The use and value of opportunistic sightings for cetacean conservation and management in Canada

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ABSTRACT

Twenty-one marine mammal species are designated under the Species at Risk Act (SARA) in Canada. When species are designated under SARA, management plans, recovery strategies, and action plans are outlined to prevent wildlife species from being extirpated or becoming extinct. In these plans, monitoring and outreach are often key recovery objectives for the species. Opportunistic sightings (OS) can help support the monitoring and outreach of species at-risk and can provide an important source of information on the presence of a species when systematic surveys are impractical or costly. To better understand the use and value of OS for cetacean conservation and management, marine mammal experts in Canada were interviewed (n= 15). A thematic analysis was used to examine the qualitative data of the interviews. Results suggested that OS are being used in a variety of different ways, from filling in data gaps, creating species distribution maps, informing management measures and being used as education and outreach tools. Experienced observers and reliability of a sighting were reported as key to being able to use the data. One main limitation of OS is the potential for poor data quality. Recommendations on how to improve OS for cetacean conservation and management include improving the quality of OS data by adding pictures or videos of cetaceans when reporting and using mobile applications to help record data, create a centralized database where open-source data is shared across the country, and improve education and outreach programs to increase cetacean identification training sessions for stakeholders on the water.

Keywords: opportunistic sightings; citizen science; cetaceans; marine mammals; whales; conservation; management; species at risk; Canada; community-based monitoring.

LIST OF ABBREVIATIONS USED

BCCSN	British Columbia Cetacean Sightings Network
COSEWIC	Committee on the Status of Endangered Wildlife
DFO	Department of Oceans and Fisheries
EIA	Environmental Impact Assessment
ENGO	Environmental Non-Government Organizations
ID	Identification
IUCN	International Union for Conservation of Nature
MMO	Marine Mammal Observers
MMON	Marine Mammal Observation Network
OS	Opportunistic Sightings
PC	Parks Canada
SARA	Species at Risk Act
SLGO	St. Lawrence Global Observatory
TC	Transport Canada

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CHAPTER 1: INTRODUCTION

1.1. Citizen Science and Opportunistic Sightings

Citizen science projects which have been defined as "scientific research and monitoring projects for which members of the public collect, categorize, transcribe or analyze scientific data," have increased over the years (Bonney et al., 2014; Cigliano et al., 2015). These include initiatives like eBird, iNaturalist, Frog Watch, and Marine Mammal Sightings, where members of the public become engaged in monitoring wildlife (Sullivan et al., 2014; Young et al., 2019; Government of Canada, 2019). eBird, for example, is a citizen science project where people collect information on the distribution and abundance of birds (Sullivan et al., 2014). It has gained traction among birder communities and researchers, with over 140 million observations of birds in 2013. Citizen science projects can differ in how they are run, from "contributory style programs, whereby volunteers participate in data collection; or co-creation and colleague style programs, wherein volunteers establish their own citizen science projects and programs often in collaboration with an expert" (Vann-Sander, Clifton, & Harvey, 2016, p.2).

Other terms in the literature for citizen science include community-based monitoring and opportunistic sightings (Conrad & Hilchey, 2011; Rechsteiner et al., 2013). For this project, the term opportunistic sightings (OS) will be used, as the following research focuses on sightings of cetaceans, and in Canada, the term OS is used among marine mammal researchers. OS provide observations of cetaceans that are not survey-based or have no effort associated with the sighting (Davies & Brillant, 2019). OS can be produced through citizen science initiatives, where community members or industries are asked to provide cetacean sightings regularly to help support research and management (Rechsteiner et al., 2013). OS for cetaceans are sightings that can be provided by the public, different industries (such as whale watching, shipping, ferries, and fishing) or observers during research activities that are not dedicated to surveying marine mammals (Rechsteiner et al., 2013; MacDonald et al., 2017). OS data can be recorded in different ways, through logbooks, phoning hotlines, or on mobile applications like Whale Alert or Whale Report (Rechsteiner et al., 2013; MacDonald et al., 2017; Whale Alert, n.d.; BCCSN, n.d.).

Scientists and managers are increasingly aware of how citizen science can help promote community participation in research and marine resource management (Vann-Sander et al.,

2016). Citizens are more engaged in community issues and are more likely to understand and accept management actions taken in their community when participating in citizen science projects.

1.2. Cetacean conservation globally and in Canada

Whales and other marine mammals face a variety of impacts from anthropogenic sources such as ship-strikes, underwater noise pollution, entanglement and bycatch from fishing gear, chemical and plastic pollution, climate change, disturbance from whale watching vessels, reduction in prey availability, habitat loss, seismic surveys, sonar disturbance, and whaling (NASEM, 2016; DFO, 2018a; Auditor General of Canada, 2018; Pirotta, Grech, Jonsen, Laurance, & Harcourt, 2019; IWC, n.d.). While whaling in Canada ended in 1972, with the exception of Indigenous whaling, there are still whale populations that have yet to recover to pre-whaling numbers (Francis, 2015). At the global scale, there are currently 89 cetacean species (whales, dolphins, and porpoises) and 39 subspecies that are on the IUCN Red List (IUCN, 2019); 29% are considered threatened (which means they are either critically endangered, endangered, vulnerable, or near threatened by IUCN categorization), and 30% are data deficient. More work needs to be done in order to protect cetaceans globally and locally.

In Canada, 21 marine mammal species are designated under the Species at Risk Act (SARA) (Government of Canada, 2011). The purpose of SARA is to

> "prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened" (SARA, 2019, p.7).

When species are designated under SARA, management plans, recovery strategies and action plans are outlined to help prevent wildlife species from being extirpated or becoming extinct (DFO, 2016). In the Northwest Atlantic, some of the most endangered cetaceans include the North Atlantic Right Whale, Blue Whale, St. Lawrence Estuary Beluga Whale, and the Northern Bottlenose Whale (see Appendix A, Table 1) (Government of Canada, 2011; DFO, 2019a). In management plans, recovery strategies and action plans for species at risk, monitoring and outreach are often key recovery objectives (DFO, 2016). Monitoring of cetaceans often

consists of obtaining distribution and abundance data through direct observations from dedicated surveys on boats, airplanes, and passive acoustic devices (DFO, 2018b; Davies & Brillant, 2019). In addition, opportunistic sightings (OS) can help inform monitoring and outreach of at-risk species and can provide an important source of information on the presence of a species when systematic surveys are impractical or too costly (Rechsteiner et al., 2013; Torreblanca et al., 2019). It is particularly useful for species that are highly migratory, sparsely distributed and wide-ranging. However, OS have some drawbacks that may prevent researchers from using them as a source of data, with sometimes no recording of effort, and observation biases, "including variation in detectability of species, reliability of species identification, observer expertise, and spatial and temporal heterogeneity in sampling effort" (Rechsteiner et al., 2013, p. 4).

1.3. Marine Mammal OS Databases in Canada

Four main marine mammal OS databases are available in Canada (Table 2). DFO manages the OS whale sightings databases in the Maritimes and in Newfoundland and Labrador (DFO, 2019b). In Quebec, there are various environmental non-governmental organizations (ENGOs), but the main one that manages OS is the Marine Mammal Observation Network (MMON), with the help of the St. Lawrence Global Observatory (SLGO) (Blier & Nolet, 2019; SLGO, n.d.). In British Columbia, OS are managed by the B.C. Cetacean Sightings Network (BCCSN) (DFO, 2019b). When it comes to responding to marine mammal incidences, each coast differs; DFO responds when whales are called in as injured, entangled, and stranded or dead in BC and ENGOs respond in the East coast provinces; however, the response is often a group effort with the government supporting the ENGOs (DFO, 2019b).

Table 2. Overview of who manages opportunistic sightings (OS) and incident databases on the West and East coasts of Canada.

	West Coast	East Coast
Department of Fisheries and Oceans (DFO)	**Incident hotline**	**OS** o Whale Sightings Database - XMAR (Maritimes) o Whale Sightings Database - Ask Jack (NL)
Environmental non-governmental organizations (ENGOs)	**OS** o B.C. Cetaceans Sightings Network (BCCSN)	**OS** o Marine Mammal Observation Network (QC) **Incident hotlines** o Group for Research and Education on Marine Mammals (GREMM) (QC) o Marine Animal Response Society (MARS) & Campobello Whale Rescue Team (CWRT) (Maritimes) o Whale Release & Strandings (NL)

The Marine Mammal and Pelagic Animals or Whale Sighting Database (WSDB), also known as XMAR, was implemented by DFO in 2002 and is a central repository of opportunistic sightings (OS) of whales, dolphins, porpoises and large pelagic animals in the Bay of Fundy and the Scotian Shelf (MacDonald et al., 2017). Cetacean surveys in the Maritimes region are rare, so OS have increased information on species observed, their location and seasonable distribution, their behaviour and life history. The XMAR database is comprised of sightings from 1963 to 2019 (Figure 1), and sources of sightings have primarily been from whale watch companies (53.032%), various government departments like DFO at-sea fishery observers, conservation and protection officers, or Canadian Coast Guard (11.713%), and NGO researchers (9.423%) (see Appendix A, Table 3). Note from 1973 to 1991 and in 1995 data was not incorporated into the XMAR database. Recently, there have been campaigns for the general public to report their sightings through a toll-free phone line (1-1-866-567-6277), email (XMAR,

whalesightings@dfo-mpo.gc.ca), and web applications, like Whale Alert (http://www.whalealert.org/) (MacDonald et al., 2017).

The Marine Mammal Observation Network (MMON) is a non-profit organization working on the conservation and promotion of fauna found in the St. Lawrence since 1998 (Blier & Nolet, 2019). Observers part of the MMON collect whale and seal observation data. MMON observer members consist of conservation park wardens, cruise and whale-watching tour companies, shipping operators, and ferries. In 2015, MMON teamed up with Green Marine, a voluntary environmental certification program for the North American marine industry, to develop a whale data collection and training program for domestic ship owners/operators. The pilot project has been running from 2015 to 2019, with seven companies collecting OS of marine mammals and contributing to the understanding of whale distribution patterns in major shipping channels (Blier & Nolet, 2019).

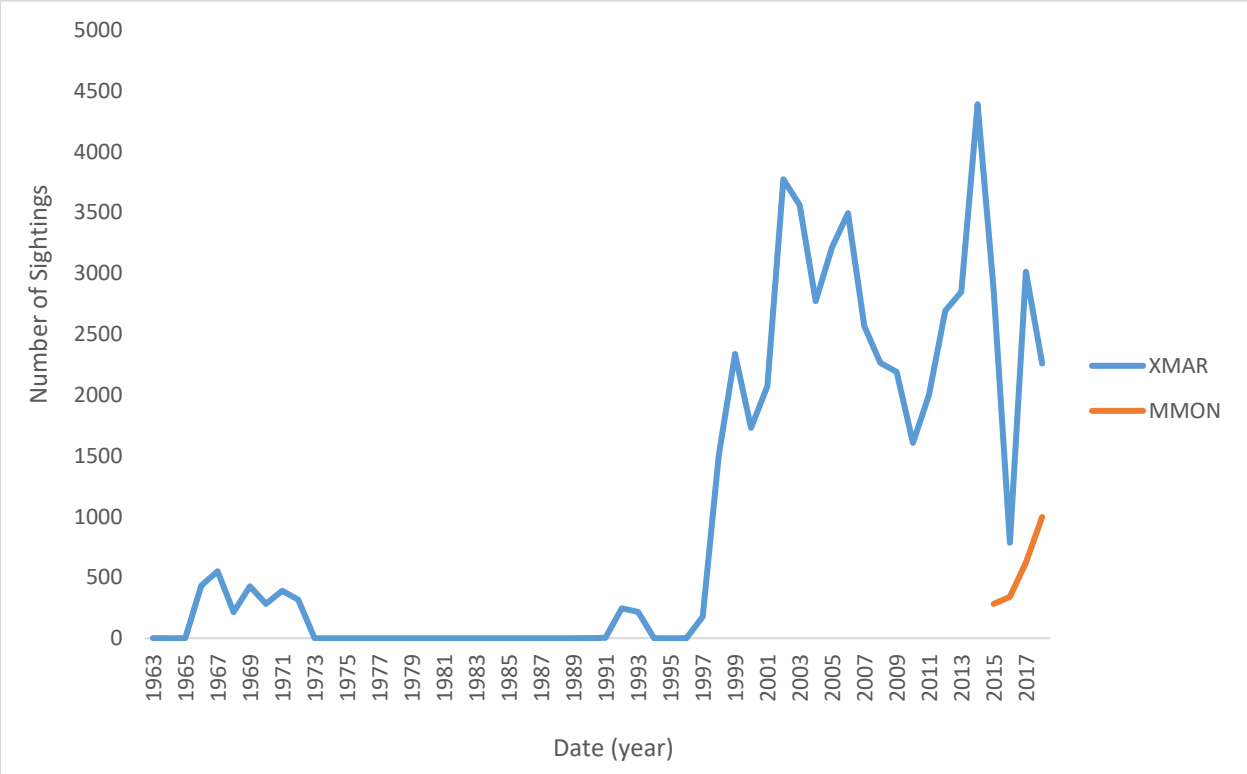

Figure 1. Number of opportunistic sightings (OS) (n= 59470) recorded through time from the Maritimes region whale sightings database (XMAR) and the Marine Mammal Observation Network marine industry database (MMON). Note 2019 was omitted as the year's data is not fully available. Whale Sightings Database, Ocean and Ecosystem Sciences Division, Dartmouth, NS, [2019/07/24] and Marine Industry Whale Data Collection, MMON, Rivière-du-Loup, QC, [2019/10/26]

The top four species reported opportunistically from XMAR and MMON are humpback whales, harbour porpoise, fin whales and minke whales, with the first three listed in SARA (see Appendix A, Table 4). Data in these databases are not effort corrected and thus only account for presence data, not absence data. When sightings are illustrated as in Figure 2, places where there are no whale sightings does not necessarily mean that there are no whales, there are just no reportings in that area. Figure 2 shows the density of OS of cetaceans in Eastern Canada with XMAR and MMON marine industry data. The marine bioregion with the most sightings in Figure 2 is the Scotian Shelf (n=50,719, 85%), followed by the Estuary and Gulf of St. Lawrence (n=6,987, 12%), and the Newfoundland and Labrador shelves (n= 1,764, 3%). However, the whale sightings database from Newfoundland and Labrador are not included in the map as the data were not available at the time of the study, potentially accounting for the low number of sightings in that region.

The B.C. Cetaceans Sightings Network (BCCSN) is a program that collects OS of cetaceans and sea turtles on the west coast of Canada and is run by the Coastal Ocean Research Institute (an Ocean Wise initiative), in partnership with Fisheries and Oceans Canada (BCCSN, n.d.). The BCCSN have been able to model observer effort along the coast of BC with its OS, to help understand where observers are looking for whales (Figure 3) (Rechsteiner et al., 2013; BCCSN, n.d.). Observers can report sightings through the Whale Report application created by BCCSN, online (https://wildwhales.org/app/), via email (sightings@vanaqua.org), through a hotline 1.866.I SAW ONE (1-866-472-9663), or by using a logbook. The extent of cetacean relative abundance in BC is shown in Figure 3, where OS from the BCCSN were combined with systematic survey sightings (Coastal Ocean Research Institute, 2016).

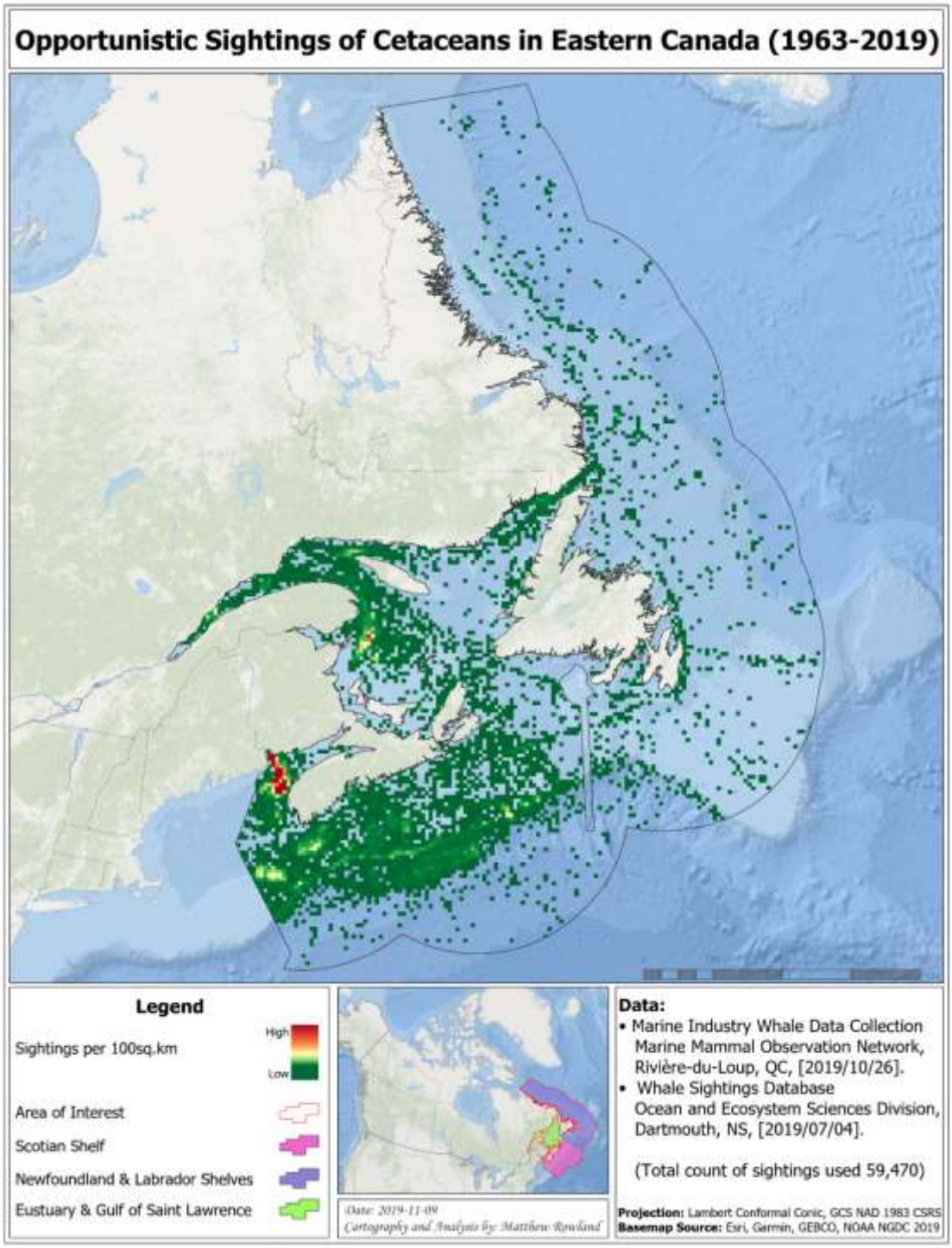

Figure 2. Density of opportunistic sightings of cetaceans in Eastern Canada from 1963 to 2019. (Note that 2019 data does not include the whole year's data, and sightings are not effort corrected, and they only represent presence data of cetaceans.)

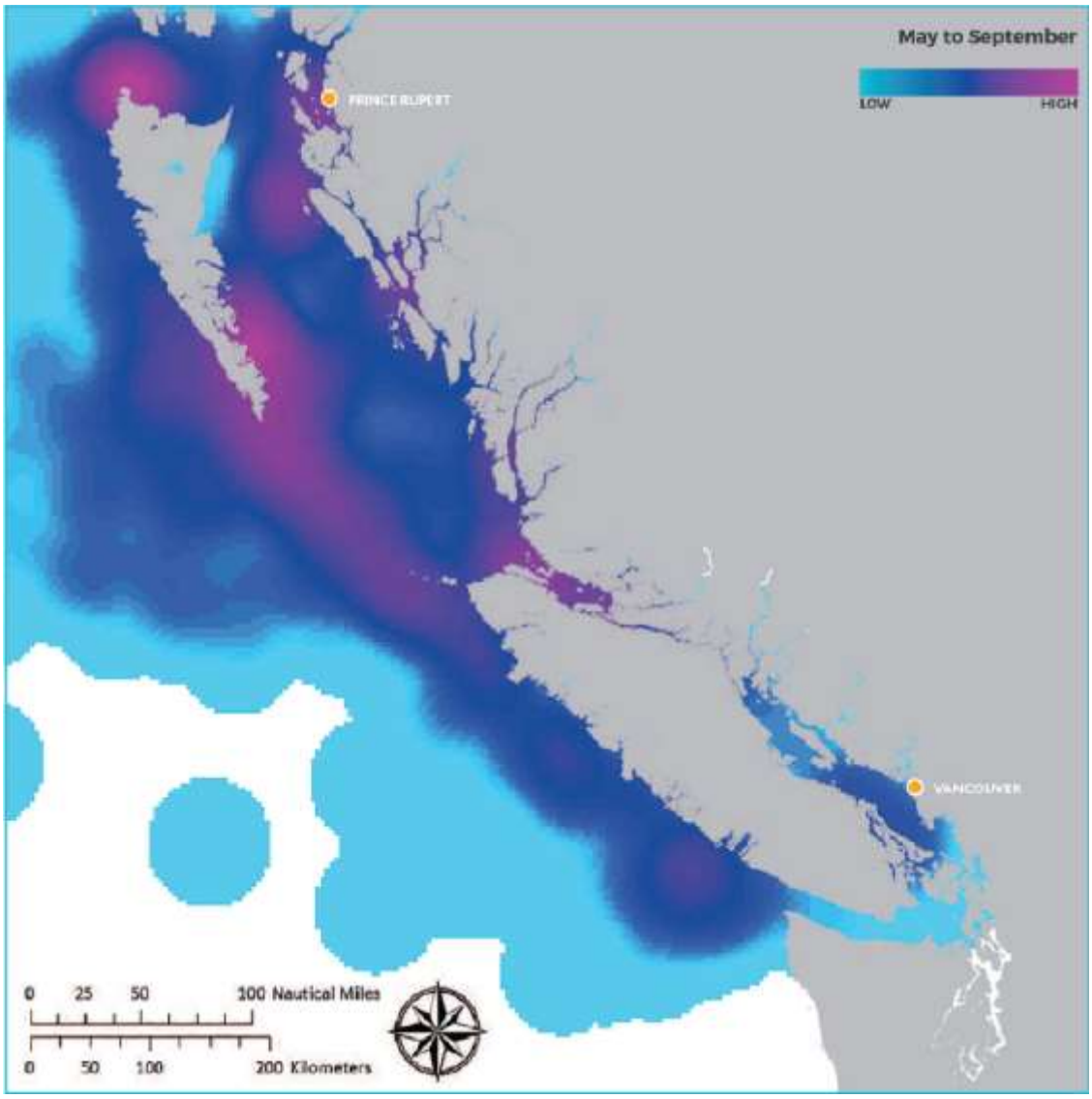

Figure 3. Relative abundance of cetaceans in British Columbia waters based on opportunistic and systematic sightings (Coastal Ocean Research Institute, 2016).

1.4. Management problem and research objectives

Despite the Canadian government's efforts to protect marine mammals in the past couple of years, the 2018 audit by the Office of the Auditor General of Canada, concluded that the four government departments responsible for protecting marine mammals (Fisheries and Oceans Canada, Environment and Climate Change Canada, Parks Canada, and Transport Canada), had "not fully applied existing policies and tools to proactively manage threats to marine mammals from commercial fishing and marine vessels" until 2017 when measures and actions began (Auditor General of Canada, 2018, p.3). With these new measures and actions to protect marine

mammals, there has been an increase in the monitoring of cetaceans at risk in order to provide scientific evidence to inform management. Monitoring of cetaceans is important to understand their distribution and critical habitats, and management measures are put in place based on understanding their habitats. However, data on cetaceans is often lacking (IUCN, 2019; Davies & Brillant, 2019). Furthermore, until recently, the technology has been limited to monitoring cetaceans primarily through visual observations (CWI, n.d.). There have been incentives for OS, through initiatives like Green Marine and the Marine Mammal Observer Network (MMON), BC Cetacean Sightings Network (BCCSN), reporting a marine mammal sighting or incident through DFO and for species at risk recovery, management, and action plans. Nevertheless, the use and value of OS for cetacean conservation and management have not been documented in Canada.

This project will identify the benefits and limitations for OS in cetacean conservation and management by addressing the following questions: who is providing cetacean OS in Canada; how are OS of cetaceans being used and valued in Canada; and how can we improve OS for cetacean conservation and management. The results of the study will inform current and future citizen science projects or industry initiatives collecting cetacean sightings to improve their utility in cetacean conservation.

CHAPTER 2: METHODS

2.1. Interviews

Semi-structured interviews (n= 15) were conducted with scientists and managers working in the marine mammal field across Canada. Interviews were carried out in person or over the phone between July and September 2019. The length of the interviews was, on average, 45 minutes long but ranged from 30 minutes to 1.5 hours. Questions explored how OS are being used, what conditions make the data useable, what are the benefits and limitations of OS, who is collecting OS data and are OS useful for cetacean management. Interview questions were developed with guidance from a similar survey in Peters, Eames, and Hamilton (2015). The full interview script and questions are included in Appendix B. The research was conducted using qualitative research methods, as described in Bhattacherjee (2012), with an interview script that helped guide the interviews to ensure that each one was carried out in a similar manner. Ethics approval to conduct the study was obtained from the Marine Affairs Program at Dalhousie

University through the Marine Affairs Program Ethics Review Standing Committee (see Appendix C).

2.2. Participants

Participants were selected based on the lead author's supervisors' professional networks and expanded through the snowball sampling technique (Bhattacherjee, 2012; Peters et al., 2015). Participants were invited to take part in the study through email and agreed to take part in the study upon signing the consent form (see Appendix D & E). Interviews were audio-recorded; however, the recording was optional, and participants were asked if they agreed to be recorded. Additional notes were taken during the interviews.

Each participant was assigned a code based on which stakeholder group they were in. Four categories of stakeholders were interviewed, academics (n=2, code= A), government scientists (n= 4, code= GS), government managers (n=5, code= GM), and ENGOs researchers (n= 4, code= NGO). The scientists and managers working within the federal government include the departments of Fisheries and Oceans Canada (DFO), Transport Canada (TC), and Parks Canada (PC). For participants at DFO, recruitment was conducted in the Maritimes, Gulf, Quebec, Newfoundland, and Pacific regions. DFO has marine mammal science teams and resource managers who work on research and management of marine mammals. For TC, recruitment was mainly conducted in the Ottawa region, as they are the headquarters that implement shipping management measures for at-risk whales. For PC, recruitment was only conducted at the Saguenay St. Lawrence Marine Park as this is currently the only marine park in the Northwestern Atlantic, and they have a long history of collecting marine mammal observations. In addition to interviewing government employees involved in science and management, marine mammal researchers in academia were contacted across the country for interviews. Environmental non-government organizations (ENGOs) researching marine mammals in Canada were also targeted to obtain their perspectives. ENGOs in the marine mammal field have researchers that have been working on cetacean research and advocacy for many years. Overall, the different stakeholder groups were interviewed to gain different perspectives (academia vs ENGOs vs government) on the use and value of OS.

The geographic scope of the interviews included participants from Quebec (n= 4), the Maritimes (n= 7), Newfoundland and Labrador (n= 1), Ottawa (n= 1), and British Columbia (n=

2), for a total of 15 interviews. The average experience of participants working in the marine mammal field was 15.3 years, and ranged from 1 to 43 years working on cetaceans.

2.3. Analysis

Audio-recorded interviews were transcribed verbatim into a word document for analysis. Transcripts were analyzed using the qualitative data software NVivo 12 plus (https://www.qsrinternational.com/nvivo/nvivo-products). The transcribed data were coded for content using the grounded theory technique: "an inductive technique of interpreting recorded data about a social phenomenon to build theories about that phenomenon" (Bhattacherjee, 2012, p. 113). This technique allows the researcher to produce themes from the interviews based on what the data has to say. However, to help guide the analysis, the overarching themes and segments of text (here-on referred to as references) were; uses and benefits of OS, limitations of OS, providers of OS and recommendations to improve OS. While analyzing the transcripts, new themes would emerge and would be categorized as sub-themes under the overarching categories. References associated with each theme were checked to ensure that they belonged in the right category. Towards the end of the analysis, similar sub-themes were merged.

An analysis of positive and negative perceptions was conducted to determine participants' views on the value of one group's data over another, with groups referring to those who collect OS data. The auto code sentiment analysis feature was used in NVivo 12 plus, where the software splits references into positive or negative sentiments. The auto coding was checked for any errors by ensuring that references belonged in the right category.

CHAPTER 3: RESULTS

The results are presented in four sections. The first section details who is reporting OS of cetaceans in Canada. The second and third sections are on the various ways OS are used, its benefits, and the limitations of OS. Finally, the fourth section reports recommendations on how to improve OS for cetacean conservation and management in Canada.

3.1. Who is reporting OS of cetaceans?

Seven main groups of OS collectors were identified during the interviews (Table 5). The general public, whale watching industry, shipping industry, fishing industry, researchers, government OS platforms, and marine mammal observers (MMOs). The general public and

different marine industries are typically thought to be those that report OS, but the results suggest that even some researchers and government officials, as well as MMOs, can provide OS. This results in a variety of different OS reporters with varying levels of marine mammal identification capabilities.

Table 5. Groups mentioned in the interviews that report opportunistic sightings across Canada, and the number of participants that discussed each group's sightings.

Groups	Description	# of Participants
General public	Recreational boaters, people who are by the coast or citizens on ferries or eco-tourism vessels.	14
Whale watch industry	Captains and/or naturalists reporting from whale watch vessels.	12
Shipping industry	Captain and crew on large and small commercial ships and ferries.	12
Fishing industry	Recreational or commercial fishers.	10
Researchers	Researchers, whether they are in academia or NGO.	10
Government OS platforms	Conservation and protection, fisheries enforcement, coast guard, department of national defence.	7
Marine mammal observers (MMO)	MMOs are trained in marine mammal identification at sea and are often on platforms of opportunity (i.e. fishing boats, ferries, ships).	3

When asked if one group's data was more valued over another, 53% (8/15) of the respondents argued that "valued is not the right word. It is more that some are categorized as trusted sources, and some are not. Because we value verified sightings over unverified sightings" (GS3), another participant mentioned, "I do not look at the specific group that I am getting data from, I am more looking at, what is the data quality that's assigned to it. So I value most the highest quality data that we are fairly confident in their species ID" (GS5). However, some participants did mention that some groups' data are better than others, mainly due to the reliability of the data. Positive vs. negative sentiment analysis was conducted on the references discussing the value of a group's OS data (Figure 4).

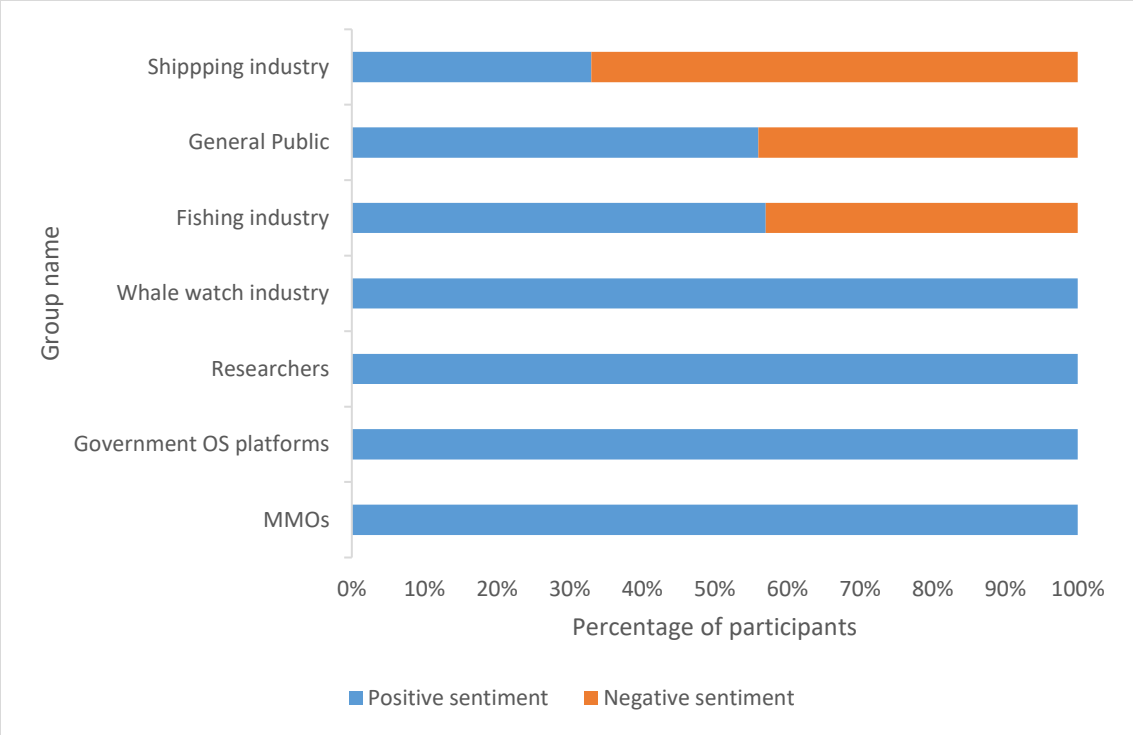

Figure 4. Positive vs. negative sentiments towards how reliable OS data is for each group that reports OS of cetaceans in Canada.

Out of the twelve people who spoke about shipping industry data, nine discussed the value of their data and three (33%) had positive sentiments, expressing that seafarers are "used to looking out at sea for danger…and are…pretty good at spotting the animals if they know where to look and for what" (A2) and "shipping companies that have received onboard training. If the mates or the captain have not changed…I would give some credibility to the data" (NGO1). Six (67%) however, were negative sentiments, mentioning that the mates on big cargo ships would change too frequently, making their data unreliable and that "a lot of the time they are so far away or so far up that we do not get the imagery associated with [the sighting]" (GS3), resulting in often an unverified OS due to unreliability with the species ID.

For the fishing industry, seven people spoke about fishers' OS value: four (57%) had positive sentiments, and three (43%) had negative sentiments. A positive comment was, "there are fishermen that are out there, and they see things all the time…they spend so much of their lives at sea…and if they have an interest in what they are seeing, they might have [done] research" (GM2) and know now what they are seeing. However, fishers often do not provide high-quality sightings and a respondent described discussions of OS as "more like dockside

chat" (NGO4). This respondent also noted, the OS reports from the fishing industry have decreased in recent years due to concerns of possible fishery closures due to reported sightings of right whales from that industry. This respondent further stated that "we do not get a near real-time position during the fishing season out of the fisherman's concern that it will close their fishery down" (NGO4). Respondents also mentioned that for fishing and shipping industries, or offshore industries, they felt that because of the nature of their work, they are not directly involved in identifying species and therefore a little bit less clear on OS details. As one respondent noted, "they have a lot of other work that they are typically doing. Thus, they often cannot spend much time trying to identify a species" (A1).

Out of the fourteen participants who spoke about OS from the general public, nine discussed its value, with five (56%) having positive sentiments, highlighting that, "coastal citizens…for example, people live on the coast observe from their homes. There is going to be a range of reliability from those people, but because there are some quite regular observers, people report regularly and send photos" (GM4). Also, respondents would mention how often they would find images or videos of whales' online, like on Facebook or Flickr. Four (44%) participants had negative sentiments, mentioning how reliable or experienced a person was, has an impact, "I would put a lower value on sightings from inexperienced observers, so that could be the fishing and shipping industry, or members of the public" (NGO4).

For the whale watching industry, researchers, government OS platforms and MMOs, no negative sentiments were mentioned on the value of their OS data. Out of the industries on the water, whale watch companies seem to be the best source of OS and have been providing OS for many years. "The whale watch industries are fantastic, and they are particularly credible because they are experts in identifying different species of whales" (A1). Researchers that are out on the water, conducting other work provide valuable OS, "because a lot of these people are people whose work is directed towards knowing marine life, often their sightings are going to be quite reliable as well" (GM5). Government OS platforms have proven to be essential sources of information, "like DFO's conservation patrols by boat or aircraft who might be patrolling for broader reasons…those people are trained in species identification of whales, so if they report a right whale, it is considered a reliable source" (GM1). Similarly, MMOs have a lot of positive sentiment, "probably the most confidence I would have are MMOs because they received the

most training…depending on how often they are doing it like they gain some experience, they know what to look for, they have seen it" (GM2).

3.2. Use and value of OS

Opportunistic sightings (OS) of cetaceans are used in a variety of ways, and when asked how they are being used and for what purposes, seven themes emerged from the interviews: prerequisites, management, benefits, publications, analyses, survey activities, and collaboration (Table 6).

Table 6. The main seven themes for the uses of OS, and the number of people who discussed each theme.

Theme Name	Description	# of Participants
Prerequisites	The specific conditions that make OS data useable such as experience, verified sightings, and follow-up with the reporter.	15
Management	OS are being used to inform management measures of cetaceans.	15
Benefits	Overall value, importance, worth of OS. Fills in data gaps, inexpensive and educational are the main benefits.	14
Publications	Publications or reports that incorporate OS. Publications or reports in academic journals, government, and industry reports.	12
Analyses	The types of analyses OS are used for research (e.g. distribution and habitat use maps)	10
Survey activities	OS can help direct where dedicated survey activities could be, or a dedicated survey team can verify the report of an OS.	10
Collaboration	Collaboration with NGOs, other researchers, other divisions of government and with industries on the water to obtain OS.	9

3.2.1. Prerequisites

Three components make OS data useable (Table 7):

1. Experience of the observer
2. Criteria for a verified sighting
3. Follow-up with the observer

Table 7. Sub-themes for the prerequisites needed to use OS data, and the number of people who discussed each sub-theme.

Sub-theme Name	Description	# of Participants
Experience	How much experience the reporter has and whether they have any training.	11
Verified sightings	If a researcher verifies the OS, it can be used, and the sub-nodes indicate what is needed for a sighting to be verified.	5*
a. Location, date and time	GPS coordinates, date and time.	9
b. Photograph or video	Photographs that allows the species to be identified helps a researcher verify the sighting.	9
c. Species ID	Ability to correctly identify the individual to species.	4
d. Description	What is the behaviour of the species, how many individuals are present and any other information.	4
Follow-up	Need to follow-up with OS providers to ask for any additional information.	3

*Outliers that did not correspond with the sub-nodes.

Eleven (73%) participants stressed the importance of an experienced observer to have good quality OS data, "people who have received training" (NGO1), "there are people who have been trained as marine mammal observers at a minimum, to be able to distinguish between the different whale species or that have certain training or that have been identified as reliable sources by DFO" (GM4). Furthermore, sightings reported need to have a date, time, location, photograph or video, species identification (and the confidence level of the sighting), and a description. NGO2 made it clear that if somebody sends them a picture, it gas to have date, position, and author of the photograph, because "if there is a little bit of a doubt, then we throw it out because we cannot depend on it."

A government scientist in the Maritimes region explained that they have different data quality levels of a sighting, high to low, with the highest level usually

> "accompanied by a photograph and we can verify the species from that photograph or video, then it will…go in as a species ID as certain…And it is just related to whether or not we can verify that species that person said it was actually that species because we do not know their background or their experience" (GS5).

Some reporters are considered trusted individuals where their reports automatically get a high data quality level; this includes experienced and well-known researchers, government OS platforms, and MMOs.

On the west coast, only two people were interviewed, one from government management and one from an ENGO. However, both mentioned that OS are highly used due to the BC Cetaceans Sightings Network (BCCSN), which allows researchers and managers to have access to verified and reliable sightings. They go through all reported data and check the quality of the data. A respondent explained that "they already have a process where they look at the confidence of the sightings…based on who the person was who reported it and they're history and expertise…and people coast wide are encouraged to report their sightings to that network" (GM5).

3.2.2. Management

For OS to be used in the management of species at risk, they have to be considered verified sightings or else it may financially impact industries and communities (Table 8):

> "It does have to be reliable; otherwise, we are spending a lot of time and energy on a non-verified sighting…But if it is not reliable and we trigger a measure based on an unreliable source A, we lose credibility and B, there is a resource implication, both to government, as well as to industry and communities. When we have a slowdown triggered in the dynamic zones on the East Coast, the port of Gaspe is hit pretty hard." (GM4).

Table 8. Sub-themes for the use of OS in management of cetaceans in Canada, and the number of people who discussed each sub-theme.

Sub-theme Name	Description	# of Participants
Management measures	Examples of how OS have or can be used in management measures.	13
OS needs to be verified	OS needs to be verified by researchers in order for them to be used in management decisions.	8
Incident reporting	OS are important for reporting when cetaceans may be entangled, injured, stranded or dead.	6
Science advice	Management decisions based on evidence provided by scientific research.	4

In order for OS to be reliable, they need to be checked by scientists or OS networks, as discussed in section 3.2.1. OS are just the initial step; that then goes through scientific research before it can be used in management. NGO4 pointed out, "really the step would be from opportunistic sighting to directing research effort to informing management." The theme of science advice emerged (4/15 participants), with many government managers expressing the sentiment that "the management of cetaceans is dependent upon science and science advice. So it would be a question for science [DFO science] to answer whether or not they feel that they would use it in providing advice to management" (GM3).

Therefore, if OS are verified by science, thirteen (87%) participants expressed that they can help inform a variety of scientific questions and management measures:

- Incident responses
- Defining critical habitat
- Vessel slowdowns or redirecting vessels
- Fishery season start or finish, or fishery closures
- Redirecting enforcement efforts
- Extension or shortening of when management measures are in place

3.2.3. Analyses

Five (33%) respondents are currently not using OS either because they are conducting research that does not use OS, for example, acoustic research related to cetaceans or because OS are not found in their study area. In some areas, they are not used because many researchers are doing systematic surveys, and the area of interest may be small. GM4 pointed out "on the east coast…a lot of it is done through aerial surveillance, as well as some acoustic detections." The utility of OS data in research depends on the research question itself, "so it depends on what you are looking for. So I think that both [systematic and opportunistic data] is necessary, but you have to know firsthand what you are going to do with the information" (GS2). However, from the number of participants views, cetaceans OS appears to be used primarily to understand the general distribution and habitat use of cetaceans followed by an analysis of anthropogenic activities and, to a lesser extent, in environmental impact assessments (EIA) and to support photo

ID of individual whales when photos are available (Table 9). For instance, OS data was used to model habitat suitability,

> "So the intent of the model is you build a map of the predicted habitat of whales based on where we know we have seen them. But...we do not know where people have looked and have not seen them yet. So…we'll use the opportunistic sightings of all the other species…as sort of like pseudo zeros. So they are not real zeros, but we know that species was seen there at that time." (GS5).

OS was also used "to assess the exposure of the southern resident killer whales population to shipping noise" (A2), or GS2 explained that if captains on ships record OS of cetaceans, it can give you information on where the whales are in relation to the ship, "it can give you a lot of information too, not just on where the whales are along the track line of the ship, but it can give you information on the activity itself, shipping" (GS2).

Table 9. Sub-themes for the types of analyses that OS can be used in, and the number of people who discussed each sub-theme.

Sub-theme Name	Description	# of Participants
Distribution and habitat use	Often distribution and habitat are visualized using maps. Also, to conduct species distribution models or maps.	8
Anthropogenic threats	Research on how human activities impact cetaceans. Tracking interactions between cetaceans and human activities.	6
Photo ID catalogue	Pictures of high quality and of areas of the whale that allows for identification can be incorporated in photo identification catalogues.	2
Environmental impact assessments (EIA)	Evaluating the environmental impacts of a proposed project on cetaceans.	2

3.2.4. Publications

Twelve (80%) participants discussed various publications or reports OS has been used in (Table 6). Publications or reports have been described as either scientific research published in journals, government reports, or industry reports. Some government reports that have included OS are species at risk recovery documents, sighting summary daily reports to managers, CSAS reports, and an ecological overview for new marine protected areas. Industry reports that may

include OS are environmental assessment documents or mariners' guides. For example, a "mariner's guide to whales in the Northwest Atlantic" (NGO1) was produced, and data used in the guide was OS data collected by various sources and systematic survey data. Some participants also mentioned the website Whale Map where opportunistic and systematic sightings of cetaceans in the Northwest Atlantic are available to the public.

3.2.5. Survey activities

Ten (67%) participants expressed how OS help inform research survey activities (Table 6). "We might use opportunistic sightings if we are out on the water and an opportunistic sightings report comes in, and there is no other information to go on. We would likely use that to inform our survey activities" (A2). OS can also be "a starting point to know where to focus efforts" (GM5), especially when little is known about an area. If an OS is reported in a management area, "this can trigger either a change or at least…sen[d] out aircrafts, or even boats with people out where the areas have been submitted," (GS3) this would not change the normal science survey plan, but would help to verify if the OS is indeed a species of concern for management measures.

3.2.6. Collaboration

Nine (60%) participants mentioned the importance of collaboration between organizations to obtain OS data (Table 6). Collaborations could be with NGOs, other researchers, other divisions of government and with industries on the water. An example was one participant collaborated with whale watching companies to get long term data on blue whales. The respondent explained:

> "So I was using platforms of opportunity to collect this data, but I've been doing it consistently in the same way for the last 25 years plus, the people that are there, the captains are very good photographers, and they're there throughout the seasons. So any blue whale that shows up. I will get pictures of it with the date and the position. So there is an example where opportunistic observations because they are much more consistent and because we know the level of effort that's put in, can be very useful" (NGO2).

3.3.7. Benefits

Participants expressed some overarching benefits of OS: it's educational, fills in data gaps and is an inexpensive way to collect data (Table 10). Fourteen (93%) participants mentioned the importance of OS filling data gaps and providing information in areas that are not surveyed, or more information in areas with little survey effort. OS provide more knowledge of species and their location, and when no scientific data is available for use, then OS can be a good source of information. "There is maybe 50% of the entire population that's in parts unknown and having a network where we can relay opportunistic sightings can help identify areas where the rest of the population, might be" (A1). They also help us have information during times of the year when scientists are not surveying, "observers will give you information on periods let's say from November to April, so we have some regular observers that will spot, for example, blue whales right into January" (GS2).

Table 10. Sub-themes for the overall benefits of using OS, and the number of people who discussed each sub-theme.

Theme Name	Description	# of Participants
Fills in data gaps	Information in areas that are not surveyed or more information in areas with little survey effort. More knowledge of species and their location. And when no scientific data is available for use, then OS can be a good source of information.	14
Inexpensive	OS saves money and resources. Less expensive than dedicated surveys.	10
Educational	When people contribute by providing OS, they also become more aware of conservation and research initiatives and more aware of marine issues. They learn more about the species that they are recording.	7

Ten (67%) participants mentioned that OS saves money and resources and is less expensive than dedicated systematic surveys. Doing research in the field is so expensive, "most of the time, you really have to cut that time that you spend collecting data, so if we can have other sources of data to complete, then you have a better answer, depending on what we want to explore" (GS4).

Seven (47%) participants discussed how, when people contribute by providing OS, they also become more aware of conservation and research initiatives and more aware of marine issues, and they learn more about the species that they are recording. A2 highlighted that:

> "It is a good way to make them realize that protecting the ocean and the species that live in it is not only the responsibility of the government or these huge agencies…but it is also something that it is part of their environment; it's part of their lives and contributing to it also I think help educate people and make them more aware of what is happening in the ocean".

3.3. Limitations of OS

Following the section on the uses of OS, several limitations may make OS challenging or unsuitable to use depending on the purpose of their use. From the interviews, six main limitations were highlighted: data quality, time, reporting, technology, accessibility, and the scientific community (Table 11).

Table 11. Six main themes of the limitations to the use of OS and the number of people who discussed each theme.

Theme Name	Description	# of Participants
Data quality	Issues of experience and reliability of the data. Difficult to ID species, this difficulty creates uncertainty in the quality of the data.	15
Time	Industries are too busy to record data and delay in relaying data to management; it needs to go through science to get verified. It also takes a lot of time to clean and analyze the data.	8
Reporting	It can be difficult to get people to report their sightings. Sometimes fear that if someone reports a sighting that it will impact their livelihood.	8
Technology	Different technology and different databases can make using the OS complex.	7
Accessibility	Challenge of being out on the water, access to the ocean and seeing marine mammals is different on each coast.	5
Scientific community	Barriers from the scientific community to use OS or to share data.	2

The most significant limitation of OS discussed was data quality, and 6 data quality issues were highlighted: reliability, effort, difficult to ID species, hard to organize, and no absence data (Table 12). Of the six data quality issues, lack of reliability was referenced the most with thirteen (87%) participants discussing how trustworthy a sighting may be or how there can be lots of uncertainty and varying confidence levels with OS. You may have an OS that has a date, time, and description, but no picture or location, or you may not know who provided the data and so that can prevent the use of the sighting. For example, NGO1 pointed out that when creating management measures to reduce the risk of ship collisions with whales it was "challenging to base the management measures on the opportunistic sightings that were nearby the shipping corridor because we couldn't know where these data were coming from," they didn't have information on who collected the data and in what context, making the sightings unreliable. Reliability issues also relate to how difficult it is to identify a cetacean species. GM2 discussed that with some rare endangered species like beaked whales, even researchers have a hard time identifying the animal to species, "there are so many different types of beaked whales, and there's a lot of similarities, some of them you'd have a hard time identifying them, even if they were lying right in front of you unless you actually extracted [one of their] tooth." Even if it is not a rare species, inexperienced observers may not be able to tell the difference between a humpback or a right whale.

When it comes to using OS in research, the lack of recording effort and that there is only presence data, no absence data (i.e. it only tells us where cetaceans are, not where they are not) can make analysis challenging. NGO2 explained that:

> "We have to make a choice...depending on what question we are trying to answer whether or not we are going to use these opportunistic sightings or not. And often, if we are trying to have something more precise or statistically sound, then we will use the data where we can quantify the effort very clearly."

Finally, the fact that data can come from different sources, and are hard to organize, can limit OS' use. GS5 pointed out that often, there are duplicates in the dataset, and it can be hard and time-consuming to clean up the data.

Table 12. Sub-themes of the limitations with data quality, and the number of people who discussed each sub-theme.

Sub-theme Name	Description	# of Participants
Reliability	How trustworthy is the sighting? Need to verify the sighting. There can be lots of uncertainty or varying confidence levels.	13
Effort	Most OS do not include effort, tracking for how long the observer was observing the water for cetaceans.	8
Difficult to ID species	You need to be an experienced observer to ID cetaceans.	7
Hard to organize	Data can come from different sources, making it hard to deal with. It can have duplicate data.	6
No absence data	OS do not tell us where species are not; they only tell us where species are, so it is just presence data no absence data. No zero data.	4

The next limitation discussed (8/15) was the difficulty of getting people to report their OS. Scientists and managers in government believe that fishers and mariners may be more reluctant to report whale sightings, especially of a whale that is a species at risk, "because they know that will imply more limitations to their activities" (GS2). GM3 also shed light on the issues of mandatory reporting,

> "Certain fishers were told in their license conditions that they had a mandatory reporting requirement which is difficult to enforce...and what it did is put the industry in a predicament. Some fishers felt that we were forcing them to report a North Atlantic Right whale that would eventually lead the area to be closed to fishing."

Making it mandatory for people to report sightings may not be a solution, but when OS are needed it can be difficult to get people involved, whether that be due to the challenges of how people can report (i.e. through email, an app, a hotline) or even just getting the right people to report and making them realize why OS are important.

Seven (47%) participants discussed the challenges of technology and how there are so many different databases or apps we can report to, "now we have so much access to technology, so we have different people developing different applications, so the citizen that wants to contribute is kind of lost" (GS4). Also, when out at sea, cell service is often limited or lacking, preventing OS reports promptly. This limitation leads to the next theme, time, with eight (53%) participants discussing how OS require time to be verified by scientists to be useful. "There is

always a delay from when an animal is sighted to when that data is provided…in the hands of managers and when that is coming from a dedicated survey platform you can…bypass the validation steps" (A1).

One-third of the (5/15) participants discussed the issue of access to the water for members of the public or other OS providers. The East and West coasts of Canada have very different geographies and differ in the ability for people to easily have access to the water and view wildlife. A1 described that on the East coast, especially with endangered species like right whales, "animals tend to be much less accessible to the general public" which makes the "opportunistic sighting landscape very different than it would be on the West Coast, where anyone with a small boat has complete access to a huge number of species". Due to access issues, providers also tend to be close to the coast, resulting in a limited number of sightings in the offshore regions.

Finally, two (13%) participants that work for ENGOs expressed how the scientific community is part of the limitation, with their barrier to sharing data and lack of willingness to use OS data. NGO1 expressed that "unfortunately, the opportunistic sightings are discredited by the scientific community. And that is a shame because it could be much more useful, and more money could be invested and better ways to collect opportunistic sightings that could bring a lot of knowledge to government".

3.4. Recommendations on how to improve OS

Three themes emerged from the discussion: data quality, education and outreach, and a shared centralized database (Table 13).

Table 13. Three main themes on how to improve OS for their use, and the number of people who discussed each theme.

Theme Name	Description	# of Participants
Data quality	Improve the reliability and quality of data. Try to correct for effort.	15
Education & Outreach	Educational campaigns to ask stakeholders to provide OS and inform them about the importance of protecting cetaceans. Need for more observers.	12
Shared database	Create a centralized platform where open-source data is shared across the country.	7

All participants recommended that the data quality of OS should be improved, with four sub-themes emerging from the interviews focusing on: prerequisites, mobile applications, whale ID training, and effort (Table 14). As described in the OS uses section of the results, there are prerequisites for OS to be verified for its use by science and management (i.e. photo or video, date, time, location, species ID, description, experience, and follow-up). Therefore, to improve OS, participants mentioned a need for clear criteria and potentially a more standardized way of collecting OS that resembles a systematic process;

> "If we have only one or two ways to collect opportunistic sightings like a common very basic protocol spread throughout all [for example] whale watching companies or an application. One single application that could be used, then that could be beneficial…when it comes to interpreting the data" (NGO1).

Nine (60%) participants discussed the mobile application Whale Alert (participants on the east coast) or Whale Report (participants on the west coast). Mobile apps make it easy for people to report sightings and the app prompts them to record necessary criteria like photos and location.

Table 14. Sub-themes on how to improve the data quality of OS, and the number of people who discussed each sub-theme.

Sub-theme Name	Description	# of Participants
Prerequisites	Training on how to collect OS information and what the prerequisites are for verified sightings. The need for a more standardized way of reporting.	14
Mobile applications	The use of mobile applications such as whale alert or whale report and how they can improve data collection and quality.	9
Whale ID training	Increase cetacean ID training sessions for stakeholders on the water to help with species ID.	8
Effort	Find a way to correct for effort.	3

In addition, eight (53%) participants discussed the importance of more or continued cetacean ID training sessions for stakeholders on the water to help with their identification skills. Training helps provide more accurate and reliable sightings, and three (20%) participants mentioned that finding a way to correct for effort can improve the data. GS4 has come up with a way to use the AIS tracks on whale watching vessels to correct for effort, "we have developed an

algorithm to identify the observations…we ask them to write down the time, and then we use the AIS data to identify where they were at the time that they made the sighting, and then we associate that position to the whale."

There are aspects of improving data quality that also can fall under education and outreach, such as providing adequate training on how to collect OS and species ID training. However, this theme focused on promoting public awareness on the importance of cetaceans in the marine environment and stressed the need for more observers to provide OS. GS4 expressed that with more boats and more people going out on the water, "citizen science and opportunistic sightings have a role to play in the comprehension and understanding of the marine environment…if…you implicate [people] in collecting the data, and they [can] understand the impact they have or may have on the environment."

Finally, seven (47%) participants mentioned that to improve the use of OS, we need to create a centralized database where open-source data is shared across the country. Most were not sure how this platform could be, but GS5 envisions "an online tool where we can display sightings from our opportunistic sightings database in a timely manner. Something that's probably quite similar to whale map…[but] broadened to include more of the species that we get information on so that people can…search it" and even find a way to incorporate opportunistic acoustic data.

CHAPTER 4: DISCUSSION

4.1. Who is reporting OS?

Several different groups collect OS of cetaceans: the general public, whale watch industries, shipping industries, fishing industries, researchers, government OS platforms, and marine mammal observers (MMOs). The results suggest that the value of OS does not necessarily depend on who is providing OS, but having high-quality data is essential. Rechsteiner et al. (2013) used OS from the BCCSN that were categorized as "Certain" or "Probable" for their analysis on determining observer effort from large vessel crew, eco-tourism operators, residents of population centres, lighthouse keeps, parks users, coastal workers, and frequent observers. Each of the observers' sightings were valid as long as the BCCSN placed a high-quality category on the sightings. Sightings that were not certain or probable were not used for the study.

However, some participants did value MMOs, researchers, government OS platforms, as well as whale watch companies' data more than from citizens, fishers, or mariners, primarily because citizens, fishers, or mariners might have less experience in species ID. Also, fishers and mariners are busy with their work and are perceived not to have the time necessary to report OS and provide high-quality data. Historically, whale watch companies, NGOs, other researchers (like NOAA), and government officials such as fishery officers have contributed to the most amount of OS in the East Coast (MacDonald et al., 2017), thus adding to the participants' perception of whose OS may be more valuable or reliable. However, if citizens, fishers or mariners had some level of marine mammal ID training, OS provided by these groups could be very valuable.

Citizen data has been used to help collect scientific data, from projects on marine protected area monitoring in California, distribution of jellyfish in the Maritimes, coral reef monitoring in the Red Sea, and marine mammal sightings in Alaska, to name a few (Freiwald et al., 2018; Nordstrom, James, Martin, & Worm, 2019; Branchini et al., 2015; Hann, Stelle, Szabo, & Torres, 2018). In each instance, citizen science data was valuable, providing researchers with information on the marine environment, like abundance and distribution of species, species identification and ecosystem health. Therefore, the value of citizen science or public data for cetaceans in Canada has the potential to increase with more initiatives or incentives. With the work of MMON and Green Marine training and encouraging the marine industry (mariners) to collect whale data along the east coast of Canada, there is potential for the perception of mariners' OS value to increase (Blier & Nolet, 2019). MMON and Green Marine's initiative is not well known outside of Quebec and is still relatively new (started in 2015). The extent of the marine industry's sightings may prove useful, especially in remote areas or periods of the year where researchers are not monitoring for cetaceans. In addition, pilot projects with fishers in collaboration with the government, NGOs or academic researchers may help improve the value of fishers' OS, because researchers can work with the fishers to ensure that the data they provide is useful for research purposes. Gawarkiewicz and Mercer (2019) discussed the value of partnering with fishing fleets to collect oceanographic and ecological data. Fishers are described as having great familiarity and knowledge of the environment, similar to what some participants in this study expressed.

4.2. Use and value of OS

Results of the study suggest that OS are being used in a variety of different ways: analyses in research (primarily distribution and habitat use), publications (academic or reports), informing dedicated survey activities, a part of a collaboration between organizations, and informing management. Furthermore, for OS to be used, a variety of prerequisites for their use were determined; experienced observer, verified sightings, and follow-up with the reporter. How OS is used in management was discussed the most due to the nature of the interview questions, but also five out of the fifteen participants were managers either working in the species at risk division, fisheries management, or shipping management. The results suggested that OS could be used in conservation and management if researchers verify the sightings before their use. Management decisions for species at risk are based on science in Canada, so if scientists use OS in their analysis and reports, then they can be essential in providing information on the occurrence and distribution of a species, especially since we often lack data on species at risk. However, this is a very science-centric view, as described by Vann-Sander et al. (2016), the view of ensuring that there is very high-quality data in citizen science projects. They argue that the traditional view of data quality concerns from citizen science projects needs to be reframed to consider the need to have successful project management, data management and volunteer management. In addition, there needs to be a shift in perception to allow community members to contribute to science and influence policy.

Furthermore, results suggested how beneficial the OS are because they fill in data gaps. OS provide information on species that we would otherwise not have, and often in areas where researchers are not always monitoring. For instance, Hann et al. (2018) were not able to compare their citizen science data of harbour seals with published data in Southern Alaska because there were no publications on harbour seal abundance and distribution, highlighting the added value of citizen science data. Also, Alessi, Bruccoleri, and Cafaro (2019) found that citizen datasets are useful to gain information in areas not monitored by scientists and encourage scientists to monitor in areas not yet surveyed for cetaceans. In Canada, more OS data could help in remote regions such as the Arctic, offshore waters (for example offshore of Nova Scotia), areas of Newfoundland and Labrador, areas of Northern BC and during times of the year where researchers may not be monitoring (like from November to April). In Eastern Canada, the

Whale Map website (https://whalemap.ocean.dal.ca/WhaleMap/) can help determine where areas have and have not been monitored by dedicated research surveys.

Other benefits include that OS are cost-effective, helping researchers optimize available funds (Torreblanca et al., 2019; Alessi et al., 2019; Hann et al., 2018; Rechsteiner et al., 2013). In addition, OS provide an educational opportunity for citizens and industries out on the water through increased knowledge and enhanced perspective on science (Hann et al. 2018; Lodi & Tardin, 2018; Conrad & Hilchey, 2011). Allowing members of the community to contribute to science also promotes increased environmental democracy, social capital, citizen inclusion in local issues, and benefits to the ecosystem being monitored (Conrad & Hilchey, 2011). Turrini et al. (2018) discuss three areas that citizen science contributes to; generating new knowledge, providing learning experiences, and empowering citizens through civic participation.

4.3. The limitations of OS and how to improve them

Despite all OS uses and benefits, several limitations remain; poor data quality, time-consuming, difficult to get reports, too many different types of technology, limited access, and negative perceptions of OS from the scientific community. Poor data quality was discussed as the main limitation with the reliability of the sightings and lack of effort being important issues. Many studies also noted the limitation of data quality and how inadequate data may add biases and unreliability to the data preventing researchers from using it (Conrad & Hilchey, 2011; Rechsteiner et al., 2013; Harvey et al., 2018; Hann et al., 2018).

Nevertheless, OS have still been proven to be useful and worth investing time and resources to improve OS for cetaceans. The results suggest that the quality of the data should be improved, ensuring adequate education and outreach for OS programs, and the creation of a shared OS database across the country. To improve data quality, mobile applications have been recommended as an easy way to do so, as apps can have fields like date, time, location, species ID, description, and prompt the observer to take a photo and markdown how confident he or she was in the sighting. Hann et al. (2018) used a mobile app called Whale mAPP to monitor marine mammals in Southern Alaska. The app accounted for observer effort by automatically recording the user's location every 30 seconds, resulting in a record of the survey track line. The project offered citizens marine mammal identification guides and the possibility of optional in-person

training to help with the use of the app and species ID. The app received positive user feedback and provided valuable scientific data (Hann et al., 2018).

Improving the use of OS may also come with the implementation of a shared central database across the country. Marine Mammal researchers in the Mediterranean Sea have a shared database for data collection, known as the Fixed Line Transect Mediterranean monitoring Network (FLT Med Net) (CIMA, n.d.). All the researchers use the same protocols and upload their information to the network's database, which helps with using the data more efficiently. Participants in Canada expressed the need for a network, and examples such as the FLT Med Net could help guide the formation of a Canadian shared database.

Finally, continuing and improving education and outreach programs will help improve the quality of OS, the number of sightings per year, and ocean literacy. By providing training and marine mammal identification material, OS providers become more experienced and provide more reliable sightings (Hann et al., 2018). With adequate training and proper recruitment of participants, studies have shown that data collected by volunteers can be similar or equivalent to data collected by researchers (Ghilardi-Lopes, 2015; Hann et al., 2018; Harvey et al., 2018). Not only is training important for high data quality, but it also aids in the retention of data providers as they become more involved and engaged in the project. Hann et al. (2018) found that it is essential to maintain communication with citizen scientists and create a community of people who enjoy volunteering together to help to maintain contributions to a project.

4.4. Study Limitations and future work

Key informants and the snowball sampling method was used for recruitment to participate in the study. These techniques may result in sampling bias due to an inability to ensure sample diversity, while random sampling is usually preferred and necessary for valid research findings (Kirchherr & Charles, 2018; Bhattacherjee, 2012). We aimed to limit sampling bias by striving to obtain a variety of participants from different stakeholder groups. Some limitations with interviews include that there may be a potential for subconscious bias during the interviews or the data analysis. However, this was mitigated by having an interview script during the interviews and using a qualitative data analysis software (NVivo 12 plus). Many participants were away either out to sea doing fieldwork, on vacation, or very busy responding to the 2019 North Atlantic Right Whale crisis, which may have limited the number of participants. The study

also had more participants from the east coast (13/15) than the west coast (2/15), which may have skewed the results to represent an east coast perspective. Future research could try to obtain more interviews from the west coast in order to determine if perceptions on OS differed. Another limitation of the study is that there were no interviews conducted in the Arctic; additional research could be conducted in the Arctic to get the perspective of researchers and managers further north. Further research could also investigate whether DFO have an OS database for the Arctic, how ENGOs are working there, and how to incorporate Indigenous Knowledge of cetaceans in conservation and management. Additionally, future research could examine the use and value of OS from the perspective of the OS providers and determine what some of the barriers and opportunities are in reporting OS.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSION

The following recommendations have been synthesized based on the project's findings:

1. **Improve the quality of OS data**
    a. By ensuring that providers add pictures or videos of cetaceans when reporting, and where not possible, a detailed description of the species.
    b. Promote the use of the Whale Alert app on the east coast. The Whale Report app has been successfully taken up on the West Coast and makes reporting more accessible and data management easier. We should promote uptake of an East Coast app to help with the management of OS. However, questions still arise as to whether Whale Alert is the appropriate app for Eastern Canada, as this is an app based out of the United States. Should we create another app for Eastern Canada that meets all the provinces' needs?
    c. Create a standard protocol with all necessary prerequisites to obtain verified OS. The prerequisites like date, time, location, pictures or video, species ID, description, experience, and follow-up are known; however, there are a variety of different OS protocols leading to data that is not always easily shared and integrated. We should consider creating a standard protocol for collecting OS across the country as this would improve data management and facilitate OS use in analyses. Often, we want to accommodate certain groups and make specific protocols for their needs; however, this

may not always be good for their use in the conservation and management of highly migratory species like cetaceans.

d. Use models to correct for effort

   Create and use statistical models that address bias and lack of observational effort (MacDonald et al., 2017). Researchers such as Rechsteiner et al. (2013) have created models to correct for effort, and more research should address creating new models if needed and applying these models to other regions of Canada. Also, with the use of mobile apps, we can potentially add a feature that allows observers to record their effort.

2. Create a centralized database where open-source data is shared across the country

As there is already a centralized database for the West Coast of Canada (BCCSN), the East Coast could greatly benefit from a similar model where all the provinces could house their OS data. The database should be developed with the intention of creating a Canada wide database for the west, east and arctic regions. This database should be open-sourced to allow researchers, government, ENGOs, and other stakeholders to have access to data for projects in conservation and management. A first step for the East Coast would be for the marine mammal science team leads in DFO Maritimes, DFO Newfoundland and Labrador, DFO Quebec and ENGOs working in the marine mammal field to come together and discuss the possibility of a centralized shared database for the East Coast. Questions during this meeting should consider who will be responsible for a centralized OS database, how will the data be shared, what is the best way to make the data open-sourced while maintaining restrictions on how it is accessed, and how to ensure that there are no duplicates in the central database. The St. Lawrence Global Observatory (SLGO) already manages data and information about the St. Lawrence global system and may be an excellent organization to create a central marine mammal OS database.

3. Continued and improved education and outreach

Many organizations or government departments are already creating education and outreach programs for marine mammals in Canada. Nevertheless, it is important to continue current efforts and improve them through new environmental education and outreach programs. Throughout the interviews, the importance of trained observers was highlighted, and the need for increased cetacean ID training sessions for stakeholders on the water. Naturalist workshops in

communities near known cetacean habitats could be a good option to invite members of the public, fishers, mariners, and whale watch companies to learn more about cetaceans and how they can contribute to monitoring. Also, workshops could be tailored for each stakeholder group, depending on the goals of the educational program. In addition, outreach campaigns targeted for each stakeholder group to promote reporting cetacean sightings could be created to help recruit groups on the water to continue reporting their sightings or to start. Specific educational programs should be designed to promote the importance of reporting species at risk and what to do if people see a whale entangled, injured, or stranded. Collaboration among different groups on the water will be essential to ensure the longevity of the OS data collection. Also, it will be necessary to consider how the programs will be evaluated to ensure that goals are met and to determine how new programs can be improved in the future.

The following study focused on the use and value of opportunistic sightings (OS) for cetacean conservation and management in Canada; however, this study is one of many discussing how citizens and other OS providers (like fishers, mariners, or whale watchers) can contribute to monitoring wildlife. The results of this study may be applied to observing the marine environment in general, and the importance of OS has been discussed as essential for understanding the distribution of species at small and large temporal scales. The project helped address one of the research gaps found by Conrad and Hilchey (2011) in citizen science research: the need for more case studies showing the use of citizen data by decision-makers and the limitations of their use as well as how these might be overcome. OS of cetaceans has immense potential in Canada, and collaboration among OS providers and researchers will be key for maintaining high data quality and knowledge of why providing OS is important for conservation and management.

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Appendix A: Tables

Table 1. The conservation status for marine mammals in the Northwest Atlantic (Government of Canada, 2011).

Marine Mammals	**COSEWIC**	**SARA Status**
Blue Whale (*Balaenoptera musculus*)	Endangered	Endangered
Fin Whale (*Balaenoptera physalus*)	Special Concern	Special Concern
Sei Whale (*Balaenoptera borealis*)	Endangered	No status
North Atlantic Right Whale (*Eubalaena glacialis*)	Endangered	Endangered
Humpback Whale (*Megaptera novaeangliae*)	Not at Risk	No status
Minke Whale (*Balaenoptera acutorostrata acutorostrata*)	Not at risk	No status
St. Lawrence Estuary Beluga Whale (*Delphinapterus leucas*)	Endangered	Endangered
Sperm Whale (*Physeter macrocephalus*)	Not at risk	No status
Harbour Porpoise (*Phocoena phocoena*)	Special Concern	Threatened
Sowerby's Beaked Whale (*Mesoplodon bidens*)	Special concern	Special concern
Northern Bottlenose Whale (*Hyperoodon ampullatus*)	Endangered	Endangered
Long-Finned Pilot Whale (*Globicephala melas*)	Not at risk	No status

Killer Whale (*Orcinus orca*)	Special Concern	No status
Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)	Not at risk	No status
White-Beaked Dolphin (*Lagenorhynchus albirostris*)	Not at risk	No status
Seals (Grey and Harbour)	Not at risk	No status

Table 3. Number of records by data provider from the Maritimes region whale sightings database (XMAR) and the Marine Mammal Observation Network marine industry database (MMON).

(Note that the data source commercial (ferries & container ships) is where MMON data contributes to the OS records (n=2,250, 3.783%). Whale Sightings Database, Ocean and Ecosystem Sciences Division, Dartmouth, NS, [2019/07/24] and Marine Industry Whale Data Collection, MMON, Rivière-du-Loup, QC, [2019/10/26])

Data source	**Number of records**	**Percent**
Whale watch	31,538	53.032
Government (DFO, Coast Guard, NRCAN, Military)	6,966	11.713
NGO research	5,604	9.423
NOAA research/ monitoring/survey	4,558	7.664
Fishing	4,247	7.141
Commercial (ferries & container ships)	2,775	4.666
Energy Sector Research (Oil and Gas, Tidal Energy)	2,563	4.310
New England Aquarium - whale survey	788	1.325
NA	208	0.350
Academic Research	133	0.224
General public (private citizen)	57	0.096
Whale Rescue	32	0.054
NAFO (ICNAF) research	1	0.002
Total	59,470	100

Table 4. Number of records by species or taxa from the Maritimes region whale sightings database (XMAR) and the Marine Mammal Observation Network marine industry database (MMON).

(Whale Sightings Database, Ocean and Ecosystem Sciences Division, Dartmouth, NS, [2019/07/24] and Marine Industry Whale Data Collection, MMON, Rivière-du-Loup, QC, [2019/10/26])

Species Common Name	Number of records	Percent
Humpback Whale*	15,725	26.442
Harbour Porpoise*	9,884	16.620
Fin Whale*	7,487	12.590
Minke Whale	7,035	11.829
North Atlantic Right Whale*	6,193	10.414
Dolphins/Porpoise	2,641	4.441
White-Sided Dolphin	1,759	2.958
Whales (Ns)	1,333	2.241
Atlantic Pilot Whale	1,233	2.073
Sei Whale	1,041	1.750
Long-Finned Pilot Whale	799	1.344
Common Dolphins	744	1.251
Cetacean Species	564	0.948
Sperm Whale	563	0.947
Northern Bottlenose Whale*	516	0.868
Blue Whale*	435	0.731
Baleen Whale	432	0.726
White-Beaked Dolphin	378	0.636
Beluga Whale*	298	0.501
Atlantic Bottlenose Dolphin	94	0.158
Striped Dolphin	84	0.141
Killer Whale	82	0.138
Risso’s Dolphin	61	0.103
Beaked Whale	58	0.098
Sowerby's Beaked Whale*	16	0.027
Spotted Dolphin	8	0.013
False Killer Whale	4	0.007
Cuvier's Beaked Whale	2	0.003
Bowhead Whale	1	0.002
Total	**59,470**	**100**

*Species at risk (SARA) listed species.

Appendix B: Interview Script and Questionnaire

If in person:
Hand the participant the consent form.
Ensure that the participant has read and signed the consent form prior to the interview.

If over the phone or skype:
Send consent form prior to the interview to get signed or get verbal consent over the phone.

Hi, how are you doing today? **Wait for response.** Thank you for taking the time to talk with me. Before we get started, did you have any questions or need clarification regarding the consent form? **Answer questions, if any.** As I mentioned in my email, my name is Nadia Dalili, and I'm researching the use and value of opportunistic sightings for cetacean conservation and management in Canada.

DISCUSSION RULES

- Note I will be taking notes but also recording, I may ask you to repeat an answer for clarity or to pause if I wanted to write something down
- Importance of personal opinions

Before we begin the interview, I wanted to go over what OS are based off my literature review. Opportunistic sightings (OS) of cetaceans, are sightings that can be provided by the public, different industries (whale watching, shipping, ferries, fishing, etc.) or observers during research activities that are not dedicated to surveying marine mammals (eg. Observers that are on government fish surveys, that may be conducting other research and they see some whales and will record it). Information can be recorded in different ways, through logbooks, calling in on hotlines, and mobile apps like Whale Alert on the east coast or Whale Report on the west coast. OS can also be produced through citizen science initiatives, where community members or industries are asked to provide cetacean sightings on a regular basis to help support research/management.

With that if you're ready, let's begin the interview.

Date: Time: Location:

Consent form: ☐ sent by email ☐ verbal acceptance ☐ given in person

Stakeholder group		**Respondent name**	
Region		**Code**	

OS definition

1. Based on the definition that I presented on OS, does this define what OS are to you or do you have a different definition?

PARTICIPANT PRESENTATION

Please tell me a bit about yourself:

1. How long have you worked on cetaceans?
2. Can you describe the nature of your work?
3. Where do you get your data/information from when you are trying to answer a research/management question on cetaceans?

THE USE AND VALUE OF OPPORTUNISTIC SIGHTINGS

2. Are you using OS data? *If not, why not (question 3)?*
   PROBE:
   a. How is it being used? For what purposes?
   b. When do you consider/use OS data in analysis or reports? If not, how can OS be integrated into existing reporting?
   c. Do you create publications using this data?
   d. What are the conditions that make the data useable?
   e. What are the benefits of OS? Or are there any other benefits you would like to mention?

3. What are the limitations of OS?
   PROBE:
   a. What are the characteristics that make OS unsuitable for your use?
   b. How could OS be more suitable for your use? Reduce limitations?
      i. Recommendations on how to improve OS.
   c. What are the benefits of OS? (*do not ask if 2e is answered*)

4. What OS data are you aware of that are being collected on cetaceans in your region?
   PROBE:
   a. By who is it being collected?
   b. Do you value one group's data over the other more? Why/or why not?
   c. Who do you consider your best source of OS data?

5. Do you think OS data is useful to inform cetacean management?
   PROBE:
   a. Why/or why not?
   b. If yes, what type of management could opportunistic sightings inform?

6. Any final comments?

Thank you very much for your participation!

Appendix C: Ethics Approval Letter

Marine Affairs Program
DALHOUSIE UNIVERSITY

Marine Affairs Program Ethics Review Standing Committee
Letter of Approval

June 24, 2019

Dear Nadia,

MAPERSC #: MAP2019-06
Project Title: Incorporating opportunistic sightings for cetacean conservation and management in Canada

Effective date: June 24, 2019
Expiry date: June 24, 2020

The Marine Affairs Program Ethics Review Standing Committee has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans. This approval will be in effect until the date indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Claudio Aporta, Chair

Appendix D: Recruitment Email

Subject: Request for participation in an interview – Master's research

Dear [x],

My name is Nadia Dalili, I am a graduate student with the Marine Affairs Program at Dalhousie University in Halifax, Nova Scotia. You are invited to take part in an interview on "What is the use and value of opportunistic sightings (OS) for cetacean conservation and management in Canada?"

I am recruiting researchers and managers in Canada working on cetaceans, to obtain their views on whether opportunistic sightings are useful to inform cetacean conservation and management. This research aims to recommend how we may improve the opportunistic sightings of cetaceans from citizens and industries.

If you choose to participate, we will set up a day and time to conduct the interview either in person or over the phone or skype. The interview should take no longer than 45 minutes to 1 hour. Your

participation will be anonymous in all results or final reports. Interviews will be conducted between July 8th, 2019 to August 30th, 2019.

This research has been approved by the Marine Affairs Program Ethics Committee at Dalhousie University. This research is also in collaboration with WWF-Canada.

If you are interested or have any questions, please feel free to contact me by email at nadia.dalili@dal.ca or by phone at 1-514-758-0142.

If you don't have the time to participate or you think there is someone else in your team better suited to participate, please feel free to recommend them for an interview.

Thank you for your time,

Kind regards,

Nadia Dalili, B.Sc. (Hons.)
Master of Marine Management Candidate
Dalhousie University | Marine Affairs Program
Email: nadia.dalili@dal.ca
Phone: 1-(514)-758-0142

Appendix E: Consent Form

Project title: Incorporating opportunistic sightings for cetacean conservation and management in Canada

Introduction

You are invited to take part in a research study being conducted by me, Nadia Dalili, a graduate student in the Marine Affairs Program at Dalhousie University as part of my master's degree in marine management. Choosing to participate in this research is voluntary. There will be no negative impact on you whether or not you participate in this research. The information below outlines what this research will entail. You may withdraw at any time during the interview and choose not to continue. This project is co-supervised by Dr. Aurelie Cosandey-Godin from WWF-Canada and Dr. Sean Brillant from the Canadian Wildlife Federation and Dalhousie University – Department of Oceanography.

Purpose and Outline of the Research Study

The purpose of this research is to understand how opportunistic sightings (OS) are used and valued in cetacean conservation and management in Canada. OS can be provided by the public, different industries (whale watching, shipping, ferries, fishing, etc.) or observers during research activities that are not dedicated to surveying marine mammals. Information can be recorded in different ways, through logbooks, hotlines, and mobile apps like Whale Alert or Whale Report. OS can also be produced through citizen science initiatives, where community members or industries are asked to provide cetacean sightings on a regular basis to help support research/management.

This research aims to understand how researchers and managers in Canada working on cetaceans use and value opportunistic sightings. Results of the study aim to inform current and future citizen science

projects or industry initiatives that are collecting cetacean sightings.

Who Can Take Part in the Research Study

You may take part in this study if you are a scientist or manager working on cetaceans in the Government of Canada, or if you are a cetacean scientist affiliated with a university, or if you conduct research/work for an ENGO focused on cetaceans. Participants in this study should be at least 18 years old.

What You Will Be Asked to Do

You will be asked to participate in an interview for about 45 minutes to 1 hour. There will be about 10-15 questions. To take part in the interview you will have read and signed the following consent form at the end of the document.

Possible Benefits, Risks and Discomforts

Participating in the study might not benefit you, but we might learn things that will benefit others. The risks associated with this study are no greater than those you encounter in your everyday life.

How your information will be protected

The only people who have access to your answers will be myself and my supervisors. Your participation in this study is confidential and this will be ensured by anonymizing the documents containing your interview information. You will not be identified in any way in our reports. Findings will be shared and described in an aggregated form that protects individuals' identities. You may also choose to share direct quotes from the interview without being identified. This will be done by replacing your name with an alpha numeric code on documents that will be used for data analysis. Any handwritten field notes and audio-recordings (provided you permit this) will be stored according to the alpha-numeric code that has been assigned to you. All the initial electronic documents containing your name will be stored on an encrypted USB. Any hard copies and interview data used will be stored in a locked filing cabinet. Data will be destroyed one year after completing and reporting the results.

If You Decide to Stop Participating

Your participation is voluntary, and you may withdraw from the interview at any time prior to completion. You can withdraw your information at any point during or up until September 1st, 2019. If you decide to withdraw your information, the information will be deleted. Following September 1st, the data analysis will begin at which point you will be unable to withdraw from the research because the information will be in aggregate form.

How to Obtain Results

Upon request, we will provide you with a short description of the results when the study is finished. You can obtain these results by contacting the lead researcher by email: nadia.dalili@dal.ca or phone: 514-758-0142 any time after January 1st, 2020. The results will also be made available to the public through Dalspace and through a presentation at Making Waves in December 2019.

Questions

For any questions, comments, concerns, or more information about the study, please contact Nadia Dalili at (514-758-0142, nadia.dalili@dal.ca) or Dr. Aurelie Cosandey-Godin at (514-709-7847, acosandeygodin@wwfcanada.org) or Dr. Sean Brillant at (902-237-9692, seanb@cwf-fcf.org). If you have any ethical concerns about your participation in this research, you may also contact Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca (and reference MAPERSC # MAP2019-06).

Signature Page

Project Title: Incorporating opportunistic sightings for cetacean conservation and management in Canada

Lead Researcher: Nadia Dalili, Marine Affairs Program at Dalhousie University

(514-758-0142, nadia.dalili@dal.ca)

I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. My participation is voluntary, and I understand that I am free to withdraw from the study at any time, until September 1st, 2019. I understand that I will not be identified in any way in any reports, and I understand how my information will be protected. I understand that I have been asked to take part in an interview over the phone or in person at a location acceptable to me. I agree to take part in this study.

_____	_____	_____"
Name	Signature	Date

I agree that my interview may be audio-recorded ☐Yes ☐No

I agree that direct quotes from my interview may be used without identifying me ☐Yes ☐No

_____	_____	_____"
Name	Signature	Date