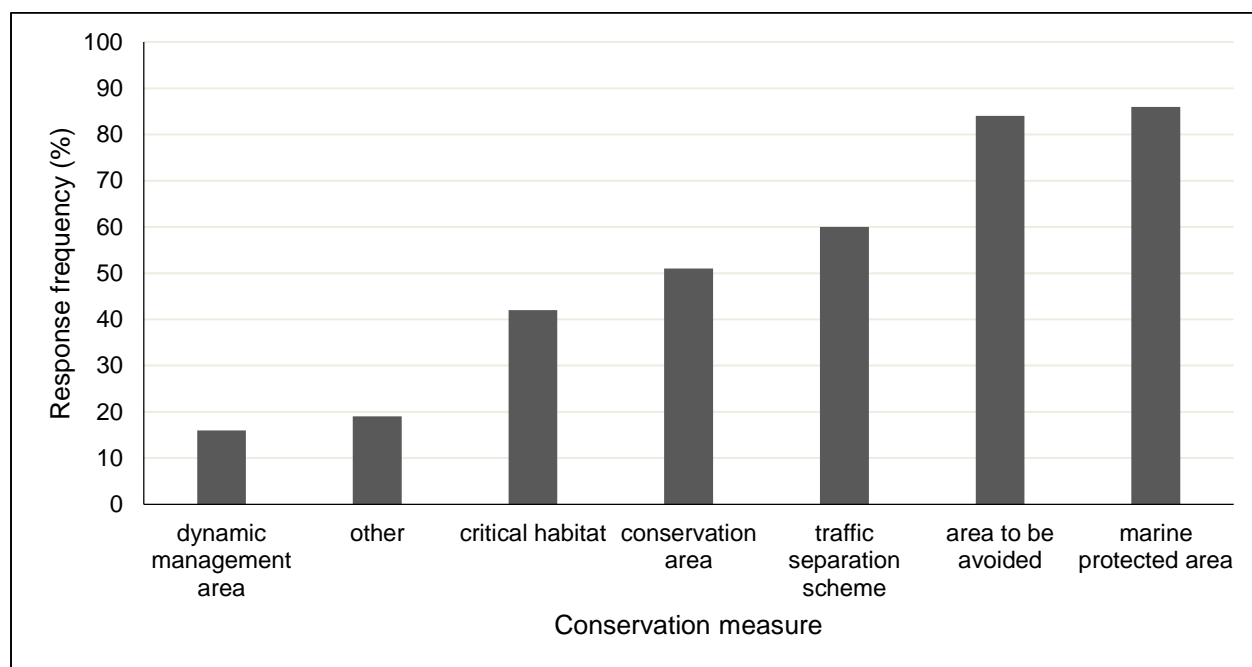


Figure 2. Bar chart showing the per cent response of mariners identifying their awareness of various whale conservation measures. Note that Dynamic Management Areas are used only in the USA.

3.2 Receptivity, needs, and preferences

When participants were asked when they would need to receive information on whale locations to aid in avoiding collisions with whales, 53% of respondents indicated before leaving port and 35% stated they needed information within a few hours of arriving at the alert location (Figure 3). The response options were not selected with equal frequency ($p= 0.001$, $\chi^2= 15.453$, $df= 3$). Ten (23%) respondents selected more than one response to this question, and seven (16%) respondents selected that they needed information both before leaving port and within a few hours of arriving at the alert location. Fewer respondents (28%) stated that they would be able to respond immediately to alerts on whale locations to reduce the likelihood of collisions with whales. Significantly fewer respondents (7%, $p\leq 0.021$) indicated that they did not require such information. This latter response option and the option in which information is required before leaving port were considered to be less flexible responses, as these options are less viable for the

implementation of near real-time conservation. The response options where information is needed within a few hours of arriving at a whale location or being able to respond immediately to location information were considered to be flexible responses, as they reflect an ability to better incorporate near real-time information in bridge planning. A cumulative 60% of respondents selected options that indicated a reduced flexibility while 63% of respondents selected the more flexible response options.

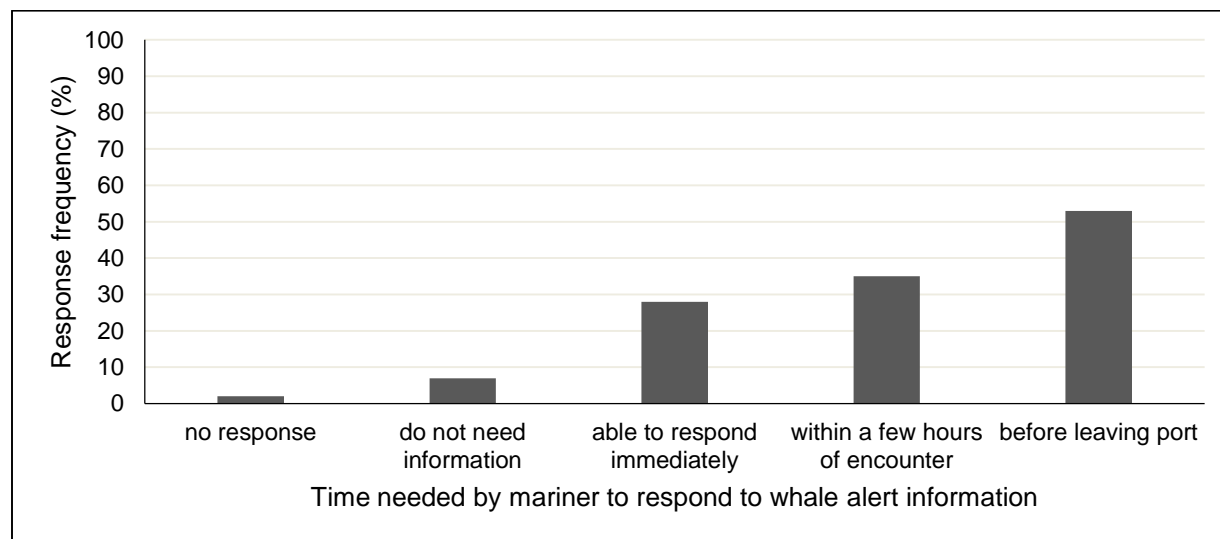


Figure 3. Bar chart showing the per cent response of mariners identifying their need for whale alert information and their ability to initiate a response to the information.

The most preferred format of receiving near real-time information on whale locations was Navtex (84%), an automated medium-frequency direct-printing service used to transmit written alerts to mariners at sea (Figure 4). Navtex was selected significantly more often than all communication options ($p \leq 0.017$). Other notable preferences for reception modality included AIS (58%), VHF radio (51%), and MTCS (40%). AIS, VHF, and MTCS were selected significantly more often than apps, web alerts, and other responses ($p < 0.01$), although the differences in response proportions did not differ significantly from each other. No respondents indicated a preference for receiving alerts through mobile applications (apps), and this difference was significant ($p < 0.001$) for all other options with the exception of the web-based alerts ($p = 0.055$) that was selected by 12% of respondents. Ten respondents (23%), however, wrote in a preference for receiving alerts through e-mail.

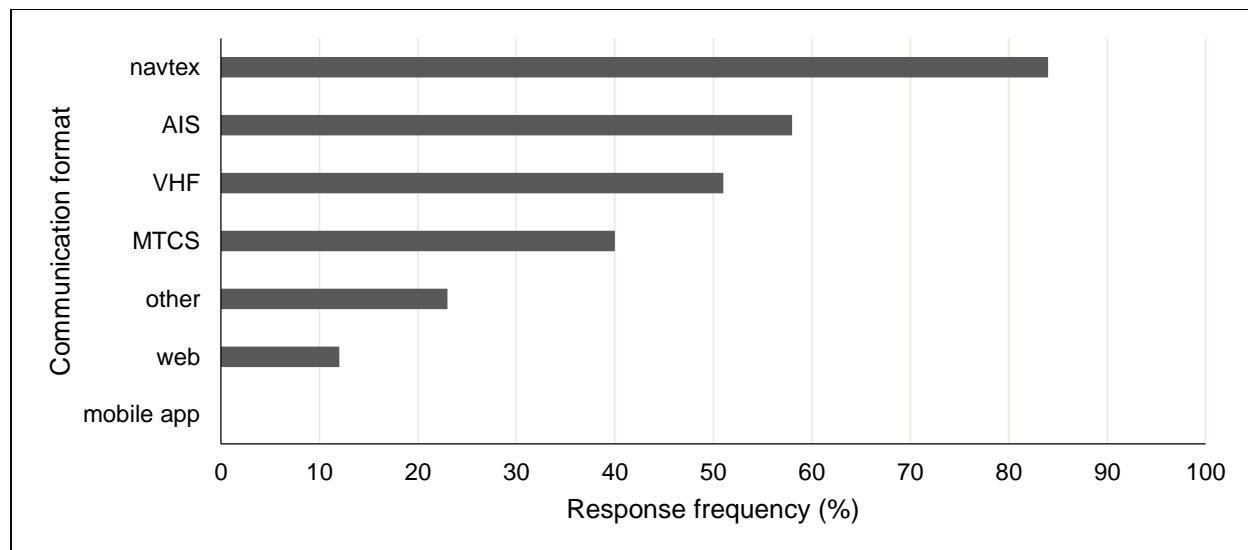


Figure 4. Bar chart showing the per cent response of mariners when identifying their preferred communication format for receiving near real-time whale alert information.

Most respondents (79%) ranked Navtex as a “not disruptive” form of receiving whale alerts (Figure 5). A similar number (72%) also ranked AIS as “not disruptive” and these two were significantly ranked as “not disruptive” more often than any other alerting method ($p \leq 0.003$ and $p \leq 0.028$, respectively). The disruptiveness of mobile apps was not ranked at all by 47% of respondents and this was significantly more often than all other options, except web-based alerts ($p \leq 0.041$). Communications media did not differ significantly in the ranking categories of moderately disruptive ($p = 0.132$, $\chi^2 = 5.619$, $df = 5$) and very disruptive ($p = 0.293$, $\chi^2 = 4.497$, $df = 4$). The modalities which respondents ranked as most preferred (above) were also found to be ranked as less disruptive to bridge protocols than non-preferred methods of receiving whale location alerts. The proportion of respondents who selected Navtex as their preferred alert media did not differ significantly from the proportion who indicated that Navtex would not be disruptive to bridge protocols ($p = 0.782$). This was also true for AIS ($p = 0.258$) and VHF ($p = 0.666$) communications. Significantly more respondents did not respond to the final question regarding willingness to pay for alerting technology (53%, $p \leq 0.001$). Of those respondents who did answer this question, 40% were not willing to pay for the technology (Table 1).

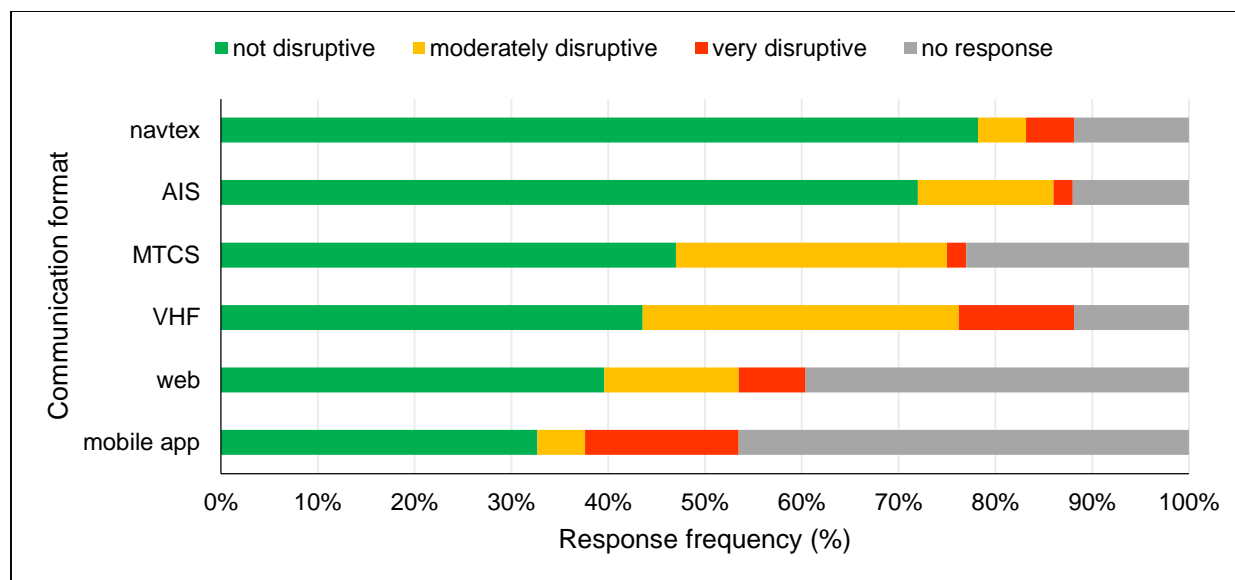


Figure 5. Bar chart showing the per cent response of mariners ranking their perceived disruptiveness of various whale alert communication methods to bridge protocols if used to transmit near real-time whale alerts.

Table 1. Per cent response of the mariner willingness to invest in near real-time whale alert technology on the bridge.

Willing to spend...	Response frequency (%)
\$0	19
\$0-100	9
\$100-500	9
\$500-1000	5
More than \$1000	5
No response	53

4. DISCUSSION

The results of this study provide new and semi-quantitative insights on the preferences, needs, and restrictions of mariners concerning the implementation of near real-time whale alert technologies (to mitigate vessel strike) on the bridge of oceangoing vessels. The results of the study show that while mariners may be knowledgeable of endangered whales, and are aware of various

conservation measures, especially those implemented for the protection of the right whale, there is no clear consensus as to when information is needed to safely initiate a response to near real-time whale location alerts. Further, the flexibility of mariners to implement these alerts into bridge planning is dichotomous; approximately half the respondents chose less flexible options for when alerts must be received and another half the more flexible options for responding to alerts. Conversely, the same sample population of mariners reached some consensus in their preference for the whale-alert communication formats, particularly Navtex and AIS, and these preferred formats were also considered significantly less disruptive than other formats. Thus, if mariners are to receive such information in near real time, it must be achieved in the least disruptive manner. This knowledge and awareness of whale conservation problems and some possible and preferred solutions regarding vessel-strike mitigation may be a precursor to actions that favour conservation, thereby easing the uptake of near real-time conservation.

4.1 Knowledge and awareness

Since the early 2000's, mariners transiting the eastern coast of Canada and the USA-Gulf of Maine regions have been receiving information on the endangered right whale and the conservation measures in place to reduce the risk of vessel strike. Given the longevity of right whale threat issues (20+ years) and protective solutions (12+ years), it was expected in this study that mariners would have a basic understanding and awareness of the endangered status of, at minimum, right whales, as well as the measures protecting the species. However, the 42% of respondents who incorrectly identified at least one species as being endangered according to Canadian listings may reflect the transitory nature of the industry. Regular crew changes and international movements are unlikely to foster specific education in a specific region. Despite this, the high percentage of respondents correctly identifying the right whale as an endangered species indicates some success among existing conservation programs and their communications strategies, as mariners are generally aware of the threatened species. However, the survey did not address the mariner knowledge or awareness of threats to baleen whales or the differential risk of these threats among whale species.

While mariners may or may not be aware of the primary risks to right whales, and baleen whales in general, the knowledge of endangered species reflects positively on the industry and the education-based conservation programs of the past. The species that were most often identified as endangered by survey respondents – right, blue, humpback, and fin whales – are also those species which have some form of endangered or threatened status through the International Union for Conservation of Nature (IUCN), SARA, or ESA. These responses may reflect a general awareness among mariners that baleen whales are threatened, and such awareness may ease the implementation of new conservation technologies by highlighting the need for adapted management as the threats persists. Since knowledge and awareness can lead to favourable behaviours (Jensen 2002), mariners who understand persisting threats and endangered whale populations might be more welcoming to partnerships with conservation practitioners. Further, since the majority of respondents indicated a desire to receive more information on endangered whales, new conservation programs could enhance their engagement with the fleet based on a shared understanding that some species and populations remain threatened. This desire to learn more may also reflect a lack of access to such information or a lack of time to become adequately informed on endangered whales, and may relate to a desire to participate in conservation. While 14% of respondents did not indicate whether or not they were interested in receiving information on endangered whales, this may reflect a group of respondents who felt they were already knowledgeable on the subject and did not require new information though there was no indication they had no interest in such information in the future. Most importantly, the results indicate mariners have not become deaf to the issue.

The efficacy of existing conservation measures in reaching target audiences is positively reflected by this study, as mariners were generally aware of most extant measures. This is of particular important since identifying the appropriate target audience is essential to achieving conservation goals through action (Aipanjiguly et al. 2003). In particular, mariners were aware of large-scale spatial conservation measures, including MPAs and ATBAs. This may indicate that mariners are disproportionately receptive to spatial information and, further, may better understand the role of spatial restrictions in conservation. At the same time, the results of this study indicate that mariners are less aware of dynamic or seasonal management areas, and this may indicate a future challenge

in implementing near real-time conservation technology. However, DMAs are exclusively located in USA waters of the NW Atlantic, and few respondents indicated the regular navigation of these regions. Dynamic conservation measures may not allow mariners to develop a sense of familiarity with, and understanding of, the measure as the measures are not permanent, are voluntary, and are more difficult to track as they come and go. This may be ameliorated by informing mariners on new conservation programs through communication media with which mariners are familiar with and use.

Mariners indicated that bridge placards and navigational charts were the most common means through which awareness of conservation measures was gained. Thus mariners may be looking to these media in the future to gain information on new programs and available technologies. The use of bridge placards and charts to inform mariners may be critical in advertising near real-time conservation as it transitions to the bridge as a voluntary measure because print media can be permanent fixtures on the bridge. However, using these media alone to share information may not compel mariners to comply with conservation requirements, as these are passive means of communication. Despite this, the high proportion of respondents who indicated a desire to learn more about conservation measures may indicate a fleet that is receptive to seeing a greater prevalence of conservation information in the industry. Similar to respondents interested in receiving more information on endangered whales, this high proportion may be further indicative of receptivity to conservation through the desire to increase knowledge and awareness.

4.2 Receptivity, needs, and preferences

Mariners may be restricted in their capacity to respond to whale location alerts depending on their voyage, weather, and company requirements with respect to operational efficiency. Additionally, such alerts, depending on format, may be quite disruptive to bridge planning and protocols and therefore may have perceived implications for navigational safety. It is thus critical that near real-time conservation measures pay careful attention to these restrictions and that the vision of providing mariners with whale location alerts is realistic only if amenable to industry requirements and operational protocols. In an attempt to understand the minimum time restriction for when

whale location information must be received to initiate a risk reducing response, the results of this study indicated a clear dichotomy among mariner respondents with respect to the flexibility of navigation.

When the responses of mariners who did not feel they needed information on whale locations was grouped with mariners who needed such information before leaving port, 60% selected response options that indicated a lack of flexibility in navigation, and perhaps an inability to feasibly incorporate near real-time information into bridge planning. However, when responses of mariners who felt they could respond to location information received within a few hours of arrival at the location was grouped with respondents who indicated an ability to respond immediately to such information, 63% selected response options that indicate flexibility for feasibly implementing near real-time conservation. This dichotomy indicates a division amongst mariners, and potentially an inability to commit to near real-time conservation without receiving more information on the conditions associated with using such technology. Further, since 16% of respondents selected both response options, mariners may need more information on the actions required to reduce collision risk an ability to comment on when information is needed with greater confidence. Alternatively, the need to receive information before leaving port may be for voyage planning assistance, while the need for information within a few hours of arrival at whale locations may be for navigational operations when approaching port of destination. Finally, the communication media by which location information is received may alter the timeliness of information delivery since some mariners appear to prefer formats that infer greater delays in information sharing.

Eight out of ten mariners indicated a preference for receiving near real-time whale location information through Navtex. Slightly fewer indicated a preference for AIS and even less so VHF. These communication media, unlike Navtex, can be updated immediately upon receiving information and do not require a delay in transmitting information, though with VHF, presumably through MCTS, this is uncertain and likely limited in coverage. All of the aforementioned options for receiving information are technologies that are commonly used by commercial vessels, and widely accepted methods of communication throughout the commercial shipping industry. It is thus not surprising that mariners are particularly uninterested in receiving information via mobile

apps or web pages. These media may be unfamiliar to mariners, and may represent an unwelcome or unavailable form of technology on the bridge, and in most cases (except satellite phone etc.) cell (mobile) phone coverage is poor or non-existent with increasing distance from the coast. These media also received the fewest responses when mariners were asked to rank the disruptiveness of each communication media to bridge protocols.

Since 40% and 47% of respondents did not address the disruptiveness of web pages and mobile apps, respectively, to bridge protocols, mariners may not consider these media as options worth consideration for receiving information mid-voyage. It is clear from the results that near real-time conservation should focus first on communication media that are more likely to be used by mariners, are most preferred, and are least disruptive so as to maintain navigational operations and safety. Navtex was the most preferred communication media, and it was also ranked as the least disruptive. Second to Navtex was AIS in both preference and disruptiveness. AIS may prove to be a more valuable communication media for near-real time conservation, as this technology enables communication of AIS messages that are regularly updated and checked by mariners. While Navtex is most preferred, the four hour delay between messages may be insufficient for timely response for reducing collision risk to whales. Further, the AIS system can allow whale location alerts to appear on electronic navigation charts, which visually presents the risk of collision and allows mariners to accordantly adjust navigational headings and (or) waypoints. Regardless, the high portion of respondents who indicated that both Navtex and AIS would not be disruptive to bridge protocols points to a greater receptivity to near real-time conservation or, at minimum, a means by which the uptake of such conservation information may be improved. In general, this study clearly indicates that mariners are likely more receptive to conservation measures that are not disruptive to bridge protocols for operational safety reasons.

Despite the positive implications arising from the survey results, more than half the survey participants did not respond to an inquiry regarding their willingness to spend money on acquiring the technology required of near real-time conservation. Moreover, of those respondents who did respond, 40% were not willing to invest in such technology. An unwillingness to pay for conservation measures can be indicative of a belief that this is the responsibility of more senior

personnel in the attendant agency (Ressurreicao et al. 2012). This may represent a barrier to implementation, as mariners are effectively not responsible for the acquisition of such technology. It appears that the necessary technology would have to be purchased by the owner/operators rather than the onboard mariners. As such, this barrier is not expected to be significant in the implementation of near real-time conservation though the process of achieving it may be difficult and time-consuming unless achieved under the auspices of some other agency such as the IMO. Agencies similar to the SFC may contribute to effective implementation by sensitizing mariners to the importance of conservation issues and identifying the mariner's role in conservation solutions. This response does, however, reflect the important role of corporations in the protection and preservation of biodiversity through action and information sharing (Kelly & Hodge 1996). Implementing near real-time conservation cannot progress without buy-in from industry partners. Moreover, shipping companies must be aware of and compliant with voluntary measures, otherwise masters may choose not to comply with these measures if they mean increased transit time and reduced efficiency (McKenna et al. 2012). The role of industry management in conservation cannot be undermined while developing new conservation programs, but must be considered jointly with the needs and preferences of mariners at the frontline of both industry and conservation.

4.3 Limitations and restrictions

While this study has provided valuable information to marine conservation practitioners, and may be used to expedite the implementation of near real-time conservation technologies, it is important to recognize that the results of this study reflect 43 mariners who chose to volunteer their responses for research. These responses may reflect only a small portion of mariners who are pro-conservation and interested in taking conservation action. These mariners may be more inclined to respond to a conservation survey as they were already knowledgeable and supportive of existing conservation measures. Further, mariners who chose not to respond to this survey may not view conservation as an industry issue and may not be receptive to the implementation of new conservation technologies; thus the need to communicate directly with the more corporate levels of the shipping industry.

Since 93% of respondents identified as representing a single vessel and 86% of respondents indicated that they annually navigate the Gulf of St. Lawrence, it is possible that the survey was completed by multiple representatives of a single fleet. This bias may significantly alter the research findings, as the needs, preferences, and restrictions captured by this study may only reflect a sub-population of mariners transiting a small portion of the Northwest Atlantic. It is therefore critical to acknowledge that this study represents only a first step toward understanding the commercial shipping fleet as a social group, and could be improved and expanded in the future to capture the opinions, preferences, and needs of a more global set of mariners who may be otherwise uninterested in conservation.

5. RECOMMENDATIONS AND CONCLUSIONS

As technologies in acoustic monitoring advance and the reception of the derived information approaches near real-time, alerting mariners of the real-time location of whales may be realized on the bridge in the near future. It is therefore imperative that conservation agencies begin to consider the challenges and restrictions of implementing these technologies such that mariners can make the best use of near-real time alerts while underway. Firstly, it is imperative that the agencies recognize that there are costs associated with the technologies and with conservation compliance. New measures must be wary of overstepping the limitations of the shipping industry, as it may compromise otherwise healthy relationships between conservationists and the shipping industry.

This research highlights the receptivity of mariners to near real-time conservation measures through an analysis of knowledge, needs, and preferences with respect to existing and emerging conservation measures. The research findings indicate that Members of the SFC, mariners who regularly transit regions of the Northwest Atlantic, are likely receptive to near real-time conservation. Mariners who responded to this research questionnaire were aware of endangered whales and existing conservation measures, particularly with respect to the endangered right whale. Most importantly, mariners were interested in receiving more information on both endangered whales and conservation measures. Respondents indicated that bridge placards and navigational charts were the most common means by which they became aware of conservation

measures. As such, it is recommended that these media be employed for future communications with mariners when developing new conservation programs, as mariners absorb the information in such documents.

With respect to receiving near real-time whale location information on the bridge, it was unclear whether mariners felt that bridge protocols were flexible enough to accommodate responses to such information. This may be due to a lack of information on how location alerts would be received and what a response would entail. It is therefore recommended that near real-time conservation programs clearly define “response” for mariners, and establish a protocol for safely initiating a response upon receiving whale location alerts mid-voyage. This protocol must consider the communication media used to transmit whale location alerts, and should not ignore the preferences identified by mariners in this study.

While Navtex was the most preferred means of receiving near real-time location information, Navtex is not the most dynamic communication media available to mariners. Since Navtex messages are broadcasted to mariners once every four hours, AIS may be a more appropriate technology for communicating whale locations in near real-time. Both Navtex and AIS were significantly different from all other media options in terms of their disruptiveness to bridge protocols. Given this, the greater flexibility of AIS messaging, and the option to passively inform mariners of whale locations, it is recommended that near real-time conservation programs consider AIS a primary option for communicating whale locations to mariners. It is essential that whatever media is used to bring whale location alerts to the bridge appropriately balances the preference for non-disruptive formats with a system that is regularly updated and monitored.

This work provides initial insights into some unknown sub-set of the commercial shipping fleet in Canada, and speaks to the effectiveness of past conservation programs in reaching mariners through education and awareness campaigns. Conservation can only be effective when coupled with changes to human behaviour. Large whale conservation in the Northwest Atlantic has been a testament to this, as the risk of lethal vessel strikes to whales has been significantly reduced

through industry compliance with conservation measures (Vanderlaan & Taggart 2009). Despite the successes of conservation, baleen whales remain threatened by commercial activities; and shipping in particular. Near real-time conservation may be an added solution to reducing the risk of vessel strikes to whale by bringing current and updated information on whale locations to mariners who are arguably at the frontline of large whale conservation. Like all conservation measures in the Northwest Atlantic, however, near real-time conservation will entirely depend on a compliant fleet, with mariners who are receptive to the implementation of new technologies.

This work represents a novel approach to solving large whale conservation issues by first considering the needs, preferences, and restrictions of vessel operators in the effort to reduce risk to whales without compromising vessel operations or navigational safety.

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7. APPENDICES

Appendix 1. Conservation measures of eastern Canada and USA-Gulf of Maine regions

1. **Area To Be Avoided:** a defined area that is recommended to be avoided by all vessels due to regional hazards to navigational safety. The Roseway Basin ATBA is a voluntary measure sanctioned by the IMO that mariners are asked to avoid to reduce vessel strike risk to endangered right whales.
2. **Conservation Areas:** regions recognized as being important for whale aggregations. Conservation areas for right whale were designated in 1993 for the Grand Manan Basin and Roseway Basin, primarily to raise mariner awareness as the areas are printed on navigational charts.
3. **Critical Habitat:** a habitat area recognized as being necessary for the survival or recovery of a species listed as endangered under the SARA. Critical habitat areas for right whales were delineated in 2007 for Grand Manan and Roseway Basins.
4. **Dynamic Management Areas:** areas in which vessels are regulated via temporary rerouting or reduced-speed recommendations when right whales have been detected. DMAs are only found in the USA and are voluntary for all vessels.
5. **Mandatory Ship-position Reporting:** ships must report on ship name, course, speed, and destination when entering two regions of the eastern USA coast. MSR was primarily introduced to provide vessel operators with timely information about right whales and the risk of vessel strikes in key feeding and nurse habitats.
6. **Mandatory vessel-speed restrictions:** regions of right whale habitat wherein vessels are required to slow down to reduce the lethality of vessel strikes, typically below 10 knots.
7. **Marine Protected Areas:** delineated regions of the ocean wherein human activities are managed primarily for the conservation of resident biodiversity.
8. **Seasonal Management Areas:** regions of vessel-speed restrictions that are seasonally active reflecting the migration of right whales along the eastern USA coast.
9. **Traffic Separation Scheme amendments:** relocated traffic-management systems ruled by the IMO to reduce vessel strike risk, primarily to right whales in the Grand Manan Basin.

Appendix 2. Marine communication media

1. **Very High Frequency radio:** an internationally recognized means of communication between vessels and between land and sea. VHF can be used on all kinds of ships and between vessels for communications anywhere on the open ocean.
2. **Automatic Identification Systems:** an automatic maritime transponder, including a GPS system, and receiver used for identifying and locating vessels, primarily to reduce vessel collisions. AIS information can be displayed electronically on a chart plotter.
3. **Navigational Telex:** an automated direct-printing service used to transmit written alerts to mariners at sea. Navtex alerts are prepared and distributed by CCG.
4. **Marine Communications and Traffic Services:** an entity of CCG responsible for the delivery of information and advice regulating the safety and efficiency of vessel movements in Canadian waters.
5. **Notice to Mariners:** communications prepared and distributed by CCG, including information on chart updates, nautical publications, initiatives, services, and announcements.
6. **Bridge placards:** printed informational materials intended to be held on the bridge.
7. **Navigational charts:** nautical charts showing oceanographic properties, topographic features, aids to navigation, and navigational hazards.

Appendix 3. Questionnaire preamble and consent form

Whales, Habitat and Listening Experiment Research Project Consent Form

On behalf of Dalhousie University researchers, the Shipping Federation of Canada invites you to take part in a study being conducted by Ms. Julie Hovey who is a Master of Marine Management graduate student in the Marine Affairs programme at Dalhousie University. **Your participation in the research by way of the attached survey questionnaire is entirely voluntary, and all participants and survey responses will remain confidential.**

Research Goals: Understanding vessel owner/operator information needs related to minimizing whale collision risk so as to reduce this risk without compromising vessel operations and the safety of navigation.

Project Description: The research is designed to increase understanding of vessel owner/operator needs, options and restrictions related to minimizing whale collision risk to whales, and to use the results to provide vessel owner/operators with an enhanced ability to minimize potential impacts of commercial navigation on large whales and their habitats without compromising vessel operations and the safety of navigation.

Lead researcher: Ms Julie Hovey, Dalhousie University, Halifax, NS. Other co-researchers involved in this project include Dr. Christopher T. Taggart, Dr. Kimberley Davies (both from Dalhousie University) and Dr. Moira Brown from the Canadian Whale Institute (Wilson's Beach, NB).

Funding provided by: Marine Environmental Observation Prediction and Response Network (MEOPAR)

Participation: Survey respondents should be representatives of corporate entities affiliated with members of the Shipping Federation of Canada (SFC) and preferably individual owner/operators or Masters of vessels affiliated with the SFC. All SFC members are encouraged to participate. Completing the survey is entirely voluntary and should take no more than 10 or 15 minutes.

Confidentiality: The identity of research participants will not be made available to the researchers. Only the completed survey questionnaires will be provided to the researchers. All results and analyses will be treated in aggregate and digitally stored in a password protected computer accessible only to the above named researchers. No person or corporation other than the Shipping Federation of Canada will be identified in any way, shape or form in any report stemming from the research.

The researchers are happy to talk with you about any questions or concerns you may have about your participation. Please contact Julie Hovey (+1 902-494-2830; hoveyjulie@gmail.com) or Dr. Christopher T. Taggart (+1 902-494-7144; chris.taggart@dal.ca) at any time with questions, comments, or concerns.

CONSENT

I understand that by returning the survey questionnaire I acknowledge having read the explanation about this study and agree to participate., that I have been given the opportunity to discuss it, and that my participation is entirely voluntary.

Please return the completed questionnaire to:

Caroline Gravel
Director, Environmental Affairs
Shipping Federation of Canada
300 St. Sacrement, Suite 326,
Montreal, QC H2Y 1X4
cgravel@shipfed.ca
Tél: (514) 849-2325 X 5 / Fax: (514) 849-877

*Research questionnaire***Survey Questionnaire****Vessel Needs, Options and Restrictions Related to Minimizing Risk to Whales Without Compromising Vessel Operations and the Safety of Navigation**

- 1) I represent (select one):
 A fleet A single vessel
- 2) Which of the following regions do you or your vessel(s) navigate annually? Select all that apply:
 Gulf of St. Lawrence
 Scotian Shelf
 Bay of Fundy
 Gulf of Maine
 None of the above (go to question #5)
- 3) If you represent a single vessel, how many trips annually does your vessel make through any or all of the regions identified above?
 1-5
 5-10
 10-20
 More than 20
- 4) If you represent a fleet, how many of your vessels annually navigate any or all regions identified above?
 2-10
 10-20
 20-40
 More than 40
- 5) a) To your knowledge, which of the whales below are considered as endangered?
 Blue whale Minke whale
 North Atlantic right whale Sei whale
 Pilot whale Fin whale
 Humpback whale
- b) If you are not aware of endangered whales, would you be interested in receiving such information in the future?
 Yes No
- 6) a) Are you aware of any of the following measures on the east coast of Canada and / or the USA-

Gulf of Maine that may help reduce ship strikes to large whales? Select all that you are aware of:

- Marine Protected Areas
- Areas To Be Avoided
- Dynamic Management Areas
- Traffic Separation Schemes
- Conservation Areas
- Critical Habitat Areas
- Other (please specify): _____

b) By what means did you become aware of these measures?

- Navigational charts
- Bridge placards
- Direct mail
- Websites
- Other (please specify): _____
- Notice to Mariners
- Automatic Identification System (AIS) messages
- Mobile device apps
- IMO Safety of Navigation Circulars (SN/Circ.)

c) If you are not aware of these measures, would you be interested in receiving advisory information

in the future?

- Yes
- No

7) When would you need information on whale locations in order to help you avoid collisions with whales?

- I do not need such information
- I need the information before leaving port
- I need the information within a few hours of arrival at the location
- I need the information on a continuous basis

8) If you were provided with near real-time information on whale locations during a voyage, in what format would you prefer to receive the information? Select all that apply:

- VHF radio
- Mobile device apps
- NAVTEX
- Other suggestions: _____
- Marine Traffic Control Services (MTCS)
- Automatic Information System (AIS) message
- Web pages

9) How disruptive would near real-time information be to bridge protocols if received in one or more of the following formats?

	Not disruptive	Moderately disruptive	Very disruptive
VHF radio broadcasts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MTCS advisories	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AIS messages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NAVTEX	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mobile device apps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
WebPages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10) How much would you or your corporation be willing to spend for the technology to be able to receive real-time whale location information on the bridge?

- \$0
- \$50-100
- \$100-\$500
- More than \$500



Thank you very much for participating!



By returning the survey you acknowledge that you have read the explanation of this study and agree to participate, that you have been given opportunity to discuss it, and that your participation is entirely voluntary. Please forward this completed survey form by land-mail, fax or email to:

Caroline Gravel
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300 St. Sacrement, Suite 326
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cgravel@shipfed.ca