Evidence-Informed Conservation Policies: Mitigating Vessel Noise within Gray Whale (*Eschrichtius robustus*) Foraging Habitat in British Columbia, Canada

By

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Abstract

Anthropogenic noise is increasing within our oceans from growing human use. This rise in the ambient soundscape of the marine environment is increasing pressure on the life processes and health of marine animals. Cetaceans rely on the use sound for their life processes, and are thereby particularly susceptible to anthropogenic noise, like that from boats and other vessels.

Whale watching vessels are directly exposing whales to their noise output. The current literature postulates that baleen whales are less susceptible to smaller vessels, like whale watching boats, as smaller boats emit high frequency sound, presumed out of the range of baleen whale low frequency communication. This interaction is analyzed within the foraging habitat of the eastern Pacific gray whales (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia using passive acoustic monitoring. Noise disturbance from whale watching vessels is investigated using acoustics to analyze the contribution of vessel noise to the background sound levels of gray whale foraging habitat, and the differences in gray whale vocalizations in the presence of vessel noise.

Evidence of acoustic disturbance is coupled with an analysis of the current policy regime and characterization of the Tofino whale watching fleet whale encounters to recommend future management and policy adoption to minimize cumulative impacts of vessel noise on gray whales. The enablers and barriers to evidence use within policy and management are identified to ease amendments to the current strategies for effective whale conservation in BC. This evidence-use approach supports strengthening acoustic protection of cetaceans, which assists in safeguarding the local tourism activities of whale watching.

Keywords: Anthropogenic noise, passive acoustic monitoring, whale watching, gray whales, evidence-informed decision-making.

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Abbreviations

AVNC	Absent vessel noise conditions
AMAR	Autonomous Multichannel Acoustic Recorder
BC	British Columbia
BPNC	Boat present noise conditions
BPPNC	Boat and plane present noise conditions
BSL	Background sound level
CBD	Convention on Biological Diversity
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EBDM	Evidence-based decision-making
GIS	Geographic Information Systems
IRCW	International Convention for the Regulation of Whaling
IWC	International Whaling Commission
MEOPAR	Marine Environmental Observation Prediction and Response Network
MOU	Memorandum of Understanding
MPA	Marine Protected Area
PDT	Pacific Daylight Time
PRATO	Pacific Rim Association of Tour Operators
RIAS	Regulatory Impact Assessment Statement
SARA	Species at Risk Act
SPL	Sound Pressure Levels
TWWOVG	Tofino Whale Watching Operators' Voluntary Guidelines
UNCBD	United Nations Convention on Biological Diversity
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization
VHF	Very High Frequency
WHaLE	Whale Habitat and Listening Experiment

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1.0 CHAPTER ONE: INTRODUCTION

Anthropogenic noise is increasing in our oceans with cumulative levels having doubled every decade since the 1960s for certain regions, such as the north-eastern Pacific coast of North America (McDonald, Hildebrand & Wiggins, 2006). This is due to the increasing human use of the ocean and a reliance on oceanic shipping routes. Internationally, underwater noise produced by vessels is being recognized as a significant pollutant (Fisheries and Oceans Canada, 2012; IMO, 2013; Williams, Clark, Ponirakis & Ashe, 2014). The increasing sound in our oceans is interacting with certain marine animals, such as cetaceans.

Whales primarily use sound to communicate, forage and navigate within the marine environment (Simmonds, Dolman & Weilgart, 2004). Cumulative and increasing intensity of underwater noise is threatening their life processes and health. This can be manifested as habitat displacement, behavioural changes, and physical stress (Rolland *et al.,* 2011; Gomez *et al.,* 2016). Increased ambient noise can also make vocalizations more energetically expensive, with changes in calling suggested for several species (Jensen *et al.,* 2009; Parks, Johnson, Nowacek & Tyack, 2011; Holt, Noren, Veirs, Emmons & Veirs, 2009; Brenowitz, 1982).

Baleen whales, such as the gray whale (*Eschrichtius robustus*), communicate using low frequency sounds, similar in range to large boat noise emissions (Allen, Peterson, Sharrard, Wright & Todd, 2012; Dahlheim, Fisher & Schempp, 1984). Such communication can be interrupted or masked by vessel noise due to its overlapping frequency, intensity, and duration (Richardson, Green, Malme & Thomson, 1995). The literature postulates that based on the low frequency communication of mysticetes (baleen whales) and a similar dominance of low-frequency energy from vessels, whales are able to hear vessel noise and may be acoustically impacted, due to the potential of vessel noise overlapping with the baleen whale hearing range (Allen *et al.,* 2012). Due to this potential conflict, certain management tactics have been implemented in other countries than Canada, such as the United States. The U.S. National Marine Fisheries Service has determined intensity benchmark thresholds in decibels for man-made noises believed to negatively affect marine mammals, discerning between thresholds for noise that causes physiological or behavioural impacts, continuous or pulsed sounds and thresholds based on animal hearing ranges (National Marine Fisheries Service, 2016; National Research Council, 1994). Due to the consistent contribution of vessel noise to the marine soundscape, it can be argued as a chronic stressor to baleen whales. Rolland *et al.* (2012) found a physiological indicator of shipping noise as a stressor to North Atlantic right whales; a positive correlation was identified between underwater shipping noise and a stress-related hormone metabolite, glucorticoids. While Watkins (1981) noted that fin whale rumble calls, thought to demonstrate aggression and dominance, are emitted in response to vessels. Gray whales have demonstrated alterations to their vocalizations in the presence of vessel noise within their breeding grounds in Mexico (Dahlheim, 1987), suggesting an audible reaction to vessel noise. This evidence of acoustic disturbance response suggests a need to acknowledge noise-producing activities within the marine management and policy regime.

Whale watching is a commercial activity that directly increases the threat of vessel noise impacts on whale species; often at times or in regions used for life history events, such as feeding or weaning. However, little is known about the short and long term acoustic effects of tourism on cetaceans. Erbe (2002) modeled noise disturbance thresholds for whale watching vessels that could elicit communication, behavioural avoidance, and potential hearing loss for killer whales within the popular southern BC and northwestern Washington State whale-watching regions. In addition to short-term effects, long-term effects for species could be habitat abandonment, or reduced fitness and reproductive success (Lusseau & Bejder, 2007). The potential for sub-lethal and long-term impacts on cetaceans from whale watching has the potential to cause disturbance and disruption to the life processes of whales. Due to the increasing recognition of vessel noise, including that from whale watching vessels, as a source of noise pollution within the marine environment and its subsequent negative impact on whales, whale-watching policies and management strategies need to be implemented to mitigate adverse acoustic impacts to whales within Canadian waters.

This research project aims to identify vessel noise levels in the foraging habitat of the Pacific Coastal Feeding Aggregation (PCFA) gray whale sub-population frequented by whale watching operators, and any audible reaction, changes in vocalizations, by whales to vessel noise. This evidence can be used to support the occurrence of whale disturbance by whale watching, as defined as the interference with "an animal's ability to hunt, feed, communicate, socialize, rest, breed, or care for its young" or their critical life processes necessary to support healthy individuals and populations (Fisheries and Oceans Canada, 2013; Appendices 10.1). Due to the potential impact of noise on the life processes of whales, the key question of this paper aims to answer how can evidence of acoustic disturbance from whale watching vessel noise be used to implement effective policies and management for gray whale conservation in British Columbia? Evidence of vessel generated acoustic risk will be used to suggest management and policy reform for the current regime, as well as the enablers and barriers to evidence use within the current policy regime, given the risks to both the longevity of the whale watching industry and the protection of gray whales in Clayoquot Sound.

1.1 Eastern Pacific Gray Whales

Eastern Pacific gray whales (herein referred to as gray whales) are a medium to large sized baleen whale that reaches approximately 15 meters in length (Evans, 1987; Figure 1.1). This mysticete is a frequent inhabitant of British Columbian (BC) waters. The eastern north Pacific population migrates annually from their breeding grounds in Baja California, Mexico along the BC coast to their foraging grounds in the Arctic and parts of B.C (Fisheries and Oceans Canada, 2010b). However, a few hundred of these baleen whales do not complete the full migration, instead feed in the near-shore waters of BC; they are called the Pacific Coastal Feeding Aggregation (PCFA) (Calambokidis, Laake & Klimek, 2010; IWC, 2011). Cow-calf pairs and immature individuals utilize the Vancouver Island feeding areas, instead of continuing to the Bering, Chukchi and Beaufort Seas arctic feeding grounds (Darling, Keogh & Steeves, 1998). These individuals have high site fidelity, returning to the same location to feed annually (Bryant, Lafferty & Lafferty, 1984; Calambokidis *et al.,* 2010). The designation of this population of gray whales under COSEWIC (2004a) and the *Species at Risk Act*, S.C. 2002, c. 29, as a species of special concern, is due to uncertainty regarding their recovery status, with the identification of underwater noise, but only from oil development, identified as a threat (COSEWIC, 2004a).

Figure 1.1. Illustration of an eastern Pacific gray whale (Domm, 2010).

As gray whales feed near-shore, they are vulnerable to human activities (Crane, 1992). Within habitats of shallow depths, noise pollution, like vessel traffic, can add 65 decibels (dB) at 10 hertz (Hz), 80 dB at 50 Hz and 30 dB at 100 Hz to the ambient soundscape (Urick, 1983), thereby significantly increasing the input of vessel noise within the environment. Vessel noise contribution to the ambient soundscape has the potential to influence gray whale calls or mask their communication, leading to problems, such as communication or navigation. Gray whales have displayed disturbance behaviours as a result of vessels, as they have avoided areas of high traffic (Bryant *et al.,* 1984; Duffus, 1996). Duffus (1996) found the PCFA gray whales within Clayoquot Sound, BC, gradually moved further away from the busy whale watching port of Tofino, BC, by 20 kilometers over a three-year period. Although this may not be direct result of vessel traffic alone, noise pollution from vessels can further aggravate habitat displacement. Vessel noise can impact gray whales physiologically, behaviourally and impact their energetics and survivorship (Sumich, 1983). Monitoring gray whale vocalization behavior in the presence of vessel noise can determine the presence of disturbance and severity of impact on gray whale communication. This information can incentivize amendments to the current whale watching policy and management regime to better mitigate noise pollution on gray whales.

1.2 Study Site: Clayoquot Sound

Clayoquot Sound is an area off the west coast of Vancouver Island, BC with high biodiversity and beautiful landscape (Figure 1.2). In 2000, the area was designated as a United Nations Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserve aimed at conserving the coastal ecosystems while practicing sustainable use (Clayoquot Biosphere Trust, n.d.). The region is highly utilized within the spring and summer months by gray whales as a migratory path or as an important site for foraging and cow-calf weaning (Fisheries and Oceans, 2010b). Due to the species' high frequency use of Clayoquot Sound, whale-watching operators seek out whales within the region.

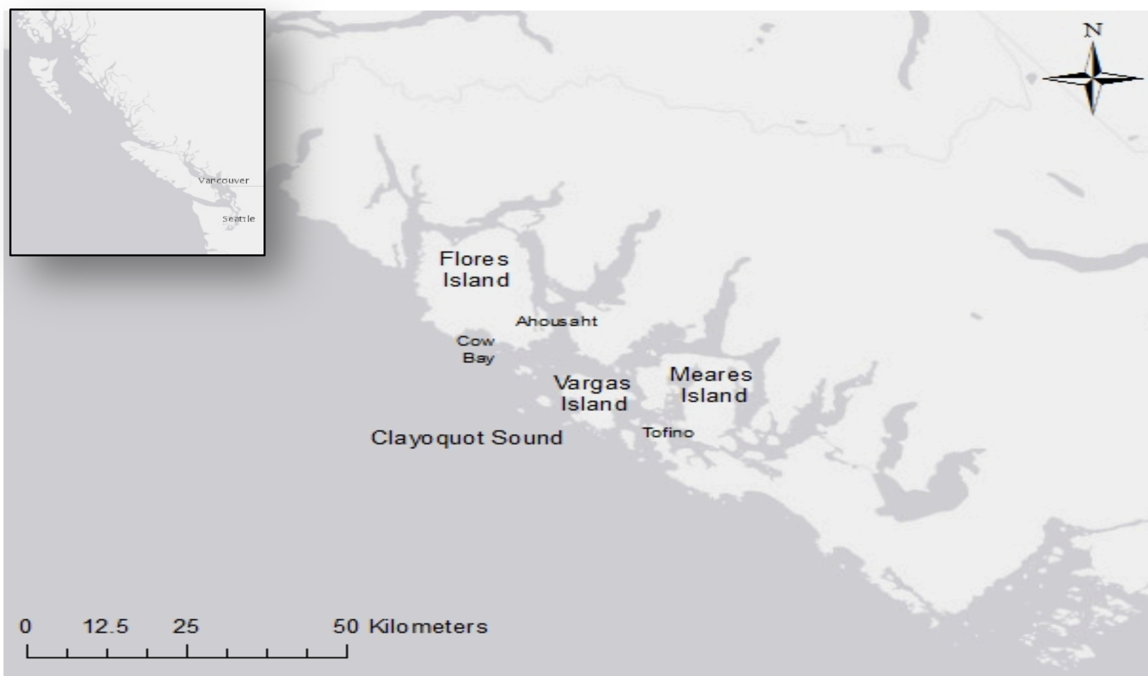

Figure 1.2. Map of Clayoquot Sound, off the west coast of Vancouver Island, British Columbia, 49°11'60.00" N, -126°05'60.00" W.

Clayoquot Sound has been the focus of gray whale research for over 25 years by the Whale Research Laboratory of the University of Victoria. Research has focused on investigating gray whale foraging behavior, ecology and interactions with the whale watching fleet (e.g.

Duffus, 1996; Malcolm, 2003; Stevenson, 2014; Dunham & Duffus, 2001, 2002; Feyer & Duffus, 2011; Burnham, 2012). The research within this paper contributes to the efforts of the Whale Research Laboratory. In collaboration with the Whale Lab, this research directly contributes to the Whale Habitat and Listening Experiment (WHaLE) project of the Marine Environmental Observation Prediction and Response (MEOPAR) Network. The WHaLE project generates research using passive acoustic monitoring (PAM) to assess whale-vessel risk (MEOPAR, 2016; Figure 1.3).

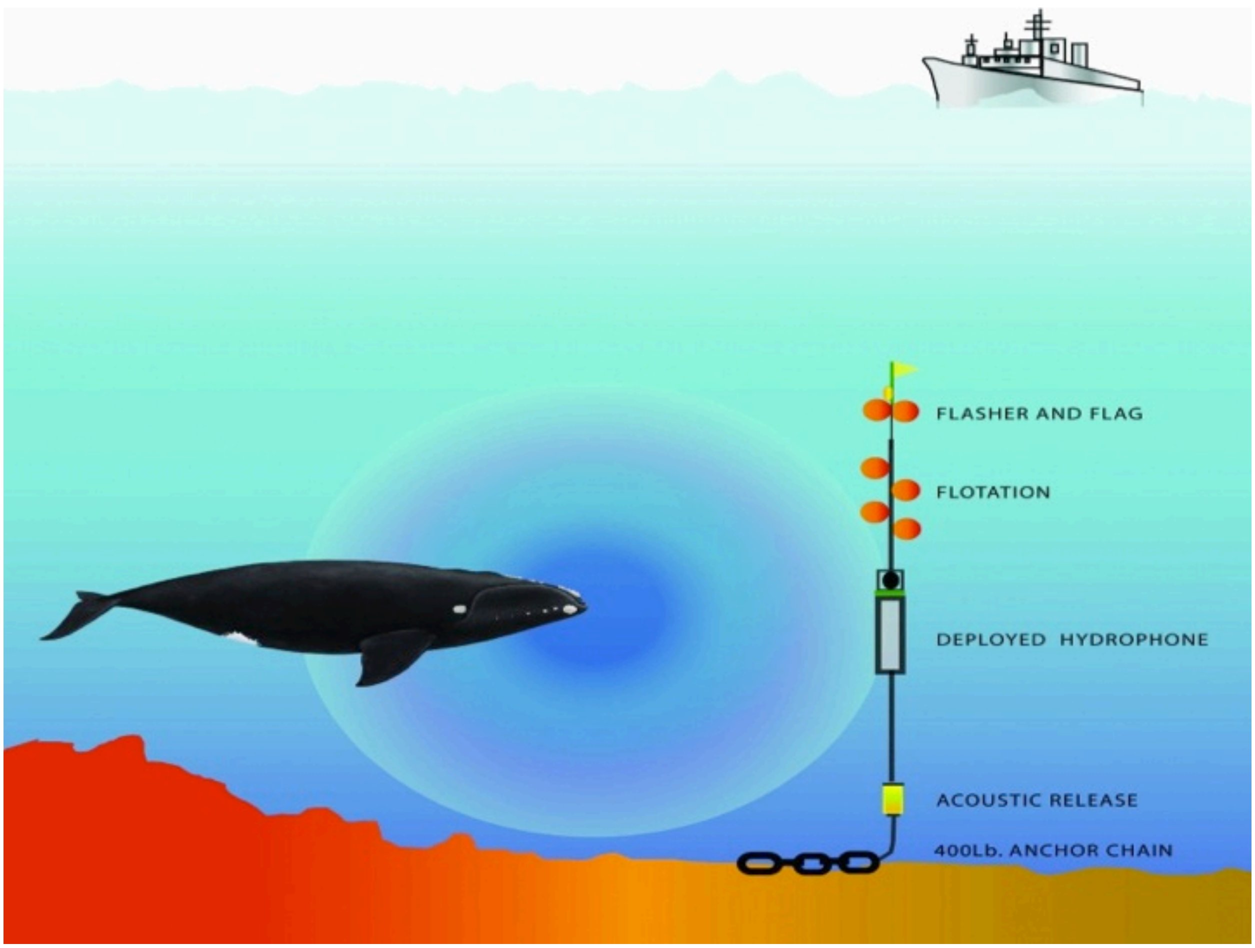

Figure 1.3. Diagram of the passive acoustic monitoring device used in Clayoquot Sound, BC, to monitor gray whale vocalizations for WHaLE (Whale Lab, n.d.).

PAM devices are ideal for data collection within the marine environment. Its remote collection ability enables continuous data collection over long periods of time, regardless of sea state and in remote areas (Sousa-Lima, Norris, Oswald, & Fernandes, 2013). However, these electronic recording systems must be retrieved to analyze the acoustic data, and are limited by the device's storage capacity, battery life, and spatially restricted to the deployment location in the case of moored devices (D. Duffus, personal communication, June 4, 2016). Despite these limitations, PAM is a cost-effective option to cetacean research that is unobtrusive to the species.

2.0 CHAPTER TWO: VESSEL NOISE CONTRIBUTIONS TO THE BACKGROUND SOUND LEVEL OF EASTERN PACIFIC GRAY WHALE FORAGING HABITAT.

2.1 Introduction

Anthropogenic noise has become prevalent within the marine environment, dominated by vessel traffic. This vessel noise is increasing, with cumulative levels having doubled every decade in the Northeast Pacific since the 1960s (McDonald, Hildebrand & Wiggins*,* 2006). An area heavily utilized by vessels of all types is subject to acoustic alterations to the ambient soundscape. Understanding the contribution of vessel noise within marine habitats will assist in comprehending the potential impacts on marine life residing within the area. The whale watching industry directly subjects whales to vessel noise. As whales depend on acoustic cues for their life processes, vessel noise has the potential to interfere with their communication and their navigation of the environment by altering the background sound level (BSL), the ambient noise level at a given location, which acts as a reference level (Richardson, Green, Malme & Thomson, 1995). Understanding vessel noise contribution to the BSL of important whale habitats, in both intensity and frequency, can highlight the potential conflict between vessel noise emissions and the acoustic transmissions of whales.

2.2 Vessel Noise Transmission

2.2.1 Boats

The movement of vessels across the ocean medium produces sounds underwater by means of a number of sources and parameters. The intensity and frequency of sound is largely dependent upon the vessel size, design and speed (Richardson *et al.,* 1995). Generally, larger vessels produce lower frequency sound, while smaller vessels produce higher frequency sound, due to shallower propellers and higher blade rotation rates (Erbe, MacGillivray & Williams, 2012). Additionally, sound production is intensified with increasing speed. Vessel noise is a combination of narrow band and tonal sounds at specific frequencies, and broadband sounds with sound energy spreading continuously over a range of frequencies (Richardson *et al.,* 1995). This creates a variety of sound signatures based on vessel types. A vessel's sound emission is the product of three sources of radiated noise: machinery noise, propeller noise, and hydrodynamic noise (Urick, 1983).

Machinery noise is caused by the mechanical vibration of the moving parts of the engine and vessel, as well as the path of vibration: noise that originates from inside the boat from the motor that is projected into the water from the vessel hull (Ross, 1976). This sound source can be intensified with irregularities in the machinery composition and function. Urick (1983) outlines five originating sources of mechanical vibrations: rotating unbalanced parts, like out-of-round shafts or motor armatures; repetitive discontinuities, such as gear teeth, armature slots or turbine blades; reciprocating parts, such as explosions in the cylinders of reciprocating engines; cavitation and turbulence of the fluid in the pumps, pipes, valves and condenser discharges; and finally, mechanical friction on the bearings and journals. The noise impact increases with the size of the boat, as the size of the hull increases the propagating capacity of noise into the environment (Urick, 1983). However, outboard motor vessels do not have as high a propagation extent from machinery noise as inboard motor vessels, because their motors are situated outside the vessel hull.

Propeller noise is the second category of vessel-radiated noise and the dominant source of noise contribution from vessels. Propeller cavitation and propeller singing are the two main factors contributing to propeller-generated noise (Richardson *et al.,* 1995). As a propeller rotates in the water, regions of negative pressure around the blades are created that cause ruptures and cavities to form in the water, creating bubbles (Urick, 1983). When these bubbles collapse, they create a pulse of sound in the water. Propeller singing is defined as vortex shedding where the rotation of the propeller creates a vibrational frequency producing a turbulent stream of collapsing bubbles (Richardson *et al.,* 1995). This produces a strong tone between 100 to 1000 Hz whose intensity increases if the propeller is damaged, or if vessels with multiple propellers operate asynchronously (Ross, 1976). Additionally, the random collapse of bubbles occurs on a continuous spectrum. For high frequencies the spectrum level (defined as the intensity level of a sound wave within a 1 Hz band) decreases, while at low frequencies the spectrum level of cavitation noise increases with frequency (Urick, 1983). Larger cavitation bubbles are generated at greater speeds, creating greater low-frequency sound, further adding to the acoustic noise output.

Finally, hydrodynamics noise is caused by the erratic flow of water past the moving vessel. This irregular flow of water causes pressure fluctuations that emit sound into the ocean or cause vibrations along parts of the vessel within the turbulent boundary layer (Urick, 1983). The flow of water can cause vibrational resonance across openings or within struts of the vessel construction creating more noise (Urick, 1983). Additionally, the noise of the bow of the boat breaking waves, the produced wake, and the intake and exhaust of the water circulating system (if applicable), increases the emission of noise from the vessel (Urick, 1983).

A combination of these three source types, machinery, propeller and hydrodynamic noise, can contribute to the level of noise output from a vessel within the marine environment. The cumulative level of vessel noise contributions within marine ecosystems can change the BSL within a particular area.

2.2.2 Aircraft

Floatplanes and helicopters are common vessels utilized for whale watching. Despite being above the water, their noise emissions can be heard in the underwater soundscape. Sound propagation across the air-water boundary layer depends on the aircraft noise emission level, altitude, flight pattern, as well as sea conditions (Richardson *et al.,* 1995). Lower flying aircraft exhibiting circling behavior will propagate more noise underwater, as they inhabit the airspace above the sea surface longer. Like boats, machinery noise due to irregularities in composition and function of the motor or mechanics of the propeller(s) will increase the propagation of sound across the air-water layer. The louder the aircraft machinery, the louder the sound heard underwater. The dominant tones for fixed wing aircraft range from 68 to 100 Hz for the propeller and engine, dependent on the speed and number of blades of the propeller (Richardson *et al.,* 1995). Helicopters have dominant tones of 10.8 Hz, and harmonics that ranges from 68 to 102 Hz. Like planes, the sound emission is dependent on the rotor speed and number of blades (Richardson *et al.,* 1995). In general, helicopters are noisier than small fixed-wing aircraft, larger aircraft are noisier than smaller ones, and an aircraft is louder taking off or gaining altitude (Richardson *et al*., 1995). Although aircraft are not in contact with the ocean medium, their sound production above the water contributes to the BSLs within ocean ecosystems.

2.3 Vessel Noise Contribution to Background Soundscape

The BSL spectrum of coastal shallow waters is highly variable on temporal and spatial scales. However, a combination of wind noise, biological noise, and shipping and industrial noise dominates shallow water background noise levels (Urick, 1983). As whale watching predominantly occurs close to the coast, the contribution of vessel noise within shallow coastal waters will be discussed. Underwater ambient noise levels are directly related to wind speed, but can vary slightly depending on the temperature and salinity stratification profile (Urick, 1983). Simplistically stated, the velocity of sound in the water column increases with temperature, salinity and pressure (Urick, 1983). In terms of the sea conditions, shallower water depths allow for greater sound wave propagation, due to the increased reflections of sound from the bottom (Urick, 1983). The bottom composition of a bay or coastal zone influences the BSL; ocean bottoms can be more absorptive or reflective, with the latter influencing the transmission of sound within the medium longer (Richardson *et al.,* 1995). With consideration of the influence of the sea conditions, topography of an area and wind speed, biological or industrial noise can dominate the BSL of an area. In an area frequented by vessel traffic, the broadband tones and frequency ranges of passing vessels will dominate the BSL. This becomes an ecological problem when acoustically dependent species like whales are competing with vessels to propagate sound within the same frequency range, or are drowned out by the intensity level of vessel traffic.

Given the spatial variability of BSLs, documenting the contribution of vessel noise to a specific ecosystem will highlight whether a state of competition exists between whales in that ecosystem and vessels. As baleen whales communicate using low-frequency sound, vessels emitting similar emissions in low frequency ranges could interfere with whale communication.

Typically, larger vessels emit low-frequency sound in the same range of communication as baleen whales (Allen, Peterson, Sharrard, Wright & Todd, 2012). Gray whale vocalizations dominate the low frequency range, with average calls occurring below 500 Hz (Fisher & Schempp, 1984; Moore & Ljungblad, 1984). As whale-watching vessels are of smaller size, theoretically, their sound production should dominate the higher frequency range (Urick, 1983); therefore there is an assumption that whale watching vessels are not in competition with baleen whales as there sound emissions do not overlap. Within an area of high whale watching vessel use and whale critical habitat, a crucial question is: what is the contribution of vessel noise to the background sound level of whale foraging habitat?

2.4 Methodology

2.4.1 Acoustic Data Collection

The study site of this sound level analysis was Cow Bay of Flores Island, a gray whale foraging habitat in Clayoquot Sound, British Columbia, Canada between 49°16'N, 126°09'W. The BSL of Cow Bay was recorded within the study site using an Autonomous Multichannel Acoustic Recorder (AMAR G3, JASCO Applied Sciences). The University of Victoria Whale Research Laboratory deployed the AMAR on the ocean floor at a depth of 20 meters within Cow Bay, 49°25'629"N, 126°15'928"W, from May 6, 2015 to September 15, 2015 recording continuously for 133 days (Figure 2.1).

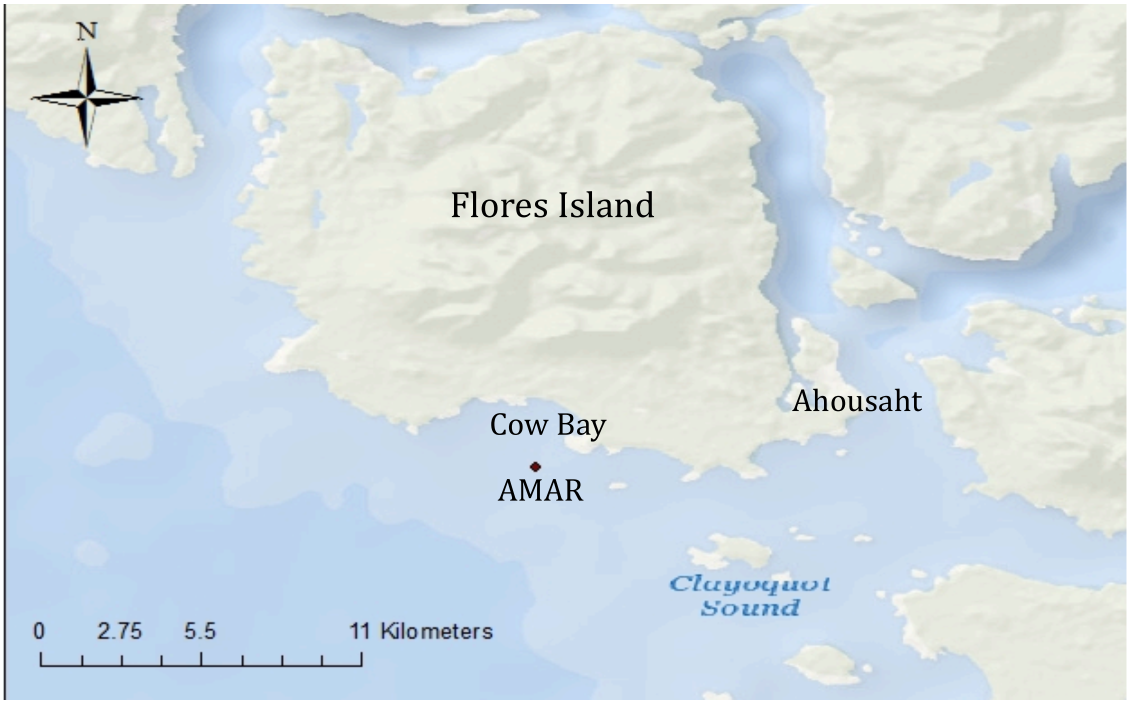

Figure 2.1. The location of the Autonomous Multichannel Acoustic Recorder (AMAR), 49°25'629"N, 126°15'928"W, in Cow Bay of Flores Island in Clayoquot Sound, British Columbia.

An M8E calibrated omnidirectional hydrophone (GeoSpectrum Technologies Inc.) set for a gain of six decibels was a part of the AMAR device. Recordings were within the first third octave-band level. The recorder sampled for 340 seconds at 16 kilo samples per second (ksps), alternating with 560 seconds at 64 ksps, an 80% duty cycle. The data are being collected for the Whale Habitat and Listening Experiment (WHaLE) project by the Whale Research Laboratory as a part of the Marine Environmental Observation Prediction and Response Network (MEOPAR), Dalhousie University.

2.4.2 Visual Data Collection

The selected acoustic recording files analyzed within this study correspond to surface observation data, which allowed annotations of the presence or absence of vessels and whales within the study site. The term vessel encompasses floatplanes, helicopters, and various boat types. Stationary observations took place by the Whale Research Laboratory from June 2, 2015 to July 31, 2015 between the hours of 5:45am and 7:30pm for a minimum of 3.5 hours to a maximum of 6 hours (Whale Research Laboratory, unpublished data, 2015-2016). Observers on the vessel maintained a scan of 360° looking for whale blows and vessels. Boats were documented if they were in Cow Bay or if a vessel was travelling along the boundary of the Bay (Figure 2.1). Additionally, transect data was collected from May 24, 2015 to August 8, 2015 between the hours of 6:00 am and 11:00am (Whale Research Laboratory, unpublished data, 2015-2016). Observations were noted from a moving vessel following a set transect route through Cow Bay at a speed of 7 knots (Figure 2.2). Observers maintained a scan of 360°. All whale survey observation data were obtained under adequate weather conditions; surveys were aborted in the presence of fog or a Beaufort Sea condition exceeding level 3 (Burnham, 2012).

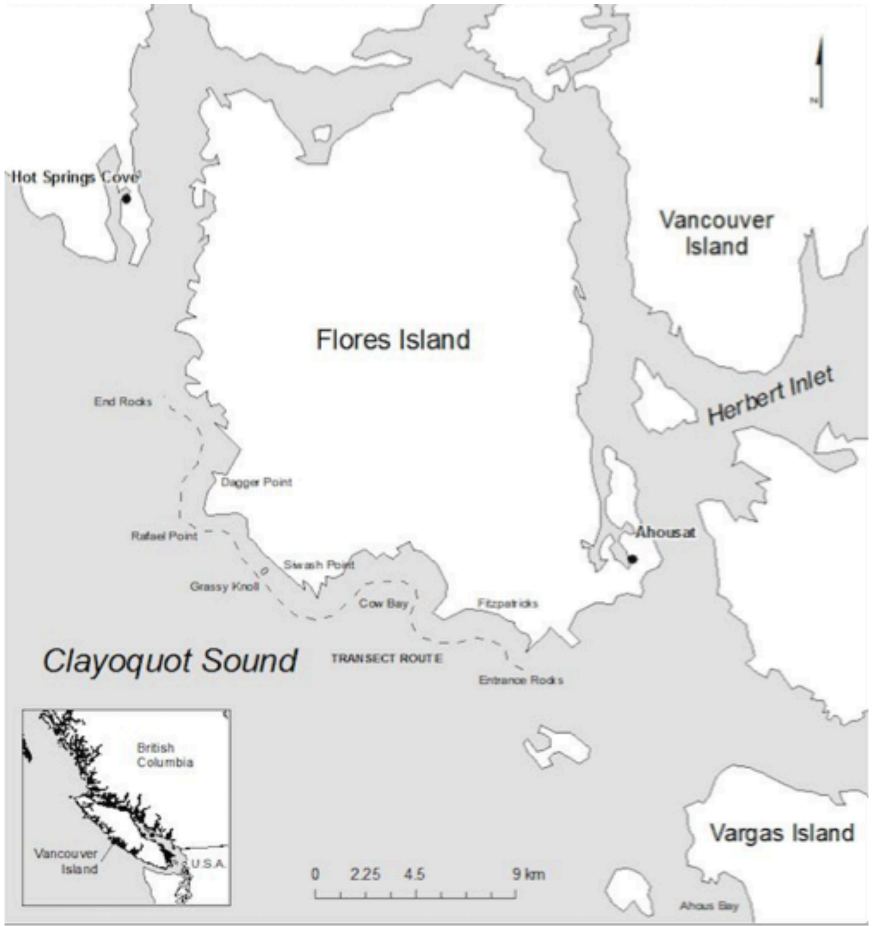

Figure 2.2. The whale survey transect route along the coast of Flores Island, Clayoquot Sound, BC, 49°11'60.00" N, -126°05'60.00" W (Stevenson, 2014).

2.4.3 Data Analysis

Acoustic recordings were categorized by the absence and presence of anthropogenic vessel noise from boats and floatplanes. The comparison of the background sound levels of these categories determined the contribution of vessel noise to the foraging habitat of gray whales in Cow Bay during the daylight hours of the summer of 2015. The AMAR recordings were analyzed using automatic vocalization recognition and vessel detection software to identify the presence of vessel noise and gray whale calls to the soundscape (JASCO Applied Sciences). The AMAR acoustic recordings for the data collection time frame were organized into 12.81-minute files for easier analysis. In addition to the automatic detection analysis, the files were analyzed manually for vessel noise and gray whale vocalizations to ensure accuracy of the automatic detection data. All AMAR files analyzed had the presence of gray whales, whether vocalizing or silent, as confirmed from stationary and transect observation data. A total of 218 acoustic files over the deployment timeframe were analyzed, totaling 46.56 hours of recordings. A total of 153 of the AMAR files correspond to observations taken from within Cow Bay from an anchored vessel and the remaining 65 AMAR recording files correspond to the transect data collected. All recordings were analyzed using Raven Pro 1.5 Interaction Sound Analysis Software using the preset annotation measurements. Each AMAR recording was amplified by 25 times (for easier analysis to visually identify sound signatures) and were measured for total peak frequency (Hz) and max power (dB), while each vessel sound signature was measured for minimum and maximum frequency range (Hz), peak frequency (Hz), and max power (dB). The boundaries of a sound signature were determined by the sound pattern and sound intensity colouration of the recording's spectrogram.

2.5 Results

There is a high presence of vessel noise within the gray whale foraging habitat of Cow Bay. Vessel noise is present within 86.3% of the recordings analyzed (N=132) with all of these recordings containing boat noise and 17.0% of these recordings containing floatplane noise (N=26). All recordings categorized as presence of vessel noise contain boat noise.

Vessel noise dominates the BSL of the AMAR recordings when vessels are present. All vessel noise types' single modal difference between the peak frequency and BSL is zero, which is the same for maximum power and BSL (Table 2.1). Watercraft noise has the highest range in frequency when vessels passing close to or over the AMAR induced a Lloyd Mirror Effect (Figure 2.3), which has the largest mean range of 58 to 6517 Hz (Table 2.1). An underwater Lloyd Mirror acoustic effect is caused by a sound generated just below the water surface that generates constructive and destructive interference between the direct sound path and reflected sound path, as the sound is reflected at 180 degrees from its source thereby interfering with the direct sound path at any receiver location (Erbe, 2011). Aircraft noise has the lowest range in frequency, with planes flying directly over the AMAR inducing an S Curve harmonic (Figure 2.4), with this occurrence having a mean range of 58 to 824 Hz for its boundaries of a sound signature (Table 2.1). The S Curve is a term used in this study to describe the sound signature of a plane flying directly over the AMAR creating an S shape in a harmonic of frequencies. The mean peak frequency contribution of all vessel noise types is similar in output, with the Lloyd Mirror Effect sound signatures contributing the highest mean peak frequency (M=249 ± 158 Hz), and S Curve sound signatures contributing the lowest mean peak frequency to the BSL (M=137 ± 63 Hz). Like peak frequency, the intensity of vessel noise contribution is similar across vessel noise types. The highest mean max power is produced from the Lloyd Mirror Effect of boats (M=148 ± 10 dB re 1 μPa) and the lowest from planes (M=131.4 ± 9 dB re 1 μPa).

Table 2.1. Summary of vessel noise type contributions to the background sound levels.

Vessel Noise Type	N	Minimum Frequency Mean ± SD (Hz)	Maximum Frequency Mean ± SD (Hz)	Peak Frequency Mean ± SD (Hz)	Difference in Peak Frequency and BSL		Max Power Mean ± SD (dB re 1 μPa)	Difference in Max Power and BSL	
					Mean (Hz)	Mode (Hz)		Mean (dB re 1 μPa)	Mode (dB re 1 μPa)
Boat	147	93 ± 56	1936 ± 2693	202 ± 96	67 ± 122	0	135 ± 14	0 ± 17	0
Lloyd Mirror Effect	53	58 ± 41	6517 ± 2840	249 ± 158	13 ± 79	0	148 ± 10	-4 ± 20	0
Plane	15	78 ± 53	1541 ± 1990	212 ± 79	13 ± 106	0	131.4 ± 9	-15 ± 11	0
S Curve	13	58 ± 35	824 ± 398	137 ± 63	2 ± 156	0	136 ± 10	-5 ± 8	0

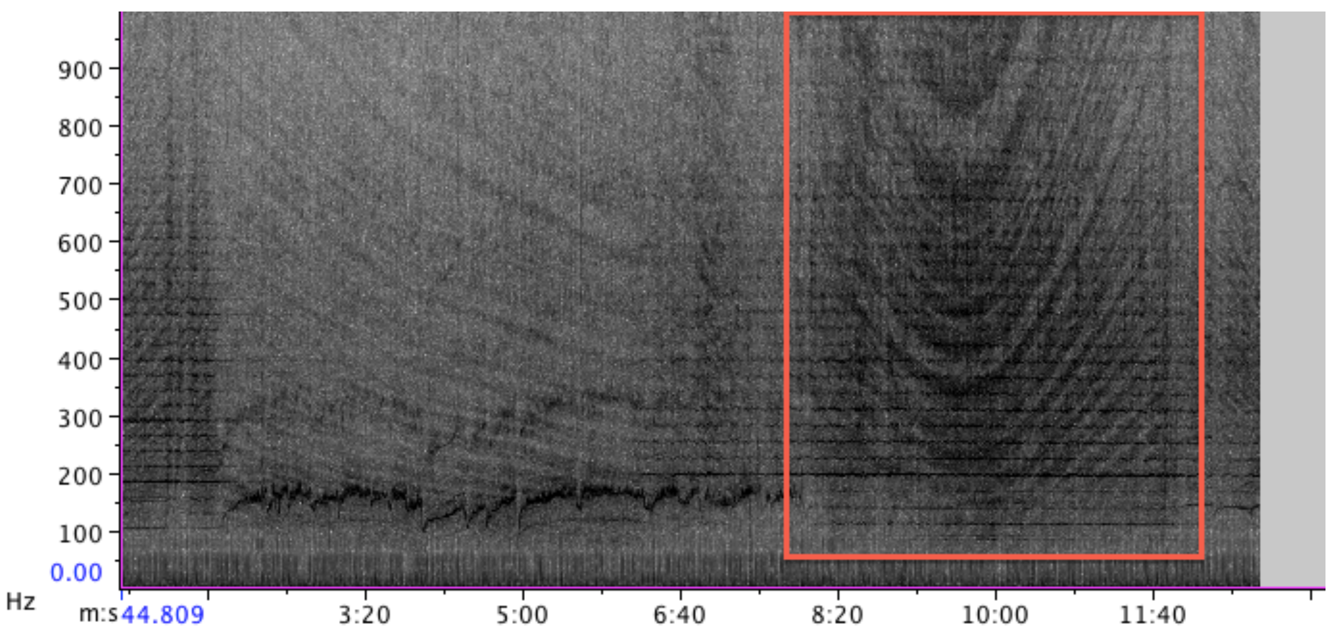

Figure 2.3. Spectrogram of a boat producing the Lloyd Mirror Effect sound signature from travelling near or over the acoustic receiver. The sound signature is illustrated by the spectrogram by frequency (Hz) over time (minutes).

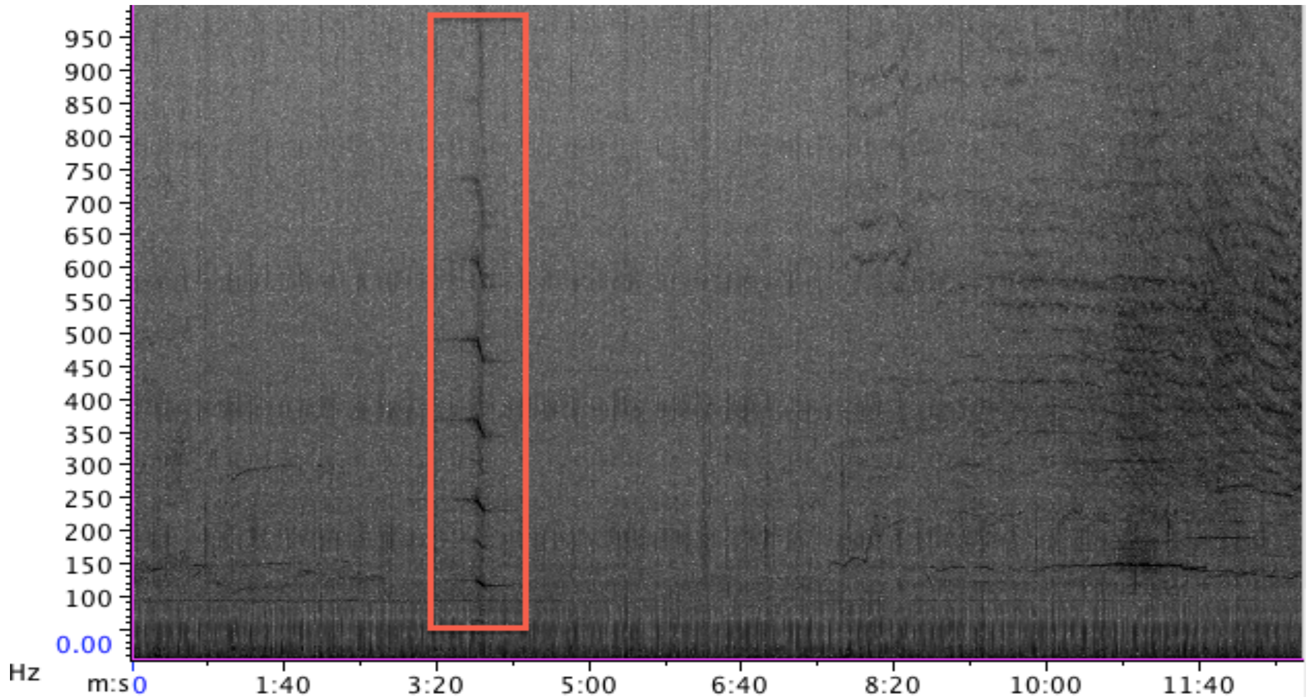

Figure 2.4. Spectrogram of S Curve harmonic sound signature of a floatplane flying over acoustic receiver. The sound signature is illustrated by the spectrogram by frequency (Hz) over time (minutes).

The BSL peak frequency was compared across vessel noise conditions measured using Raven Pro 1.5's peak frequency tool. The BSL peak frequency is higher in the presence of vessel noise when compared to absent vessel noise conditions (AVNC) (Figure 2.5). A non-parametric Friedman's Test compared BSL peak frequencies across noise conditions resulting in a test statistic of 26.482, which was significant ($p=0.05$); ranks Mean Rank of AVNC as 1.10, BPNC as 2.36, and BPPNC as 2.55. A pairwise comparison indicates a significant difference between AVNC and BPNC ($p<0.0001$) and AVNC and BPPNC ($p<0.0001$), but not between BPNC and BPPNC. The noise conditions were compared to document the variability in vessel noise contributions (Figure 2.6). The ambient noise level (sounds below 30 Hz) was removed in the vessel noise conditions to compare boat noise and plane noise contributions to the BSL. A distinction to be made is that the ambient sound of a habitat is comprised of abiotic sources, such as wind and wave action, and biotic sources from the variety of marine life residing within the region; defined by Urick (1983) as the sound of the sea itself or the sound left over after allocating all other noise sources. Whereas the BSL is defined as all noise detected within a habitat (Urick, 1983). A Mann Whitney U Test compared vessel noise conditions and yielded a difference between boat present noise conditions (BPNC) (Mdn=151.9), and boat and plane present noise conditions (BPPNC) (Mdn=147.6) (U=12.80; p=0.1796).

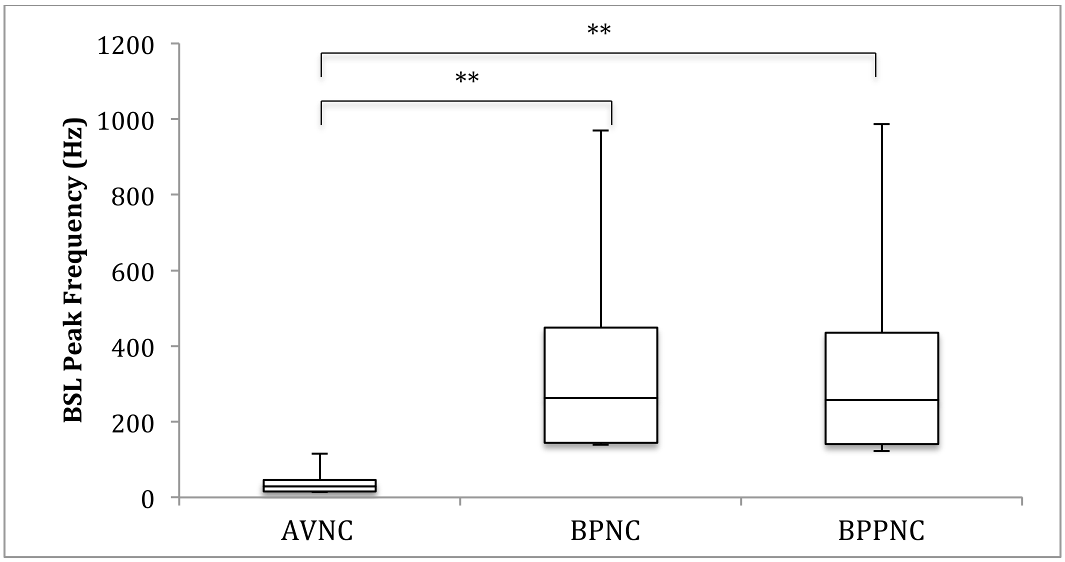

Figure 2.5. The background sound level (BSL) peak frequency (Hz) in the absence and presence of vessel noise (Absence =AVNC; Boat=BPNC; Boat & Plane=BPPNC).

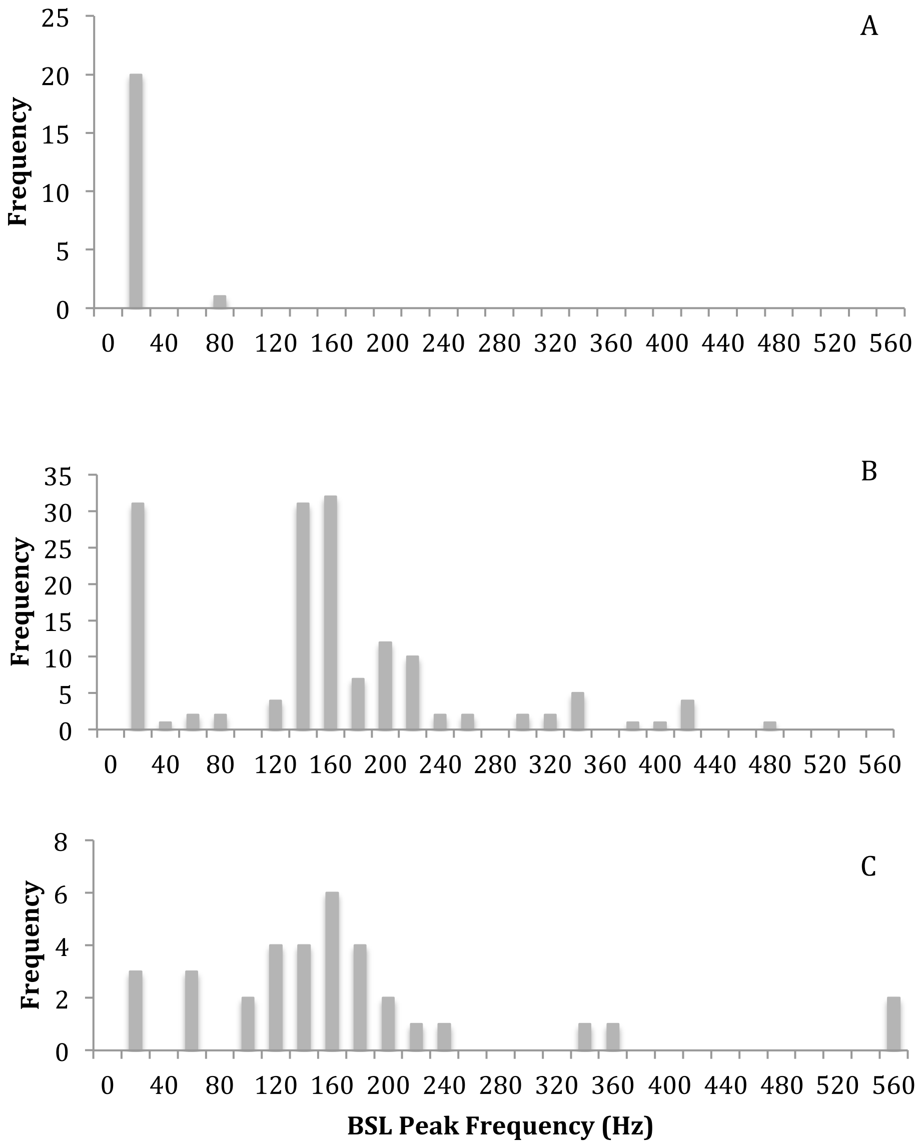

Figure 2.6. Range of BSL peak frequency ranges across the noise conditions: Absent vessel noise conditions (AVNC) (A), Boat present noise conditions (BPNC) (B) and Boat and plane present noise conditions (BPPNC) (C). These graphs compare the frequency of occurrence for the three noise conditions.

The maximum peak intensity of sound, max power (determined using Raven Pro 1.5's max power calculation tool), within the background sound levels of Cow Bay did not differ among conditions on average (Figure 2.7). There is higher variability in the intensity of the BSL within vessel present conditions (BPNC and BPPNC), than AVNC.

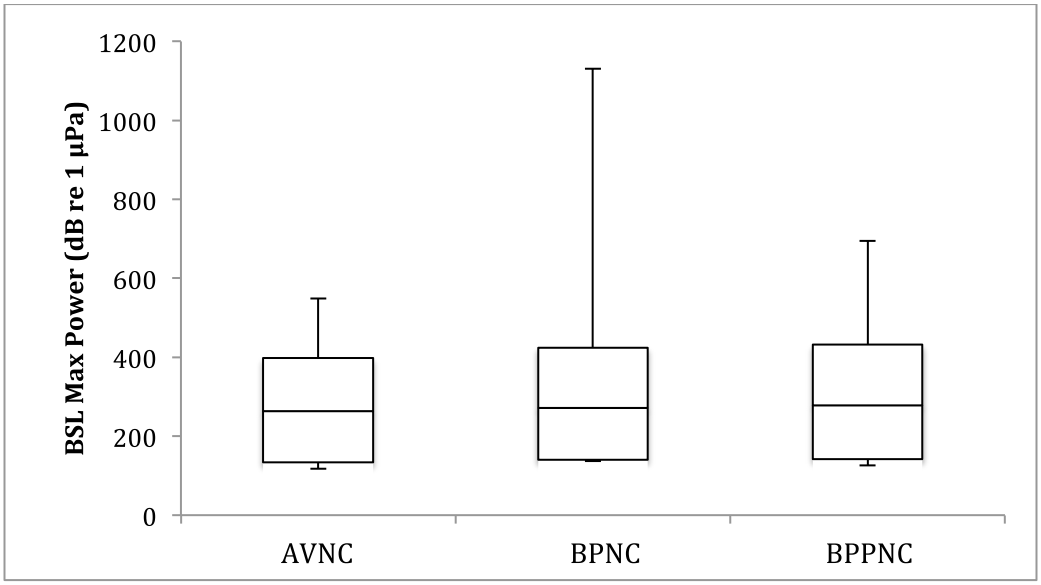

Figure 2.7. The background sound level (BSL) max power in the conditions of the presence and absence of vessel noise.

To determine the contribution of vessel noise over time, the sound pressure levels of Cow Bay are averaged to characterize a typical day of the summer of 2015. Sound pressure levels (SPL) increase during daylight hours and remain constant during the night (Figure 2.8). The sound frequency range of 100 to 1000 Hz remains relatively constant at 85 dB re 1 μPa during the night and increases to between 90 and 100 dB re 1 μPa during the hours of 10:00am and 8:00pm Pacific Standard Time. Similarly, the sound frequency range of 1000 to 6300 Hz has a relatively constant SPL of 82 dB re 1 μPa during the night, and increases in intensity to between 90 and 100 dB re 1 μPa during the daylight hours of 10:00am to 8:00pm. The lowest sound frequency range of 10 to 100 Hz remains constant at 87 dB re 1 μPa over the duration of a full 24-hour day.

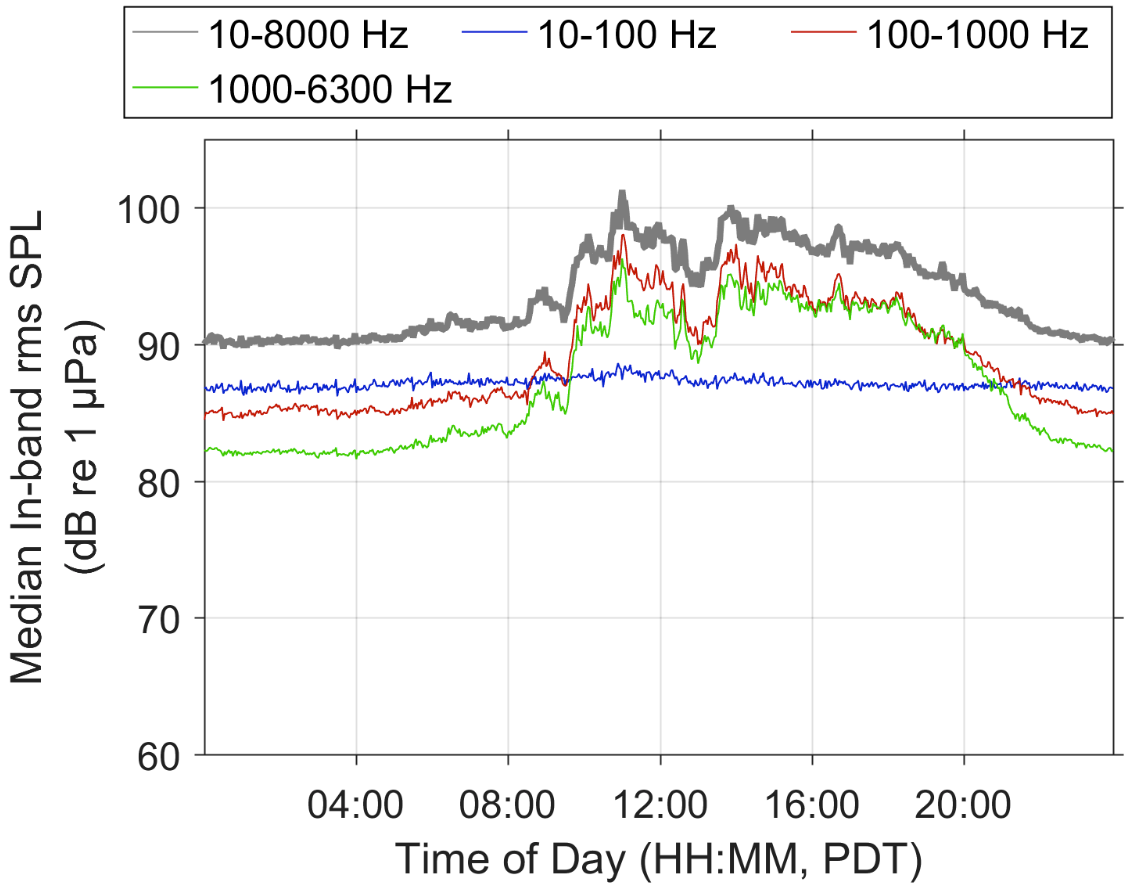

Figure 2.8. The median root-mean-square (rms) sound pressure levels (SPL) of the ambient soundscape for the average day in Pacific Standard Time (PST) of the summer of 2015 from May 6, 2015 to September 15, 2015 for various frequency ranges (Hz) (X. Mouy, unpublished data, 2015).

2.6 Discussion

2.6.1 Vessel Noise Implications for Gray Whales

Within the gray whale foraging habitat of Cow Bay, vessel sound dominates the BSL. The frequency range of vessel sound emission falls directly within gray whale vocalization range of below two kilohertz (Richardson *et al.,* 1995). The vessel mean peak frequency was found to occur in the vocalization range of low frequency gray whale call types of grunts and moans, the most commonly recorded call for gray whales off the Pacific North American Coast (Crane &

Lashkari, 1996). Contrary to theoretical literature about underwater acoustics stating that smaller boats emit higher frequency sound (Richardson *et al.,* 1995; Urick, 1983), the AMAR recordings document the mean range of boat noise to occur in the lower frequency broadband range. Small vessels, including small whale watching vessels, water taxis, recreational fishing boats and smaller leisure watercrafts, frequent the area of Clayoquot Sound. This study documents all vessel types, boats or floatplanes, produced noise within the frequency range of gray whale communication. This low frequency vessel dominated BSL creates a state of potential competition between vessel sound and gray whale communication, as the two sound source ranges overlap. This conflict has the potential to create a state of call interference (Richardson *et al.,* 1995), or mask whale conspecific communication.

Acoustic masking can reduce the receiver's performance in perception, recognition and understanding (Clark *et al.,* 2009). Energetic masking occurs when energy is emitted in the same frequency and the same time, making the signal inaudible (Watson, 1987). As baleen whales are low frequency specialists, they are particularly susceptible to changes in low frequency background sound level changes, and therefore acoustic masking from vessels (Richardson *et al.,* 1995). Not only can acoustic masking cover conspecific communication but may also mask biologically important sounds, such as those from predators (Clark *et al.,* 2009). This can induce stress as whales struggle to communicate and navigate their environment in BSLs dominated by vessel noise. Depending on the level of chronic stress imposed, life history processes, such as foraging and reproductive success, can be negatively impacted (Clark *et al.,* 2009; Rolland *et al.,* 2012). This in turn can impact the population as a whole (Lusseau & Bejder, 2007). As a result, vessel noise may induce behavioural changes that may be more taxing to whale life processes or cause habitat displacement. Once a level of chronic stress has been reached, the cost of foraging within the habitat of Cow Bay may become too high, causing gray whales to abandon the area if noise levels remain elevated. This would be a cause of great economic strain for the Tofino whale watching industry and community (further discussed in Chapter Five). As vessel noise is highly prevalent within the foraging habitat of Cow Bay, gray whales are experiencing continuous vessel noises during whale watching operation hours, as the peak frequency is lower during twilight hours. This suggests that whale watching within Clayoquot Sound could be considered a chronic stress to gray whale within their foraging habitat.

The vessel sound emission to the BSL is highly variable. Although vessel contribution is consistent within the first third octave band, each vessel contributes noise at different frequencies and harmonics within the broadband range. This can be explained by the differences in vessel design, size, and speed (Richardson *et al.,* 1995). The Tofino whale watching fleet is composed of mostly small outboard engine vessels with a few larger inboard engine vessels, with vessels fitted with dual propellers (personal observations, 2016; Chapter Five). Additionally, due to variations in machinery noise, the sound signature and range of frequency sound output varies, which is also the case for floatplanes. Although Gray whales can alter their calls to emphasize specific frequencies, vary bandwidth and call rates, and frequency modulate their signals to increase the ratio of their signal intensity to dominate ambient noise (Dahlheim, 1987; Norris 1995), the variation in sound output could strain the ability for gray whales to dominate the BSL. Although the maximum power across the conditions of vessel noise was not significantly different, the frequency of vessel noise and the range of harmonics varied, which could further unpredictable vessel noise conditions. This may not only strain species-specific communication but the ability of gray whales to accurately read the ambient soundscape of their environment and overcome the additions.

2.6.2 Industry Opportunities

Given the contribution of vessel noise to the BSL and the implications for gray whales, the whale watching industry of Tofino would benefit from addressing their vessel noise contribution to Clayoquot Sound. As vessel noise is highly varied, operators should measure their output to identify noise levels and establish a benchmark for improvement. Vessel noise has been identified as an indicator of the inefficiency of vessel operation and can be used as an industry incentive to quiet vessel output (Simmonds, Dolman & Weilgart, 2004).

Vessels should be measured for machinery, propeller and hydrodynamic noise emissions. A key contributor of machinery noise is irregularities in construction and function, like the vibration of loose bolts, or poor maintenance (Urick, 1983). Isolating sounds or using absorbing techniques can reduce noise propagation. Diesel electric engines may be fitted with resilient isolation mounts, flexible hoses, and pipe hangers to reduce vibration (Southall, 2005). Propeller cavitation can be addressed by upgrading propeller design to have tips without weights, larger diameters, using lower rotations per minute, increasing propeller blade length, or placing the propeller deeper in the water column using propeller pods to reduce cavitation (Southall, 2005). Reducing hydrodynamic noise can be achieved through hull damping or decoupling to reduce flow noise (Southall, 2005). The presence of these adaptations should be communicated to the industry, which could increase their use among operators.

Finally, turning to quieter propulsion technology, like that of electric drive propulsion or thrusters, can reduce noise output from the propeller and the motor. For instance, podded propulsion has a submerged electric motor attached to the propeller that minimizes water flow to the propeller, thereby reducing propeller cavitation without reducing vessel maneuverability (Southall, 2005). This technology is already present within the whale watching industry, including Tofino. Tofino Water Taxi has employed the first (and only) electric charter boat, boasting zero carbon emissions and lower sound emissions (Tofino Water Taxi, 2016). Whale Watch Kaikoura in New Zealand has won numerous awards for their best ecotourism practices. Their catamaran vessels are equipped with inboard diesel engines, as well as propulsion units specifically utilized to reduce underwater noise employed when in close proximity of a whale (Whale Watch Kaikoura, 2016). These technologies and the level of commitment to environmentally sustainable practices in New Zealand can be upheld in Canada with further education, economic incentives and regulations to minimize underwater noise. Reducing vessel noise output will benefit the whale watching industry by promoting more ecologically sustainable interactions with whales, and reducing vessel noise contribution to the BSL of Clayoquot Sound.

2.7 Conclusions

The contribution of vessel noise to the underwater environment of Clayoquot Sound, BC, is prevalent within gray whale foraging habitat. As whale watching vessels are intentionally interacting and subjecting whales to the noise output of their vessels, efforts should be made to reduce this potential stressor on these ecologically significant and key industry species. Due to the experimental design of this study, the use of a single AMAR, the sound intensity of vessel noise did not yield significant results due to the inability to estimate the vessel distance from the AMAR that corresponded to specific sound signatures. Additionally, this study would have benefited from determining the AMAR detection range of the hydrophone to understand the distance of vocalizations and vessel noise being recorded. Further research and proactive measures to better understand and safeguard against harmful vessel noise emissions is the way forward to adequate whale protection. This not only sustains current whale watching practices and whale protection, but the future of the industry within Clayoquot Sound.

3.0 CHAPTER THREE: GRAY WHALE VOCALIZATIONS IN THE PRESENCE OF VESSEL NOISE

3.1 Introduction

Baleen whales utilize low frequency sound to navigate their environment and accomplish communication and foraging behaviours (Simmonds, Dolman, & Weilgart, 2004). Whales' auditory organs sit completely outside of the skull, which increases directional hearing capacity underwater (Richardson, Green, Malme, & Thomson, 1995). Norris and Leatherwood (1981) theorizes that the large distance between a whales' two ears, coupled with the ear isolation physiology, enhances its ability to localize sound, aiding in finding concentrations of prey, or discerning topography for navigation. Indeed much more physiological emphasis is given to hearing than other sense, for example vision (Ketten, 1997). Their physiology and evolutionary history reinforce the high level of dependency on sound in their environment.

Gray whale vocalizations range from 20 to 2000 Hz with the most common calls occurring below 500 Hz (Dahlheim, Fisher & Schempp, 1984; Moore & Ljungblad, 1984). Dahlheim (1987) identified six distinct vocalizations of gray whales in their breeding grounds in Laguna San Ignacio, Mexico. Crane and Lashkari (1996) corroborated the classification of call types off the coast of California during their migration. Knock vocalizations and bongo pulses are greater than 100 Hz to 2 kHz, while moans and grunts vocalization energy range from 327 to 825 Hz (Richardson *et al.,* 1995). Within high Arctic foraging habitat, low frequency pulses are the most common calls (Moore & Ljungblad, 1984; Stafford, Moore, Spillane & Wiggins, 2007). Gray whales were thought not to produce sound when foraging. Historically, they were considered to not produce underwater sounds at all, giving the epithet of the silent whale (Rasmussen & Head, 1965). For the purposes of this study, the calls previously identified within the northern hemisphere and their characteristics were used to identify and analyze the vocalizations detected within the data of this study (Table 3.1).

Table 3.1. Gray whale call types and their characteristics (adapted from JASCO Applied Sciences, 2014; Dahlheim, 1987; Richardson *et al.,* 1995).

Call Type	Frequency Range	Description
Knock	100 Hz to 2 kHz	Knocking-like sounds. No frequency modulation.
Bongo pulses	100 Hz to 2 kHz	Series of knock calls
Click	100 Hz to 2 kHz	Similar to knocks but in a series of impulsive sounds varying in pitch throughout.
Grunt	327 to 825 Hz	Grunt-like moans in the low frequency range.
Moan	327 to 825 Hz	Moans are low frequency broadband phonations with little attenuation and low complexity.
Growl	Near 100 Hz	Low frequency calls that are moan-like with growly texture.
Whump	327 to 825 Hz	Long wave-like call in low frequency range with defined sound completion.

This chapter disproves the theory of the silent foraging gray whale through the analysis of underwater acoustic recordings of the soundscape of Clayoquot Sound's gray whale foraging habitat and their interaction with vessel noise. Vessel noise contributions to the background sound level (BSL) of the environment can influence their calls or mask their communication (Chapter Two). This chapter analyzes the audible reaction, changes to vocalizations, of gray whales to vessel noise by comparing vocalizations in its' absence and presence, thereby establishing any evidence of acoustic disturbance.

3.2 Methodology

3.2.1 Data Collection

Refer to Chapter Two's Methodology Data Collection Sections for a description of the data collection procedure.

3.2.2 Data Analysis

As acoustic recordings were categorized by the absence and presence of anthropogenic vessel noise from boats and floatplanes, vocalizations were compared between these categories. The data analysis utilized the same procedures as Chapter Two using Raven Pro 1.5 Interactive Sound Analysis Software (Bioacoustics Research Program, Cornell Lab of Ornithology, Ithaca, NY). Of the 218 AMAR clips, 89 of these files contain the presence of gray whale vocalizations, totaling 211 calls. Identified vocalizations were measured for total peak frequency (Hz), the frequency range of the call (Hz), max power (dB re 1 μPa), and duration of the call (s) using the preset annotation measures of Raven Pro 1.5 software. The boundaries of a sound signature were determined by the sound pattern and sound intensity established by gradients in colouration of the recording's spectrogram (Figure 3.1.).

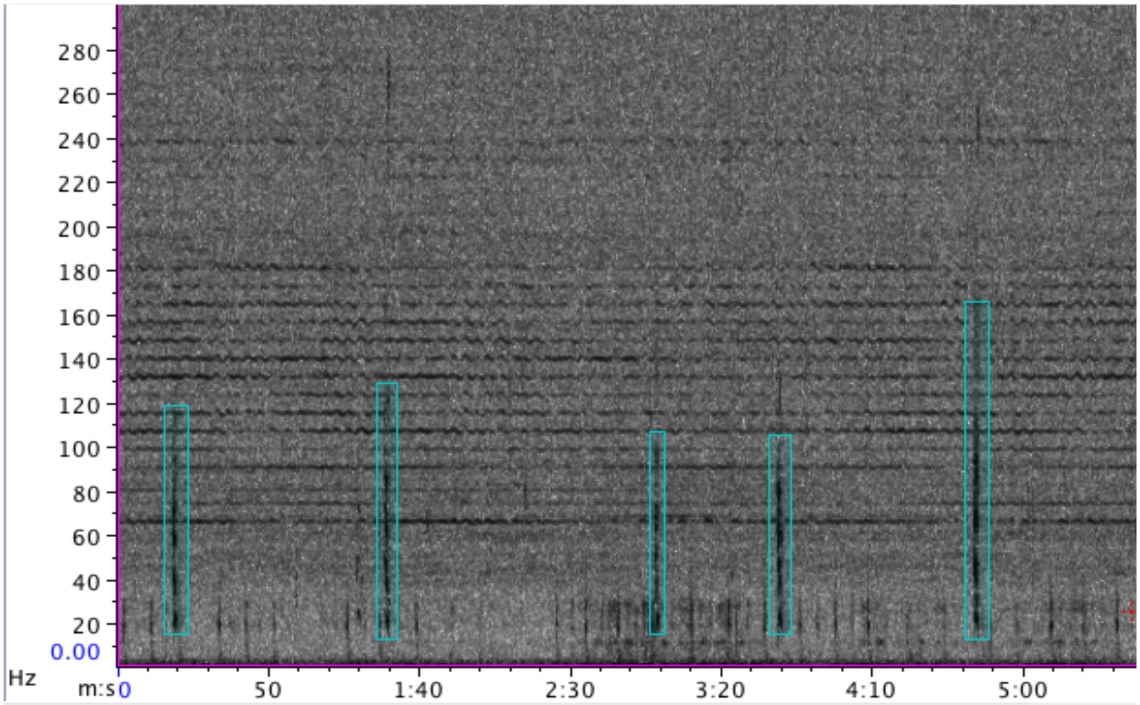

Figure 3.1. Spectrogram of gray whale moan vocalizations (Hz) during the collection period of 2015 (Whale Research Laboratory, unpublished data). The vocalizations are illustrated within the blue boxes on the spectrogram in frequency (Hz) over time (minutes).

3.3 Results

Gray whale vocalizations were prevalent across all vessel noise conditions. Gray whale vocalizations are present within 42% of the AMAR clips during observation surveys. Within AVNC, 11% of the total vocalizations were recorded (N=22), 69% of the vocalizations were emitted within BPNC (N=151), and 19% of vocalizations occurred within BPPNC (N=38); 83.6% of the AMAR clips contained vessel noise overall (Chapter Two). The average rate of calling increased in the presence of vessel noise (Table 3.2.), although was not statistically significant. BPPNC had the highest calling rate (0.084 ± 0.13 calls/min) and AVNC had the lowest rate of calling (0.071 ± 0.13 calls/min). A non-parametric Friedman's Test compared calling rate across noise conditions resulting in a test statistic of 1.216, which was insignificant (p=0.545). The average call duration also increased in the presence of vessel noise. BPPNC had the longest call duration (4.7 ± 2.8 s) and AVNC had the shortest call duration (3.0 ± 0.83 s). A non-parametric Friedman's Test compared calling duration across noise conditions resulting in a test statistic of 5.047, which was insignificant (p=0.080).

Table 3.2. Gray whale calling repetoire in various vessel noise conditions.

Noise Condition	N	Number of Calls	Average Calling Rate ± SD (calls/min)	Average Calling Duration ± SD (s)
AVNC	22	24	0.071 ± 0.13	3.0 ± 0.83
BPNC	151	146	0.075 ± 0.13	4.6 ± 2.0
BPPNC	38	41	0.084 ± 0.13	4.7 ± 2.8

The most common call types for gray whales are moans across noise conditions. AVNC has the lowest percentage of moan calls with 75% comprising the total vocalization types within that noise condition, and BPPNC has the highest frequency of moans, as 95% of vocalizations are moans (Figure 3.2.). The highest variability of call type frequency is present in AVNC with decreasing frequency of whump and growl calling types across vessel noise present conditions. Whump calls are only present in BPNC and AVNC. When vessel noise was absence, whump calls account for 17% of the gray whale calling repertoire; in BPNC, 10% of calls are whump vocalizations. Growl call types had the highest frequency in AVNC with 8%, and the lowest frequency in BPNC with 4%.

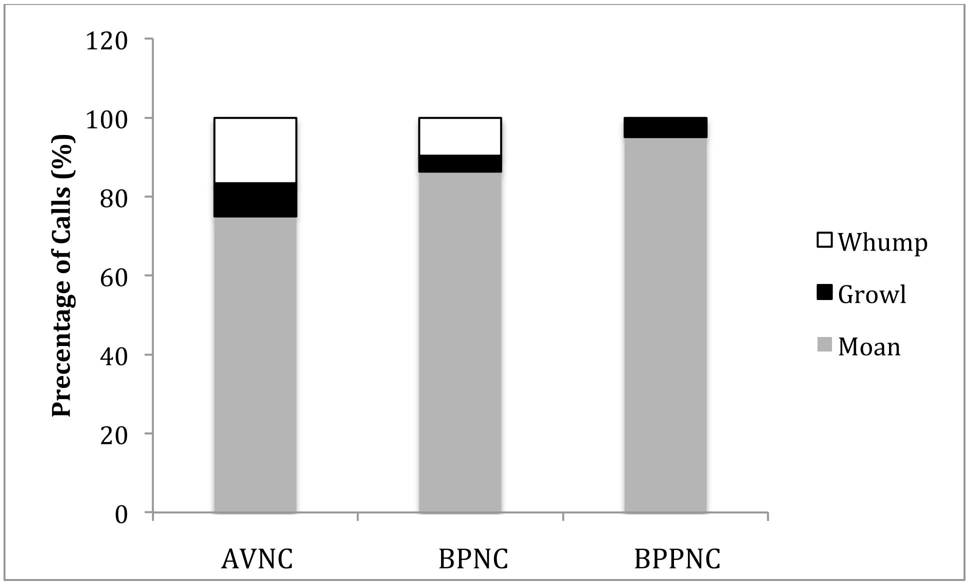

Figure 3.2. Percentage of gray whale call types per noise condition.

Variability in vocalization peak frequency of gray whales was not found to be significant across vessel noise conditions (Figure 3.3.). In BPNC, there is a higher variability in peak frequency when compared to the other conditions and has the highest peak frequency calling on average (M=50.28 Hz). Calling peak frequency in BPPNC has the lowest average peak frequency (M=13.53 Hz) when compared to BPNC and AVNC (M=18.06 Hz). A non-parametric Friedman's Test compared calling peak frequencies across noise conditions resulting in a test statistic of 3.095, which was insignificant (p=0.213).

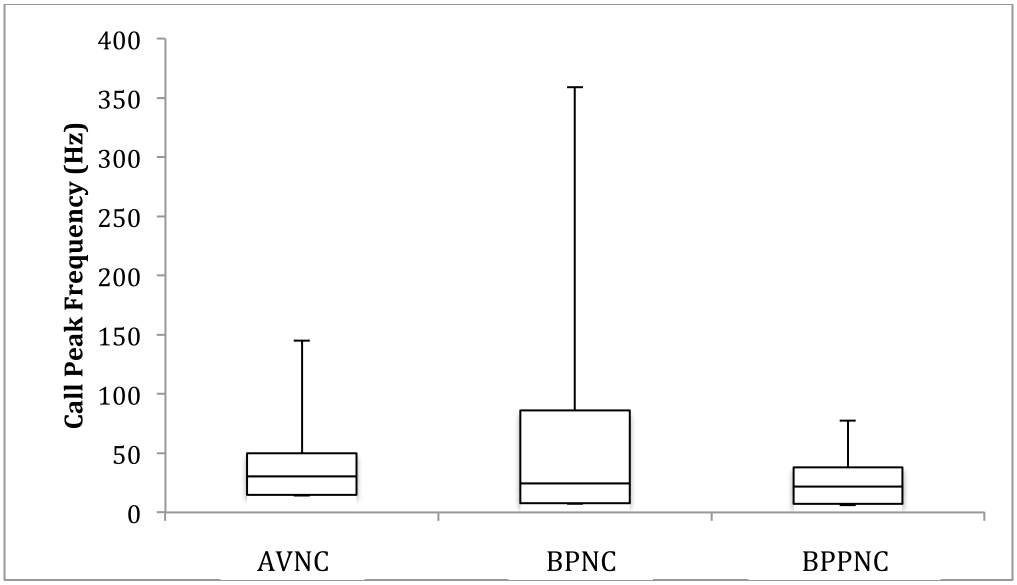

Figure 3.3. Gray whale vocalizations' average peak frequency (Hz) per vessel noise condition.

Gray whale calling intensity did not vary across noise conditions (Figure 3.4). The three conditions demonstrate similar variability in calling power. Yet calling intensity could not be confirmed as whale distance could not be determined using one AMAR. The average vocalization power of AVNC had the lowest calling power on average (M=123.34), while vessel presence conditions of BPNC (M=125.73) and BPPNC had the same average calling power (M=125.47). A non-parametric Friedman's Test compared calling peak frequencies across noise conditions resulting in a test statistic of 2.583, which was insignificant (p=0.275).

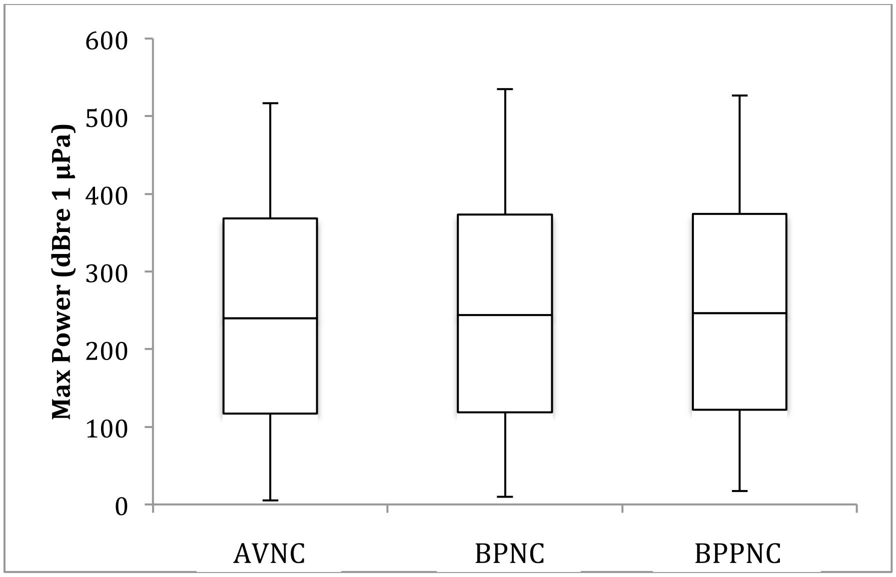

Figure 3.4. Gray whale call max power (dB re 1 μPa) in the presence and absence of vessel noise.

3.4 Discussion

As gray whales primarily utilize sound to communicate and understand their surrounding environment, it is logical for their vocalizations to change as the BSL of their environment changes. Gray whales can modify their call type, select specific frequencies, vary calling rates, and frequency-modulate their sound to increase the ratio of their signal intensity to dominate the ambient noise (Dahlheim, 1987; Norris, 1995). Many mechanisms may compensate for noisy environmental conditions, including increasing signal to noise ratio, increasing amplitude, changing frequency, or changing their call timing by altering calling rate, call repertoire or simply waiting for the other noise to cease (Brumm & Slabbekoorn, 2005). The ability of whales to modify their calling behavior enables them to adapt to varying BSL conditions, hence to increase the likelihood of accurate communication or reading of their surrounding environment.

Within the study site, gray whales increased their calling rate and duration of calls in the presence of vessel noise. This suggests that they are able to transmit their sound within their normal frequency range in the presence of outboard motors. However, broadcasting a high calling rate may require gray whales to concentrate their acoustic energy within a “free acoustic corridor” for effective communication (Lesage*,* Barrette, Kingsley & Sjare, 1999, p. 79). This may have increased energetic demands or be specified to particular regions, given ambient and topographic conditions. During the analysis of their call patterns within a spectrogram, whale-calling rate appeared to be concentrated into a pattern in the presence of vessel noise. Calling rate would increase between sound signatures of vessels; therefore, whales could be waiting to call during the quietest periods, in accordance with vessels leaving the bay for example (R. Burnham, personal communication, July 4, 2016; personal observation, 2016). This would enable more efficient allocation of energy for greater effective calling strategies. Yet, the increased duration of calls and behavior of repetitive calling have energetic costs based on higher production requirements. Deviation from normal calling behavior can be more costly to individuals, as it is more energetic to produce, the content of a call’s information may be altered, and it can increase the risk of detection by predators (Patricelli & Blickley, 2006). Audible reactions to vessels are supported by Dahlheim (1987) playback experiments within Mexican breeding grounds of gray whales, which revealed that their call rates increased and call structure changed when underwater playbacks of recorded outboard engines noises were used. Behavioural responses vary for baleen and toothed whales, depending on the source of the sound, severity and exposure length, resulting in varied acoustic behavioural changes (Gomez et al., 2016). Redundancy and increasing duration are utilized to reduce signal deterioration in noisy conditions across species and ecosystems (Richardson & Wiley, 1980; Richardson *et al.,* 1995;

Turnbull & Terhune, 1993). For example in addition to gray whales, this is documented in blue whales (*Balaenoptera musculus)*, which call more consistently during seismic survey days (Di Iorio & Clark, 2009), in beluga whales (*Delphinapterus leucas*) in response to shipping and ice breakers (Finley, Miller, Davis & Greene, 1990), and in other species such as the Amazonian treefrog (*Dendropsophus triangulum)* which doubled its calling rate in response to traffic noise (Kaiser & Hammers, 2009).

Gray whale calling type within Clayoquot Sound is dominated by low frequency moans. This is consistent with the most commonly documented vocalization of this species (Dahlheim *et al.*, 1984; Moore & Ljungblad, 1984; Crane & Lashkari, 1996). Although moans were the dominant call across vessel noise conditions, the frequency of other call types, including growls and whumps, diminished within vessel noise present conditions. Dahlheim (1987) found higher prevalence of longer tonal calls within noisier conditions for gray whales. As tonal calls are simple in structure and longer in duration, they are easily transmittable and more detectable in noisy environments (Richards, 1981). However, the message conveyed may be limited due to the restraints of the BSL, thereby limiting the whales' capacity for communication and listening to their environment.

A common compensatory response to calling in noisy environments is increasing calling intensity or amplitude. Within this study, gray whales did not increase their calling intensity with increasing BSL. Call intensity would have been more accurately analyzed with the identification a call's spatial location. Distance identification can be achieved with the use of multiple AMAR devices. Increasing call intensity is a documented response to increasing BSL within the ocean by other cetaceans. North Atlantic right whales (*Eubalaena glacialis*) individually call louder in response to increasing background sound levels (Parks, Johnson, Nowacek & Tyack, 2011), as well as killer whales, *Orcinus orca* (Holt, Noren, Veirs, Emmons & Veirs, 2009). As anthropogenic noise within the oceans is likely to increase with increasing human use, the limit of intensity compensation will be reached (Parks *et al.,* 2010), thereby possibly forcing species to use other alternative mechanisms of compensation or to abandon their habitat. Another limitation of this paper's study design is the inability to measure all calls within the environment. The noise of floatplane and boat noise has the potential to mask calls not only within the marine environment but also in the spectrogram used to measure vocalizations. Therefore, it is possible that more quiet calls from gray whales are documented by passive acoustic monitoring in less noisy conditions or vessel absent conditions, than noisy vessel conditions. This is compounded by the inability to spatially locate a calling whale from one AMAR. Deploying multiple PAM devices would enable greater spatial accuracy and increase the likelihood of detecting quiet calls, as well as differentiate vocalizations received by the hydrophone from long distances.

Audible responses in the presence of floatplanes and boat vessels did not differ across vocalization classifications. Floatplane and boat noise have similar ranges in frequency and intensity output, although floatplanes have a broad range in frequencies within a single sound signature due to their harmonic sound signature (Chapter Two). Floatplane sound signatures are more condensed and last for shorter periods of time (personal observations, 2016; Chapter Two). Gray whales have displayed disturbance responses from aircraft in other coastal ecosystems. Cow-calf pairs in Alaskan summering grounds displayed an aversion to aircraft surveys of 335 meters in altitude; the mother moved over the calf or the calf swam under the cow in response to the aircraft overhead (Clarke, Moore, & Ljungblad, 1989). A group of mating gray whales dispersed when an aircraft circled at an altitude of 670m overhead after 11 minutes (Clark, et al. 1989). Observing the physical behaviour of the gray whales within Cow Bay could have provided insight to support past responses. Gray whales are documented as being disturbed from aircraft presence and modifying their vocalization behavior in response to its sound signature, thereby introducing potential negative impacts of energetic output and communication.

3.5 Conclusions

Although there was not a large difference of audible reactions across noise conditions, this does not mean that there is a lack of influence from vessel noise on gray whales. The high variability in the alteration of gray whale vocal repertoire in conditions of vessel acoustic noise conditions could be an indication of increased stress on gray whale populations. In contrast to one distinct alteration to vocalizations in the presence of boats or floatplane noise, gray whales could respond by using a multitude of compromising responses to their communication strategies, thereby increasing the likelihood of receiver misunderstanding or misreading of environmental conditions. Additionally, the audible changes in response to vessel noise have energetic costs for individuals towards social communication, navigation and foraging, as well as potential effects on the population in terms of reproductive fitness and health (Clark et al., 2009; Rolland et al., 2012). Modified vocalizations are an indicator of acoustic disturbance. Richardson & Wursig (2009) suggest a bias within the perception of whales' noise sensitivity, as this is determined by observations of less-responsive individuals. There is variability in reactions across the population. The healthiest individuals can display the greatest reaction; therefore whales potentially already stressed by vessel noise may not be able to afford a reaction (Simmonds et al., 2004). However, stressed individuals are more vulnerable to the effects of acoustic disturbance due to lower resiliency. This variability creates difficulty concluding the level of impact of vessel noise on cetaceans. However, this information can be used by managers to assist in alleviating the imposed stress by vessel noise to ensure that the selected compromising mechanisms utilized by gray whales, such as altered call frequency, are not compounded by management decisions regarding mechanical alterations to motors or propellers (Chapter Two) or whale watching viewing regulations. Management decisions, in light of acoustic disturbance from whale watching boats, should ensure that machinery alterations do not exacerbate the vessel noise output by concentrating frequency within gray whale communication, or that regulations do not increase the impact of vessel noise on gray whale populations through alterations in viewing timelines.

4.0 CHAPTER FOUR: CURRENT WHALE WATCHING POLICY REGIME

4.1 Introduction

Whale watching is a rapidly evolving industry where guidelines and regulations develop on an ad hoc basis. This fosters a reactive regime, addressing circumstances after the fact. Yet, the industry is relatively new allowing leeway for additional actions or alterations to current whale watching policies. Understanding the present policy regime will highlight strategies that are effective in acoustic disturbance diminishment or to identify policy gaps that need to be addressed for effective cetacean protection from whale watching practices. This chapter outlines whale watching policy frameworks from the international level to the local, identifying the specifics of Clayoquot Sound, BC. This will aid in understanding how evidence of acoustic disturbance can be considered by policy makers to maximize whale conservation, while maintaining policy benefits for the whale watching industry.

4.2 International Whale Conservation Policies

Animal conservation, especially for charismatic megafauna such as whales, is a priority for international protection objectives. This is represented within many international agreements and conventions. The *United Nations Convention on Biological Diversity* (UNCBD), 1760 UNTS 79; 31 ILM 818 (1992) (CBD), primary objective is the conservation of biodiversity and secondarily, the sustainable use of its components; this includes the conservation of marine mammals, including whales. Canada created the Canadian Biodiversity Strategy in response to this Convention. Yet, it has been criticized for lacking specific mention of marine mammal biodiversity protection comparable to the UNCBD (Campbell & Thomas, 2002). However, it is only one convention among many that considers whale conservation, and it does advance the prioritization of biodiversity conservation as a whole.

Due to the lack of obligation for contracting parties to protect marine areas beyond their national jurisdiction, migrating marine mammals are at risk of having inadequate protection when traveling outside a nation's waters. The 1979 *Convention on the Conservation of Migratory Species of Wild Animals* 1651 UNTS 333; 19 ILM 15(1980); ATS 1991.32; BTS 87 (1990), Cm. 1332 (Migratory Species Convention), provides a framework for member states across national jurisdictions to manage migrating species through regional or international agreements (Warner, 2015). The *North American Agreement for Environmental Cooperation* (32 ILM 1482 (1993)) and the Strategic Plan for North American Cooperation in the Conservation of Biodiversity (2003) are agreements between Canada, the United States of America and Mexico for the conservation and management of transboundary species (Commission for Environmental Cooperation, 2003). Together, these agreements aid in the creation of a unified management approach for whales to ensure consistent conservation practices across nations for the same population.

Apart from agreements and conventions directly related to the protection of species internationally, the *United Nations Convention on the Law of the Sea*, 1833 UNTS 3; 21 ILM 1261 (1982) (UNCLOS) governs the international law of the ocean, and the rights and responsibilities of member states. Specific to whales, Article 65 identifies that

> states [,ratified nations,] shall cooperate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organizations for their conservation, management and study.

The UN interprets ‘international organization’ in this case to be the International Whaling Commission (IWC). Canada has been criticized for not abiding by Article 65 of UNCLOS, as it is not a contracting party to the IWC (Campbell & Thomas, 2002). However, Canada has ratified UNCLOS, therefore the nation should abide by the conservation views and management of marine mammals as per its cooperation with this convention.

Whales are a strong force for conservation on an international scale. This interest grew from the awareness of depleting stocks in the 1930s, and a need to ensure a stable market of whale oil (Gambell, 1977). The *International Convention for the Regulation of Whaling*, 62 Stat. 1716; 161 UNTS 72 (1946) (ICRW), was completed in 1946 requiring signatory nations to determine the abundance and distribution of whales within their national waters for cetacean conservation (Dickinson & Sanger, 2005). From this convention, the International Whaling Commission (IWC) was established in 1946 for the management and conservation of whales. Although Canada is no longer a member of the IWC, its historical participation influences national regulations and the protection of cetaceans in Canada.

The IWC has a whale-watching sector to identify best practices, and identify short-term and long-term threats. They have identified three principles for whale-watching: i) manage the development of whale-watching to minimize the risk of adverse effects; ii) maintain and operate platforms to minimize these risks including disturbance from noise; and iii) allow cetaceans to control the nature and duration of 'interactions' (IWC, 1996). The first principle supports the minimization of acoustic disturbance by advocating the regulation of encounters through the number of vessels, the size of vessels, frequency and length of encounters, or having closed seasons or areas (IWC, 1996). Monitoring the effectiveness of management, scientific research, operator education and whale-watcher education is encouraged to fulfill the application of the second principle (IWC, 1996). The second principle is focused upon acoustic disturbance, encouraging the engine and boat design to operate with minimal acoustic output and indicates that operators should recognize the difference in low and high frequency sound impacts on various species (IWC, 1996). Finally, the third principle outlines the necessity of operators understanding whale behaviour, establishing a maximum speed when approaching a whale, the angle of approach with the elimination of a head on approach, avoiding sudden changes in vessel interaction, and ensuring that whale(s) can detect the operator at all times (IWC, 1996). These guidelines have been the basis to develop national or regional whale watching guidelines. The emphasis on acoustic disturbance minimization reiterates the importance of acoustic management within the marine environment. Again, although Canada is no longer a member state of the IWC, Canada can use these guidelines to influence domestic regulations.

4.3 Canadian Policies

4.3.1 Marine Mammal Regulations

The interaction of marine mammals and humans is primarily governed under one piece of legislation in Canada. The *Marine Mammal Regulations,* S.O.R./93-56, under the *Fisheries Act,* R.S.C., 1985, c. F-14, manages human activities involving marine mammals, primarily marine mammal fishing regulations. Protection of marine mammals, including whales, is essentially moderated under section 7, which states that "no person shall disturb a marine mammal except when fishing for marine mammals" under federal authority (*Marine Mammal Regulations* of 1993). The term disturbance or disturb is not legally defined within the regulations, therefore is up for interpretation within the courts, which may enable noise to be considered a disturbance to whales. Under current regulation, underwater noise disturbance from vessels could be regulated for animal welfare protection, although, underwater noise has not been tested as a type of disturbance under the law. *HMTQ v. Andrews,* 2000 B.C.S.C. 1246, challenged the definition of disturbance in its applicability for recreational boating interaction with killer whales in British Columbia. The judge considered the vagueness of the term as an asset, as it can be applicable to many scenarios and is flexible for future circumstances. In 2012, a Campbell River recreational boater, Carl Peterson, was found guilty of disturbing a marine mammal under section 7 of the *Marine Mammal Regulations,* S.O.R./93-56 and under section 32 of the *Species at Risk Act,* S.C. 2002, c. 29, marking the first occasion of prosecution under *SARA* for wildlife species harassment (Douglas, 2013). Peterson was charged a $7,500 fine for these two charges out of a maximum of $350,000 (CBC, 2013). This case has set a precedent for marine mammal legislative enforcement, and can be used as a benchmark for future marine mammal disturbance and harassment cases in Canadian waters.

Whale-watching guidelines are not included within the *Marine Mammal Regulations,* S.O.R./93-56. However, these regulations are currently under revision for the inclusion of whale watching guidelines that would create legally enforceable practices (Canadian Gazette, 2012). The potential amendments include minimum approach distances, certain vessel behavior prohibitions, and operator disturbance licenses (Giles & Koski, 2012). Until this time, section 7 of the regulations, outlining the harm of disturbance, is the best tool for mitigating vessel noise and behaviour for the benefit of whales. In support of the enforcement of the *Marine Mammal Regulations,* S.O.R./93-56, Notices to Mariners is an information source and policy that disseminates information about marine mammal viewing guidelines to the mariner community. The Canadian Coast Guard Notices to Mariners (NOTMAR) provides pertinent information about nautical charts and publications, including new initiatives or policies for the maritime community (NOTMAR, n.d.). NOTMAR includes general guidelines for viewing whales under the *Marine Mammal Regulations,* S.O.R./93-56, and the *Species at Risk Act,* S.C. 2002, c. 29, which identifies disturbance as "any intentional or negligent act resulting in disruption of normal [cetacean] behaviour" (NOTMAR, 2016). Additionally, the notice includes species-specific information per ocean region (NOTMAR, 2016). NOTMAR annual publications further support the mitigation of whale watching practices, as well as relevant laws and policies for the conservation of whales.

4.3.2 Species at Risk Act

In Canada, conservation management of declining and potentially endangered or threatened wildlife populations is regulated under the *Species at Risk Act,* S.C. 2002, c. 29. Its purpose is to protect species at risk of extinction or extirpation, and ameliorate listed species populations through effective protection. Section 32 of the Act states: "no person shall kill, harm, harass, capture or take an individual of wildlife species that is listed as an extirpated species, an endangered species or a threatened species" (*Species at Risk Act* of 2002). Harm is defined within the act as an activity where single or multiple events reduce the fitness of an individual, and harass is defined as the disruption, alarming or molestation of an individual that could impact the behavior or life history functions of the species (*Species at Risk Act* of 2002). Noise can be considered under the terms of harm and harassment, but is not legally defined as such. There are supporting documents and policies specific to different sources of sound, such as defining harm and harassment for seismic activity (Fisheries and Oceans Canada, 2015), yet there is one lacking specifically for vessel noise or for commercial whale watching. Instead of universal mitigation of vessel noise under the Act, vessel noise can be mitigated specifically per species listed under the protection of the Act. Threats to the species, such as vessel noise, can be addressed under the protection of the Act. Additionally, species listed as endangered or threatened can address noise within their critical habitat, habitat necessary for the survival or recovery of listed species, as under the Act listed endangered or threatened species require the identification and protection of critical habitat in their recovery strategies (*Species at Risk Act* of 2002). Due to the difference in listing of species, species-specific strategies are best upheld under the Act, and can address noise mitigation more effectively.

Legal cases have been made towards the adverse impacts of underwater noise on listed cetaceans. *The David Suzuki Foundation* v. *Canada (Fisheries and Oceans*), 2010, F.C. 1233, challenged the *Northern and Southern Resident Killer Whales (Orcinus orca) in Canada: Critical Habitat Protection Statement* of the Minister of Fisheries and Oceans, and the Minister of Environment as not being adequate for protection under the *Species at Risk Act,* S.C. 2002, c. 29, s. 58(5)(a)(b). This section states that the competent minister must put forth an order or statement specifying how the species' critical habitat will be legally protected once a recovery strategy for the listed species has been identified. Species listed under the Act as endangered or threatened must have a recovery strategy put in place for its recovery, as per section 37. Critical habitat protection is a part of the requirements of the recovery strategy under the *Species at Risk Act,* S.C. 2002, c. 29, s. 41(1)(b)(c)(c.1). The Protection Order for the Northern and Southern Resident Killer Whales had limited scope, as it did not consider noise within the geospatial and geophysical attributes of critical habitat. The court found in favor of the David Suzuki Foundation because the *Fisheries Act,* R.S.C. 1985, c. F-14, and the *Canada Environmental Assessment Act, 2012*, S.C. 2012, c.19, require legal protection of these criteria within critical habitat of the Resident Killer Whales. Although this case did not involve a baleen whale species, it did set a precedent for underwater noise regulation and enforcement in relation to whale conservation.

4.3.2.1 Eastern Pacific Gray Whale Listing Status

There are currently 14 cetacean species listed under *SARA* of the 33 species found in Canadian waters (Fisheries and Oceans, 2012). Eastern Pacific gray whales are currently listed as a species of Special Concern under the Act (COSEWIC, 2004a). A species of special concern is defined as a wildlife species that may become threatened or endangered because of a combination of biological characteristics and/or threats (Species at Risk Act of 2002). Effective protection of a species for their recovery requires evidentiary support of threats and how to address them. Gray whale within the feeding grounds of British Columbia are listed as a species of Special Concern due to the threats of acute noise pollution from drilling construction or seismic surveying, toxic spills and the potential renewed interest in subsistence whaling (Fisheries and Oceans, 2010b). Chronic disturbance from shipping is mentioned in the federal management plan as a threat, yet identifies a need for more research to understand the acoustic ecology of gray whales and their habitat (Fisheries and Oceans, 2010b). As with all threats, noise disturbance requires evidence of its negative impacts, which is lacking for gray whales within its Canadian feeding grounds. In lieu of concrete scientific evidence, the management plan would benefit from precautionary mitigation measures to address the threat of vessel noise for gray whales, instead of only identifying the need for more research.

4.3.3 Provincial Responsibility for Cetacean Protection

The jurisdictional responsibility of the province of BC to protect the marine environment and its sustainable use is authorized by the 2004 Memorandum of Understanding Respecting the Implementation of Canada's Ocean Strategy on the Pacific Coast of Canada (MOU of 2004). It identifies the shared responsibility of the objectives of protection and the activities with the provincial and federal governments, including the contribution to the marine protected area network, coastal planning and integrated oceans management planning. Further to MPAs, the two governments created the Canada-British Columbia Marine Protected Area Network Strategy to establish a collaborative network on the Pacific coast (2014).

Specific to species, the federal and provincial governments share the responsibility of species protection and the recovery of species at risk, which takes the form of the Agreement for the Protection of Species at Risk (Canada-British Columbia Agreement on Species at Risk, 2005). The two governments are to collaborate on designating species, implementing recovery and management strategies, and action plans. These agreements enable an increase in provincial input for ocean management decision-making, while ensuring the federal government is acknowledging the province (Edmondson, 2015). The province develops and establishes conservation measures under the *Wildlife Act*, R.S.B.C. 1996, c. 488. This enables the government authority to establish designations for threatened or endangered species, and habitats for protection through management areas, critical wildlife areas or wildlife sanctuaries. The BC Ministry of Environment's management of species at risk increases strategies of protection and the authority to have more regionally specific actions. The Eastern Pacific gray whale is listed as threatened or blue listed in 2006 (BC Conservation Data Centre, 2016); blue listed species are indigenous species in BC of special concern, formerly listed as vulnerable to extinction. Their provincial protection follows the management plan of *SARA.*

4.3.4 Be Whale Wise: Marine Wildlife Guidelines for Boaters, Paddlers, and Viewers

The Be Whale Wise guidelines, compiled by Fisheries and Oceans Canada and the National Oceanic and Atmospheric Administration of the United States, indicate measures to reduce the impact of boaters on marine life (Appendices 10.1). These guidelines are applicable to all boaters but are highly relevant for whale watching operators so as to institute best practices for vessels purposely interacting with whales. The guidelines are voluntary and not legally enforceable within Canadian waters. Until the amendments to the *Marine Mammal Regulations,* S.O.R./93-56, to include whale-watching guidelines, compliance of the voluntary guidelines is highly important to minimize vessel impacts on whales, but unfortunately, compliance can vary among operators.

The guidelines advocate certain measures to reduce impacts on whales. These measures include not approaching a whale any closer than 100 meters; keeping clear of a whale's path and not to approach a whale from the front or behind; position vessel on the offshore side of the whale when travelling close to shore; limit viewing of an individual to a maximum of 30 minutes; and not to feed or touch a whale (Fisheries and Oceans, 2013). The guideline dictating the reduction of speed to less than seven knots when within 400 meters of a marine mammal indicate its purpose as to reduce engine noise and minimize the wake of an approaching vessel (Fisheries and Oceans, 2013). This is the only measure that correlates its significance to the reduction of anthropogenic noise. Operators are urged to place their engines in neutral if an animal is less than 100 meters from their vessel and limit their viewing to 30 minutes or less to reduce cumulative impacts (Fisheries and Oceans, 2013). These two measures reduce vessel noise output, but do not explicitly state this measure's benefit for vessel noise reduction. The guidelines also indicate not to disturb, touch or feed marine wildlife. Unlike the *Marine Mammal Regulations,* S.O.R./93-56, the Be Whale Wise Guidelines define disturbance as the interference with the "animal's ability to hunt, feed, communicate, socialize, rest, breed, or care for its young" or any critical life processes (Fisheries and Oceans, 2013). Additionally, these guidelines include specific measures for pinnipeds and sea birds, as well as noting pertinent laws and alternative regulations, such as marine protected areas and for species under the *Species at Risk Act,* S.C. 2002, c. 29, for instances the northern and southern resident killer whale population (Fisheries and Oceans, 2013). These notations are to alert boaters to other relevant regulations within the area.

The Be Whale Wise Guidelines have been criticized under two different shortcomings: the precautionary approach and compliance. There are knowledge gaps in understanding the ecological impact of whale watching practices. This is due to the difficulty of measuring impacts in the ocean environment, as well as a lack of research completed upon impacts until recently, due to the relatively young industry (Malcolm, 2003). Due to these uncertainties, Malcolm

(2003) argues the guideline measures are pseudo-precautionary as opposed to precautionary since there is no evidentiary support for these measures. Research is needed to fill these gaps for more effective policies for whale conservation. Research to understand the contribution of vessel noise within a whale's environment (Chapter Two), the interaction of vessel noise with whale communication (Chapter Two and Chapter Three), whale watching interactions with whales (Chapter Four), as well as feasibility of whale watching regulations, behaviours and policies will enable more effective guidelines.

In addressing the second shortcoming of guideline compliance, legally binding measures would increase the application of these measures for boaters around whales. Regulations that are supported by legislation are often the most effective measure (Cockeron, 2006). The voluntary nature of the practices within the recommended guidelines can be perceived as arbitrary markers, therefore their enforceability will set precedence for best practices within the industry. However, Fisheries and Oceans Canada will have to increase their presence within the region to increase compliance and enforcement. Their presence in the Pacific is minimal to date, thereby dis-incentivizing operators to follow the guidelines (Duffus, 1989; Malcolm, 2003). Clayoquot Sound whale watching operators have historically had high compliance with whale-watching guidelines, therefore legally enforceable standards may not be the best management tool within the region; however, it would institute the recognition of non-consumptive uses of whales under the law (Stevenson, 2014). Incorporating certain measures of the Be Whale Wise Guidelines into the *Marine Mammal Regulations,* S.O.R./93-56, and leaving some within the voluntary guidelines may be the most effective approach to minimize the impact of whale watching on marine mammals while ensuring measures are followed and are effective.

4.3.5 Tofino Whale Watching Operators' Voluntary Guidelines

As the Be Whale Wise guidelines were not implemented until 2002, the community undertook the implementation of guidelines from a bottom-up approach. As whale watching became increasingly popular on Vancouver Island in the 1990s, specifically in Clayoquot Sound through the town of Tofino, guidelines were created for the local area (Malcolm, 2003). In 1995, this took the form of the Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG) (Appendices 10.2) by Strawberry Isle Marine Research Society, a registered charitable organization dedicated to independent research and monitoring of the marine ecosystems of Clayoquot Sound (Strawberry Isle Marine Research Society, 2016). This instituted measures of vessel etiquette for whale watching operators within the region (Strawberry Isle Research, 1995). Although these guidelines are voluntary, the conservation measures for whale watching were implemented at the community level well before the top down approach from the government. Unlike the Be Whale Wise guidelines, the TWWOVG include species-specific guidelines to tailor vessel etiquette for regional fauna. As gray whales are the largest draw for the whale watchers of the region, the species-specific measures could increase the likelihood of protection effectiveness against adverse effects. Further, measures tailored to species can more easily incorporate research findings of best practices for whale watching operators, as effective protection is often species specific.

Gray whale measures within the TWWOVG differ from the Be Whale Wise guidelines. Vessels are encouraged to slow their vessel speed within a half-mile radius of a whale; whales should not be approached any closer than 50 meters; and vessel movement should be kept to a minimum when viewing a whale within their feedings grounds (Strawberry Isle Research, 1995).

The gray whale measures are also applicable to killer whales, which are mentioned within the TWWOVG. In addition, killer whale guidelines include measures indicating a minimum distance of 100 meters when a predatory kill is in progress, engines should be shut down when viewing the animals when in rock-lined inlets, and the Harbor Seal lagoon is off limits to killer whale watching (Strawberry Isle Research, 1995). Research vessels are also included within the TWWOVG. The protocols included are to follow the same guidelines as the whale watching fleet, to limit one vessel per whale at a time, and the research work should be explained to passengers on the vessel (Strawberry Isle Research, 1995). Like the Be Whale Wise Guidelines, the TWWOVG includes measures for sea birds and pinnipeds as well.

Despite the initiative of the regional guidelines for the local whale-watching fleet, there are a few problems with its content and application. The TWWOVG has less conservative guideline measures than the Be Whale Wise guidelines. For example, the minimum vessel approach distance to a whale is 100 meters as per the Be Whale Wise Guidelines but 50 meters within the TWWOVG. Like the Be Whale Wise guidelines, the TWWOVG is also pseudo-precautionary because of a lack of evidentiary support for minimum vessel distances and other measures. Due to the voluntary nature of both guidelines, the fleet does not uniformly adhere to one guideline, but to both of them. Almost all the operators adhere to the Be Whale Wise guidelines, and some follow the additional practices of TWWOVG that are absent within the Be Whale Wise guidelines (R. Palm, personal communication, June 2, 2016). As neither guideline is legally enforceable, this can cause confusion amongst the fleet towards which measures are the best practices to follow. Reviewing the TWWOVG to become more consistent with the Be Whale Wise guidelines would be helpful to address this confusion. Additionally, identifying

TWWOVG's more conservative measures for cetacean well being that differ from the Be Whale Wise guidelines could further simply compliance, as it would identify additionally measures to be taken by operators that do not contradict the measures of the Be Whale Wise guidelines. With completion of the whale-watching guideline amendments to the *Marine Mammal Regulations,* S.O.R./93-56, the TWWOVG would need to be amended to have the same measures or more conservative measures to allow for operators to follow these guidelines under the new law. Guidelines such as these do not have to become obsolete once federal legislation is implemented. More conservative measures for specific species would allow for practical regional guidelines, and potentially be more effective for whale conservation. Adaptable regional guidelines would allow for the incorporation of species-specific evidence to increase the effectiveness of the guidelines to minimize adverse effects of vessels interacting with local species. Regional-specific geographic information or notation of other guidelines within the region can be mentioned, such as local marine protected areas or national parks. The Pacific Rim National Park Reserve specifies different measures for vessels within the area, as well as the requirement of whale watching operator licenses under the *Pacific Rim National Park Reserve Voluntary Marine Wildlife Viewing Guidelines* (BC Parks, 2003; Appendices 10.3). Like the Be Whale Wise guidelines, the TWWOVG can be used to identify other sources of pertinent information for the whale watching fleet or recreational boaters. Regardless of the approach, measures across the hierarchical scale of governance can play an effective role in the success of whale protection.

4.3.6 Aerial Whale Watching Regulations

In addition to whale watching on the water, whales and other marine wildlife can be observed from helicopters and seaplanes. The *Canadian Aviation Regulations,* S.O.R./96-433, s.

602, 14(2)(b), stipulate a vertical distance of 500 feet from any person, vessel, vehicle or structure, thereby limiting whale watching in the presence of these considerations, such as whale watching boats or other ocean vessels. In terms of the animals themselves, various legislation dictates viewing by species and region. BC's *Wildlife Act,* R.S.B.C. 1996, c. 488, s. 108, empowers the Lieutenant Governor in Council the authority by the province to create regulations imposing certain conditions under which boats, aircraft or motor vehicles are able to view wildlife. Airplanes and helicopters are not to descend lower than 450 meters from the water when whales are detected near the surface (Carlson, 2001).

Within Clayoquot Sound, three operators conduct aerial whale watching. All three operators had different responses when identifying the minimum viewing distance from whales during the tour (Anonymous, personal communication, July 27, 2016). This leads one to believe that this regulation is followed with less rigor within the region than that for boat operators. It is not unusual to view floatplanes circling 200 feet above a whale or a whale watching boat viewing a whale (personal observations, 2016). The Be Whale Wise and TWWOVG do not include measures for aircraft. The Whale Watching Guidelines for Southern BC and Washington stipulate a limited approach of an aircraft to a whale to a distance of 305 meters or 1000 feet above the whale, and prohibit circling or hovering above the whales. Additionally, landing near whales is discouraged, explaining that it can endanger both humans and whales life due to the unpredictability of their behaviour. Operators are asked to ensure travel patterns of landing or taking off occur 300 meters from a whale (Lifeforce Foundation, 2001). It would be ideal to incorporate the maximum approach distance and adequate behaviour measures within the Be

Whale Wise and TWWOVG guidelines to ensure consistent viewing by aerial operators within Clayoquot Sound.

4.3.7 Marine Protected Area Guidelines

Within Canada, marine areas, both coastal and offshore, can be protected under numerous pieces of legislation. Marine Protected Areas (MPAs) are utilized as a means of establishing spatial protection for whales. In Canada, the *Oceans Act*, S.C. 1996, c.31, facilitates the implementation of MPAs under the authority of the federal government. The preamble of the Act states that conservation is of fundamental importance to maintaining biological diversity and productivity in the Canadian marine environment (Oceans Act of 1996). Under section 35, the Cabinet has the authority to designate MPAs, prescribed zones within an MPA and prohibit activities within an MPA, thereby allowing for the prohibition of noise pollution, such as that of vessel noise within an MPA.

Protected areas can also be established within the marine environment under the *Canada National Marine Conservation Areas Act,* S.C. 2002, c. 18, s. 16(1). The Governor in Council has the authority to make regulations, consistent with international law, for the control and management of any or all marine conservation areas, including regulations for the protection of ecosystems and the elements of ecosystems, and restricting, prohibiting or regulating activities in a marine conservation areas or a section of the conservation area (Canada National Marine Conservation Areas Act of 2002). This thereby authorizes the federal authority to regulate noise pollution through the regulation of activities within marine conservation areas established under the Act.

The *Wildlife Area Regulations,* C.R.C., c. 1609 of the *Canada Wildlife Act,* R.S.C., 1985, c. W-9, is another form of federal protection of an environmental area. Under section 4.1, the Governor in Council may establish marine protected areas or marine conservation areas in any section of the sea under Canadian jurisdiction (Wildlife Area Regulations of 1984). Although the regulations do not prohibit any noise related activities, the minister could implement restrictions in the future.

Within BC, the provincial government authorizes the protection of marine areas through a variety of acts. The *Ecological Reserve Act,* R.S.B.C. 1996, c. 103, s. 2 established an ecological reserve as a marine protected area to ensure the preservation and maintenance of the natural environment. This Act grants BC Parks the authority to limit vessels to a distance of 200 meters from a reserve (Stevenson, 2014). The *Environment and Land Use Act,* R.S.B.C. 1996, c. 177, s. 7, enables the establishment of provincial parks and conservancies as protected marine areas. The *Park Act*, R.S.B.C. 1996, c. 344, and the *Protected Areas of British Columbia Act,* S.B.C. 2000, c. 17, enables the protection of marine areas through a park, recreation area or conservancy for the goal of conservation. The *Wildlife Act,* R.S.B.C. 1996, c. 488 enables provincial designation of species conservation status. This Act enables the provincial Ministry of Environment to focus provincial conservation efforts or to make recommendations for the federal protection of species under *SARA* (BC Conservation Data Centre, 2016). Under the authority of section four through six, wildlife management areas, critical wildlife areas and species considered threatened or endangered can be designated (Wildlife Act of 1996). Hence this Act can be used for the management of marine mammals and whale watching.

4.3.7.1 Regional Protected Marine Area Guidelines

Due to the variation in purpose and legal range in protection measures of marine areas, dependent on specific legislation, areas can dictate different guidelines for whale watching operators and other vessels within the boundaries of a protected area. MPA design is often implemented on an ad hoc basis, thereby invoking questions as to the utility in protecting marine species (Halpern, 2003). Although the objectives of individual MPAs vary, the areas must be considered as a whole to establish an ecologically functional connected network. This would include connectivity among MPAs, and include ecologically significant areas for all trophic levels important for species protection (Short, 2005). For gray whales, this includes important foraging areas, as well as the consideration to minimize species threats within the MPAs.

Within Clayoquot Sound, nine MPAs and two ecological reserves have been established (Dunham *et al.,* 2002; Stevenson, 2014; Table 4.1). The MPAs within Clayoquot Sound vary in their relevancy for gray whale conservation. The ecological reserves are enacted under the authority of the *Ecological Reserve Act,* R.S.B.C. 1996, c. 103, and the class A MPAs are under the authority of the *Park Act*, R.S.B.C. 1996, c. 344 and schedule D of the *Protected Areas of British Columbia Act,* S.B.C. 2000, c. 17.

Table 4.1. Established marine protected areas (MPAs) and ecological reserves within Clayoquot Sound, BC, indicating various levels of protection for Eastern Pacific Gray Whales (Dunham *et al.,* 2002; Short, 2005).

Name	Date of Establishment	MPA Protection Class	Location	Total marine area (ha)	Relevant Protection Goals
Hesquiat Peninsula	July 12, 1995	Class A	49°26'N 126°27'W (Hesquiat Harbour)	1,210	Primary goal to protect the natural values of the area including the blue listed species of the gray whale.
Sydney Inlet	July 12, 1995	Class A	49°26'N, 126°15'W	691	Protected rare and endangered values of the provincial park including the blue listed gray whale.
Maquinna Marine Park	July 1, 1955; with addition in 1995	Class A	49°22'N, 126°16'W	1,398	The tertiary role of the park is to protect habitat for red and blue listed species including gray whales.
Flores Island Marine Park	July 12, 1995	Class A	49°16'N, 126°09'W (Cow Bay)	2,969.8	Conservation of rare and endangered values, including the grey whale, its foraging habitats, and recreational viewing opportunities.
Vargas Island Provincial Park	July 12, 1995	Class A	49°'11'N, 126°01W (Ahous Bay)	5,920	Conservation of rare and endangered values, including the grey whale, its foraging habitats, and recreational viewing opportunities.
Sulphur Passage	July 12, 1995	Class A	49°24.50' N, 126°04'W	1,943.4	Protect Vancouver Island Shelf Marine Ecosection and habitats for marine mammals residing within the area.
Epper Passage	July 12, 1995	Class A	49°13'N,	251	The primary role of

			125°57'W		the park is to protect habitat, which is occasionally used by resident gray whales for foraging.
Dawley Passage	July 12, 1995	Class A	49°09'N, 125°48'W	92.5	Protect habitat for marine mammals.
Strathcona	Mar 1, 2011	Class A	49°26.00' N, 126°21.50 'W (Shelter Inlet) 49°25.00' N, 125°54.40 'W (Herbert Inlet)	708	Protection of ecologically important habitat.
Cleland Island	May 4, 1971	Ecological Reserve	49°11'N, 126°01'W (Within Vargas Island MPA)	7.7 (total)	Protection ecologically significant habitat and for education and research purposes.
Megin River	July 9, 1981	Ecological Reserve	49°26.00' N, 126°21.50 'W (Within Shelter Inlet)	50 (total)	Protection ecologically significant habitat and for education and research purposes.

Additionally in BC, site-specific guidelines exist for Cleland Island Ecological Reserve, Gowland Rocks, Sea Lion Rocks, White Island, Seabird Rocks, Wouwer Island, Sea Caves, and La Croix Group (Parks Canada, 2003). Parks Canada now requires whale-watching operators to possess Parks Canada business licenses when conducting commercial activities within the national park boundaries (Parks Canada, 2013). This furthers specifications towards conduct enforcement within Parks Canada MPAs.

MPAs are a legislative tool that can be effective in spatially protecting whales against direct exposure to vessel noise. As sound travels vast distances underwater, MPAs would be most effective in regulating the activity within an MPA that emits large sound output. The Gully MPA on the Scotian Shelf off the coast of Nova Scotia and the St Lawrence Estuary MPA of Canada are examples of mitigating noisy activities (WWF-Canada, 2013). Although shipping is not prohibited, voluntary avoidance is recommended. Within the Gully, Notice to Mariners asks operators to voluntarily avoid the area or slow their speed and watch for whales, as the Gully is a site of bottlenose whale habitat (NOTMAR, 2015). Additionally, the Gully MPA has a vicinity clause within its regulations stating that transboundary adverse effects originating outside of the MPA border could be considered as a breach of the regulations (WWF-Canada, 2013). Although the vicinity clause has never been legally tested, this could be considered within the future. This would mostly likely be used to object to oil and gas activities, as the Gully MPA regulations do not explicitly prohibit oil and gas activities in the area (Weilgart, 2012). The Canadian Science Advisory Secretariat identified emitted sound from vessel engine noise, seismic noise, and sonar emissions as a threat to whales and other animals within the MPA (Fisheries and Oceans, 2010a). Weilgart (2012) suggests management plans include acoustic buffer zones for MPAs as a precautionary approach to minimizing adverse effects, considering that current authorized legislation to create and manage MPAs does not include these provisions. The measures from the Gully MPA and the St. Lawrence MPA can be used as examples to increase management of noise within the MPAs in Clayoquot Sound. Alternatively, vessels can be legally prohibited from an area. The Robson Bight (Michael Bigg) Ecological Reserve in BC is a protected area under the *Species at Risk Act,* S.C. 2002, c. 29, and the *Ecological Reserve Act,* R.S.B.C. 1996, c. 103, for the protection of Northern Resident Killer Whales that prohibits boaters from entering the reserve or viewing whales within the boundaries of the reserve (BC Parks, n.d.). These examples should be extended to the MPAs in Clayoquot Sound for the protection of gray whales against vessel noise, as the current protection does not include measures to protect whales from vessel noise or prohibit the entry of boaters.

4.4 Assessment

A comparison of whale watching guidelines will allow for the identification of vessel noise mitigation measures, as well as any gaps in protection. The International Whaling Commission's (IWC) General Principles for Whalewatching, the Be Whale Wise Guidelines of Fisheries and Oceans Canada and the United States National Oceanic and Atmospheric Administration, and the Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG) are compared to analyze whale watching measures across geographic and vertical governance levels (Table 4.2).

Table 4.2. Comparison of whale watching guideline measures across international to local level, including the General Principles for Whale watching by the International Whaling Commission (IWC), the Be Whale Wise by Fisheries and Oceans Canada and the National Oceanic and Atmospheric Administration, and the Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG).

Measures	**General Principles for Whale watching (IWC)**	**Be Whale Wise**	**TWWOVG**
Do not disturb cetaceans	✔	✔	✔
Reduce speed upon approach	✔	✔	✔
Avoid changes in speed or direction	✔	✔	×
No direct contact	✔	✔	✔
Appropriate angle	✔	✔	✔

of approach (preclude head-on approach)			
Minimum approach distance	✔	✔	✔
Minimum encounter time	×	✔	✔
Operators on the offshore side of whale	×	✔	✔
Operators should keep track of whales during encounter	✔	×	✔
Area specific restrictions	×	×	✔
Engines to neutral or turned off when cetaceans are within certain distance	×	✔ (Neutral)	✔ (Engines off)
Radio contact other operators viewing cetacean	×	×	✔
Minimum viewing within feeding grounds	×	×	✔
Restricted approach to mother/calf pairs	✔ (Special care to be taken)	×	×
Be cautious and quiet upon approach	✔	✔	×
Operator behavior to reduce vessel noise	✔	✔	×
Vessel design and engine to reduce acoustic disturbance	✔	×	×
Species specific	×	✔	✔
Aircrafts included	✔	×	×

The three guidelines clearly prohibit the disturbance of whales and indicate clear vessel conduct to minimize disturbance. The regional guidelines of the Be Whale Wise and TWWOVG include specifics towards species-specific restrictions, which is intuitive due to scale. The

TWWOVG include measures such as the communication of operators using their VHF radio when viewing cetaceans, minimizing viewing within feeding grounds, and area specific restrictions that could be adopted within the other guidelines. The IWC guidelines include more specificity towards vessel noise mitigation. It includes aircraft restrictions that are absent in the other two guidelines and more emphasis on vessel noise reduction in its measures of approach, vessel or operator behavior, and vessel design. This indicates a need and ability for stronger specificity within measures to minimize vessel noise within Canadian guidelines.

4.5 Conclusions

The range of conventions, legislation and policies concerning whale conservation, with a focus of whale watching and sound pollution, is vast. The variety of these approaches can be maximized to protect whales through different regulatory avenues. Federal protection must work in tandem with provincial jurisdiction and regulations to offer complimentary policies. Likewise, regional policies should complement legislation and provide more specific measures that are applicable within their regional scale. Federal policies benefit from a blanket tactic towards whale conservation being broader, while local level policies can address specific issues with tailored measures. Identifying gaps in protection across the levels of the policy regime and unifying measures will best protect whales and the whale watching industry. Successful examples noted within this chapter, like stronger MPA measures against vessel noise or whale watching guidelines measures specific to vessel noise minimization from the IWC, can enrich policies relevant to whale watching within Clayoquot Sound. Overall, the policy regime needs to address vessel noise impacts on whales more directly across the various approaches. Specificity within the relevant legislation and policies will increase this effectiveness towards protection of whales from the vessel noise disturbance of whale watching practices

5.0 CHAPTER FIVE: CHARACTERIZING WHALE ENCOUNTERS OF THE TOFINO WHALE WATCHING FLEET

5.1 Introduction

Whale watching is an important economic generator and environmental link for Canadian society. In 2008, whale watching in BC had a total expenditure of $118,176,000 for wildlife viewing and indirectly through businesses supporting the industry (O'Connor, Campbell, Cortez, & Knowles, 2009). From the early development of whale watching in Tofino in the 1980s, environmentally conscious tourism has been proudly advertised. Ecotourism encompasses sustainable use of wildlife, providing an educational component to convey conservation messages, while maintaining economic benefits (Ryel & Grasse, 1991). Given the seemingly ingrained mentality of ecotourism within the industry, it is assumed that the Tofino fleet would exhibit environmentally conscious practices or would be open to tailor their methods, given new information on the negative impacts of acoustic underwater noise. This would be mutually beneficial for both the marine ecosystem, as well as the longevity of the whale watching industry. To increase the likelihood of successful eco-management tactics, a characterization of the whale watching fleet's whale encounters is undertaken. This chapter outlines unique characteristics of the regional fleet and highlights management opportunities from the industry perspective to aid in developing effective management tactics towards vessel noise impacts on whales.

5.2 Study Site

The Tofino whale watching fleet operates within the region of Clayoquot Sound, BC This geographic region extends as far south as Long Beach 49.0689° N, 125.7538° W within the

Pacific Rim National Park, and occasionally as far north as Estevan Point 49.3834° N, 126.5447° W (Figure 5.1). All operators are based out of the Tofino Habour, with a few opportunistic operators running from Ahousaht, BC, located on Flores Island in the middle of the Clayoquot Sound region. This area is rich in biodiversity, with its temperate coastal rainforests, sandy beaches and kelp forests. Gray whales, killer whales, humpback whales, as well as other wildlife like pinnipeds, sea birds and bears, frequent the area.

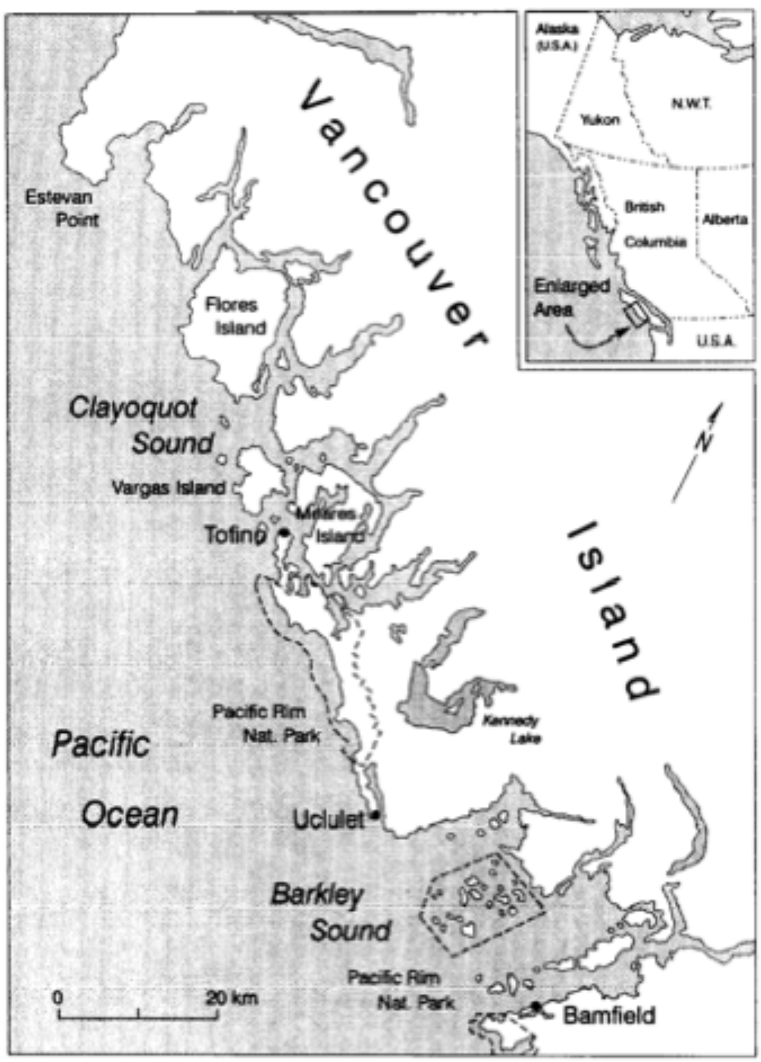

Figure 5.1. Map of Clayoquot Sound, 49°11'60.00" N, -126°05'60.00" W, whale watching area on the west coast of Vancouver Island, British Columbia, Canada (Stevenson, 2014).

5.3 Whale Watching Fleet

The Tofino whale watching fleet is comprised of five main companies dedicated to whale watching. During the summer season, 15 to 25 scheduled tours operate on an average daily basis from May through to September (Stevenson, 2014). These tours operate between 9am and 8pm, each running for approximately two to three hours. Three of the original companies are founding members of the Pacific Rim Association of Tour Operators (PRATO), which is a voluntary organization commited to operate in a responsible manner when viewing marine mammals and sea birds to prevent disturbance (Stevenson, 2014). Operators are commonly long-term residents of Tofino and continue within this role for multiple seasons. Tofino is well known as a tourist destination, being designated a resort region in 2008 under the BC Resort Municipality Initiative (Rural BC, 2013). Whale watching is high on the list of attractions when visiting Tofino, among other wildlife viewing and outdoor activities.

5.4 Methodology

5.4.1 Data Collection

To document and understand fleet interaction amongst operators and whales, Very High Frequency (VHF) marine radio channels, used by the fleet, were listened to as a form of acoustic observation. This allowed for unobtrusive observation of whale watching encounters. VHF radio is utilized for safety reasons, to communicate with their whale watching centres in Tofino, as well as to communicate with other operators on whale location, behaviour, visibility, sea conditions and route of travel. The radio was listened to between June 3, 2016 and July 27, 2016 between the hours of 7am to 5pm for a minimum of three hours per day for a total of 30 days and 127 hours. The listening duration of the three hour minimum and the listening timeframe was chosen due to whale watching operation hours, the length of tours which are between two to three hours, and the feasibility for listeners for this study. The number of vessels, name of vessels, number of whales, species of whale and location of the encounter were recorded. An encounter is defined as one or more whale watching operators purposely viewing a whale. Additionally, any pertinent information regarding an encounter was recorded in the form of a quote from the boat drivers. The use of this dataset includes a number of assumptions, including that all statements made on the radio are considered to be true and the accuracy of location or species identification is correct. There are certain limitations regarding the assumptions and the acquired dataset, where only information about an encounter communicated on the radio is documented.

5.4.2 Data Analysis

The VHF marine radio notes were analyzed for frequency of encounters based on the location within Clayoquot Sound, BC. An encounter is defined as an interaction between one or more whales and a whale-watching operator (boat operator) for whale viewing purposes. Arc GIS was utilized to spatially analyze encounters to identify areas of high use for whale watching operators and their spatial significance. Encounter duration was analyzed across species of whale, including gray whales, humpback whales and killer whales. An encounter can be one vessel viewing a whale until it departs the whale, or one whale or one group of whales being viewed continuously over time by multiple vessels.

Operator quotes were documented when addressing encounters or whale watching interactions through the VHF marine radio channel listening. Otherwise, communication regarding other subject matter, including the weather or selected routes, was not considered significant to document within a quote. The quotes were analyzed using Casey & Krueger's (1994) framework of data analysis, a type of conversation analysis for focus groups, as a guideline. The quotes were analyzed considering four perspectives of interpretation (Table 5.1.) Firstly, words were documented as notable when common in frequency of use. Additionally, interpreting the speaker's intention could involve re-defining the term used (Rabiee, 2004). The second perspective of interpretation considers the context of the quote, which is important to adequate interpretation. Proper comprehension must take into account the speaker, the receiver and the circumstance of the quotation. The third interpretation perspective is frequency and extensiveness. Frequency refers to the count of viewpoints amongst the quotations, whereas extensiveness refers to the relevancy of said viewpoints within the fleet (Rabiee, 2004). Viewpoints are common perceptions across the fleet that relates to whale watching encounters. The final interpretation concept of big ideas relates to the big picture that emerges from the quotes, allowing the analysis to consider overall trends. This framework allowed quotes to be categorized into thematic concepts, creating insight into the whale watching fleet's perception and interaction of whale encounters.

Table 5.1. Four perspective categories to analyze the interpretation of whale watching operator VHF marine radio data (adapted from Casey & Krueger, 1994).

Interpretation Category	**Definition**
Words	Notable, representative and high frequency of use.
Context	Defining statement in terms of speaker's intention and comprehension of meaning.
Frequency and extensiveness	Frequency of viewpoint and applicability of viewpoint encompassed by the quote.
Big ideas	Connecting the quote in relation to the big picture of the circumstance to identify trends in quote data.

5.5 Results

5.5.1 Spatial Significance

The whale watching fleet does not utilize the region of Clayoquot Sound uniformly. Large red circles indicate areas with high frequency of encounters, whereas singular encounters are the smallest dark green circles (Figure 5.2.). Ahous Bay, Long Beach, Rafael Point, Cow Bay, Tree Island and Cleland Island have the highest frequency of whale watching encounters; whereas the locations of Green point, Incinerator Rock, Lovington Rock, MacKay Reef, Obstruction Island, Rocky Pass, Russell Channel, Schooner Cove, Saranac Island, Stewardson Inlet and Sulphur Passage only have a single encounter.

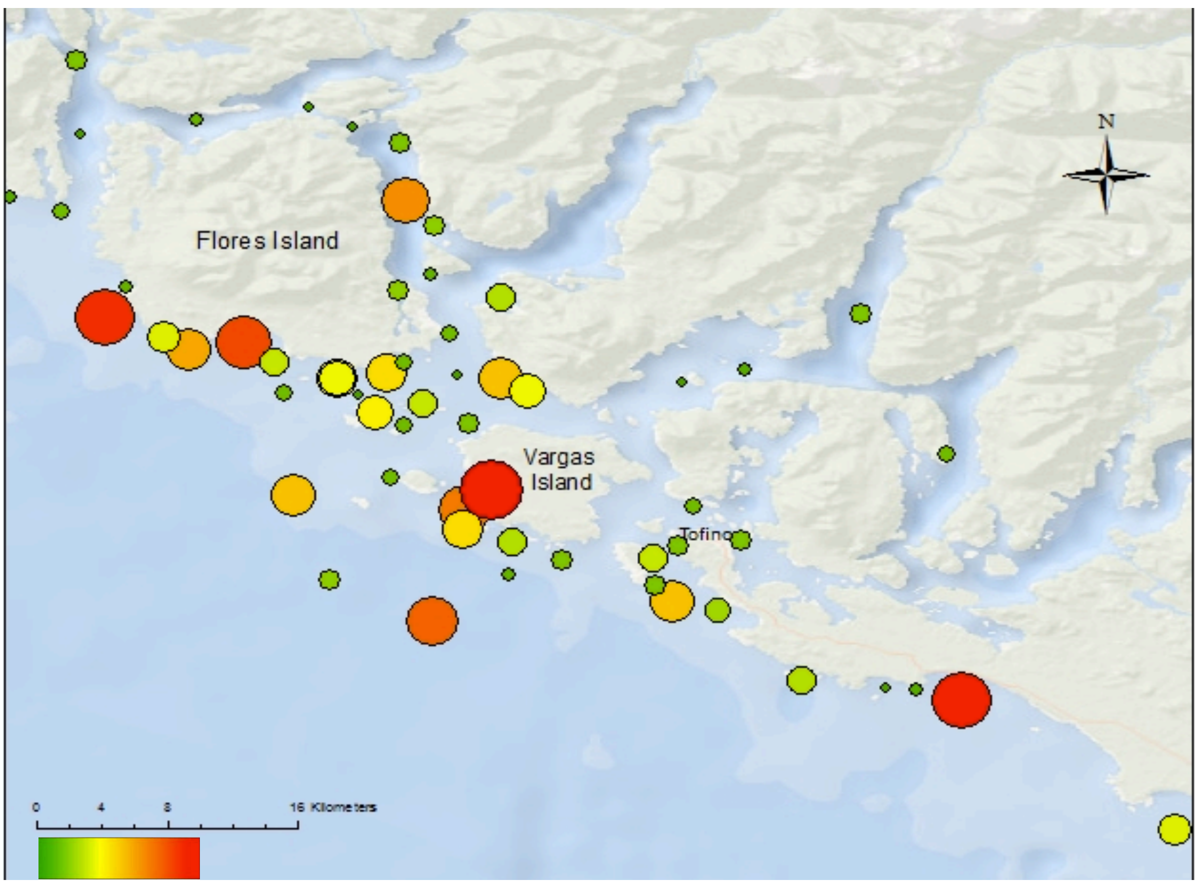

Figure 5.2. Spatial distribution of whale watching encounters in Clayoquot Sound, BC, 49°11’60.00” N, -126°05’60.00” W, for the summer of 2016. The largest red circles have the highest encounters, whereas smaller dark green circles symbolize singular encounters.

5.5.2 Encounter Duration

The duration of a whale encounter is documented across the fleet. The mean encounter duration is separated by species where killer whales endure the longest encounters, followed by humpback whales, and finally gray whales (Figure 5.3.). For gray whales, the encounter is, on average, just over an hour; humpback encounters were more than two hours; and killer whale encounters were more than four hours. The maximum time period is seven and half-hours for a killer whale encounter. A non-parametric Friedman's Test compared encounter durations across species were conducted with a test statistic of 8.074, which was significant (p=0.018); ranks Mean Rank of gray whales 1.14, humpback whales 2.36, and killer whales 2.5. A pairwise comparison indicates a significant difference between gray whale and killer whale encounters (p=0.033), but not between gray whale and humpback or humpback and killer whale encounters (Figure 5.3).

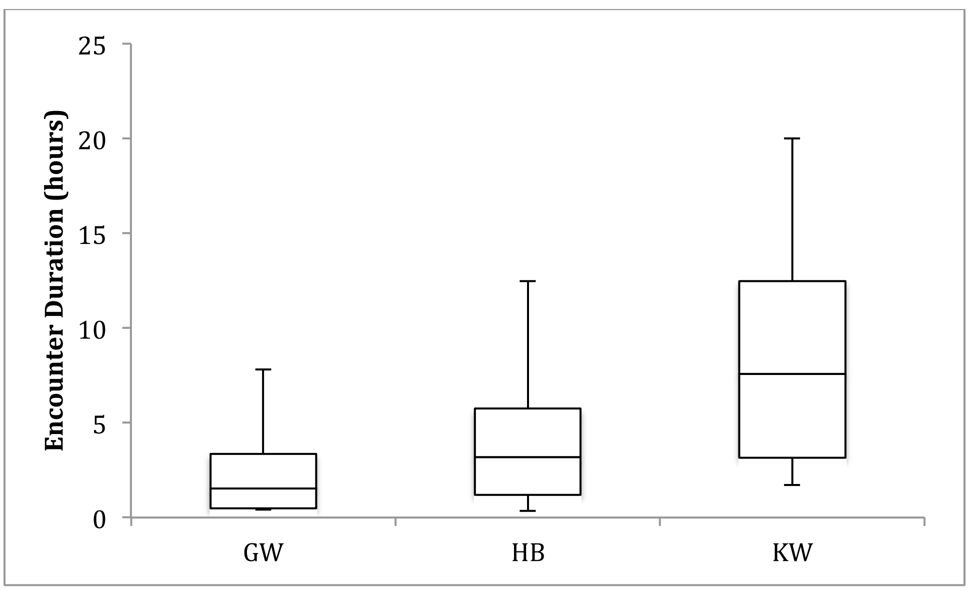

Figure 5.3. Duration of whale watching encounters, per whale species, (GW=gray whale, HB=humpback whale, KW=killer whale) for the Tofino whale watching fleet.

5.5.3 Fleet Perspective

The quotes collected from VHF marine radio listening were categorized based on four common themes (Table 5.2.). There were a total of 88 quotes recorded with 76 quotes being categorized into the four themes. The remaining 12 quotes did not correspond to any of the four categories, but communicated information about operators losing whales, or characteristics about the environment and whale features. The most prevalent theme is whale transfers (N=40). A transfer is defined as a single or group whales being passed for an encounter among the fleet, where operators use the VHF marine radio to organize a transfer. This means that an operator is observing a whale for whale watching purposes and then ensures another operator overtakes the encounter before the original operator departments. The second most prevalent theme is encounter quality (N=18). Operators communicate the level of satisfaction of a whale encounter to other members of the fleet. This information could include the number of whales or any behavioural traits being displayed, such as feeding or seeing the tail when whales are diving. The third most common theme is whale location (N=16). Operators communicate the location of whales to the fleet using the radio. Finally, acoustic consideration was the forth quote category (N=2). Although not many quotes contained context of acoustic consideration, such as boat noise or whale noise, shutting down an operators' engines and the use of a hydrophone were mentioned.

Table 5.2. The themes of categorized quotes of the Tofino Whale Watching Fleet in the summer of 2016 using VHF marine radio.

Theme Category	**Count**	**Interpretation**	**Quote Example**
1. Encounter Quality	18	Quotes communicating quality of whale encounter to the fleet.	"Four grays in Ahous giving a good show." "Pretty cool, good show. Tail slapping galore."
2. Whale Location	16	Identifying whale location within the fleet.	"They're travelling towards Tree Island."
3. Whale Transfer	40	When two or more operators are transferring a whale to continue encounter.	"We're following them in and out of the bay." "Let's do the whole switch-a-roo." "I'll be here for a few minutes, so I'll wait for ya. We'll be here until someone else shows up."
4. Acoustic Consideration	2	When operators mention acoustic conditions of the environment.	"There's 2 to 3 whales milling around. I shut the engines off. It's nice just to shut'er down." "Hydrophone down there, can hear them crunching on bones."

5.6 Discussion

5.6.1 Spatial Significance

Clayoquot Sound is a multifarious region allowing variation in species encounters for whale watching customers. The spatial clustering of encounters reflects the targeted species. The highest frequency of encounters occurs in gray whale feeding habitats. The spatial distribution of encounters is due to operators following foraging whale behaviour. Ahous Bay and Long Beach are both sandy bottom substrate bays that used to be the main foraging areas of gray whales for the ampeliscid amphipod, *Ampelisca agassizi*. Due to overexploitation of amphipods by gray whales in the 1990s, Ahous Bay is no longer the current primary foraging site, but is still frequented by gray whales testing the amphipod reserves within the area (Dunham and Duffus, 2001; Burnham & Duffus, 2016; Burnham, personal communication, July 25, 2016). Rafael Bay and Cow Bay have been the primary foraging sites within Clayoquot Sound since the amphipod decline, which is reflected in the third and fourth most frequented areas by the whale watching fleet in June and July of 2016. Gray whales forage in these northwestern areas mainly for mysid, shrimp-like species, as well as porcelain crab larvae (Kim & Oliver, 1989; Duffus, 1996; Dunham & Duffus, 2001; Burnham, 2012). The temporal change in foraging areas is due to gray whales exhibiting prey-switching behaviour to utilize alternative sites and species to maximize energy acquired (Burnham, 2012; Dunham & Duffus, 2001). Gray whales forage on multiple species and require multiple feeding sites over large spatial scales to locate sufficient prey patches (Short, 2005).

The spatial variation in encounters in relation to prey can be explained by the foraging frequency over the summer of 2016. At the beginning of the 2016 feeding season for gray whales, there was a high abundance of foraging whales within Cow Bay and off Rafael Point (Whale Lab, unpublished data, 2016; personal observations, 2016). As April and May 2016 hosted such high numbers, gray whales may have exploited the swarms of mysids within these areas to a level that it is no longer energy efficient to forage in these sites in late summer (D. Duffus & R. Burnham, personal communication, July 30, 2016). The VHF marine radio listening data timeframe is from June 3, 2016 to July 27, 2016, thereby supporting this explanation. If the alternative foraging sites of Cow Bay and Rafael Point were diminishing in the middle of the summer, it is logical to hypothesize that gray whales would move to amphipod foraging areas to test the site's abundance. Additionally, it is advantageous for gray whales to forage on amphipods later in the season, to allow for individuals to grow to their largest size before consumption (Dunham & Duffus, 2001). The longer the amphipods stay in the sand, the longer they feed and grow in size. Amphipod abundance surveys in Ahous Bay in 2016 indicated low reserve levels (Whale Lab, unpublished data, 2016). It is unknown as to whether whales were foraging out of necessity within these diminished prey patches and the level of energy need from the whales. Additionally the consideration of feeding stress on the whales could potentially increase the cumulative stress upon whales viewed by the fleet.

Besides gray whales, there are many other species of viewing interest within the region. Due to the diversity of fauna, the whale watching fleet frequents Cleland Island. This site is home to Stellar sea lions, California sea lions, sea otters, seals, and many bird species, such as puffins and commorants. This site guarantees viewing at least one of these species. As whale watching operators work for gratuities, this site increases the likelihood of a wildlife encounter. This is a viable option for operators if there are no known whales within the region. Additionally, whales also frequent this area, allowing operators to minimize their pursuit effort and double their customer satisfaction. This high likelihood of wildlife encounters when visiting Cleland Island is reflected in the high whale watching encounter frequency in this chapter's dataset.

Unlike the high site fidelity of gray whales and pinnipeds, other whale species are less predicable in location. This is reflected in the dataset by multiple single encounter locations. Humpback whales and killer whales frequent Clayoquot Sound but more infrequently than gray whales. Importantly, humpback whales and killer whales hunt prey that is more mobile than gray whales, thereby having more movement in their foraging behaviour. Humpback whales feed on euphausiids and forage fish (Jurasz & Jurasz, 1979), while killer whales feed on these species or marine mammals if they are of the transient ecotype (Baird, 1994). For all encounters, the fleet is deferential to the whales, seeking out encounters by whale's known preferred location or by following their activities. Within the summer season, this commonly corresponds to known foraging or other preferred locations where whales have been known to frequent in the past. As the spatial distribution of encounters correlates with foraging behavior, operators are most commonly viewing whales during foraging behaviour.

5.6.2 Encounter Duration

Whale watching encounters involve following or viewing an animal to allow customers to observe wildlife for an extended period for recreational purposes. This dataset demonstrates encounters occur for long durations of time, longer than one single vessel viewing time period. The Be Whale Wise Guidelines, voluntary whale watching guidelines for BC, limit viewing to a maximum of 30 minutes to minimize the cumulative effects from vessel presence and acoustic disturbance (Fisheries and Oceans Canada, 2013). Yet, on average, encounters are well above this endorsed time frame. The recommended viewing time within the Be Whale Wise Guidelines is directed towards individual vessels but not the cumulative impact of the fleet per whale over the course of a whale-watching day. Both boat presence and noise can impact whale behaviour. Gray whales have displayed behavioural responses to vessel presence, such as avoidance and habitat abandonment (Bryant, Lafferty & Lafferty, 1984). Humpback whales show avoidance behaviours, or alter their diving and surface patterns depending on the proximity of a vessel (Stamation, Croft, Shaughnessy, Waples & Briggs, 2010). Recording playback studies for humpback and gray whales document whales moving away from vessel and other industrial noise (Richardson *et al.,* 1995; Dahlheim, 1986). Killer whales also demonstrate avoidance behaviours with whale watching boats when closer than 100 meters (Williams, Trites & Bain, 2006). The acoustic emission from a vessel has the potential to mask whale communication and alter their vocalizations, including gray whale calls (Chapter Two & Chapter Three). Vessel noise is linked to decreased male humpback singing during whale watching operation hours (Sousa-Lima & Clark, 2008). Vocalizations can be altered due to vessel noise. Killer whales increase their call amplitude by 1 dB for every 1 dB increase in background sound levels, indicating acoustic disturbance (Holt, Noren, Veris, Emmons & Veirs, 2009). The long duration of encounters can increase the risk of these behavioural impacts on whales, which can have long-term effects on the life processes of the individuals and their population (Parsons, 2012; Van Parjis & Corkeron, 2001).

The difference in encounter duration can be explained due to the behavioural traits of the various whale species. Gray whales have the lowest encounter duration with whale watching operators. Gray whales are the most common whales within Clayoquot Sound. They sustain the whale watching industry of Tofino. This may cause operators to limit their viewing per individual as they may encounter another gray whale or seek out other wildlife for viewing. Gray whales forage on a swarm of prey high in density and biomass (Dunham & Duffus, 2001). This feeding technique keeps an individual within the same area until it is no longer energetically efficient to continue. Once this stage has been reached, gray whales will move onto the next patch to feed or travel to another location. Whales can forage within the same area for days or longer (D. Duffus, personal communication, June 5, 2016), making them easy to relocate. This behaviour is ideal for whale watching operators. Vessels can position themselves near the foraging whale, which will continue to surface within the same proximity as before. Humpback whales and killer whales have higher encounter durations than gray whales. Their foraging behavior of hunting fish shoals or marine mammals, in the case of transient killer whales, requires that they travel greater distances chasing their prey. This foraging behaviour incentivizes whale-watching operators to follow these species more carefully, as it is more difficult to locate them later or predict their route of travel. Whale watching vessels follow along side a foraging whale, matching their speed to position themselves for optimal viewing (Personal observation, 2016). This optimizes customers' views of the whale, while maintaining safe driving practices when within close proximity to whales.

There is a difference in the public desire for viewing across the three whale species. The draw of humpback fin slapping, lunge feeding and breaching, as well as the colouration and dorsal fin of killer whales, entices the public for their viewing. These two species are more commonly recognizable to most people, compared to a gray whale. Observing these iconic whales increases customer satisfaction, leading operators to choose humpbacks and killer whales over gray whales. This general public familiarity with humpbacks and killer whales is due to the macrocultural change in the conceptualization of whales (Lawrence & Phillips, 2004). The public changed their conceptual perspective of the species. This can be exemplified with the change in name from killer whales to Orcas through media and branding, putting killer whales to the top of conservation agendas (Lawrence & Phillips, 2004). This perception of killer whales increases the desire of whale watchers to view this species over others. With regards to the location, coastal First Nations hold killer whales in high cultural significance. Additionally, killer whales are a symbol of the BC coast, motivating tourists to see them in the wild to fulfill their Canadian Pacific northwest experience. This creates a duel draw of environmental and cultural reasoning to view killer whales in their natural habitat. Due to this public stronghold, killer whales are sought out over all other whales when in the region. In the context of encounters, this increases the time that the whale watching fleet spends with a killer whale. Operators choose killer whales over humpback whales and humpbacks over gray whales (personal observation, 2016). This causes operators to carefully track located killer whales to maximize the likelihood that they will be able to locate the whale upon their next tour for further encounters.

5.6.3 Fleet Perspective

The commercial whale watching industry depends on the health and frequency of whales within their coastal region. Although operators are supportive of a whales' wellbeing, they are relying on the viewing of these animals for their livelihood. The better the encounter, the better the monetary gain for drivers and their companies. Due to the impeding economic value of whales within the wild, whale watching operators and companies have altered their perspective of encounters. The analysis of the operator quotations revealed their main objectives and unique industry perspectives regarding whale-watching interactions.

The main area of concern for whale watching operators is the quality of the encounter. They are interested in seeking out whales that will allow their customers to see as much of the whale as possible. This results in whales that are displaying behaviour on the surface or preferably out of the water. This includes breaching, spyhopping where the animal juts its head out of the water, humpback whale lunge feeding, transient killer whale marine mammal hunting, fluking where whales display their tail when diving, or porpoising where the animal dives and bobs across the surface. In terms of the drivers, they are seeking a good whale watching "show". These encounter quality quotes discuss the prevalence of these behavioural displays, thereby increasing the value of the encounter for operators, as well as customers. "Pretty cool and great show. Tail slapping galore! Are these the right guys for the show!" (Anonymous, 2016). It is clear the operators are seeking entertainment for their customers with the minimum effort needed to find the best show.

Operator perceptions of the whales within Clayoquot Sound for the benefit of the whale watching industry at times transcend their value of wildlife viewing. There seems to be an increasing trend of dissociation between the whales and operators. "He doesn't really participate when you get in close" (Anonymous, 2016). Additionally, the operators begin to falsely transplant their influence on these wild animals. "Bull clobbered a harbor seal. Well trained" (Anonymous, 2016). Although it is likely operators do not truly believe they have hold over the whales' actions, their language suggests that they are dissociating themselves from being in nature and interacting with wild animals. These animals are becoming objectified rather than the subjects of tourism (Hughes, 2001). This mentality distances operators and viewers from the ideal of valuing animals intrinsically. The prevalence of captive whales may influence the level of comfort and range of control that humans believe they have over whales. The language of whale encounters, from whale watching operators, brings to the surface numerous issues of animal and environmental ethics. Although not a battle of morality versus economy or ecology, the ethical dimension of whale encounters must be considered within management regimes.

The quality of an encounter is important information for operators, as it is an indication of the encounter's value if an operator were to seek out this particular whale. Drivers can coordinate with other vessels to locate animals putting on a "good show" where the whales are easily approachable. "They're really comfy in there" (Anonymous, 2016). This quote exemplifies the quality of the encounter, where comfy is being used to describe the whales as easily approachable. Alternatively, operators can avoid locations where animals are not displaying optimal behaviours. “The one spout wonder over here” (Anonymous, 2016) is not an ideal whale for an encounter, as it is rarely seen when surfacing. Whales that are deemed “super elusive” are also avoided by the fleet if other locations have whales displaying more ideal behaviours. This allows operators to maximize their customers’ time, spending less time searching for wildlife or travelling across less than favourable sea conditions.

One of the most prevalent uses among operators for whale encounter radio communication is to track the whales, as exemplified as the most common quote theme recorded for this study. Operators who have identified a whale that is displaying a good show will spread the word to other drivers: “Good whale show at Tonquin Beach for those interested” (Anonymous, 2016). Once a whale displaying a good show is identified, the fleet will try and track the whale for as long as possible. “I’ll be here for a few minutes, so I’ll wait for ya. We’ll be here until someone else shows up” or “Try and hang on to him as long as possible” (Anonymous, 2016). This benefits’ the driver and the whole fleet. The driver can easily radio to locate the whale for the start of their next tour. Alternatively, sharing knowledge of optimal whale encounters to the fleet may benefit an individual in the future when another operator locates a whale and spreads the message. Operators may also use the radio to track whales strategically to optimize their tour satisfaction. If multiple whale species are being tracked, an operator can potentially design their route to see all of the whales, such as “Let’s do the whole switch-a-roo” (Anonymous, 2016). This operator is arranging a change in location with another operator with a different whale species, as to keep track of whales displaying good encounter behavior. On the fortunate day that all three-whale species (humpback, killer whale and gray whale) were present in Clayoquot Sound, operators stated it would be "Kinda cool to get a hat trick" (Anonymous, 2016), which multiple operators achieved using VHF marine radio communication. This enables a driver to maximize customer satisfaction by viewing multiple species, viewing good shows, spending less time looking for whales, and avoiding customer discomfort, like sea sickness when risker areas are attempted. Operators are separated from tracking an individual or group of whales by the timing of their tours, weather, sea conditions, comfort level of their customers, or an inability to transfer their tracked whale to another operator. Under favourable conditions, whales are ideally tracked for the entire whale-watching day by "trading" the whale from vessel to vessel. Despite the many benefits to the whale watching industry, the whale is receiving increasingly more encounter time, thereby increasing the potential negative impacts associated from whale watching vessels.

Finally, operators mentioned acoustic consideration within the quotes recorded. Although not mentioned frequently, an operator indicated turning off their engines: There are "2 to 3 whales milling around. I shut the engines off. It's nice just to shut'er down" (Anonymous, 2016). This quote may suggest needing to encourage shutting engines down more frequently among operators when safe, and the benefit for operators and whales. Operators can save gas and relax during the length of the encounter instead of driving, which also minimizes vessel acoustic input within the environment. Additionally, one of the operators in the fleet used a hydrophone during the summer of 2016 whale-watching season. This operator stated he released a "hydrophone down there, [and he could] hear them crunching on the bones" (Anonymous, 2016). This quote referred to transient killer whales feeding on local seals. The use of a hydrophone would require engines to be turned off, which would benefit whales acoustically. Using hydrophones within the industry could be beneficial for operators to increase customer satisfaction, as it delivers further insight into the whale encounters. Further, operators may learn more about their acoustic input from using hydrophones, which could lead to increasing awareness of reducing noise output from the fleet.

5.7 Management Implications

Whale watching management tactics and regulations are subject to industry feasibility and benefit, as well as protecting whales. Operators are dependent on whale movement and behaviour, as demonstrated in the spatial distribution of encounters. This suggests that there is the opportunity for spatial management through marine protected areas and quiet zones. As whales alter the use of habitats over time or alternate their use of habitats, adaptive management can be incorporated into management planning to better reflect this dynamic nature. Monitoring whale's spatial patterns within their habitats can assist in ensuring spatial restrictions remain effective.

Whale watching regulations regarding the limitation of encounter duration need to be changed. The 30-minute viewing limitation per vessel is rendered ineffective due to fleet communication through VHF radio. Alternatively, encounters can limit the number of vessels per whale to minimize acoustic disturbance and the impact of vessel presence on whales. This is common practice in other nations where 33% of whale watching codes of conduct limit the number of vessels per animal, such as the regulations in New Zealand and Australia (Garrod & Fennell, 2004). Canada would benefit from instituting similar restrictions. Additionally, establishing an industry break time during the day will allow whales a rest period from the disturbance of whale watching and force operators to abandon animal tracking.

Addressing whale watching operator encounter perspectives and the value of whales may help in realizing the impacts and increase compliance of whale watching regulations. Education has been accepted as an effective tool in ensuring regulation compliance (Orams & Hill, 1998). The diversity of these strategies may enable the industry to continue their interactions with whales in the wild, while minimizing any adverse effects from these encounters.

5.8 Conclusions

The whale watching industry is one form of ecotourism on the BC coast. Operators are to sustainably use cetacean viewing for economic gain, without ecological or biological harm to the animals. However, whale watching is not a benign activity and should be realized as such within management regimes. Documenting whale encounters with a focus on industry conduct is beneficial towards implementing adequate regulations that support the economic gain of the industry without ecological or biological degradation. This chapter highlights the opportunity to improve whale watching viewing measures to minimize the impact of vessel noise exposure to whales by minimizing encounter durations. This in turn will improve human interactions with whales within Clayoquot Sound and support more realistic ecotourism operations.

6.0 CHAPTER SIX: THE INCORPORATION OF EVIDENCE WITHIN THE CURRENT POLICY AND MANAGEMENT REGIME FOR WHALE CONSERVATION

6.1 Introduction

Given the complexity in the management and policy strategies relevant to whale conservation and whale watching in BC, the incorporation of evidence to support the mitigation of whale watching acoustic disturbance has many considerations. To ensure adequate protection, a balance between effective conservation measures and support of the ongoing sustainable practices of the whale watching industry must be achieved. Inevitability, certain enablers and barriers will arise through the execution of management or policy amendments to the current regime. By analyzing evidence of the influence of acoustic disturbance within the interacting systems of the whale watching industry and whale conservation, they can be better understood to achieve successful mitigation of whale watching acoustic noise on whales through appropriate management and policy strategies.

6.1.1 Evidence within the Science-Policy Interfaces

Evidence-based decision-making (EBDM) is an approach to management and policy strategies to support actions informed by the best available information (Nutley, Walter & Davies, 2012; MacDonald, Soomai, De Santo & Wells, 2016). Concrete evidence can inform decision-makers of solutions that are objectively and more rigorously justified. This is in contrast to decisions that are opinion-based (Nutley *et al.*, 2012). The use of evidence to guide decision-makers allows for logically evaluated actions, thereby supporting robust conservation policies.

The communication of evidence between those collecting it and the decision makers can be understood through the conceptual framework called the science-policy interfaces (SPIs).

> Science-policy interfaces are social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making. (Van den Hove, 2007, p.807)

This conceptual framework can be beneficial to conservation policies and management as a means to understand the effectiveness of evidence use within decision-making. Predicting interactions between whale conservation and the whale watching industry, through the incorporation of evidence within policy and management measures, can assist decision-makers in addressing sources of conflict and enhancing enablers leading to the most successful outcome. Sarkki *et al.* (2015) outline four attributes within effective SPIs, including credibility, relevancy, legitimacy and iterativity. Tradeoffs can occur between attributes to favor some over others. For example, scientific evidence of vessel noise impacts on cetaceans increases the credibility and the legitimacy of advice, but does not necessarily increase the relevancy for policy. The iterativity attribute of SPIs is the dynamic flow of information within the decision-making process, enabling review and connectivity among actors, thereby support the three other attributes (Sarkki *et al.,* 2015). Analysis of the decision-making process can be undertaken using the SPIs framework to understand the presence of tradeoffs allowing for more effective EBDM. Enabling the ease of evidence use within management and policy, as well as ensuring understandable and usable information for decision-makers, will ultimately create more effective conservation policies.

6.2 Methodology

To identify and understand the interactions of the integration of acoustic disturbance evidence within the current policy system, aspects were categorized based on their positive and negative effects. A SWOT framework can be used to identify the characteristics of a regime (Table 6.1). This analysis identifies internal strengths and weaknesses, while safeguarding the system from external threats and enabling improvements from outlined opportunities. A SWOT framework can be used to adopt or alter the current regime by enabling identified strengths and exploiting external opportunities, while managing the weaknesses and threats of the regime to reduce their impacts (Atari, Yiridoe, Smale & Duinker, 2009).

Within this chapter, the whale watching policy regime is the focus of the analysis. The interrelations between whale conservation and the Tofino whale watching industry are included to summarize the key strengths and weaknesses that their interactions have within the policy regime, as well as the opportunities and threats of the overall policy system. Strengths are identified as beneficial attributes of the current policy regime; weaknesses are identified as negatively impacting both whale conservation and the whale watching industry or only one of the two; opportunities identify how policies can be improved with the use of evidence for the benefit of both conservation and industry; threats are considerations external to the policy system that can have adverse consequences. The analysis will focus on the policy parameters of this interaction and the use of evidence to strengthen and maximize opportunities for effective whale conservation and the whale watching industry.

Table 6.1. SWOT analysis of the incorporation of acoustic disturbance evidence within the current policy regime of whale conservation in Clayoquot Sound, BC, and the Tofino whale watching industry.

Strengths	Weaknesses	Opportunities	Threats
1. Evidence-informed decision-making framework. 2. Multiple evidence sources. 3. Existing policies.	1.Perceptions of trade-offs. 2. Evidence skepticism. 3. Transparency of evidence use. 4. Objectivity within decision-making. 5. Mismatch between science and policy processes. 6. Low policy adaptability.	1. Current Legislative review. 2. Specificity capacity of local policies. 3. Creation of a working group. 4. Successful example of conservation policy. 5. The whale watching industry as conservation stewards.	1. Compliance variability across vessel sectors. 2. Paper policy. 3. Balance of vagueness and specificity. 4. Political prioritization.

6.3 Results

6.3.1 Strengths

6.3.1.1 Evidence-Informed Decision-Making Framework

In recent years, EBDM has grown in popularity with government decision-makers to increase the implementation of successful policies. First arising in the 1990s in health care policies, EBDM is a tool to ensure healthcare is practiced to the best possible knowledge available (Rycroft-Malone *et al.,* 2004). This decision-making framework tool spread to other departments of government and management institutions. The EBDM process aims "to avoid or minimize policy failures caused by a mismatch between government expectations and actual" conditions through the use of relevant and accurate information (Howlett, 2009, p.153). After the election of the Liberal government in Canada, the 2015 mandate letter to the minister of

Fisheries and Oceans gave an endorsement of science-based decision-making by the Prime Minister and Cabinet (Trudeau, 2015). The emphasis on evidence-based or science-based decision-making is prevalent within the Liberal government regime, although it is a well-practiced tool by the Canadian government despite the preference of the political party. The current prioritization of EBDM by the federal government of Canada can be an attribute to the effective incorporation of evidence within current management and policy actions. Supporting the application of this tool within government decision-making will benefit future use of evidence within the regime and conservation success.

6.3.1.2 Multiple Evidence Sources

Although government is highly focused on science-based decision-making, additional information sources for evidence acquisition are welcomed. Evidence obtained through scientific research, whether academic or governmental, is the norm for the foundation of conservation policies. Yet, the feasibility and implementation of evidence use in policy must couple scientific evidence with that of social, economic and other forms of knowledge (Bowen & Zwi, 2005). This coupling of information strengthens the understanding, applicability and implementation of evidence within policy to solve a problem, such as the acoustic disturbance of whales due to whale watching vessels. As management problems are complex and span sectorial boundaries, a combination of various types of complimentary evidence will increase the likelihood of policy reform. For example, whale watching is an economic practice that has social and environmental implications; thereby evidence should be reflective of all of these perspectives to fully represent the management scenario within policies. The collection of scientific and social evidence supporting solutions for a management problem, for instance that of the interaction of vessel noise in gray whale habitat, can be combined leading to a solution useful for decision-makers (Chapter Two, Chapter Three and Chapter Five).

Alternatively, various sources of information, as opposed to conventional academic or scientific sources, can be utilized to increase effective decision-making in the face of knowledge gaps or to bolster other information from various sources. The distinction can be made between propositional knowledge, formal or explicit knowledge obtained from research and scholarly sources, and non-propositional knowledge, which is informal and implicit information sourced from experience (Rycroft-Malone *et al.,* 2004). The latter would include local knowledge and traditional knowledge, providing evidence in support of the problem, such as acoustic disturbance of whales from whale watching vessels, and fostering a policy solution. COSEWIC is an example of an associated government body that utilizes both scientific and traditional knowledge as a source for management and policy recommendations. Relevant traditional knowledge is obtained by the Aboriginal Traditional Knowledge Subcommittee of COSEWIC to contribute to species' status reports (COSEWIC, 2010). These reports are recommendations to the federal government to list species for federal protection, due to their risk of extinction or extirpation (COSEWIC, 2010). Traditional knowledge, as well as scientific knowledge, is utilized as evidentiary support for COSEWIC's recommendations. For conservation issues, all relevant and reliable knowledge must be obtained and evaluated to potentially contribute to conservation policies and management solutions.

<u>6.3.1.3 Existing Policies</u>

Whale conservation and regulation have been present in Canada for decades, thereby allowing for the incorporation of evidence within an established regime. This allows greater ease in the amendments to current management and policy strategies, instead of the use of greater resources that would be necessary for producing a foundational piece of legislation or policy document for whale conservation and whale watching practices. Whale conservation is managed through multiple pieces of legislation between the federal and provincial government, as well as voluntary whale watching practices (Chapter Four). Although vessel noise is not explicitly addressed within Canadian law, it can be incorporated through the definition of disturbance within the *Marine Mammal Regulations,* S.O.R./93-56, s. 7; *Species at Risk Act,* S.C. 2002, c. 29, s. 32; and the provincial *Wildlife Act*, R.S.B.C. 1996, c. 488. The incorporation of acoustics as a source of disturbance would allow for better legislative enforcement of mitigation strategies to minimize noise pollution in the marine environment. In addition, whale watching guidelines, such as the Be Whale Wise: Marine Wildlife Guidelines for Boaters, Paddlers, and Viewers, should incorporate vessel noise mitigation strategies more explicitly within their measures (Chapter Four).

6.3.2 Weaknesses

<u>6.3.2.1 Perceptions of Trade-Offs</u>

Balancing the needs of conservation and industry can be difficult to achieve, due to potential conflict between sectors. Industry could be reluctant to accept management and policy amendments, based on the perception of an increased focus on environmental protection with the sacrifice of socioeconomic benefits to industry. This impression is a primary concern of whale watching operators for fear of losing revenue, due to the potential alteration of their current whale encounter repertoire. Restrictions could include closures of certain areas, alterations in acceptable vessel approach behaviour to whales, length of encounters, or requiring operators to turn off their engines within a certain proximity of whales (IWC, 1996). The industry is reliant on whale wellbeing for the continued longevity of the regional industry; therefore a balance must be achieved between whale watching and cetacean health. Tremblay (2001) suggests that whale watching is falsely labeled as a non-consumptive practice, creating a challenge for wildlife management, as whale watching can potentially permanently affect the whales. Given this viewpoint, it is paramount that industry understands the value in protecting the environment through policies and industry practices, as their source of income could disappear if whale disturbance was pushed past a certain threshold.

Education and framing for the mutual benefit to both sectors will overcome potential conflict regarding the perceptions surrounding trade-offs.

> Framing theory recognizes that the words chosen to convey a given issue can exert a powerful effect on how audiences process and perceive messages by bringing certain considerations to mind over others. (McComas, Schuldt, Burge & Roh, 2015, p.45)

Conscious framing to ensure amendments to management and policy measures, in the context of conservation and socioeconomic benefits, would increase the likelihood of the successful application of evidence. Framing combined with education can be used as a powerful tool to persuade conservationists, industry and decision-makers towards achieving a compromise for the best-case scenario for public policy.

6.3.2.2 Evidence Skepticism

Evidence skepticism can be fueled by many agendas, including the fear of trade-offs (as discussed above) or due to scientific uncertainty. Conservation decision-making struggles to account for uncertainty, as the full implications of a policy must be considered before it is implemented. Noise is a chronic pollutant that is difficult to regulate, manage and quantify (Williams, Clark, Ponirakis & Ashe, 2014). There are knowledge gaps within the biological and ecological understanding of whale species, leading to difficulties in effective conservation (Ford et al., 2010). In addition to biologically significant evidence, socioeconomic evidence must be considered to determine feasibility and implications for industry and society of the proposed conservation measures. Uncertainties and knowledge gaps, or resistance to strategies supported by evidence, will create difficulties in implementing effective policies for whale watching that support the environment of whales and industry.

In the face of uncertainty and variability, the precautionary approach should be a key governing principle within whale watching policies and management, as well as overall cetacean conservation. This principle integrates a responsibility to better incorporate uncertainty within governance, as it is defined as an action in the face of insufficient evidence or scientific uncertainty (UNESCO, 2005). In the context of whale watching, this principle would support the proactive implementation of cautious measures to guide whale-watching activities to avoid cetacean harm (Lien, 2001). Yet, noise management for cetaceans is lacking the precautionary approach in Canada. There is a need to reduce noise and distance noise in biologically important areas (Weilgart, 2007). Canadian legislation has been criticized for not adequately adopting precautionary approach management (Powles, 2000; Mooers et al., 2010). Given the uncertainties surrounding whales and underwater acoustic implications, stronger precautionary measures need to be actualized. Increasing decision-makers' understanding of the credibility of scientific evidence, even in the face of uncertainty, will increase potential evidence use within the management and policy regime.

6.3.2.3 Transparency of Evidence Use

Transparency in the use of evidence in decision-making will foster trust in effective and appropriate approaches. Skewed perceptions towards policy intention may be rectified through transparency in decision-making; hence avoiding conflicts between conservation agendas and the whale watching industry. Questions surrounding what is considered evidence and the weight given to evidence introduce doubt about the effective use of EBDM. This brings forth a question of replacement by opinion-based policy-making. Opinion-based decision-making is the selective use of evidence, thereby undermining the intent of EBDM and its use of the best available information (Young, 2013). An increase in the transparency of the decision-making process will then increase the accountability of decisions, and the evidence used to support these decisions. As evidence must be used within the realm of feasibility and to uphold the values and objectives across sectors, relevant opinions can be used to apply evidence appropriately within decision-making. In terms of whale watching policies, transparency in decision-making can be used in tandem to education towards the effectiveness of practices based on credible scientific evidence.

Decision-makers hold the power to utilize the evidence that researchers provide for policy change. This manifests as instrumental, conceptual or symbolic use of research. Most researchers strive for the instrumental use of evidence by decision-makers, to fill gaps in knowledge and solve management or policy problems (Amara, Ouimet & Landry, 2004). Secondly, decision-makers may use evidence in a diluted or indirect fashion to conceptually support policy initiatives; and lastly, evidence may be applied symbolically, which is implemented in an even more removed way than the conceptual application of evidence-use in policy decisions (Amara, Ouimet & Landry, 2004). Decision-makers can justify the relevancy of evidence use across these three applications within policy, yet transparency can increase accountability of their choices. By upholding transparency in decision-making, the legitimacy of evidence use, whether applied instrumentally or symbolically, will be increasingly justified, thereby creating an incentive to use evidence appropriately.

6.3.2.4 Objectivity within Decision-Making

The use of evidence-based research in the decision-making process is foundational, as it provides the basis of objectivity supporting the legitimacy of policy solutions. The scientific method is the cornerstone of scientific credibility, as it supports the objective and inquisitive exploration for truth. Occam's razor can be used to explain the philosophy of this quantitative investigation: "among competing hypotheses, the one with the fewest assumptions should be selected, or the simplest explanation is the correct hypothesis" (Burgess, 1998, p.197). Parsimony is a guiding principle of the scientific method. Specificity in investigation allows for the accurate application of the scientific method, leading to a conclusion from the agreement of multiple variables. Although this is a sound approach, it can fail to encompass all influential variables completing the big picture perspective essential for management problems.

Science's assumption of objectivity can be overstated, as evidence can never truly be objective; "all knowledge is relative and contextual in nature to social perspectives" (Nutley *et al.*, 2012, p.254). The social influence within the evidence chosen, and the way that it is considered, is bound by the human way of thinking (Nutley *et al.*, 2012). Although using frameworks to support objective decision-making and knowledge acquisition are valuable, it is important to remember that true objectivity is difficult to achieve. Within the consideration of whale watching policies, measures are implemented due to social values toward whale protection, and ultimately favouring humanity's curiosities regarding species. It is important to recognize the inherent biases of human thinking, instead of solely relying on science as the holy grail of objectivity.

It is important to consider the weight that the evidence is given towards rationality within decision-making (Nutley *et al.*, 2012). The perceived objectivity of scientific evidence can be over-accounted within the decision-making process. This dependency on evidence to guide the "right" decisions fuels the majority of the considerations for conservation policy-making. Although EBDM can be a powerful tool in making confident management and policy choices, a balance must be achieved to incorporate the recognition of human biases and values. This will strengthen the use of evidence within decision-making, instead of stifling its use by assuming inherent objectivity.

6.3.2.5 Mismatch Between Science and Policy Processes

The policy process is typically a slow and rigidly instituted mechanism. A disconnect between stakeholders within this process can contribute to further process deceleration and fuel a mismatch among entities. Spatial and temporal mismatches occur when the scale of ecological variation and scale of social organization are aligned in a fashion that causes disruptions between both entities' processes. This results in inefficiencies or can cause components of the decision-making process to be neglected from the whole altogether (Cumming, Cumming & Redman, 2006). A lack of understanding towards entity priorities and timelines can exacerbate ineffectual conservation policies. This perspective supports Caplan's (1979) two communities thesis, which assumes that a fundamental gap exists between research and policy, due to the cultural differences between the two entities. This theory supports the lack of fluidity within the overall decision-making process, and fragments information leading to potentially poor decision-making within conservation policies. Greater interaction between the two groups can be the greatest enabler to overcome this shortcoming (Nutley *et al.*, 2012). Communication between the two entities would increase understanding of sector objectives, cultures, practices, and processes (Nutley *et al.*, 2012). Integration of ecological and socioeconomic evidence, in addition to acceptance and understanding of sectorial process differences, will lead to the greatest likelihood of balancing sectors' needs and obtaining policy effectiveness for the long-term.

6.3.2.6 Low Policy Adaptability

There can be lack of adaptability within management and policy frameworks. Ecological processes are dynamic, continuous and can be incompletely understood, which can clash with policy and management timelines and measures. This can create ineffective tactics and a waste of resources for conservation and industry practices. Social-ecological systems must maintain resilience through their capacity to adapt to changes recognized by stakeholders within the systems, and promote flexibility to accommodate alterations to management and policy (Folke, Hahn, Olsson & Norberg, 2005). Although adaptive management is recognized as a formidable framework to accommodate ecological system dynamics, it is difficult to implement this approach practically. Structuring management plans and policies with the objective of adaptability is key. This assists in incorporating new information and monitoring the effectiveness of current strategies, which can assist in accounting for the variable nature of managing natural ecosystems and their components.

Adaptability among stakeholder contributions within the decision-making process is recommended for successful management and policies. The collaborative structure between sectors to uphold adaptability within the regime can be considered a bridge to encourage partnerships, hence reducing conflicts and enabling effective efforts (Folke *et al.*, 2005). Using adaptive management strategies to bridge the gap between science and policy is supported by openness to learning from change, fostering collective action to solve ecological and social problems across scales, and promoting polycentricity governance; a collaborative multi-level governance structure (Milkoreit, Moore, Schoon & Meek, 2014). Although incorporating adaptability within policy making may be difficult, including processes for review and becoming cognizant of matching entity processes will facilitate successful results.

6.3.3 Opportunities

6.3.3.1 Current Legislative Review

The *Marine Mammal Regulations,* S.O.R./93-56, is the primary piece of legislation for cetacean protection in Canada, and as such is the greatest asset towards effective protection of all whales from a legal standpoint. Currently, the *MMR* is being reviewed to include amendments to reduce disturbance to cetaceans (Fisheries and Oceans Canada, 2016a). The forward regulatory plan includes the primary inclusion of whale watching provisions (Fisheries and Oceans, 2016a). The alteration of the definition of disturbance under the regulations could include acoustic sources as a means of disturbance, thereby enabling more effective management. This opportunity increases the mitigation capacity for acoustic pollution through enabling enforcement and more specific guidelines. The federal legislative amendments could also spur voluntary guideline amendments to coincide with national regulations or apply more specific guidelines to regional whale watching protocols. Together these opportunities will increase the mitigation of underwater noise pollution from whale watching and in turn increase the protection from disturbance to whales.

6.3.3.2 Specificity Capacity of Local Policies

Local voluntary policies can be used to increase specificity towards local species, ecology and their regional whale watching industry. This may increase the uptake and application of local evidence of acoustic disturbance and options for industry measures within local policies. Voluntary and local guidelines have the liberty and lack of constraints that legislative processes endure to implement plans or alter current guideline measures. The Be Whale Wise Guidelines is a voluntary whale watching guideline policy that would be able to include alterations with greater ease than the *MMR*. However, they are still produced by the Canadian government and must abide by the service standards for regulatory authorizations, which ensures a level of performance and standard for national government legislation and policies (Fisheries and Oceans Canada, 2016b). In contrast, the non-governmental organization, Strawberry Isle of Tofino BC, published the Tofino Whale Watching Operators’ Voluntary

Guidelines (TWWOVG) and therefore has the authority to alter the guidelines with fewer political restrictions than government policies. Their freedom and greater flexibility has the potential to include measures to minimize acoustic disturbance with greater regional and species specificity. This may enable more efficient mitigation measures for whale watching practices within the Tofino fleet.

6.3.3.3 Creation of a Working Group

To overcome the challenges of whale conservation, a working group could be established. This would best incorporate the considerations and variety of stakeholders to formulate management and policy solutions more directly. A working group would increase collaboration, resources and minimize duplication in efforts. A group similar to the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOMBAMS), which focuses on collaboration across stakeholders and countries in the purpose of reducing threats to cetaceans (ACCOBAMS, 2012). An emphasis on the threat of acoustic disturbance to cetaceans could be established within the working group, as well as a focus on using EBDM to further influence government policy and management decisions. The working group is an opportunity to have coordinated action across stakeholders and transnational cetacean protection.

6.3.3.4 Successful Example of Conservation Policy

This case study of acoustic disturbance mitigation for gray whales in Clayoquot Sound can be used as an example in other policy and jurisdictional realms. "This knowledge repository [can] serve as institutional memory…and is [a] mechanism for sharing and preserving knowledge" across organizations (Liebowitz & Beckman, 1998, p.5). By analyzing the evidence of acoustic disturbance on cetaceans, as well as the incorporation of evidence in management and policy, other management and governing bodies can build on this knowledge instead of reinventing the wheel. "States will devise creative strategies that not only respond better to their own conditions but also provide models for fellow states and federal programs" (Mossberger, 1999, p.33). Although this model may not exemplify perfection in execution and conservation, the information and assimilation of research into management and policy can be beneficial to increase the effectiveness of current and future conservation measures.

6.3.3.5 The Whale Watching Industry as Conservation Stewards

With daily interactions during the tourism season, whale-watching operators have high cetacean encounters within their environment, privy to monitoring their conditions. This leads them to be perfect candidates for the assessment and monitoring of whale behavior and conditional changes over time. As data collection is costly, in terms of financial and time commitment, harnessing participants already in the field or industry can increase data collection while minimizing costs (New *et al.,* 2015). Empowering whale-watching operators to collect data on whale behavior, environmental conditions and industry encounters can inform researchers and policy makers, thereby enriching scientific knowledge bases and the information used in decision-making. Within Clayoquot Sound, whale watching operators have been a key source of local and ecological knowledge to regional researchers (Burham, Palm, Duffus, Mouy & Riera, 2016). Operator contributions can become more formalized validating their input, as well as incentivizing their participation in data collection. Formal projects can increase the legitimacy and relevancy of data collected, as collection methods can be standardized, thereby increasing data utility (New *et al.,* 2015). Whale watching operators as conservation stewards, in the form of a citizen science project, can help operators contribute to advancing scientific knowledge on eco-tourism whale watching practices.

Citizen science projects facilitate centralized collection of scientific information about a species, ecosystem or interacting activities, as well as provide an educational experience to the participants that will enrich their connection to the ecosystem (Bonney *et al.,* 2009). This educational participation can further operator compliance in ecologically sustainable whale watching practices. Since management and policies focus on mitigating human behavior, involving those directly targeted by regional policies can increase compliance, as this can increase operators' understanding towards the benefits of the measures in place and facilitate buy-in. Finally, a citizen science platform for whale watching operators can foster innovative management solutions, such as acoustic pollution mitigation, due to their unique local perspective.

6.3.4 Threats

6.3.4.1 Compliance Variability Across Vessel Sectors

Given the policy landscape geared towards whale-watching operators, regulations apply measures more strictly towards those within the industry than other vessels. As whale-watching operators are more cognizant of whale wellbeing than other vessel operators, they are more compliant towards regulation abidance or cautionary behavior regarding encounters with whales. The Tofino whale watching fleet upholds a self-policing strategy among operators, which discourages non-compliance (Stevenson, 2014). Whale watching operators benefit from measures in place to mitigate boating behaviour in favour of whale wellbeing. This incentivizes whale-watching companies to follow regulations in full, while opportunistic whale watching vessels, like ferries, fishermen or recreational boaters, conduct themselves differently. Stevenson (2014) found dedicated companies to be significantly more compliant than other vessel types. This could cause frustration in dedicated operators. They may feel as if their actions are futile when most other users of the marine area are not being restrained by the regulations. Due to the large area of Clayoquot Sound and the remoteness of the study site on the west coast of Vancouver Island, enforcement capacity is minimal for the region. This is due in part to limited funding and resources (Malcolm, 2003). Due to their capacity, it is important to overcome this obstacle by providing education to all vessel operators and reinforcing appropriate compliance within the regulations. Additionally, reinforcing appropriate behaviour by compliant vessels can aid in assisting the continuation of compliant behaviour. This could be accomplished through monetary incentives for dedicated whale watching operators. For example, if operators are not fined or found to be non-compliant, their vessel and commercial whale watching operation could receive a discount in operating expenses. As the *Marine Mammal Regulations*, S.O.R./93-56, proposed amendments are set to include licensing for whale watching operators (Canada Gazette, 2012), this fee could be discounted with continued compliant behaviour.

6.3.4.2 Paper Policies

One of the fears for policy and management tactics is that of policies without tangible measures or results. When policies are executed in lip service, instead of realistically attainable goals, management tactics will fall short of their objectives. There are many explanations for this outcome, including lack of resources, enforcement capacity, monitoring capability, and the consideration of the complexity of policy design. This threat can be exemplified for marine protected areas (MPAs). This has been a common criticism of MPA establishment, known as paper parks, those that are established but lack a true contribution towards conservation goals. Paper park establishment is explained as “a politically expedient way for some nations to attain [conservation] targets…while avoiding tough conservation decisions” (Wilhelm *et al.,* 2014, p.24). Without robust policies and management strategies in place, it is difficult to incorporate evidence within existing measures to increase effective conservation. This threat should be taken into consideration when going forward with whale watching guideline amendments to ensure robust and effective policies are out in place.

6.3.4.3 Balance of Vagueness and Specificity

Vagueness and lack of specificity has been deemed an asset in law and policy, but can contribute to a lack of effectiveness in policy applicability. Vagueness in judicial and policy language is an attribute as it can encompass many circumstances and scenarios. Policy is more adaptable when maintaining a certain level of ambiguity (Staton & Vanberg, 2008). It is a blanketing effect towards many variables and future circumstances. This ambiguity is a strategy for managing uncertainty and control on policy outcomes (Staton & Vanberg, 2008). Although vagueness can be an attribute, there is a range in effectiveness, where if policies are written too vaguely (on one end of the spectrum), they become ineffective in addressing regulations valuable for problem solving. Additionally, vague policies can be less likely to be effectively implemented and can have lower compliance (Staton &Vanberg, 2008). There is a threshold of trade-offs in terms of the effectiveness of vagueness. A balance between specificity towards policy purpose and addressing the management problem, as well as upholding a certain level of vagueness to encompass a variety of scenarios, is key. In terms of the current whale watching policy regime, policies would benefit from more specificity towards how acoustic noise can be minimized during whale watching encounters. For example, strategies such as turning off an operators' engine when viewing an animal, minimizes noise, risk of vessel strike and fuel consumption for operators. Limiting circling behavior from floatplanes reduces noise exposure length and fuel consumption for operators, due to less time idling above the whales. These measures are specific and directly address the problem of noise, while maintaining appropriateness in a variety of circumstances. Identifying the measures to maintain vagueness, while incorporating specific measures to minimize the disturbance of whale by noise, will create a more robust policy. Additionally, coupling this scale of vagueness to specificity with the appropriate hierarchical scale of governance can further policy effectiveness. For example, having more vague policy measures applicable for a wider geographic and jurisdictional scale, while more specific measures at the local and regional scale will enhance the strength of the two strategies.

6.3.4.4 Political Prioritization

Evidence of acoustic disturbance can clearly demonstrate to decision-makers the need for management and policy reform. However, political prioritization can be a difficult contender to meaningful policy amendments, despite evidentiary support. If resources, financial and human, are not allocated to incorporate evidence of acoustic disturbance within policy, it will be difficult to maintain progress and change. Under certain government regimes in Canada, conservation is given a lower political priority. Bailey *et al.* (2016) identify a deficiency in the full implementation of key pieces of ocean legislation, resulting in a lack of ocean ecosystem conservation and sustaining Canada's maritime economy over the last decade under the Conservative government regime. Political will can be the cause for stagnation in the incorporation of evidence within management and policy for conservation objectives. Despite governance principles, such as the precautionary approach, governments can continue to delay conservation actions. Although courts have stated that scientific uncertainty is not a legal justification for postponing conservation decision-making (*Environmental Defence Canada et al. v. Ministry of Fisheries and Oceans*), the government has continued to exclude independent peer-reviewed research as evidence for conservation policies and regulation implementation in the past (Edmonson, 2015). Despite the significance of evidence for management and policy, government has the authority to regulate the flow of policy actions. Regardless of political persuasion, the government has an obligation to fulfill ocean legislation and uphold effective management and policy strategies (Bailey *et al.,* 2016). Awareness of the need for conservation action, coupled with evidence appropriate for policy-making, can assist in overcoming the barrier of political prioritization pressure.

6.4 Assessment

Maintaining effectiveness within the components of a policy regime is a difficult feat. Balancing the needs of conservation and industry can be achieved using EBDM and education to explain the reasoning behind the optimal scenario. The greatest strength of the current whale watching policy regime is the existent policies for whale watching regulation and whale conservation, as well as the present acceptance of EBDM as an effective tool for policy-makers. The weaknesses of the regime can be summarized as issues surrounding evidence use and policy processes. Overcoming these issues is possible through a variety of tactics, including effective communication of evidence use among stakeholders; acquiring complimentary evidence and coupling evidence across sectors; and transparency in decision-making to increase the credibility and legitimacy of policy choices. The internal influences of the current government regimes can be monitored to ensure that they are enabling effective decision-making, and that barriers are overcome by identifying alternative strategies.

The external influences of the policy regime can further its effectiveness and safeguard the whale watching industry's longevity, as well as whale conservation. The opportunities build on current infrastructure, as well as facilitate collaboration to increase competent knowledge management within the regime. Alternatively, one opportunity is using this regime as an example of effective EBDM for other sectors or regions in Canada, as well as internationally. The threats to the current policy regime can be overcome again, through transparency in decision-making to ensure accountability, as well as education to inform actors of the importance of following the measures of the regime or contributing to create tangible goals of effectiveness.

Given the analysis, certain enablers and barriers have been elucidated. Enablers include infrastructure to allow EBDM within the policy process, transparency in evidence use and its merit, collaborating with stakeholders to increase evidence obtainment and compliance of policies, and capitalizing on the structure of governance hierarchy to highlight the strengths of national or regional measures. Certain barriers include balancing benefits and costs to sectors, (such as the whale watching industry), the current policy process, government constraints, and political prioritization. It should be noted that emphasizing enablers within the regime, and addressing barriers, to either minimize their impact or alleviate them thereby converting them into an enabler, could benefit the overall effectiveness of the regime.

6.5 Conclusions

Although the application of the conceptual framework of the science-policy interfaces is theoretical, its principles can assist in the practical use of EBDM. This chapter's analysis highlights the enablers and barriers to effective EBDM within the whale watching policy regime. It should be noted that although many threats and weaknesses exist, there are options for each to turn them into enablers that will increase the effectiveness of public policy. An appropriate balance must be achieved to integrate relevant evidence within the decision-making process to inform public policy. The government, comparable to the whale watching industry, responds to incentives. "Government is objective and views equilibrium policy as the optimal choice given the objective and the relevant constraints" leading to a normative prescription for policy (Persson and Tabellini, 1990, p.2). This theory holds that the problem is incentivizing decision-makers to select the most effective scenario, given the collective incentives and constraints. The enablers put forth in this chapter can be used as incentives for the optimal policy regime, while the barriers are constraints that can hopefully be overcome to maximize effective EBDM to produce an optimal whale watching policy regime for Clayoquot Sound and Canada.

7.0 CHAPTER SEVEN: CONCLUSIONS

Anthropogenic noise is difficult to manage in the marine environment. The impacts of underwater noise on species, life history processes and ecosystem functioning is challenging to discern. To date, there has been limited consideration of the problem of underwater noise in decision-making and planning within Canada (Heise & Alidina, 2012). Whale watching utilizes wildlife and is a non-consumptive practice; however, there are impact thresholds that can be breached to eliminate the future practices of whale watching in Tofino if noise pollution is ignored. Using biological and socioeconomic evidence of whale watching impacts can inform management and policy of the best practices to mitigate vessel noise.

This study outlines the contribution of vessel noise within the foraging habitat of Cow Bay in Clayoquot Sound, and the audible reactions of gray whales to vessel noise (Chapter One; Chapter Two). Vessels are contributing noise within the frequency range of gray whale communication. Although their audible reactions are minimal, the changes in vocalizations in the presence of vessel noise may be indications that tourist based viewings are causing stress and disturbance to the PCFA gray whale population within Clayoquot Sound. The overall biological ramifications of whale watching vessel noise on gray whales are unknown. However, sustained or increasing pressure may result in habitat abandonment or negative impacts to foraging and reproductive fitness.

The behaviour of the whale watching fleet of Tofino emphasizes the need for management and policy intervention (Chapter Five). Whale encounters of the fleet are a continuous activity, increasing the pressure of the impacts of vessel noise for longer periods of time than previously thought. The cumulative impacts of vessel noise are not being avoided through the current guideline measures. Alternative practices should be considered to minimize the duration of encounters by the whale watching fleet, such as restricted areas, operator hour restrictions or breaks in whale watching operation hours.

The policy analysis outlines the need for stronger incorporation of vessel noise mitigation measures across vertical governance guidelines (Chapter Four). Amendments to policies are recommended to address these gaps in protection within the *Marine Mammal Regulations*, S.O.R./93-56, the Be Whale Wise Guidelines and the Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG).

Evidence assimilation within the regime is influenced by the needs of the whale watching industry and whale conservation (Chapter Six). The enablers to evidence use include infrastructure to support EBDM, transparency in evidence use, stakeholder collaboration, and emphasizing the specific strengths across the vertical governance regime, such as specific measures on local scales and utilizing broad encompassing measures on a national scale. The barriers of evidence incorporation within policy include balancing the cost and benefit to sectors, the structure of the policy process, and political prioritization. Awareness and understanding of these enablers and barriers will allow for more effective implementation and ongoing practice of management and policy measures for sustainable whale watching.

Utilizing frameworks such as SPIs and EBDM can apply biological and social evidence more effectively. Decision-makers can understand and incorporate evidence framed in this manner to implement and amend policies to be more reflective of the actual conditions in the field. Without complimentary evidence, mitigating whale watching noise pollution can be challenging, that is to do so feasibility, accurately and effectively using the tactics selected. Long term monitoring, such as that conducted by the Whale Research Laboratory, is paramount to ensuring the conservation of important species, such as gray whales, and effective management techniques. Given the dynamic nature of marine ecosystems and the socioeconomic conditions of the whale watching industry, EBDM driven decisions, coupled with adaptive management, are needed for the effective mitigation of vessel noise and protection of gray whales in their foraging habitats. This results in effective public policies reflecting evidence-informed decision-making.

8.0 CHAPTER EIGHT: RECOMMENDATIONS

To ensure the continued sustainable use and conservation of gray whales in Clayoquot Sound, the potential ecological ramifications of whale watching practices must be understood and mitigated. EBDM can be utilized to identify the best available information on the ecological role of gray whales and the socioeconomic practices that can alleviate noise pollution pressures on them. To summarize the evidence collected by this study, four recommendations to ameliorate the current mitigation practices are presented.

1. Amendments of the Current Guidelines

Relevant whale watching policies should be amended to include greater specificity towards noise mitigation. The inclusion of a variety of practices, directly informing and addressing vessel noise, can be incorporated across the vertical governance hierarchy. Inclusion of aircraft measures is of outmost importance as they are currently absent from applicable whale watching guidelines in Tofino. Amendments should include measures specific to the behaviour of the fleet and the definition of whale disturbance to increase future applicability. Completion of the amendments to the *Marine Mammal Regulations,* S.O.R./93-56, to incorporate whale watching regulations will increase enforcement capabilities. Although voluntary compliance is high by whale watching operators within Tofino (Corkeron, 2006), legislated guidelines can further increase compliance among whale watching operators, opportunistic boaters and aircraft operators (Chapter Five). Increasing legal regulations and voluntary measures across whale watching guidelines to address noise pollution will assist the whale watching industry to uphold its ecotourism practice title with greater respect and credibility.

2. Increasing and Maintaining Monitoring

EBDM is based on the best available action given the best available information; therefore the continued acquisition of evidence is key to continue to inform public policies. Ecological monitoring of the stressors of gray whales and the ecosystem functioning of Clayoquot Sound can continue to inform policy and management. As the ecosystem is dynamic, adaptive management must be upheld to incorporate new ecological evidence relevant to better management and policy practices. In the face of uncertainty and use of the precautionary approach in whale watching practices, adaptive management can be used to alleviate the concern about the best practices to implement. Adaptive management "deals with uncertainty through a structured improvement of relevant knowledge, while seeking to minimize risks associated with ongoing management" that arise from imperfect knowledge using structured alternative approaches (Keith, Martin, McDonald-Madden & Walters, 2011, p. 1175). Monitoring is essential to document changes in the ecosystem due to threats such as climate change, but also to ensure that management and policy tactics are effective in practice.

3. The Creation of a Working Group

The establishment of a working group dedicated to monitoring ecosystem functioning and industry practices would increase the resiliency of best practices being upheld. This working group could act as an advisory committee to the government and would be responsible for collecting, monitoring and disseminating pertinent information concerning the industry, as well as the population health of the whales (Chapter Six). A regional or provincial working group for Canada's Pacific coast would be a formidable advancement for monitoring and evaluating best practices in terms of mitigating noise pollution within the area. The working group could be composed of a diversity of stakeholders within BC connected to research, industry operations and other relevant sectors associated with underwater noise. A specific team for whale watching within the working group would be key to ensure adequate consideration of mitigating the industry's impact on cetaceans from their noise output. The formal establishment of a working group could be an extension of the World Wildlife Fund (WWF) for Nature Canada's Ocean Noise in Canada's Pacific Workshop (Heise & Alidina, 2012; P. Wells, personal communication, November 14, 2016). The working group could be formalized as such, or could be instituted annually to better facilitate a network of anthropogenic noise knowledge management and to inform decision-making. This would assist in evidence collection and evidence use by the government, industry and other relevant stakeholders. The success of the Pacific regional working group could create incentive for the establishment of a nation-wide working group dedicated to underwater anthropogenic noise mitigation.

4. Education

Dissemination of information is key in understanding the impact of noise pollution on whales and regulation compliance. Increasing the educational capacity of whale watching operators will increase the understanding of why certain measures are in place and the benefits of following guidelines, making operators more likely to comply. Education can increase voluntary compliance, as well as following legislated regulations. It is likely that most operators do not realize the impact that their vessels have on the environment. Informing operators can also increase the dissemination of information to other relevant stakeholders and the public, increasing the general awareness about the effects of anthropogenic noise on the environment and the measures necessary for mitigation. Operators within Clayoquot Sound do have the opportunity to complete workshops in the region, such as naturalist courses (Whale Lab, 2016). Including a component about anthropogenic noise and increasing the frequency these courses are offered will increase educational impact. Additionally, instituting mandatory naturalist courses or certifications for whale watching companies can reinforce the importance of upholding eco-practices within the tourism industry.

These recommendations summarize the main areas of focus for whale watching noise pollution mitigation of this study. They build on previous recommendations put forth by other researchers and are not the only recommendations to consider for improvement (Duffus & Dearden, 1989; Malcolm, 2003; Stevenson, 2014). However, these four recommendations can be areas of focus for improved mitigation of whale watching vessel noise on gray whales, and improved policy measures, now and in the future. Recognizing the need to change management and policy measures is paramount to the continued sustainable use and conservation of gray whales for tourism operations in Clayoquot Sound.

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Oceans Act, S.C. 1996, c.31

Park Act, R.S.B.C. 1996, c. 344

Protected Areas of British Columbia Act, S.B.C. 2000, c. 17

Species at Risk Act, S.C. 2002, c. 29

Wildlife Act, R.S.B.C. 1996, c. 488

Wildlife Area Regulations, C.R.C., c. 1609

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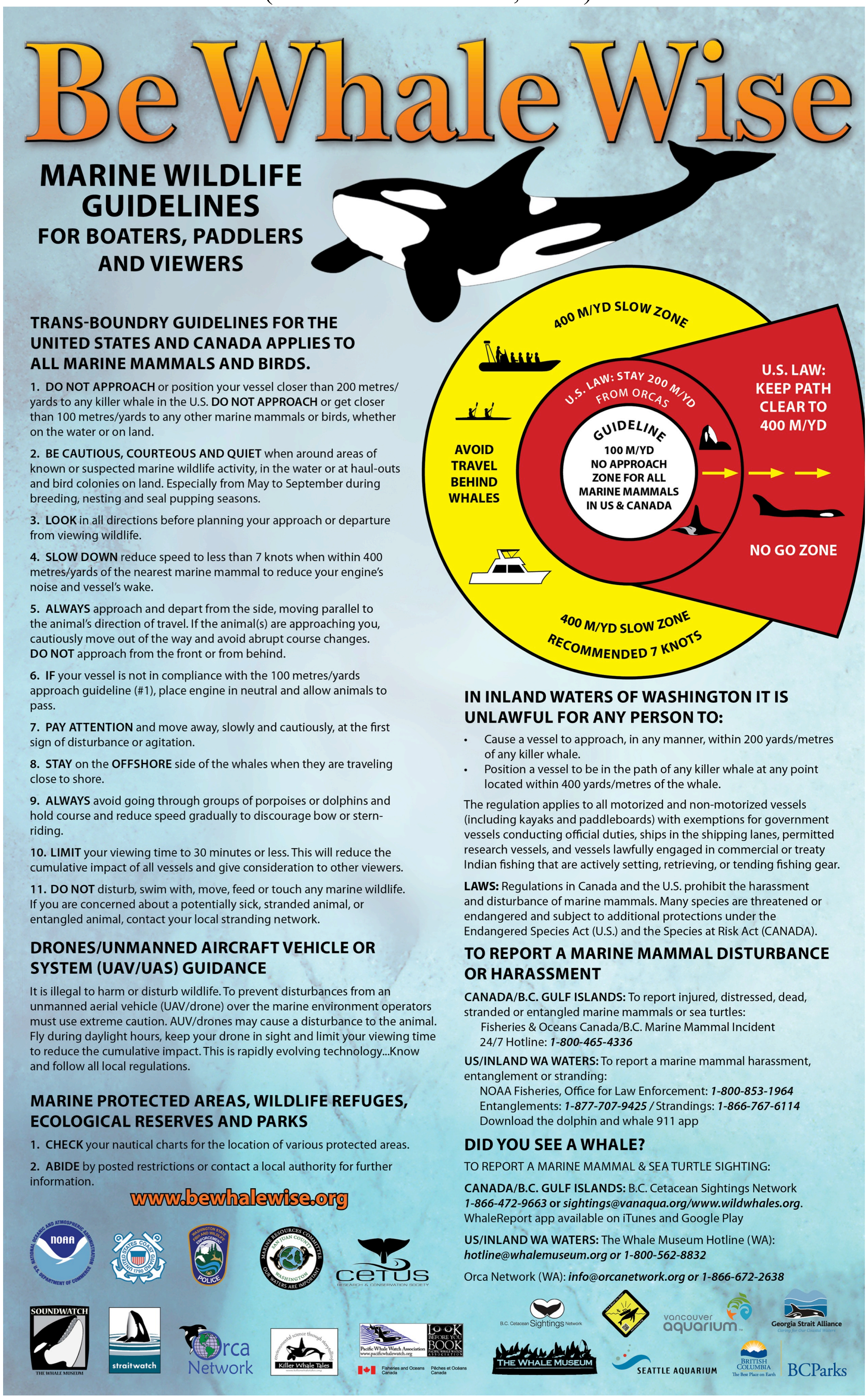
10.0 APPENDIX

Appendices 10.1 - Be Whale Wise Marine Wildlife Guidelines for Boaters, Paddlers and Viewers. (Fisheries and Oceans, 2016).



Appendices 10.2 – Tofino Whale Watching Operators' Voluntary Guidelines (Strawberry Isle, 1995).

TOFINO WHALE WATCHING OPERATORS' VOLUNTARY GUIDELINES

ON SITE ETIQUETTE - GRAY WHALES

Vessels should slow down 1/2 mile or more before arriving with the whales or other whale watching vessels. This time should be used to establish the layout of the boats, the whales and both their movements. It may be necessary to make radio contact with one of the on scene vessels to establish the whales' behaviour and location.

The slow approach should not be made directly towards the whale but rather at an angle. If an approach must be made across the path of travelling whales, there should be at least 1/2 mile of clearance.

Whenever possible, vessels should try to work with the whales in rotation. It is not uncommon for a number of boats to arrive on site at very close to the same time. Rather than move in right away, a newly-arrived vessel should wait on the outskirts. The vessels in a more favourable position should veer off after about 15 minutes.

Whales should not be approached any closer than 50 meters.

On leaving the whales, vessels should travel slowly until they are at least 1/4 mile away. Also take into consideration the location of other whales in the vicinity.

It is understood that approaches vary with the conditions of the encounter (e.g. number of whales or boats, location, weather etc.).

***During the migration,** standard procedure is to approach on an angle or curve from behind and to the side of the whales, then match their speed and direction of travel so that your vessel is off to one side. If circumstances dictate that several vessels need to view the same travelling whale then they should do so in a line off to one side, or loosely spread out behind. **The whales should not be hemmed in on both sides.**

Especially during the migration, a vessel should spend some time looking for its own animals before joining another vessel already with whales. In turn, if the first vessel has spotted other whales he should transmit this information to the approaching vessel.

In the feeding grounds, vessel movement *should be kept to a minimum.

As a distance guide; if you are standing at the bottom of the ramp at the fuel dock:

It is 1/2 mile to Deadman Islands.
It is 1/4 mile to Arnet Island.
It is 50 meters to the 3 pile dolphin on the Sea Prime foreshore.

1

ON SITE ETIQUETTE - KILLER WHALES

The Gray Whale guidelines are also appropriate for Killer Whales with the following addenda identified:

When a kill is in progress, vessels should back off to at least 100 meters.

The Harbour Seal lagoon on the east side of Gowland Rocks should be off limits.

Try to establish how many animals you are seeing, number of bulls, number of infants, direction of travel and if there are any distinguishing physical features.

Whenever practical, it is recommended that engines be shut down when viewing Killer Whales in the confines of the rock-lined inlets.

ON SITE ETIQUETTE - RESEARCH VESSELS

Research vessels should be clearly marked and identify their business on V.H.F. Ch. 18A.

On approaching the whales, research vessels should follow the same guidelines as the whale watch fleet.

Close range photo ID work should be carried out by research vessels only unless the circumstance arises where one is not in range, is tied up with other works or if the whales are heading towards adverse sea conditions. These decisions should, if practical, be made by a researcher.

Drivers should explain to their customers what the research vessel is doing, and that it is working with the permission of the Department of Fisheries and Oceans.

Not more than one research vessel should be working in close proximity with the whales at one time.

If a research vessel is carrying more than two paying passengers, it should follow the same guidelines as a commercial tour vessel.

ON SITE ETIQUETTE - PINIPEDS

The goal is not to drive the animals into the water. **The tour vessels should not initiate any change in behaviour that would affect the animals' energy output.** A lesser consideration is that the animals should be left on the rocks for the next boat.

Vessels should slow down *at least* 100 *meters* from any haul out. The approach should be very slow, all the while watching for signs of disturbance. Sea Lions will sit up and start shifting position on their fore flippers and *Harbour Seals* will start bouncing about on their bellies. **At the first sign of disturbance, back off slowly.**

At the start of the season approaches must be made very carefully. Later on these animals will become more accustomed to the boats and put up with a closer viewing distance.

Loud noises or rapid movement from the boat or its passengers should be avoided while on the scene.

Particular caution should be exercised at the start of the season.

ON SITE ETIQUETTE - BIRDS

The goal is not to activate a flight response. Approach slowly, watching for signs of agitation, and leave slowly.

Nesting sights (Cleland I., Sea Lion Rks., Wilf Rks. area, White I., etc) require a more diligent awareness during the nesting through fledging months (beginning of May to the end of August). Though disturbed birds will generally circle around and return very quickly to their nest, this imposition should be avoided.

For the months of April and May, the west *side* of Clayoquot Spit should be given a wide berth as it is a very important stopover for Brant and they are easily disturbed.

Birds on the water should be given as wide a berth as is practical. It is likely that disturbance while fishing is more detrimental than it is while resting on land. Consider the number of boats these birds must avoid, particularly during the summer months.

Like the pinipeds, birds will become more tolerant as the season progresses.

It is noted that there is a great deal of variation in how different species respond to marine traffic.

Appendices 10.3 - Pacific Rim National Park Reserve Marine Mammal Viewing Regulations (Parks Canada 2003).

THE NATIONAL PARKS AND NATIONAL HISTORIC SITES OF CANADA

Canada

LES PARCS NATIONAUX ET LES LIEUX HISTORIQUES NATIONAUX DU CANADA

WHALE VIEWING GUIDELINES

APPROACH GUIDELINES

- Approach whales from the side or rear
- Establish layout and movement of vessels before approaching whales
- Do not approach whales head on
- Use radio communication with others on-scene to assess viewing situation
- Move closer gradually
- Slow down to 7-8 knots 800 m away
- Reduce speed to "*no wake speed*" at 250 away
- Approach travelling whales from behind or from the side with speed and direction consistent with the behaviour of the whales
- If whales appear to be avoiding the vessel, increase distance between the vessel and whale
- Don't chase whales
- Vessels should be positioned only on one side of the whales
- Whales should not be circled
- Positioning vessels ahead of whales and waiting for the whales to pass is not to be used
- Avoid crossing ahead of travelling whales
- If crossing ahead of whales is unavoidable, there should be 800 m clearance

VIEWING GUIDELINES

- Do not approach closer than 50 m "*no go zone*"
- Vessels should work with other whale watching vessels in rotation
- When the "*close viewing zone*" (50-100 m) is occupied, other vessels should wait beyond 100 m
- Use radio communications to co-ordinate rotation into and out of the "*close viewing zone*"
- Up to 3 vessels "*under 5 tons*" or 1 vessel "*over 5 tons*" inside the "*close viewing zone*"
- Time in the "*close viewing zone*" (50–100 m) should be limited to 10-15 minutes
- All vessels should be on one side of the whale(s)
- Do not get between a mother and calf
- ______________________________

Parks Canada Parcs Canada

Canada

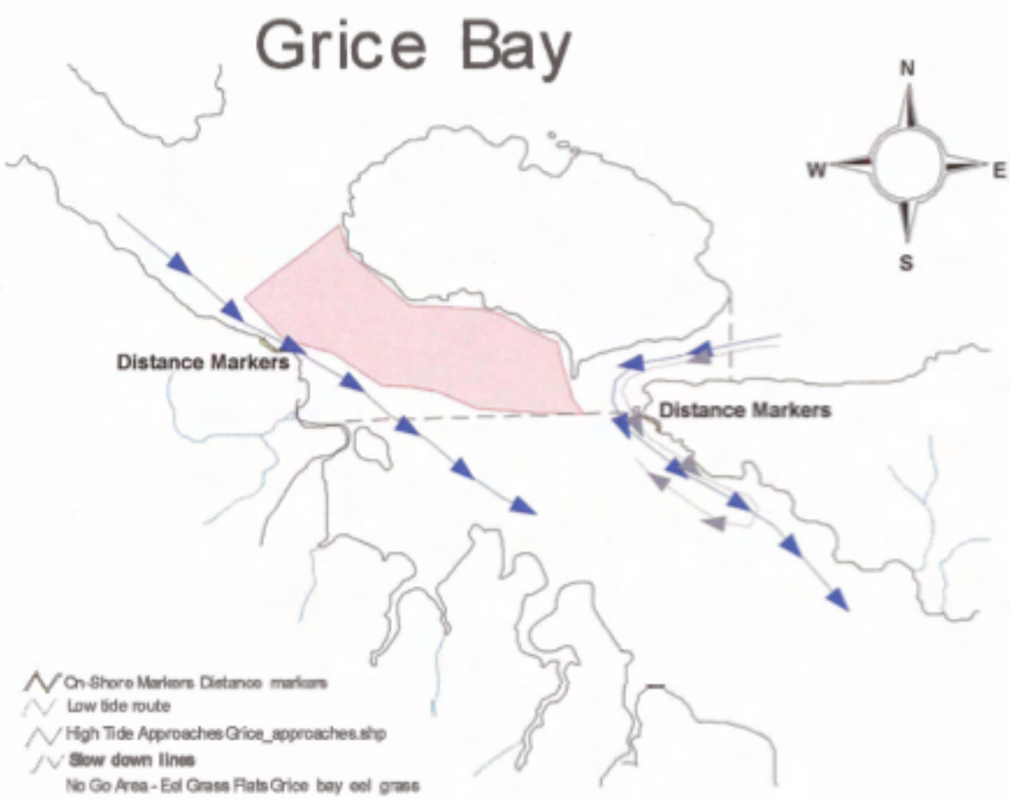
- To avoid startling whales, paddlers should make some sort of regular, repetitive, low volume noise (like tapping floor of vessel) when inside the "*close viewing zone*"
- Avoid sudden alteration of vessel speed
- Avoid sudden alteration of vessel direction
- Avoid sudden alteration of vessel angle
- If a whale approaches the vessel, stop until it moves away at least 50-100 m
- Fixed-wing aircraft must maintain a minimum height if 1000 feet
  Helicopters should maintain a minimum of 1000 feet

KILLER WHALE GUIDELINES

Response and needs may be different for transient and resident killer whales
- There is a greater potential to impact transients with noise: keep noise low

GRICE BAY GUIDELINES

-



During high tide (>6 feet), whale watching vessels should only enter and exit Grice Bay by means of the specified high tide route (see map)
During low tide (<6 feet), whale watching vessels should only enter and exit Grice Bay by means of the specified low tide route (see map)
- Slow down to 7-8 knots at 800 m or upon entering designated slow areas
  Boats should travel single file in a slow one-way loop, staying in the deep water channel
  Boats should keep on the deep side of whales

- During high tide, general gray whale viewing guidelines apply
-

DEPARTURE GUIDELINES

- Depart slowly until beyond "*no wake zone*" (250 m) and then increase speed gradually

RESEARCH GUIDELINES

- With a research permit, researchers may be allowed to approach whales at a distance less than 50 m
- Researchers must display a "research flag" or "research markings" on their vessel indicating they are engaged in research
- Researchers must be contactable by VHF radio

PINNIPED VIEWING GUIDELINES

APPROACH GUIDELINES

- Vessel behaviour should be based on the most sensitive or easily disturbed species site (which may not be the species that is sought for viewing)
- Approach at an indirect angle that provides the maximum visibility for the animals birds
- Move closer gradually
- Monitor behaviour on approach. Watch for signs of agitation and increase your an *away* from the animals or birds if they become visibly agitated.
- Slow down to 5 knots (*no wake speed*) at 250 m
- Do not approach head on
- Avoid loud noises
- Avoid rapid movements
- Avoid sneaking up to animals
- Use radio communication with others on-scene to assess the situation
- Avoid circling islands or travelling close to shore at close distances
- Kayakers should avoid hugging the shore
- Use binoculars instead of your vessel to bring animals into closer view
- Aircraft must maintain a minimum height of 1000 feet
- When viewing pinnipeds, aircraft should be attentive to the response of birds, wh may occupy the same site: adjust height and/or approach to avoid flushing birds
- Helicopters are not appropriate for viewing animals or sea birds
- Personal watercraft are not appropriate for viewing animals or sea birds
- Be more cautious at the beginning of the season. Animals may require more space ea in the season. Later in the season animals may become more accustomed to boa allowing closer viewingwe
- Birthing areas are "*no go zones*": remain at least 250 m offshore
- Avoid approaching pinnipeds on cliff areas or areas with steep drops where animals m injure themselves if they flee the area

VIEWING GUIDELINES

- Do not approach closer than 50 m "*no go zone*"
- Be aware that this 50 m "*no go zone*" is a minimum distance: a greater distance may be required earlier in the season and/or year round at certain sites
- If stopping to view pinnipeds, avoid rapid movements: stop and depart slowly and keep a steady speed when viewing.
- Leave engine running is up to the discretion of the driver
- Do not go ashore
- Vessels should view animals and shorebirds in rotation with other vessels
- Use radio communication to co-ordinate rotation into and out of *the "close viewing zone*" (50-100 m)
- Up to 3 vessels "*under 5 tons*" or 1 vessel "*over 5 tons*" inside *the "close viewing zone*" (50-100 m)
- 10 minutes maximum in the "*close viewing zone*" (50-100 m)
- If an animal approaches the vessel, it is appropriate to observe it at whatever distance the animal chooses
- Move slowly away from the animals or birds when leaving the area
- Do not feed the animals or birds

DEPARTURE GUIDELINES

- Depart slowly from the "*no wake zone*" (250 m) and then increase speed gradually

RESEARCH GUIDELINES

- With a park permit, researchers may collect data inside the 50 m "*no go zone*"
- Researchers must display a research flag or research markings on their vessel to indicate they are engaged in research
- Researchers must be contactable by VHF radio

SEABIRD AND SHORLINE VIEWING GUIDELINES

APPROACH GUIDELINES

- Vessel behaviour should be based on the most sensitive or easily disturbed species o site (which may not be the species that is sought for viewing)
- Approach at an indirect angle that provides the maximum visibility for the animals o birds
- Move closer gradually
- Monitor behaviour on approach. Watch for signs of agitation and increase your angl *away* from the animals or birds if they become visibly agitated
- Slow down to 5 knots (*no wake speed*) at 250 m
- Do not approach head on
- Avoid loud noises
- Avoid rapid movements
- Avoid sneaking up to animals
- Use radio communication with others on-scene to assess the situation
- Kayakers should avoid hugging the shore
- Use binoculars instead of your vessel to bring animals into closer view
- Aircraft must maintain a minimum height of 1000 feet
- Helicopters are not appropriate for viewing animals or sea birds
- Personal watercraft are not appropriate for viewing animals or sea birds
- Personal watercraft should maintain a minimum distance of 500 m from flocks, colonies haul out sites, nesting sites or shorelines
- Give birds on the water a wide birth
- Birds in large flocks are easily flushed: give them more space
- Nesting sites and colonies are sensitive sites: approach with extra diligence
- Sea caves and other areas with cliff-nesting cormorants and murres *are "no go zones"* remain 50 m away

VIEWING GUIDELINES

- Do not approach closer than 50 m
- Be aware that this 50 m "*no go zone*" is a minimum distance: a greater distance may be required earlier in the season and/or year round at certain sites
- Leave engine running is up to the discretion of the driver
- Do not go ashore
- Vessels should view animals and shorebirds in rotation with other vessels
- Use radio communication to co-ordinate rotation into and out of *the "close viewing zone*" (50-100 m)
- 10 minutes maximum in the "*close viewing zone*" (50-100 m)
- Move slowly away from the animals or birds when leaving the area
- If an animal approaches the vessel, it is appropriate to observe it at whatever distance the animal chooses
- Do not feed the animals or birds
- Give large flocks in estuaries more space as they are easily flushed

DEPARTURE GUIDELINES

- Depart slowly from the "*no wake zone*" (250 m) and then increase speed gradually

RESEARCH GUIDELINES

- With a park permit, researchers may be allowed to collect data inside the 50 m "*no go zone*"
- Researchers must display a research flag or research markings on their vessel to indicate they are engaged in research
- Researchers must be contactable by VHF radio

SITE SPECIFIC VIEWING GUIDELINES

CLELAND ISLAND ECOLOGICAL RESERVE

- Use radio communication with all vessels on site to agree on consistent direction of travel
- Stay at least 100 m offshore, **except through the Gap.** Vessel travel is permitted through the Gap on the conditions that 1) there is no whale in the Gap and 2) vessels continue moving at slow (no-wake) speed and maintain course through the Gap's centre
- Maximum speed 5 knots in "close viewing zone" (100 m – 200 m)

GOWLAND ROCKS

- Approach and view from the beach side only
- The entire seaward shore is buffered by a 200 m "no-go zone"
- Harbour Seal Lagoon on the east side is a "no-go zone" (200 m buffer)

SEA LION ROCKS

- The entire seaward shore is buffered by a 100 m "no-go zone"

WHITE ISLAND

- Nesting are and study site. Entire area is buffered by a 200 m "no-go zone"

SEABIRD ROCKS

- Approach and view from the beach side only
- Stay 100 m offshore

WOUWER ISLAND

- Stay 50 m offshore inner Wouwer

SEA CAVES

- "no-go zones". Stay 50 m offshore

LA CROIX GROUP

- Maintain no-wake speed while travelling through the islands (area locally referred to as "the snake pit": Tree Island and Rocks, including Foam Reef and rocks south of Tree Island.