

**Using long-term ecological research to promote sustainable whale-watching practices in  
Clayoquot Sound, British Columbia**

By

Kira Kim Stevenson  
B.Sc., University of Victoria, 2011

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of

MASTER OF SCIENCE

in the Department of Geography

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## **Supervisory Committee**

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Supervisor

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## ABSTRACT

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Whale-watching is a major tourism venture in developed and developing countries around the world. The management and conservation of this industry is dependent on social, economic, and ecological factors, but long-term ecological research is often absent. In this study, I present an example of a mature whale-watching location where research on all three variables is available. The University of Victoria's Whale Research Lab has studied gray whales (*Eschrichtius robustus*) in Clayoquot Sound, Vancouver Island for over 25 years and I use this information to form the basis for management recommendations that promote sustainable whale-watching practices and other resource use. To do this, I review how whale-watching is managed in Canada, B.C., and Clayoquot Sound, including the legislation and voluntary guidelines that are currently in place, and previous recommendations that have been made. I then analyze how whale-watching is conducted in southern Clayoquot Sound. I quantify boat behaviour with respect to whales and present six indicators of industry pressure that have been related to cetacean disturbance. The 2012 and 2013 seasons had significantly different numbers of whales present, and this was reflected in the fleet behaviour. Whale-watching activities do not appear to alter gray whale foraging efforts between seasons. Results indicated that both industry pressure and vessel behaviour with respect to whales changes depending on the season and the biological dynamics that influence whale presence. Finally, I synthesize findings of the Whale Research Lab in conjunction with my preceding chapters and present five management recommendations to all stakeholders with a vested interest in the continuation of sustainable whale-watching practices in Clayoquot Sound.

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## CHAPTER ONE

### Introduction

Whale-watching is a form of wildlife tourism that has been managed *ad hoc*, assumed an apparent precautionary approach, and lacked an ecological understanding of the species of focus. Academic literature has covered the social and economic components of whale-watching, yet little research has focused on the collection and use of ecological data systematically collected over a long time period (Duffus 1989, Duffus & Dearden 1990, Hoyt 1995, 2001, Finkler 2001, Malcolm 2003). When considering the management of wildlife and related tourism activities, both socioeconomic and biological factors should be considered in tandem and not as isolated circumstances, including the effects of whale-watching (Duffus & Dearden 1990, Forestell & Kaufman 1993).

The whale-watching industry in Clayoquot Sound revolves around the presence of the eastern North Pacific gray whale (*Eschrichtius robustus*), a baleen whale species that annually migrates from warm breeding lagoons in Baja California to feeding grounds as far north as the Bering and Chukchi seas (Pike 1962). However, a number of individuals do not complete this migration and instead spend the summer months foraging along the west coast of North America, between California and Alaska (Pike 1962, Rice & Wolman 1971, Darling 1984, Kim & Oliver 1984, Dunham & Duffus 2001, Calambokidis *et al.* 2010, Lang *et al.* 2011, Sumich 2013). Commercial companies operating in Clayoquot Sound are based out of Tofino, enjoying a relatively long season from March through October with few recreational boaters to compete for viewing space.

As gray whales migrate north and enter colder, more productive waters, they forage continually to restore exhausted energy reserves. As a result, whales are consistently found in coastal areas where prey quantity and quality are high enough to meet energy demands (Dunham & Duffus 2001, Olsen 2006, Feyrer 2010). Preferred prey types have differed, and whales in Clayoquot Sound (Figure 1.1) have been observed opportunistically foraging on different prey species (Dunham & Duffus 2001).

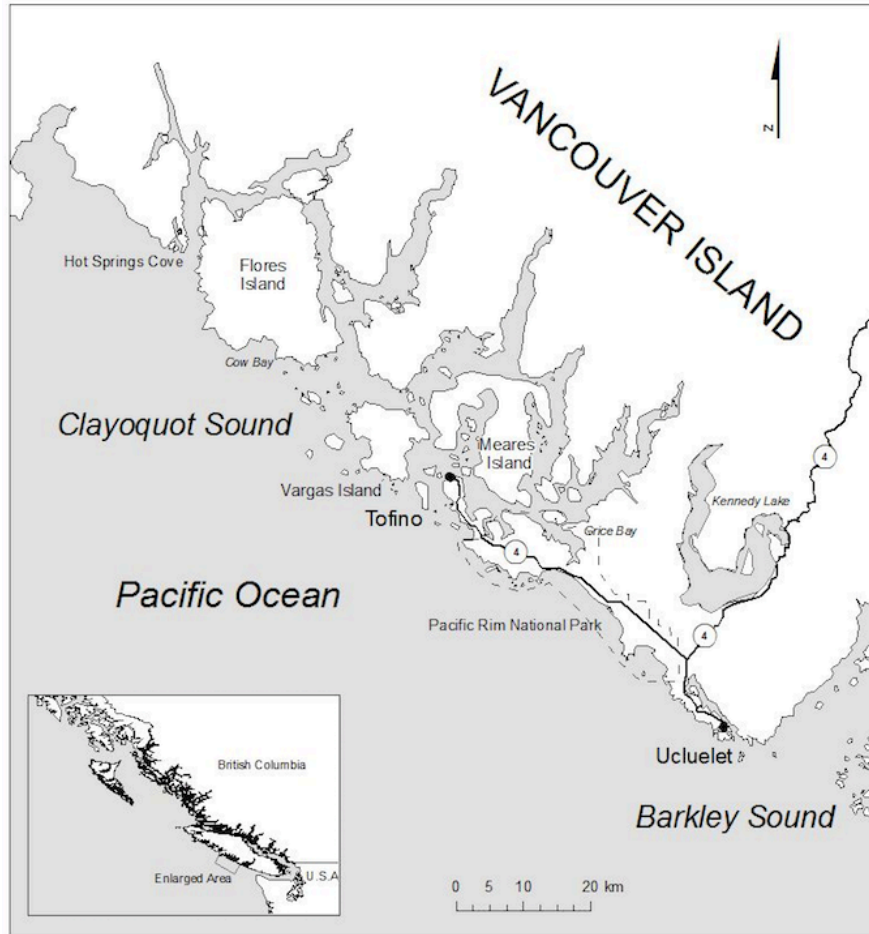


Figure 1.1. Clayoquot Sound, located on the west coast of Vancouver Island in British Columbia, Canada.

Mysids (order Mysidacea), a small shrimp-like crustacean, are currently the primary prey item of gray whales off the west coast of Vancouver Island. Their presence is a product of environmental factors including phytoplankton blooms, nutrient upwelling, water temperature, ocean floor topography, currents, tides, and terrestrial inputs (Burnham 2012). Prey is patchily distributed, and as eastern Pacific gray whale population numbers continue to increase post-commercial whaling era, primary foraging grounds in the Arctic may now be exceeding the carrying capacity of the amphipod prey population and additional feeding areas such as Clayoquot Sound may experience further pressure (Highsmith & Coyle 1992, Calambokidis *et al.* 2002, Coyle *et al.* 2007, Moore *et al.* 2007).

In Canada, Fisheries and Oceans Canada (DFO) govern the harvesting and conservation of cetaceans, in addition to monitoring and regulating research. While the

Marine Mammal Regulations within the *Fisheries Act* prohibit a person from disturbing marine mammals at any time, these rules are general, vague, and do not explicitly address whale-watching or other non-lethal activities. In response to declining numbers of the endangered southern resident killer whales in the Salish sea and increasing scientific reports of vessel impacts on whales, the DFO and the National Ocean and Atmospheric Administration (NOAA) of the United States collaborated to create voluntary marine mammal viewing guidelines entitled *Be Whale Wise* in an effort to mitigate vessel disturbance (Giles & Koski 2012, Fisheries and Oceans Canada 2013). These rules remain difficult to enforce in Canada. Despite this, incidents of non-compliance among commercial operators are rare, as many associations often incorporate *Be Whale Wise* guidelines into their mission statements and practices (Giles & Koski 2012).

The University of Victoria's Whale Research Lab has studied the ecology of gray whales in Clayoquot Sound, Vancouver Island for over 25 years. The purpose of this study is to use the work of the Whale Research Lab to make management recommendations that promote ecologically sustainable whale-watching practices in Clayoquot Sound. Before management recommendations can be put forward, the next chapter will present introductory material pertinent to understanding how the current regime has come to exist. In Chapter Two, I will discuss how whale-watching is managed in Canada and Clayoquot Sound. This will include an overview of how the industry first developed on Vancouver Island and how it has changed over time. Previous management interventions have varied, with the DFO now considering amendments to the Marine Mammal Regulations within the *Fisheries Act*. The current regulations in place are voluntary, and their management will be discussed. As well, insights into the management of similar industries worldwide will be reflected upon.

In order to make relevant management recommendations related to whale-watching, it is important to understand the behaviour and associated pressure of the industry. In Chapter Three, a typical whale-watching encounter based out of Tofino will be presented. The structure of the local whale-watching companies is unique, with five major companies dedicated to marine-based wildlife viewing and capitalizing on the variety of species available including cetaceans, birds, pinnipeds, and black bears. I will present some aspects of commercial whale-watching that assert pressure on local whales, including satellite locations where whales are being watching, identifying the population membership of the

whales being watched, how long each whale-watching encounter lasts, and the total amount of time whales spend with boats in a given day. Lastly, vessel behaviour with respect to whales will be measured, as will industry compliance rates and a quantified description of commercial boat behaviour in the presence of gray whales.

In light of the results of Chapter Three, I will review the past projects and publications of the Whale Research Lab I will reiterate the significant findings relating to the ecology of the gray whale in Chapter Four. Of particular interest are trends in gray whale location within the study area and how it has changed between and within seasons, as well as the limiting factors for gray whale presence in Clayoquot Sound. Ecological concepts that are fundamental to our understanding of gray whale presence include trophodynamics, optimal foraging theory, the role of predators in influencing the food web community, intermediate disturbance theory (Connell 1978), prey switching (Springer *et al.* 2003), and the importance of pattern and scale (Levin 1992). After summarizing this long-term research and previous and current management practices reviewed in earlier chapters, I will offer five management recommendations aimed at the sustainable whale-watching practices in Clayoquot. In the final chapter, I offer a final discussion and concluding thoughts.

As a result of the rapid growth of the whale-watching industry, regulation and management efforts have lagged behind (Higham *et al.* 2009). Management decisions are often made before sufficient scientific data is available. In contrast, this thesis presents an opportunity for long-term, quantitative data based in ecology to be incorporated into a management regime. While recommendations will be specific to this study area, the methods by which these suggestions are generated can be applied to wildlife tourism enterprises in a variety of other locations.



## LITERATURE CITED

- Burnham, R.E. 2012. The importance of the mid-tropic layers in ecosystem structure, process and function: the relationship between the Eastern Pacific Gray Whale (*Eschrichtius robustus*) and mysids (order *Mysidacea*) in Clayoquot Sound. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Calambokidis, J., Darling, J.D., Deecke, V., Gearin, P., Gosho, M., Megill, W.M., Tomach, C.M., Goley, D., Toropova, C. and B. Gisborne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California to southeastern Alaska in 1998. *Journal of Cetacean Resource Management*, 4(3):267-276.
- Calambokidis, J., Laake, J.L. and A. Kilmek. 2010. Abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998-2008. Paper IWC/62/BRG32 submitted to the International Whaling Commission Scientific Committee. 50 pp.
- Connell, J.H. 1978. Diversity in tropical rain forests and coral reefs. *Science*, 199:1302-1310.
- Coyle, K.O., Bluhm, B.A., Konar, B., Blanchard, A.L. and R.C. Highsmith. 2007. Amphipod prey of gray whales in the northern Bering Sea: comparison of biomass and distribution between the 1980s and 2002 - 2003. *Deep Sea Research II*. 54:2906-2918
- Darling, J.D. 1984. Gray whales (*Eschrichtius robustus*) off Vancouver Island, British Columbia. In M.L. Jones, S.L. Swartz and S. Leatherwood (Eds.) *The Gray Whale*. Academic Press: Orlando, Florida.
- Duffus, D.A. 1989. Non-consumptive use and management of cetaceans in British Columbia coastal waters. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Duffus, D.A. and P. Dearden. 1990. Non-consumptive wildlife-oriented recreation: a conceptual framework. *Biological Conservation*, 53:213-231.
- Dunham, J.S. and D.A. Duffus. 2001. Foraging patterns of gray whales in central Clayoquot Sound, British Columbia, Canada. *Marine Ecology Progress Series*, 223:299-310.
- Feyrer, L.J. 2010. The foraging ecology of gray whales in Clayoquot Sound: interactions between predator and prey across a continuum of scales. M.Sc. thesis, University of Victoria, British Columbia, Canada.

- Finkler, W. 2001. The experiential impact of whale watching: Implications for management in the case of the San Juan Islands, USA. Unpublished Master of Science Thesis. Department of Marine Science, University of Otago, New Zealand.
- Fisheries and Oceans Canada. 2013. Be whale wise: Marine wildlife guidelines for boaters, paddlers and viewers. Retrieved February 7, 2014, from <http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especies/mammals-mammiferes/view-observer-eng.htm>
- Forestell, P. H. and G.D. Kaufman. 1993. Resource managers and field researchers: Allies or adversaries? In D. Postle & M. Simmons (Eds.), *Encounters with Whales '93* (pp. 17–26). Townsville, Queensland: Great Barrier Reef Marine Park Authority.
- Giles, D.A. and K.L. Koski. 2012. Managing vessel-based killer whale watching: a critical assessment of the evolution from voluntary guidelines to regulations in the Salish Sea. *Journal of International Wildlife Law and Policy*, 15:125-151.
- Higham, J.E.S., Bejder, L. and D. Lusseau. 2009. An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. *Environmental Conservation*, 35:294-302.
- Highsmith, R.C. and K.O. Coyle. 1992. Productivity of arctic amphipods relative to gray whale energy requirements. *Marine Ecology Progress Series*, 83:141-150.
- Hoyt, E. 1995. The worldwide value and extent of whale watching. Bath, UK: Whale and Dolphin Conservation Society.
- Hoyt, E. 2001. Whale watching 2001. World wide tourism numbers, expenditures and expanding socioeconomic benefits. IFAW.
- Kim, S.L. and J. Oliver. 1989. Swarming benthic crustaceans in the Bering and Chukchi seas and their relation to geographic patterns in gray whale feeding. *Canadian Journal of Zoology*, 67:1531-1542.
- Lang, A.R., Taylor, B.L., Calambokidis, J.C., Pease, V.L., Klimek, A., Scordino, J., Robertson, K.M., Litovka, D., Burkanov, V., Gearin, P., George, J.C. and B. Mate. 2011. Assessment of stock structure among gray whales utilizing feeding grounds in the Eastern North Pacific. Paper SC/M11/AWMP4, presented to the International Whaling Commission Scientific Committee. 22pp.
- Levin, S.A. 1992. The problem of pattern and scale in ecology. *Ecology*, 73(6):1943-1967.

- Malcolm, C.D. 2003. The current state and future prospects of whale-watching management, with special emphasis on whale-watching in British Columbia, Canada. Ph.D. dissertation, University of Victoria, British Columbia, Canada.
- Moore, S.E., Grebmeier, J.M. and J.R. Davies. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. *Canadian Journal of Zoology*, 81:734-742.
- Olsen, S.S. 2006. Gray whales (*Eschrichtius robustus*) and mysids (family Mysidae): the predator-prey relationship and a new approach to prey quantification in Clayoquot Sound, British Columbia. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Pike, G.C. 1962. Migration and feeding of the gray whale (*Eschrichtius gibbosus*). *Journal of the Fisheries Research Board of Canada*, 19:815-838.
- Rice, D.W. and A.A. Wolman. 1971. *The life history of the gray whale (Eschrichtius robustus)*. American Society of Mammalogists, Special Publication 3.
- Springer, A.M., Estes, J.A., Van Vliet, G.B., Williams, T.M., Doak, D.F., Danner, E.M., Forney, K.A. and B. Pfister. 2003. Sequential megafaunal collapse in the North Pacific Ocean: an ongoing legacy of industrial whaling? *Proceedings of the National Academy of Sciences of the United States of America*. 100:12223-12228.
- Sumich, J. 2013. Gray whale: from devilfish to gentle giant. In: *Whalewatcher gray whale: from devilfish to gentle giants*, *Journal of the American Cetacean Society*, 42(1), 21-23.

## CHAPTER TWO

### Whale-watching management in Clayoquot Sound

#### INTRODUCTION

The management of cetaceans encompasses policy, planning, and practice, occurring at global, national, and local or regional scales (Higham *et al.* 2009). Marine mammals have expansive ranges, regularly crossing political boundaries, stressing the importance of cooperation between countries and communities regarding the use and protection of these species. Whale-watching is a nature-based tourism activity based on the viewing of wild cetaceans (Allen 2014). It is considered a non-consumptive use of cetaceans, though this does not necessarily translate to zero effect (Duffus & Dearden 1990, Orams 1996a, Tremblay 2001, Christiansen & Lusseau 2014). To prevent the overexploitation of marine mammals for wildlife viewing, management interventions have been designed and implemented, often in an *ad hoc* style with a precautionary approach. However, this caution is better described as ‘pseudo-precautionary’ because guidelines often lack rigorous research and a biological foundation (Malcolm 2003).

Whale-watching is a worldwide enterprise occurring in 119 countries on all continents, with more than 3,000 whale-watching operators in over 500 host communities (Higham *et al.* 2009, O’Connor *et al.* 2009). The rapid growth of the industry mirrors the exponential growth of wildlife tourism and ecotourism in general (Hoyt 2001, Higham *et al.* 2009). Over the past thirty years, scientists have questioned the sustainability of whale-watching, including the short- and long-term effects of tourism on marine mammals in addition to the motivations of whale-watchers (Orams 2000, Corkeron 2006, Higham & Shelton 2011, Constantine 2014). A review of academic literature on other best whale-watching practices around the world shows industry themes for minimizing disturbance while still facilitating a marine wildlife experience for tourists. From this, potential management interventions to consider in Canada are discussed after reviewing industry management in Clayoquot Sound and how the current regime came to be.

Clayoquot Sound, located on the west coast of Vancouver Island in British Columbia (Figure 2.1), was one of the first locations in Canada to experience commercial whale-watch activity and continues to be a major contributor of tourism-generated income for the province

(O'Connor *et al.* 2009). This area is internationally recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) biosphere reserve for the diversity of ecosystems, Nuu-chah-nulth culture, and shift from primarily logging and fishing activities to those that support biodiversity and conservation values, including tourism (UNESCO 2007). There are also a number of provincial parks, marine protected areas, and ecological reserves within the study area, although awareness, enforcement, and signage of boundaries are essentially nonexistent (Malcolm 2003, Short 2005, Duffus pers. comm.).

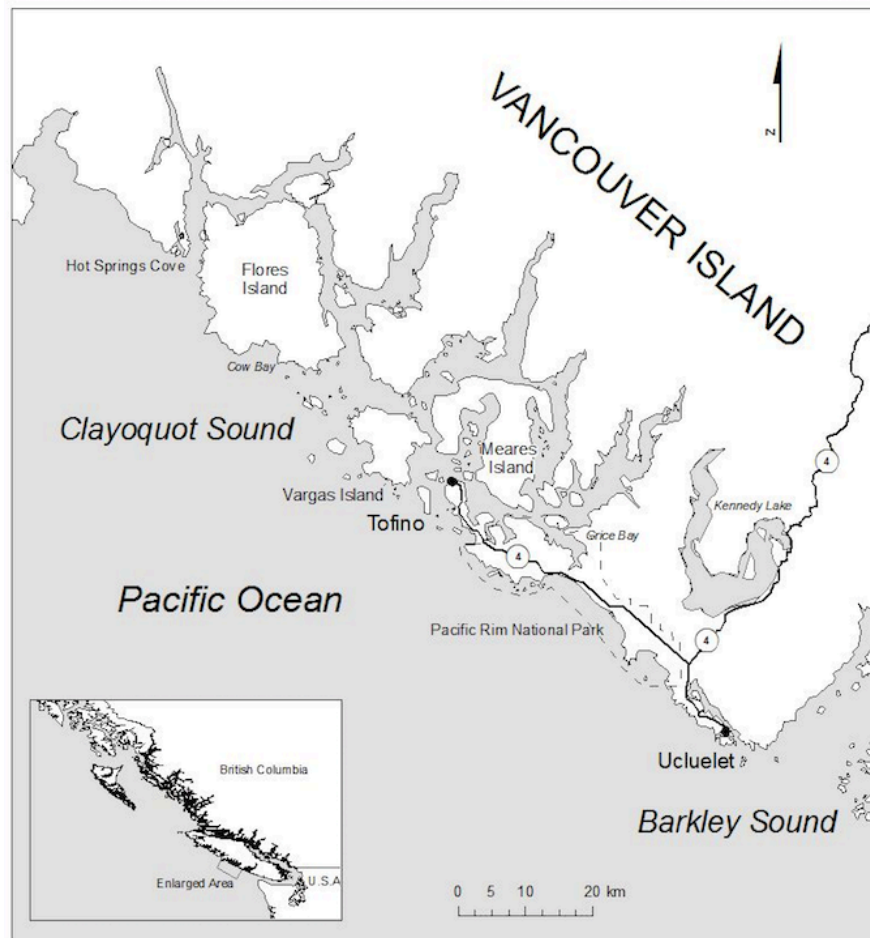


Figure 2.1. Clayoquot Sound, located on the west coast of Vancouver Island in British Columbia, Canada.

Local whale-watch operators out of Tofino, the main port for whale-watching activities in Clayoquot Sound, have shown concern about their activities potentially disturbing the marine wildlife since the early 1990s and are highly regarded by provincial and national governments for their responsible boating behaviour with respect to marine

wildlife (R. Palm pers. com.). This concern was not originally mirrored by Fisheries and Oceans Canada (DFO), under whom marine mammals were regulated entirely for quota and catch-related purposes, who believed whale-watching was a phase that did not require long-term management strategies (D. Duffus pers. com.). As a result, the industry has been mainly self-regulated by industry operators, drivers, environmental nongovernmental organizations (NGOs) and researchers. Local interests produced Tofino-based whale-watching guidelines, incorporating local knowledge and site- and species-specific regulations, many of which were incorporated into the current national whale-watching guideline standards, *Be Whale Wise: Marine Wildlife Guidelines for Boaters, Paddlers and Viewers*. Additionally, DFO has been in the process of amending the *Marine Mammal Regulations* under the *Fisheries Act* since 2002, but until amendments are complete, legal prosecution for the disturbance of marine mammals is extremely difficult to achieve. Parks Canada also has jurisdictional responsibility for whale-watching practices when gray whales and subsequent whale-watching vessels frequent waters within and around the marine boundaries of the Pacific Rim National Park Reserve.

The overall goal of this study is to provide management recommendations that promote sustainable whale-watching practices in Clayoquot Sound, based on long-term ecological research. Before management recommendations can be put forward, this chapter presents introductory material pertinent to understanding how the current regime has come to exist. I review the current legislation and voluntary regulations that apply to marine mammals on global, national, and regional scales. Next, I discuss the emergence of commercial whale-watching, and the current popular whale-watching locations in Canada. Lastly, I discuss management possibilities for the industry in B.C., first reviewing previous management interventions that have occurred in Clayoquot Sound and then reviewing the industry standards for whale-watching management in other areas of the world.

## **METHODS OF MANAGEMENT WORLDWIDE**

Commercial whale-watching originated in California in 1955 when boat drivers from California began taking tourists on the water, charging \$1 USD to see the eastern North Pacific gray whales (*Eschrichtius robustus*) migrating from breeding lagoons in Mexico to the productive foraging grounds in the Bering and Chukchi seas (Tilt 1985, Hoyt & Parsons

2014). The popularity of recreational whale-watching began to increase in the 1980s and by the next decade the industry had grown into a global tourism activity (Hoyt 2001). The unreserved growth and little management of the industry has long raised concerns regarding the affects that human interactions can have on cetaceans (Baker & Herman 1989, Higham *et al.* 2009, Higham *et al.* 2014).

In an effort to mitigate short-term and long-term anthropogenic impacts on whales, academic and management literature has extensively reviewed former, current, and suggested management techniques worldwide. The International Whaling Commission (IWC) maintains a continuous review of whale-watching guidelines and regulations from around the world (Carlson 2011a, 2011b), and academic journals such as *Tourism in Marine Environments*, *Journal of Ecotourism*, and *Journal of Sustainable Tourism* are dedicated to managing human interactions with wildlife and related habitats.

Globally, management interventions fall into three general categories: prohibition, regulation, and education. Activities that have been associated with the disturbance of marine mammals, such as hunting, feeding, touching, or otherwise harassing, have been prohibited in numerous countries through legislation and voluntary guidelines (Orams & Hill 1998, Lien 2001, Higham & Bejder 2008, Giles & Koski 2012). Regulation and promotion of appropriate boating behaviour when in the vicinity of whales is the most common form of industry regulation, including restrictions on the number of vessels, speed and direction changes, minimum approach distances, and limiting the spatial and temporal extents of whale-watching. As well, education is a popular and very effective method of moderating tourist behaviour around whales, increasing interest in conservation topics, and reducing pressure on tour operators to defy regulations (Lien 2001, Draheim *et al.* 2010, Kessler & Harcourt 2013). The most successful management plan includes a combination of regulation approaches (Corkeron 2006, Christiansen & Lusseau 2014, Tyne *et al.* 2014).

### **Prohibition of Activities**

In countries such as Japan, Iceland, Greenland, Tonga, Norway, South Korea, Saint Vincent and the Grenadines, and Saint Lucia both whale-watching and whaling activities occur within country boundaries (Orams 2001, Kuo *et al.* 2012, Corkeron 2014). The revenue generated by whale-watching exceeds the revenue from whaling in every practicing

nation (Kuo *et al.* 2012). However, it is unclear whether both consumptive and non-consumptive uses of whales can continue without one being a detriment to the other. The relationship between whaling and whale-watching is complex, and not simply a matter of substituting one with the other (Corkeron 2006, 2014). In Japan it appears that this is not the case, as whale-watching began in Ogasawara in 1988 and the industry continues to grow despite whaling practices in surrounding waters (Cunningham *et al.* 2012). Similarly, Iceland has seen some growth in marine tourism since the early 1990s, although expansion abruptly ended shortly after the country announced the resumption of scientific whaling in 2003 (Higham & Lusseau 2008, Cunningham *et al.* 2012). Of course, these trends in tourism and number of whale-watchers could be explained by any number of other factors that may not be directly connected to whaling, such as the cultural importance of whaling and the connection to national identity, or the influence of popular media portrayals of marine mammals (movies such as *Flipper*, *Free Willy*, *The Cove*, and *Blackfish*) (Cunningham *et al.* 2012). In contrast to Japan, whale-watching in South Korea has produced low sighting rates of minke and right whales that are hypothesized to be affected by high levels of illegal whaling (Choi 2010). Vacationing tourists may be deterred from visiting countries that practice whaling (Higham & Lusseau 2007). Whale-watching in Tonga has been a very important economic resource for the nation, and human dimension surveys had indicated that it would be highly unlikely for whale-watching and whaling to coexist (Orams 2002). More research on the human dimensions of whale-watching in these differing world regions will be needed to further determine if whale-watching and hunting of whales can coincide.

Cetacean programs where direct contact is involved, including swim-with programs and feeding, have been widely described as harmful to cetaceans, which have exhibited short- and long-term impacts such as aggression towards humans, avoidance, disruption of natural behaviour, and consequences of increased exposure or tolerance to human contact, including entanglement and vessel strikes (Orams & Hill 1998, Constantine 2001, Allen 2014). Despite *Be Whale Wise* regulations explicitly prohibiting swimming with marine wildlife, swim-with programs occur in both Manitoba as well as Newfoundland. In New Zealand, the feeding of dolphins is illegal though largely unregulated, and swim-with tourism opportunities are allowed only with permits (Orams & Hill 1998). In the United States, the Marine Mammal Protection Act (1972) (MMPA) prohibits the harassment of cetaceans,



including swimming with or feeding wild dolphins (Bryant 1994, Orams & Hill 1998), not including permits for the capture, import, and transfer of marine mammals (NOAA 2013). Other countries that prohibit swim-with interactions with cetaceans include Argentina, Brazil, Mexico, South Africa, and Spain (Allen 2014). Notably, public display of marine mammals does not require a National Oceanic and Atmospheric Administration (NOAA) permit (NOAA 2013). The global prohibition of touching, feeding, and swimming with whales and dolphins is a management technique that can prevent obvious disturbance. Tourists may be deterred from desiring these types of marine mammal experiences through educational programs that have demonstrated significant reductions in detrimental interactions (Orams & Hill 1998). Unfortunately, human-cetacean interactions cannot be effectively managed through prohibition of certain actions alone. Continuing activities, such as boat-based whale-watching, can be controlled through regulation.

### **Regulations for Interactions Between Vessels and Cetaceans**

The most common type of management intervention in wildlife tourism is the implementation of regulations, whether compulsory or voluntary. Marine mammal regulations based on national legislation allow rules to be legally enforced, while voluntary rules have no legal support. When laws are clear, well known, and enforced, legislation is argued to be the most effective method for regulating the whale-watching industry (Constantine 2014, Tyne *et al.* 2014).

#### *Legislation*

The mandatory licensing of whale-watching operators is a contested issue around the globe. Licenses are often used as a tool to limit the number of boats permitted in a tourism area. Proponents for licenses argue that it is one of the only effective methods for managing the cumulative effects that multiple vessels can have on whale and dolphin species by providing a mechanism by which to regulate exposure through limiting or revoking permits (Corkeron 2006, Higham & Bejder 2008, Kessler & Harcourt 2013, Tyne *et al.* 2014). However, the presence of private boats are not addressed through commercial licenses or permits, and recreational boaters often demonstrate lower compliance rates and outnumber commercial vessels (Erbe 2002, Visser *et al.* 2010, Kessler & Harcourt 2013). In countries such as Canada and Australia, boaters are required to have a license. However, boating

course material does not contain any material on cetaceans, how to maneuver a vessel in their vicinity, or the regulations and consequences associated with intentionally or accidentally breaching whale-watching guidelines, even though the penalties are the same for both recreational and commercial boaters (Giles & Koski 2012, Kessler & Harcourt 2013). Corkeron (2006) suggests that the most effective regulations are those that are based on legislation and are therefore legally enforceable. He argues that management bodies responsible for sustainable whale-watching practices need to have the authority to deliver fines for drivers that violate regulations. Where licensing has been implemented, tourism operator licenses are suspended or revoked from those who repeatedly disregard marine mammal-watching regulations (Corkeron 2006, Kessler & Harcourt 2013). For licenses and regulations to be effective, there must be enforcement on the water. Enforcement is rare, often the result of limited funding and subsequently limited resources (Malcolm 2003, Corkeron 2006, Kessler & Harcourt 2013). This may be a factor in Canada's Department of Fisheries and Oceans (DFO) stance on whale-watching regulations, which is an emphasis on compliance rather than enforcement (Lien 2001). Support programs that ensure public awareness of regulations may positively impact both compliance and enforcement.

It is widely accepted that guidelines to manage human interactions with marine mammals contribute to the sustainability of the wildlife tourism industry (Duffus & Dearden 1990). To prevent disturbance and sustain whale-watching, guidelines need to be implemented where none exist, or where implementation is poor. Effective guidelines commonly include a spatial or temporal component, or a combination of both.

#### *Vessel Operation*

Even with seasonal and temporal restrictions, boating in the presence of marine mammals should also be regulated. Restrictions to vessel operation are more specific and up to the individual boat driver to comply with. A number of different vessel restrictions have been employed around the world. Commonly regulated boat behaviours include number of vessels within a certain distance of a cetacean, duration of encounter, approach distance and speed, and engine use (Carlson 2011a, b).

Interactions with whale-watching boats elicit short-term behaviour responses by cetaceans. Short-term effects are commonly used to measure human disturbance because of the directly observable relation between subjects, as well as ease of data collection

(Christiansen & Lusseau 2014). Vertical avoidance tactics involve cetaceans avoiding boats by spending less time at the surface through decreased resting time (Lusseau 2003, Lien 2001, Constantine *et al.* 2004, Constantine 2014), dives of increasing depth and duration (Nowacek *et al.* 2001, Lusseau 2003, Bejder *et al.* 2006, Schaffar *et al.* 2009, Christiansen *et al.* 2013), or a shift in habitat preference or use (Blane & Jaakson 1994, Allen & Read 2000, Lusseau 2005). Horizontal avoidance tactics involve increased swimming speed and frequency of heading changes (Nowacek *et al.* 2001, Williams *et al.* 2002) to outrun or outmaneuver vessels (Christiansen & Lusseau 2014). On occasion, boats may actually attract cetaceans, although the long-term effects of this type of interaction are largely unknown (Malcolm & Penner 2011, Condit & Jones 2013). These short-term reactions to boats can negatively affect the health of individuals by causing whales to increase energy expended to avoid boats and thus decreasing the amount of energy available to perform important life history traits (Lien 2001, Williams *et al.* 2002, Ford & Reeves 2008, Higham & Bejder 2008). However, only three longitudinal studies have demonstrated the long-term effects of whale-watching on odontocete populations (Bejder *et al.* 2006, Fortuna 2006, Lusseau *et al.* 2006), and the long-term effects on mysticetes remains unknown (Christiansen & Lusseau 2014).

To decrease the cumulative effects of exposing cetaceans to vessels, the most frequently suggested or implemented regulation worldwide is a minimum approach distance (Lien 2001, Erbe 2002, Carlson 2011a, Tseng *et al.* 2011, Kessler & Harcourt 2013). Close or aggressive boat behaviour when approaching cetaceans has resulted in immediate behaviour alterations, including abrupt direction changes and shortened surface time (Blane & Jaakson 1994, Constantine 2001, Lien 2001). It is the characteristic pursuit of animals when whale-watching that makes focal cetaceans particularly vulnerable to the effects of vessels, so minimum approach distances are often applied in tandem with limiting the duration of encounters (Carlson 2011a). Controlling the length of time that vessels are in close contact with whales decreases the opportunity for disturbing animal's short-term behaviours (Lien 2001, Schaffar *et al.* 2010)

To prevent underwater boat noise from reaching a harmful level, approach speed, excessive noise, and idling are often addressed in both voluntary and legislated regulations (Carlson 2011a). A harmful level may be one that causes hearing damage (Erbe 2002), masks

communication (Bain & Dahlheim 1994), makes it difficult to find prey (Williams *et al.* 2002), or results in cetaceans leaving a previously used area (Higham & Bejder 2008). In Johnstone Strait, northern resident killer whales in the presence of vessels were found to swim away from boats at faster speeds when vessel numbers increased (Erbe 2002). Techniques such as turning off engines instead of idling or positioning a vessel downwind from whales can decrease the negative effects that vessel noise can have on focal species (Lien 2001, Erbe 2002, Lachmuth *et al.* 2011). When considering the implementation of boater restrictions, effective guidelines commonly include a spatial or temporal component, or a combination of both.

### *Spatial and Temporal Restrictions*

Spatial restrictions may refer to marine protected areas (MPAs), sanctuaries, quiet zones, or some combination of the like. The use of MPAs to protect both terrestrial and marine habitats is an increasingly popular method of marine mammal management (Williams *et al.* 2009, Hoyt 2011, Carlson 2011b, Tyne *et al.* 2014). In order to prevent disturbance of critical behaviours (resting, socializing, foraging, breeding), important wildlife habitats where these behaviours take place may be protected (Lusseau & Higham 2004, Higham & Bejder 2008). Spatially segregating sensitive areas can limit the impact that whale-watching presence may have on multiple wildlife species, not merely the focal species (Corkeron 2006). MPAs allow for protection of marine habitats and the associated species through legislation, which is often the most effective form of marine mammal regulation (Croll *et al.* 2001, Jamieson & Levings 2001, Wiley *et al.* 2008, Tyne *et al.* 2014). Marine mammal sanctuaries have been established to protect vulnerable species such as manatees in places such as Florida (Crystal River National Wildlife Refuge, established in 1983) as well as more mobile species like humpback whales in Maine and Hawaii (Stellwagen Bank Sanctuary in 1989, and Hawaiian Islands Humpback Whale Sanctuary in 1997) (Higham & Lusseau 2004). Quiet zones are the designation of use and non-use areas (Duffus & Dearden 1992). These may be supported with legislation or through an MPA label, or they may be voluntary. When concerns of noise pollution and proximity are main concerns, spatially restricting vessels from pursuing whales into certain areas may reduce the impact of the fleet (Duffus 1996). The appropriate spatial extent of an MPA will vary, as long as it is biologically

relevant and boating operations are logistically manageable within protected area boundaries (Ashe *et al.* 2013, Tyne *et al.* 2014).

Temporal restrictions prohibit certain interactions at critical times for individual or populations of cetaceans (Constantine *et al.* 2004, Tyne *et al.* 2014). “No vessel” periods each day ensure cetaceans have time to rest from boat pressure and the associated noise and air pollution (Visser *et al.* 2010, Lachmuth *et al.* 2011). The success of a population is directly related to the productivity and quality of prey in the home habitat (Lusseau 2005), and vessel presence has been a significant factor in prompting short-term changes cetacean behaviour (Lusseau 2005, Christiansen *et al.* 2013). Avoidance strategies include increased speed at which animals swam away from boats, direction of travel, changing position and time spent at the surface, or leaving important foraging areas (Trites *et al.* 1996, Erbe 2002, Lusseau 2005, Williams *et al.* 2002, Kessler & Harcourt 2013). In Australia, bottlenose dolphins (*Tursiops* spp.) spend over 35% of daylight hours with commercial boats, decreasing the time available for essential life behaviours (Lusseau 2004). Suggested quiet periods for cetaceans range from 25-30% of the period of daylight, restricting all whale-watching activities from boats and aircraft (Richter *et al.* 2006, Carlson 2011a). Seasonal restrictions at varying scales may also be beneficial when a focal species forages, breeds, and calves in differing locations. By restricting access to cetaceans when critical life behaviours are probable, whales can be protected while simultaneously allowing whale-watching to continue at other periods during the year. In order to inform both the operator and the public about these effects that human interactions can have on wild marine life, naturalists and tourists alike can be instructed in a variety of settings, whether in a classroom or on the water.

### **Providing Information: Informing the Operator and the Public**

Education is a critical aspect of all ecotourism activities, including whale-watching (Forestell 1990; Orams & Hill 1998, Orams 2002, Parsons *et al.* 2006, Fisheries and Oceans Canada 2010). The definition of ‘education’ can be vague or missing entirely, but Orams (1996b) promotes the attempt to engage eco-tourists in actively contributing to the benefit of that environment, as opposed to only minimizing their impact (Johnson & McInnis 2014). In general, the whale-watching industry has typically focused on endangered species and the

possibility of disrupting the natural behaviour of characteristic mega-fauna has been a driver for research into many aspects of the activity, including education (Orams 2000). Naturalists aboard whale-watching vessels are tasked with facilitating the learning experience that tourists have during a tour by interpreting and presenting complex ecological concepts in a limited time period to guests with different educational backgrounds. When naturalists are not provided, the responsibility of educating visitors may fall to the driver, where safe and responsible boat handling is the main priority. Ecotourism guides have been successful in increasing tourist knowledge of the local area, local issues related to resource management, and support for conservation while still providing a highly satisfying tourism experience (Powell & Ham 2008, Johnson & McInnis 2014). However, without a trained facilitator, the educational potential of whale-watching may be lost. Tourists are supportive of conservation and sustainability, and an educational experience is a priority (Draheim *et al.* 2010, Chen 2011, Zeppel & Muloin 2014), but they often need to be informed of what constitutes a realistic expectation for a marine mammal encounter, including what type of behaviours are inappropriate (*i.e.* touching, feeding) (Orams & Hill 1998, Scheer 2010). Where regulations are found ineffective, environmental education programs can be a useful supplement (Wiley *et al.* 2008).

A key component of marine mammal education during tours is addressing concerns of disturbance. Raising awareness of marine mammal watching regulations may increase the compliance of both recreational and commercial boaters, as well as inform tourists about what realistic boat-whale interactions to expect on a typical tour. Advertising of regulations may be displayed in boating magazines, on whale-watching websites, or using social marketing strategies (Jett *et al.* 2013, Kessler & Harcourt 2013). Posting signage in marine tourism areas, however, has been largely ineffective for managing tourist interactions with wildlife, having no significant effect in increasing compliance to regulations (Acevedo-Guitierrez *et al.* 2010). Operators may feel pressure to neglect regulations for the sake of satisfying visitors that expect a close encounter with wild marine life, increasing the negative impact on focal animals and risking the viability of the local industry (Kessler & Harcourt 2010). Human-whale interactions are often glorified by images portrayed in the media, which then prompts operators to use advertising material that display uncommon and exciting whale behaviours, such as breaching and spy hopping. Local operations can educate tourists on the

regulations and realistic expectations of their whale-watching tours to minimize the impact on marine mammal populations, as well as reduce the pressure on individual boat drivers to disobey rules for the sake of visitor satisfaction. Ultimately, managing unrealistic expectations of tourists is an issue of understanding why tourists desire close-proximity wildlife encounters, regardless of the negative impacts this may have on the animal of interest, and the psychological motivations behind this desire are outside the scope of this paper.

For boat operators, education in boat handling around cetaceans is crucial. A driver should have a complete understanding of the applicable regulations for waters that their tours may frequent, and know when they cross jurisdictional boundaries where regulations differ. Variations in compliance with guidelines may indicate an incorrect interpretation of how regulations translate to boat handling, or ineffective management. Additionally, tourists want assurance that drivers are well-trained and abide by whale-watch practices (Condit & Jones 2013). Informing guests on the connections between their vessel, the focal animals, the marine environment, and addressing concerns of disturbance are educational opportunities that can be directly related to how drivers are operating at that present time.

Whether educating whale-watchers on a tour or managing industry operations, the best available science should be utilized and continued research efforts supported. There is worldwide support for collection of baseline data wherever possible, continual monitoring, and adaptive management techniques responsive to the ongoing research (IWC 2012). As whale-watching continues to grow worldwide, the subsequent consequences of these activities will be felt by whale and dolphin populations in coastal communities around the globe. It is of increasing importance that tourism activities are examined so that management can be adaptive and appropriate for the location and time period. On-going research programs can assess the effectiveness of current management interventions by monitoring limits of acceptable change for each cetacean species and population as well as the level of compliance with whale-watching regulations (Corkeron 2006). There is an increasing body of academic literature on the effects of whale watching on cetacean populations, yet management bodies has often ignored or failed to implement scientist suggestions (Malcolm 2003, Higham & Bejder 2008, Constantine 2014). To counter this, marine mammal science needs to be accessible or otherwise interpreted to the general public and widely distributed in

a variety of media forms. Scientists have a social responsibility to go beyond research and participate in the integration of research results and resource management, ensuring correct interpretation and gaining a first-hand understanding of logistical implementation issues (Schindler 2014). The benefits of environmental education are widespread, felt by operators, naturalists and other guides, visitors, researchers, management bodies, and the greater public (Orams & Hill 1998, Orams 2002, Powell & Ham 2008, Johnson & McInnis 2014).

## **HISTORY OF THE DEVELOPMENT OF WHALE-WATCHING IN CANADA**

Before 1976, commercial whale-watching on the west coast of Canada and the United States was non-existent (Lachmuth *et al.* 2011), as land-based whale-watching was much more popular than boat-based excursions (Hoyt & Parsons 2014). As time progressed, the development of whale-watching in B.C. reflected the exponential growth of ecotourism and whale-watching on a global scale. Today, Canada has one of the largest national whale-watching industries in the world that has persisted despite recent obstacles to international travel for tourism purposes (O'Connor *et al.* 2009). Global tourism in the 2000s was negatively affected by a variety of events, including the 9/11 attack on the United States, the spread of severe acute respiratory syndrome (SARS), the threat of the bird flu, and various wars, and international inbound tourism stagnated or decreased in four out of ten years (O'Connor *et al.* 2009, Hoyt & Parsons 2014). Since 2000, whale-watching has shown promising growth, yet more modest than the increase of global tourism as a whole (Hoyt & Parsons 2014).

In Canada, there are operations on the Pacific coast (British Columbia), Atlantic coast (Quebec, Nova Scotia, New Brunswick, and Newfoundland and Labrador), and the Arctic (Manitoba and Nunavut). Overall, Canada had 1,165,684 whale-watchers in 2008, an average annual growth rate of 0.8% since 1998, 206 operators, and a total annual expenditure of \$150,366,000. More specifically, the Pacific coast has seen growth in recent years (from 1998 to 2008), but growth has slowed or decreased in the Atlantic and Arctic regions (Table 2.1). These three regions will now be examined in turn.



Table 2.1. Canada whale-watching tourism statistics 2008 (adapted from O'Connor *et al.* 2009).

| Canadian region | Province | Number of whale watchers | Annual average growth rate since 1998 | Number of operators | Total annual expenditure | Average adult ticket price | Estimated employment numbers | Main whale-watch season |
|-----------------|----------|--------------------------|---------------------------------------|---------------------|--------------------------|----------------------------|------------------------------|-------------------------|
| Pacific         | BC       | 430,000                  | 4.2%                                  | 47                  | \$118,176,000            | \$114                      | 200                          | April to October        |
| Atlantic        | QC       | 567,161                  | 1.12%                                 | 56                  | \$80,850,467             | \$50                       | 2,000                        | May to October          |
|                 | NS, NB   | 135,000                  | -0.4%                                 | 43                  | \$19,075,149             | \$37                       | 175                          | June to September       |
|                 | NL       | 138,000                  | 0%                                    | 35                  | \$16,769,000             | \$37                       | 150                          | June to September       |
| Arctic          | MB, NU   | 4,800                    | -3.3%                                 | 28                  | \$3,989,000              | \$70                       | 40                           | June to September       |

### Pacific Coast

British Columbia has the most profitable whale-watching operation in Canada, with 430,600 tourists participating annually (O'Connor *et al.* 2009). There are three main whale-watching centres in B.C., all of which are on Vancouver Island: Johnstone Strait, Clayoquot Sound, and Southern Vancouver Island. The focal species of whale-watching in these three areas vary: the northern resident killer whale (*Orcinus orca*) in Johnstone Strait; the gray whale in Clayoquot and Barkley Sounds; the southern resident killer whale (*Orcinus orca*) in Southern Vancouver Island. Additional marine mammal species frequently sighted include Dall's and harbour porpoises (*Phocoenoides dalli* and *Phocoena phocoena*, respectively), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), minke whales (*Balaenoptera acutorostrata*), humpback whales (*Megaptera novaeangliae*), California and Steller sea lions (*Zalophus californianus* and *Eumetopias jubatus*, respectively), sea otters (*Enhydra lutris*), and a variety of pelagic bird species. The majority of excursions are boat-based tours around 2.5 to 3 hours in duration. Land-based whale-watching also occurs along the west coast of Vancouver Island where the migrating gray whales can be seen.

### Atlantic Coast

The Atlantic coast supports a number of marine mammal tourism enterprises. Locations have seen a general plateau in whale-watching numbers, possibly due to higher

fuel prices or a decline in tourism in general, and operators have amalgamated businesses or diversified in the types of tours offered, such as scenic cruises or bird watching (O'Connor *et al.* 2009). The long-established industries in Nova Scotia and New Brunswick are centered on the Bay of Fundy, Halifax, and Cape Breton, with 135,000 whale-watching tourists per year (O'Connor *et al.* 2009). Wildlife tourism operations run from spring until late summer, observing fin (*Balaenoptera physalus*), minke, humpback, and North Atlantic right whales (*Eubalaena glacialis*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), harbour porpoises, and Atlantic puffins (*Fratercula arctica*). Newfoundland and Labrador whale-watching activities have remained steady at 138,000 whale-watchers per year (O'Connor *et al.* 2009). Unlike the majority of other Canadian industries, land-based whale-watching facilitates a considerably large number of tourists. Operators offer boat tours focusing on scenery, icebergs, puffins and other pelagic birds, as well as humpback, minke, and fin whales, and the majority of operators are small, family-owned businesses.

The St. Lawrence River Estuary and Gulf in Quebec is host to the largest whale-watching industry in the country, with the greatest number of operators supporting the greatest number of tourists, approximately 567,000 participants annually (O'Connor *et al.* 2009). Commonly sighted cetaceans include harbour porpoises, beluga (*Delphinapterus leucas*), minke, fin, humpback and blue whales (*Balaenoptera musculus*), and occasionally sperm, long-finned pilot (*Globicephala melas*), killer, and North Atlantic right whales (O'Connor *et al.* 2009). Boat-based whale-watching is the most popular, though land-based ventures are increasingly popular in the Saguenay-St. Lawrence Marine Park where telescopes and covered lookouts are available.

### **Canadian Arctic**

Arctic whale-watching tours range greatly in duration, length, dedication to whales, and style, with 4,800 participants per year (O'Connor *et al.* 2009). From canoeing or kayaking to fully catered, multi-day trips with an included helicopter flight, most whale-watching occurs in Manitoba and a variety of other locations around the Arctic including Pond Inlet, Nunavut, and Baffin Island. Polar bears (*Ursus maritimus*) and belugas are the main marine mammal attractions in Hudson Bay, while narwhals (*Monodon monoceros*),

seals (family Phocidae), orcas, and bowhead whales (*Balaena mysticetus*) can be seen from guided trips to Baffin Island (O'Connor *et al.* 2009).

### **History of the Development of Whale-Watching in Clayoquot Sound**

Researchers were the first group to take interest in the gray whales along the shores of Clayoquot Sound in the 1960s (Pike 1962). In 1982, local entrepreneurs in Tofino and Ucluelet began taking customers on the water to see the migrating gray whales in Clayoquot Sound and Barkley Sound, respectively. Tickets were sold at local laundromats, bookstores, and boat docks, and by 1986 three Tofino companies offered regular summer tours to view the gray whales that resided in Clayoquot Sound either during or instead of completing the northern migration (Malcolm 2003). Tours were based out of Tofino as well as Ucluelet, the former able to reach as far north as Hot Springs Cove in Clayoquot Sound and the latter stretching south into Barkley Sound (Figure 2.1). The industry began to grow at an exponential rate in 1990 as companies set up permanent offices dedicated exclusively to whale-watching ticket sales and increased the number and diversity of vessels available for tours (Malcolm 2003). Advertising expanded to areas at main tourist transportation hubs, including the B.C. Ferries terminals and ships, coach bus terminuses, and the Victoria and Vancouver international airports (pers. obs.).

Surrounded on three sides by ocean, Tofino is located at the north tip of the Esowista Peninsula within the traditional territory of the Tla-o-qui-aht, a Nuu-chah-nulth tribe (Horsfield 2008). Home to under 2,000 residents, Tofino was designated a “resort region” in 2008 under the B.C. Resort Municipality Initiative, which provides funding to resort-oriented municipalities in the province to help meet provincial goals of sustainable environmental management, job creation in the tourism sector, and doubling tourism by 2015 (Statistics Canada 2011, Rural B.C. 2013). It is a very popular destination for activities other than whale-watching, including bear- and bird-watching, fishing, kayaking, camping, hiking, storm-watching, surfing, and beachcombing.

The Tofino whale-watching fleet consists of five dedicated whale-watching companies whose primary activity is offering whale-related tours and run 15 to 25 scheduled tours every day May through September. Most boat operators as well as company owners are local or seasonal residents that know each other and interact on land as well as on the water.

Drivers are regularly heard on the VHF marine radio sharing details on whale location and behaviour, visibility and sea conditions, and expected route of travel. It is not uncommon for drivers to work for an operator for a number of consecutive seasons. There is no formal operators' association and the network of drivers is essentially self-regulated regarding whale-vessel interaction laws. Three original Tofino whale-watching companies (Jamie's Whaling Station, Ocean Outfitters, and The Whale Centre) are founding members of the Pacific Rim Association of Tour Operators (PRATO), pledging to support and abide by responsible cetacean and bird viewing guidelines to prevent the disturbance of marine mammals. Tofino residents and whale-watch employees have a vested interest in the long-term survival of the industry, as Tofino is "the end of the road", or the town at the northernmost point of the Pacific Rim Highway, and dependent on tourism success. Now that the origins of the industry are clear, and whale-watch operations in Clayoquot Sound have been summarized, current whale-watching management methods in Canada will be discussed.

## **CURRENT MARINE MAMMAL MANAGEMENT IN CANADA**

In Canada, the protection of marine mammals falls under the *Fisheries Act* (1985), which originally defined marine mammals as fish and focused solely on the consumptive use of cetaceans. The Marine Mammal Regulations (MMR) were established in 1993 and prohibit the disturbance of marine mammals except when fishing for marine mammals with the appropriate permit (Lien 2001), though the focus is still mainly on the fishing or hunting of marine mammals within and surrounding Canadian waters. However, in March 2012 the DFO announced possible regulation amendments to the current MMR that would recognize the watching of and nonconsumptive interactions with whales, dolphins, porpoises, and other marine mammals as activities that may disturb wildlife (Giles & Koski 2012). DFO has determined that the current regulations are not effectively managing the variety of activities that may disturb these animals, that the definition of "disturbance" is vague, and that by expanding the scope of the MMR to include conservation these activities may better protect the marine species (Canada Gazette 2012). The existing federal, provincial, and regional legislation and regulations responsible for the protection of marine mammals are variable in their methods and effectiveness, and will now be discussed in turn.

## **Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES)**

As a party of the international Convention on International Trade of Endangered Species of Wild Fauna and Flora), Canada participates in the regulation of species trade and transport by requiring permits for the import, export, or re-export of CITES-listed species. While the aim of CITES has been to prevent the extinction of wild plants and animals, it focuses on only the species, instead of major human threats such as habitat destruction and the commercial interests in hunting and trapping wildlife (Hall 1990). Commonly sighted B.C. marine mammals on the CITES species checklist include Pacific white-sided dolphins, gray whales, harbour porpoises, Dall's porpoises, minke whales, humpback whales, killer whales, and sea otters. Since observations or indirect disturbance are not addressed by CITES, this Convention does not apply to general whale-watching activities.

## **Species at Risk Act (SARA)**

The Species at Risk Act (SARA) is a federal Act created in 2003 to protect and conserve species at risk in Canada, ideally preventing such species from becoming extirpated, endangered, or threatened, or allowing for the recovery of said species (Fisheries and Oceans Canada 2010). The eastern Pacific gray whale (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), harbour porpoises (*Phocoena phocoena*) and both northern and southern resident killer whales (*Orcinus orca*) are common focal species for whale-watching in British Columbia and currently of special concern, or those that may become threatened or endangered as a result of a combination of identified threats and unique biological characteristics (Fisheries and Oceans Canada 2010, Species at Risk Act [SARA] 2013). SARA prohibits the killing, harming, harassment, and capture of only wildlife species listed as extirpated, endangered or threatened (SARA 2013). Species of special concern require a management plan with the purpose of alleviating threats to eventually remove the species from the list of wildlife at risk, or at least preventing a species from progressing to a threatened or endangered status. The plan provides direction regarding species-specific goals, objectives, threats, and areas of focus for various stakeholders to consider, but does not require action to be taken in any of these areas, including whale-watching activity.

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

The DFO, the Pacific Whale Watch Association (formally the Whale Watch Operators Association Northwest, or WWOANW), Marine Mammal Monitoring Project (M3, piloted by the DFO), Soundwatch, and the U.S. National Marine Fisheries Service (NMFS) developed the *Be Whale Wise: Marine Wildlife Guidelines for Boaters, Paddlers and Viewers*, a simple set of voluntary guidelines for boaters designed to be best practices for vessel practices when in the vicinity of cetaceans (Giles & Koski 2012; see Appendix 2.1). Guidelines include slowing down to less than 7 knots when within 400 metres of the nearest whale, keeping out of the whales' path, a minimum approach distance of 100 metres, limiting viewing time to 30 minutes, and refraining from touching, feeding, or swimming with marine wildlife (Fisheries & Oceans 2013). Both Canada and U.S. governments support *Be Whale Wise* and continue to collaborate on the adaptation of the guidelines, adjusting them four times since the release in 2002, most recently in 2011 to alter the minimum approach distance to southern resident killer whales to 200 metres in U.S. waters (Giles & Koski 2012).

The *Be Whale Wise* guidelines are voluntary and are not legally enforceable in Canada. Traditionally these guidelines have not been used under Canadian law because courts do not accept them as a basis for determining whether a cetacean was “disturbed”, as defined under the MMR (Giles & Koski 2012). However, on August 7, 2012 a recreational boater from Campbell River was charged with and found guilty on two charges of unlawfully disturbing a marine mammal while not fishing (Section 7 of the MMR of the *Fisheries Act*, with fines reaching up to \$100,000), and of unlawfully harassing a extirpated, endangered, or threatened wildlife species (falls under SARA, with fines reaching up to \$250,000), marking the first time SARA has been used to prosecute a case surrounding cetaceans (Lien 2001, CBC 2013, Douglas 2013). The interaction of interest occurred on October 3, 2010 in Discovery Passage, where a Fishery Officer witnessed the power boater accelerate towards at least two resident killer whales up to five times before coming within 15 to 25 meters behind the whales, then abruptly changing direction and immediately speeding away. John Ford testified that vessel behaviour like this can disrupt short-term killer whale behaviours including feeding, socializing, mating, and resting and that there was a “very high probability” that the killer whales being pursued in this instance were disturbed, which is sufficient for a

conviction since Canadian law does not require proof of disturbance (Douglas 2013). The convicted man was charged with a \$7,500 fine to be paid to Environment Canada's Environmental Damages Fund, and was court-ordered to write an article for a local Campbell River newspaper, apologizing and cautioning other boaters to not harass whales (CBC 2013).

Despite this legal success, it still remains that convicting boaters of disturbing marine mammals is extremely difficult. The conviction in August 2012 was very likely the result of the testimonial from a Fishery Officer that was coincidentally in the same area. DFO presence on the water in the Pacific is scarce, thus governmental enforcement like this is not considered to be an effective management tool (Duffus 1989, Malcolm 2003). The proposed amendments to the MMR would create legally enforceable guidelines that include minimum approach distances, prohibition of some aircraft behaviour, and the introduction of operator licenses (Giles & Koski 2012). As stated earlier, regulations that are supported by legislation are often the most effective (Corkeron 2006), yet the aggressive amendments can be controversial, as regulations would legally recognize nonconsumptive uses of cetaceans (Giles & Koski 2012).

### **Upcoming Amendments to the Marine Mammal Regulations**

DFO is currently amending the MMR to be more cognitive of marine mammal viewing and its increasing popularity in Canada, a process that has been on-going since the publication of Lien's report on the conservation basis for the regulation of whale-watching in Canada in 2001 (M. Landry, pers. com.). The goal is to ensure the protection of marine mammals through understandable and explicit laws that are clear on nonconsumptive human activities that may impact cetaceans including whale-watching, seismic and sonar activities, excessive engine noise, ship strikes, and net entanglements (Canada Gazette 2012). Based on academic consultations, awareness campaigns, mail outs, Internet consultations, and meetings with the general public, industry operators, stakeholders, and First Nations across Canada, DFO published a pre-publication version in the *Canada Gazette* for the public to comment; final publication was expected before the end of 2013, but DFO announced in June 2014 that final publication is now expected during a planning period between 2014 and 2016. Proposed changes include expanding the current Regulations to include conservation and protection, introducing a 100m minimum approach distance to all marine mammals (not

applicable to commercial vessels in transit) and alternate approach distances for specific circumstances (depending on the focal species, vessel type, location, ice presence, and time of year), restricting aircraft behaviour when within 304.8m (1000 feet) and one-half nautical mile radius of a marine mammal (not applicable to commercial aircraft, or those with seal fishery observation licenses), a mandatory reporting system when any accidental contact with a marine mammal occurs, and attempted to introduce a licensing program applicable to potentially disturbing activities but this program was later revoked (Canada Gazette 2012). The term “disturb” is further defined to include approaching a marine mammal to interact with it (*i.e.* feed, swim with), moving or otherwise manipulating a marine mammal to move from the immediate area, tagging or marking a marine mammal, or attempting to do any these things (Canada Gazette 2012). While these changes would provide legislative support for a number of *Be Whale Wise* guidelines already in place, collaboration between different levels of Canadian government as well as coordination with bordering United States governments will be key in determining the effectiveness of these amendments.

As whale-watching continues to grow in Canada, it is feared that related tourism operations may expand to a point of frequently, repeatedly, and persistently disturbing cetaceans (Lien 2001). To ensure the long-term sustainability of the industry, the DFO supports a precautionary approach when interacting with cetaceans within Canadian waters and the provision and collection of information on human activities that may disturb critical life behaviours (Lien 2001). Precautionary measures are often considered preventative and have been loosely applied in environmental management issues such as pollution, ozone depletion, greenhouse gas emission, and the loss of biodiversity on a global scale. It aims to anticipate harmful or irreversible damages to the environment and have decision makers take action to avoid it, even without a complete understanding of the system in question (Mitchell 2002). The definition of precautionary is frequently debated, allowing for the principle to be widely applied and interpreted in many number of ways depending on the circumstances. However, it is a general method that cannot be considered a regulatory standard because it is too vague on how much caution to take, unspecific on when the principle is suitable to use, and unclear on what precautionary management decisions to make and at what cost (Crawford-Brown & Crawford-Brown 2011). With whale-watching regulations in Canada, DFO maintains that marine mammals are managed using a precautionary approach (*i.e.* Lien



2001, MMWG 2012) despite the scientific uncertainty and inconsistency associated with regulations such as minimum approach distances, maximum viewing times, and vessel speed. There is no scientific basis for these limits, and results regarding the short-term effects on marine mammals when vessels are in the vicinity vary considerably (*i.e.* Bass 2000, Erbe 2002, Richter 2002, Malcolm & Penner 2011). Originally created with precautionary principles in mind, these regulations – and most other regulations worldwide – are instead ‘pseudo-precautionary’ because of the lack of data on what actually constitutes a precaution (Malcolm 2003). Without an understanding of the ecological system that a focal species exists in, measures to manage whale-watching activities will not effectively anticipate nor address probable negative impacts. Similarly, understanding the previous management efforts and areas of both failure and success contribute to a more effective management plan. These past interventions will now be discussed.

## **PREVIOUS MARINE MAMMAL MANAGEMENT INTERVENTIONS IN CLAYOQUOT SOUND**

Clayoquot Sound is host to one national park, two ecological reserves, nine marine protected areas, and five provincial parks (B.C. Parks 2002, Dunham *et al.* 2002). In 2000, Clayoquot Sound was designated as a UNESCO biosphere reserve, promoting sustainable development of an area where local interests and comprehensive scientific research are applied (Biosphere Reserves 2013). A total of 350,000 hectares of both land and marine areas fall under the designation, yet the title does not bring any protection or regulation in Canada. Despite the Biosphere Reserve’s intention to demonstrate species biodiversity, this does not prevent activities such as commercial fishing, open-pen salmon farming, exploratory mining, and old-growth logging from occurring within reserve boundaries. Tofino has a DFO office, yet their presence on the water and therefore enforcement of marine mammal guidelines or regulations is essentially non-existent. B.C. Parks is also largely missing. Clayoquot Sound whale-watching practices have been entirely regulated by the industry itself via local meetings, peer pressure, and VHF marine radio communications.

In 1989, Duffus and Dearden (1989) submitted a report to the B.C. Ministry of Tourism (now the Ministry of Jobs, Tourism and Skills Training) on the current state and future of whale-watching in British Columbia including thirteen management

recommendations directed at the Ministry, DFO, and the whale-watching industry (Appendix 2.2). At the time, whale-watching was a new industry, and the growing popularity of ecotourism activities in general indicated that cetacean-related tourism had the potential to grow substantially as public awareness and industry infrastructure increased (Duffus & Dearden 1989). To guide the development of multiple aspects of whale-watching (vessel type, on-board education, site infrastructure), preliminary market research investigated what demographic of the public would be most likely to participate in whale-watching (Duffus & Dearden 1989, 1990, Malcolm 2003). As tourists became less specialized and knowledgeable about whales and marine ecosystems in general, the number of visitors to an area increased exponentially, and the demand for infrastructure and interpretation increased as well (Duffus 1990). The authors stressed the importance of diversifying within the industry, including focusing on multiple species, and creating central hubs around new ports in places such as Victoria, which now has a thriving tourism industry centered on whale-watch activities. The lack of scientific knowledge on the effects of whale-watching activities on cetacean populations was a driving force for the authors to recommend whale-watching guidelines based on scientific estimates of species' ecological fitness (Duffus & Dearden 1989). Unfortunately, Duffus and Dearden's (1989) report was never published nor dispersed to B.C. or Canadian levels of government, whale-watch operators, or the public (Malcolm 2003). Of the thirteen recommendations for management (Appendix 2.2), nine have never been addressed. Arguably, progress has been made regarding four of the suggestions: continued integration and development of the industry within the context of nature and marine tourism as a whole (whale-watching tours today in B.C. facilitate viewing of other species, including cetaceans, pinnipeds, sea otters, marine birds, fish, and opportunistic phenomena such as the presence of the free-floating by-the-wind sailors, or *Velella velella*, along the west coast of North America during the 2014 summer); development of new sites (since the 1989 report, Victoria, B.C. has matured into an established whale-watching hub and water-based expeditions in Haida Gwaii (formerly Queen Charlotte Islands) are becoming available); whale-watching used as a theme to spearhead tourism promotions (popular areas for tourist information emphasize wilderness, wildlife, and marine exploration. BC Ferries, Tourism Victoria, Go Tofino, and Tourism Tofino are examples of venues that stress whale-watching as an activity for visitors to the province); formation of an

industry association of charter operators (Victoria belongs to the Pacific Whale Watch Association which includes 17 ports in B.C. and Washington. Similarly, most industry operators in Tofino are members of the Pacific Rim Association of Tour Operators. Neither association is a formal representation of industry interests for B.C. or Canada). Regarding these four suggestions, there is no indication of whether or not the 1989 report had any influence on the results.

In initial years, the Tofino whale-watching fleet voiced a need for written guidelines on how drivers should operate to minimize the disturbance that vessels have on focal animals. In 1995, the *Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG)* were drafted by Strawberry Isle Research in collaboration with company owners and their drivers, and each year these groups revisited the guidelines to amend or improve them (R. Palm pers. com.). These guidelines detail the speed, angle and direction a vessel should approach gray whales, killer whales, pinnipeds and sea birds, and were the most detailed guidelines relating to vessel operation that B.C. has seen (Appendix 2.3). Similar to DFO's *Be Whale Wise* guidelines, the *TWWOVG* suggest making radio contact with vessels already on scene to determine whales' location and behaviour, match whales' speed and direction of travel, and approach from the side. The *TWWOVG* offer additional rules of boating etiquette not addressed in *Be Whale Wise*, such as working with whales in rotation when multiple boats are present, spending 15 minutes or less in more advantageous viewing positions, not approaching any closer than 50m (versus *Be Whale Wise*'s 100m), minimizing vessel movement when whales are feeding, and noting the importance of knowing the location of all other whales in the vicinity when preparing to depart. Importantly, the *TWWOVG* acknowledge that vessel behaviour in any given encounter may vary depending on the number of whales or boats, location, weather, and sea conditions, which are constantly variable and not addressed by federal regulations. Guidelines also address pinnipeds and nesting birds, instructing vessels to not instigate any change in behaviour that may detrimentally affect the energy expenditure of animals (*i.e.* driving sea lions or seals off haul-outs, or causing nesting birds to take flight). Spatially and seasonally specific, the *TWWOVG* note that animal tolerance will increase as the tour season progresses, though habituation or tolerance are not discussed. The gray whale guidelines are also applicable to killer whales, with additional recommendations to stay at least 100m away when a kill is in progress,

prohibited access to Harbour Seal lagoon on the east side of Gowland Rocks, and turning off boat engines whenever possible when in rock-lined inlets (Strawberry Isle Research 1995). However, the designation between resident and transient killer whales and the presence of humpback whales are not addressed by these guidelines (Malcolm 2003), nor are other increasingly common marine mammal species such as harbour porpoises and sea otters. Guidelines also do not address different vessel sizes or engine types. While some long-time drivers may still abide by the *TWVOVG*, it is not mandatory. Issues with this may arise from a discrepancy in the minimum approach distance and behaviour around the Cleland Island Ecological Reserve, a sanctuary for nesting birds and a popular sea lion haul-out. The *TWVOVG* state that boats approaching gray whales should come no closer than 50m while *Be Whale Wise* assert no closer than 100m for all marine mammals. As well, *TWVOVG* assert that boats may come within 100m of the island and can also navigate through a shallow gap that brings vessels much closer than 100m to land, as long as there is no whale present. In contrast to this, *Be Whale Wise* supports that boats cannot be less than 100m from sea lions, and *Ecological Reserves Act* prohibits vessels from coming within 200m of any ecological reserve. It is critical that all operators and boat drivers are abiding by the same laws and guidelines for the sake of maintaining positive industry relationships. For instance, long-standing drivers remember and abide by old agreements or previous regulations, whereas newer drivers may be unaware or unwilling to follow these rules. This has been a source of industry tension, as have misinterpretation, confusion, or contradicting regulations (R. Palm pers. comm.).

Clayoquot Sound vessel operators are well-respected by Parks Canada and DFO for both the drafted *TWVOVG* as well as respectful boat behaviour when in the presence of whales (Rod Palm pers. com). In 1999, The University of Victoria and Fisheries and Oceans hosted a Marine Mammal Viewing Workshop where all the whale-watching stakeholders of British Columbia were gathered for the first time. Contributors included DFO, Canadian Coast Guard, Parks Canada, B.C. Parks, B.C. Ministry of Small Business Tourism and Culture, B.C. Land Use Coordination Office, researchers from University of Victoria, Simon Fraser University, University of British Columbia, Malaspina (now Vancouver Island University), and the Vancouver Aquarium, environmental non-governmental organizations (NGOs) and industry operators from all over the province; local indigenous peoples were

invited but none attended (Malcolm 2003). Working groups produced five recommendations to lead future management of commercial whale-watching in B.C. (see Appendix 2.4), but only the first recommendation, to “facilitate the development of a B.C. forum/association/council to act as a formal advisory body to government, the scientific community and the general public” was ratified but never completed due to the internal transfer of the council facilitator, the DFO Marine Mammal Coordinator (Malcolm & Lochbaum 1999, Malcolm 2003).

For a short period of time between November 1999 and November 2000, a working group of 12 to 20 volunteers and stakeholders met to form a B.C. Marine Mammal Viewing Advisory Council (recommended by Duffus & Dearden in 1989 and again by Malcolm & Lochbaum in 1999; see Appendices 2.2, 2.4). A draft of amended Marine Mammal Regulations was produced, further adjusting vessel approach distances, taking into account the presence of juvenile animals, and introducing a licensing program for commercial operators (Malcolm 2003). Unfortunately, the DFO Marine Mammal Coordinator at the time was transferred within the department and the B.C. Marine Mammal Viewing Advisory Council was never formed (Malcolm 2003).

In March 2000, Parks Canada hosted a regional workshop to address wildlife tourism activities within and surrounding Pacific Rim National Park Reserve boundaries. In terms of cetaceans, gray whales were foraging in intertidal gravel and mud flats of Grice Bay, which falls within the national park borders. Representatives from Parks Canada, B.C. Parks, DFO, local industry operators, the University of Victoria Whale Research Lab, Strawberry Isle Research, local First Nations, and local community members were present (Malcolm 2003). However, even in 2000 the majority of whale-watching happened outside park areas and when Parks Canada finalized and published resulting guidelines in April 2002, operators were concerned that DFO was not valuing local management and research efforts nor were they cooperating with Parks Canada (Malcolm 2003). Nonetheless, Parks Canada continued working with Tofino operators and embraced the *TWVOVG* to implement their own *Pacific Rim National Park Reserve Voluntary Marine Wildlife Viewing Guidelines* when vessels are within or around the marine boundaries of the Pacific Rim National Park Reserve along Long Beach and the Broken Islands of Barkley Sound (Parks Canada 2003, Appendix 2.5). In addition to the *TWVOVG*, the national park guidelines involved site-specific viewing

guidelines for Cleland Island Ecological Reserve, Gowland Rocks, Sea Lion Rocks, White Island, Seabird Rocks, Wouwer Island, Sea Caves and the La Croix Group, recognizing unique spatial scenarios with acute detail due to operator and researcher input (Parks Canada 2003). Beginning in 2003, whale-watching operators are now required to possess a Parks Canada business license when conducting commercial practices within the national park (Parks Canada 2013), although gray whales do not consistently frequent the area and have not been reliably sighted in Grice Bay since 1999 (C. Tombach pers. com.).

Also 2000, a workshop titled “Viewing Marine Mammals in the Wild: A Workshop to Discuss Responsible Guidelines and Regulations for Minimizing Disturbance” took place before the 14<sup>th</sup> Biennial Conference on the Biology of Marine Mammals in Vancouver, British Columbia and featured a number of Clayoquot Sound examples (see P. Clarkson and W. Szaniszlo in Spradlin *et al.* 2001). Group discussions with marine mammal researchers, government wildlife officials, and commercial ecotourism industry operators focused on viewing practices and what types of interactions were inappropriate, specifically those where humans and whales are in extremely close proximity.

DFO began informal discussions with industry operators in regards to managing the effects of whale-watching on marine mammals after the DFO contracted a report on the conservation basis for regulating whale-watching that was published in 2001 (Lien 2001, M. Landry pers. com.). By January 2003, formal consultations began with various stakeholders including tourism operators, researchers, recreational boaters, First Nations, NGOs, fishers, sport fishing advisory board members, and related government departments in four Quebec communities and seven B.C. communities, including Tofino (Canada Gazette 2012). A draft of proposed regulation amendments was delivered to the public by Spring of 2005, where Pacific coast consultations approved of the 100m approach distance that was already enacted through voluntary guidelines, but rejected the idea of whale-watching licenses due to cost and implementation complications. Since then, the proposed licensing program has been revoked.

The province also has jurisdictional responsibility of marine mammals in Clayoquot Sound. A provincially designated MPA is any zone of tidal water or terrain with significant natural, historical and cultural features that is protected under the *Protected Areas of British Columbia Act*, *Ecological Reserve Act*, *Park Act*, *Wildlife Act* or the *Environment and Land*

*Use Act* (B.C. Parks 2007). While traditionally provincial and federal governments have failed to work cooperatively in marine matters, collaborating with the *Fisheries Act* and *Oceans Act* may assist in identifying areas of “opportunities and conflicts with other coastal marine uses” (Dunham *et al.* 2002, p.2, Short 2005). Clayoquot Sound contains nine MPAs and two ecological reserves, all of which include habitats for gray whales, harbour porpoises, harbour seals, California sea lions, Steller sea lions, and sea otters within their borders (Dunham *et al.* 2002, see Table 2.2)

Table 2.2. Clayoquot Sound marine protected areas (MPAs) and ecological reserves.

| Name                 | Date established           | MPA class                                      | Location  | Total marine and land area (ha) | Primary goal (from Dunham <i>et al.</i> 2002)  |
|----------------------|----------------------------|--|---|---------------------------------|--|
| Hesquiat Peninsula   | 12-Jul-95                  | Class A  | 49°26'N, 126°27'W (Hesquiat Harbour)  | 7,899.00                        | Protect the natural values associated with the temperate rainforest on the west coast of Vancouver Island and the nearshore marine environment |
| Sydney Inlet         | 12-Jul-95                  | Class A  | 49°26'N, 126°15'W   | 2,774.20                        | Protect one of the best examples of a coastal fjord on Vancouver Island  |
| Maquinna Marine      | 1/7/1955; addition in 1995 | Class A  | 49°22'N, 126°16'W (Hot Springs Cove)  | 2,667.60                        | Protect and showcase special values such as geothermal and geological features   |
| Flores Island Marine | 12-Jul-95                  | Class A  | 49°16'N, 126°09'W (Cow Bay)   | 7,114.00                        | Protect the natural values associated with the temperate rainforest on the west coast of Vancouver Island                                      |
| Vargas Island        | 12-Jul-95                  | Class A  | 49°11'N, 126°01'W (Ahou Bay)  | 5,788.00                        | Protect the natural values associated with the temperate rainforest on the west coast of Vancouver Island                                      |
| Sulphur Passage      | 12-Jul-95                  | Class A  | 49°24.50'N, 126°04'W  | 2,298.60                        | Protect an entire island of coastal temperate rainforest and the surrounding marine environment  |
| Epper Passage        | 12-Jul-95                  | Class A  | 49°13'N, 125°57'W   | 306.3                           | Protect the natural values associated with a fast water marine ecosystem   |
| Dawley Passage       | 12-Jul-95                  | Class A  | 49°09'N, 125°48'W   | 154.1                           | Protect the natural values associated with a fast water marine ecosystem   |
| Strathcona           | 1-Mar-11                   | Class A (both Shelter Inlet and Herbert Inlet) | 49°26.00'N, 126°21.50'W (Shelter Inlet);<br>49°25.00'N, 125°54.40'W (Herbert Inlet) | 245,779.00                      | Conservation role in both protecting the unspoiled wilderness of Vancouver Island mountain ranges and preserving special features              |
| Cleland Island       | 4-May-71                   | Ecological reserve                             | 49°11'N, 126°01'W (within Vargas Island MPA)  | 7.7                             | Protect habitat of breeding populations of numerous species of seabirds, many of which are rare and endangered                                 |
| Megin River          | 9-Jul-81                   | Ecological reserve                             | 49°26.00'N, 126°21.50'W (within Shelter Inlet)                                      | 50                              | Preserve rich alluvial site that supports an old growth Sitka spruce and western red cedar forest  |

Often, visitors in Clayoquot Sound are unaware of MPA boundaries because of a lack of signage, lack of education material and marine charts missing park borders. Nautical

charts are commissioned by the Canadian Hydrographic Service (CHS), a division of the DFO, and despite efforts from the Ministry of Forests, Lands, and Natural Resource Operations to have provincially designated parks be included in CHS-produced maps, marine maps still only show federal park boundaries, with the exception of Gibson Marine Provincial Park (C. Short pers. com.). MPAs have been used all over the world to protect and conserve marine mammals and their habitats with varying degrees of success (Wiley *et al.* 2008, Gormley *et al.* 2012, Schofield *et al.* 2013), often implemented in an *ad hoc* manner and based on subjective ecological records (Dunham *et al.* 2002, Malcolm 2003, Short 2005). A network of coastal MPAs in Clayoquot Sound, if minimally altered to reflect ecological data, cover 97% of foraging whale encounters and can serve as an effective measure to protect gray whale foraging habitat (Short 2005). Short (2005) demonstrated that MPAs could be designed for wide-ranging marine animals by using data on primary production, prey dispersion, and foraging patterns of a focal species. Potential disturbances in important feeding grounds in this study area can be minimized through management of human activities. However, the motivations behind MPA design are often constrained by limited time, funds, and political will, and there are no known MPAs in the world designed around the spatial movements of a single species (C. Short pers. com.).

Commercial whale-watching activities are controlled and managed through a variety of national, provincial, and regional laws and guidelines. The use, both consumptive and nonconsumptive, of marine mammals is legislated through the federal *Marine Mammal Regulations* of the *Fisheries Act*, the *Oceans Act*, the *Canada Wildlife Act*, the *Canada National Marine Conservation Areas Act*, and the *Species at Risk Act*. In Clayoquot Sound, whale-watching activities occur within the boundaries of a national park, ecological reserves, provincial parks, or marine protected areas, where marine mammals are subject to the protection of the variety of related federal and provincial Acts, including the *Protected Areas of British Columbia Act*, the *Ecological Reserve Act*, the *Park Act*, the *Wildlife Act*, and the *Environment and Land Use Act*. Historically, the local operators themselves have driven the management and regulation of whale-watching activities. The Tofino industry is largely self-regulated despite no formal industry operator association, and Chapter Three will further investigate the results of this self-maintenance. For whale-watching activities, in addition to national voluntary *Be Whale Wise* guidelines some Tofino drivers still choose to operate by



local regulations produced in 1995 by local operators and researchers. Forthcoming amendments to the *Marine Mammal Regulations* will provide governmental support for at least two of these guidelines, but regardless of the basis for enforcement, high compliance of ecologically based rules should be a primary goal of industry managers.

### **MANAGEMENT SUGGESTIONS FOR CLAYOQUOT SOUND, B.C.**

After reviewing common methods of whale-watching management around the globe in light of current whale-watching practices and regulations in Canada, some approaches to managing tourist interactions may be more applicable to Clayoquot Sound than others. Wildlife tourism is dynamic, and management decisions that are appropriate for the stage that the local industry is in will be the most effective. Tofino operations have reached a peak and since matured, based on tourist numbers (D. Duffus pers. com., R. Palm pers. com.). B.C. whale-watching tourists are generalists, only 18.1% of whale-watchers travelled to Tofino specifically to take part in whale-watching activities (Malcolm 2003). This is likely the result of a combination of factors, including increased accessibility, greater popularity, and that the activity itself requires no specific skills, prior education or high level of physical fitness, yet it is relatively inaccessible without a vessel and an experienced driver. With a site dominated by generalist tourists, the types of tours offered and infrastructure diversified, as seen in Tofino with bear watching tours, hot springs day trips, accommodation, and floatplane package deals. Based on Duffus and Dearden's (1990) nonconsumptive wildlife management model, this indicates that these types of tourists are heavily reliant on developed infrastructure and interpretation. This is a crucial point in the evolution of a wildlife tourism site, as the community and ecosystems both may become stressed to the point of requiring management intervention (Duffus & Dearden 1990).

The primary goal of whale-watching management is to minimize the adverse impacts on cetacean species. The Tofino whale-watching industry abides by a number of industry management suggestions to do this, but is lacking in other areas. After reviewing management measures that have been effective for other maritime operations, some are more applicable to B.C. than others.

Tofino-based boat drivers have long been respected for their whale-conscious boating behaviour. Since the early 1990s, local operators expressed a desire for guidelines based on

local research (Rod Palm pers. com) and have self-regulated boat behaviour and interactions with cetaceans when on the water through peer pressure, meetings at the beginning of the season (or during, if there is an issue – Malcolm 2003), and willingness to cooperate with provincial and federal levels of government. Both Tofino and Victoria-based whale-watch companies encourage their naturalists and boat drivers to take the naturalist course taught by marine researchers from the Society for Ecological and Coastal Research (SEACR, a non-profit organization run by the Whale Research Lab), one that is recognized by professional whale-watching operators along the coast.

The *Be Whale Wise* guidelines and proposed amendments to the MMR promote precautionary management practices, though the uncertainty of current research regarding the short- and long-term impacts of vessels on cetaceans indicates that precautionary measures are instead ‘pseudo-precautionary’. The delayed action to amend the long-outdated MMR indicates DFO’s unwillingness to participate in the management of whale-watching activities. This is consistent with their reluctance to become involved in the 1980s and 1990s, believing the industry was merely a phase and would eventually pass (D. Duffus pers. com.). When the revised MMR are enacted, DFO will have enforcement authority over both commercial and recreational boaters within Canadian waters.

Licensing is a form of management that is unlikely to be enacted in B.C. in the near future. The idea has been presented at various times over the past two decades – most recently in the proposed MMR amendments – and operators have expressed hesitation and concern on the effects of licensing being introduced to an already established and mature industry (D. Duffus pers. com., Canada Gazette 2012). Proponents argue that legal licenses allow for violators of marine mammal regulations to be punished through fines or revoked permits while simultaneously controlling the number of operators in a given area (IWC 2012). Operators in Tofino, however, are largely compliant of present guidelines, so this management strategy may not increase the already high compliance rates of local drivers (pers. obs., see results of Chapter Three).

Of the management techniques that are effective in other whale-watching communities, some may be useful in this study area. In particular, spatial and temporal restrictions are largely unexplored for managing marine mammals in Clayoquot Sound. Coupled with the extensive whale distribution research produced by the Whale Research

Lab, consistently productive gray whale foraging areas, or ‘hot spots’, can be protected from human perturbations. Closing off productive feeding areas to boats will allow whales to forage without vessels present. These closures could be coupled with temporal restrictions as well, so as not to permanently ban all water traffic from an area. Specific weeks, months, or seasons may see stricter spatial limitations, for example during migration of mother and calf pairs, or when whales are present in multiple foraging sites. A period of time in the middle of the day may be set aside for no whale-watching activities, so as to prevent individual whales from experiencing prolonged periods of continuous whale-watching activities. Introducing spatial or temporal restrictions would be a pseudo-precautionary measure, as the long-effects of whale-watching on baleen whales are poorly understood and generally unknown (Christiansen & Lusseau 2014).

Activities that have the potential to alter local ecosystems should be prohibited. The protection of prime foraging habitat may allow gray whales in the area to persist, supports the whale-watching industry that is based upon it. In Clayoquot Sound, logging of old growth forests, exploratory copper mining, and multiple fish farm pens are recent threats to current ecosystem health (Friends of Clayoquot Sound 2014). Activities such as log sorting and barging have the potential to alter the substrate, and chemistry of nearshore habitat (Moring 1982, Davies & Nelson 1992, Fuchs *et al.* 2003). Similarly, mining activity can create water chemistry issues and increased sediment, noise, and chemical pollution from run-off and ship traffic along the coastline, in and around prime whale foraging areas (Castilla & Nealler 1978, Marsden & DeWreede 2000, Burd 2002, Carr *et al.* 2003). Despite this, there has been no discussion about the effect these activities may have on this coastal species of whale and the enormous tourism industry based upon their presence.

In order for management to be effective, it needs to be adaptive and based on the most up-to-date science available. Site-specific solutions are key, and the least costly, most efficient way to access the information required to make such decisions is for governments to collaborate with local operators and drivers who live and experience the phenomena that is to be managed (Duffus & Dearden 1990, Clarkson 2001, Higham *et al.* 2014). Wildlife is not static, nor should wildlife management be; guidelines must be reviewed and adapted to be relevant. Tofino is an example of successful self-regulation, which is much less difficult and expensive than enforcement. For the town to continue to be a leading example in industry

management success, additional boater restrictions should be considered, such as spatial restrictions in primary foraging areas and temporal restrictions at peak foraging periods.

## **CONCLUSION**

Overall, the future of whale-watching regulations will depend on the research committed to the anthropogenic effects of vessels on cetaceans that can only result from thorough, long-term studies dedicated to an ecosystem-based approach to management. Whale-watch operators in Clayoquot Sound have been proactive in taking measures to minimize impacts of vessel traffic on gray whales, pinnipeds and shore birds, and evidence of the unsustainable management of tourist interactions with wild marine animals is growing. With the impending release of the updated marine mammal viewing regulations, federal legislation is finally addressing pressures to mitigate the impacts of tourism on wild cetaceans.

The purpose of this chapter was to review the management of commercial whale-watching practices in other maritime communities around the world, Canada, and Clayoquot Sound. With an understanding of existing guidelines and legislation, appropriate management recommendations can be devised after reviewing the current state of the Tofino whale-watching industry and the ecological history of the gray whale. A combination of regulating boating behaviour, education of both naturalists and tourists, and continuous monitoring of site-specific ecology and species life history will be central to creating an effective management regime that can be adapted to a variety of wildlife tourism outfits worldwide.

## LITERATURE CITED

- Acevedo-Guitierrez, A., Acevedo, L., Belonovich, O. and L. Boren. 2010. How effective are posted signs to regulate tourism? An example with New Zealand fur seals. *Tourism in Marine Environments*, 7(1):39-41.
- Allen, S.J. 2014. From exploitation to adoration: the historical and contemporary contexts of human-cetacean interactions. In *Whale-Watching: Sustainable Tourism and Ecological Management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: New York, New York, United States of America. 31-47.
- Allen, M.C. and A.J. Read. 2000. Habitat selection of foraging bottlenose dolphins in relation to boat density near Clearwater, Florida. *Marine Mammal Science*, 16:81-824.
- Ashe, E., Wray, J., Picard, C.R. and R. Williams. 2013. Abundance and survival of Pacific Humpback whales in a proposed critical habitat area. *Public Library of Science ONE*, 8(9):e75228
- Bain, D.E. and M.E. Dahlheim. 1994. Effects of masking noise on detection thresholds of killer whales. In *Marine mammals and the Exxon Valdez*: 243-256. (Ed. T.R. Loughlin). Academic Press: San Diego, California, United States of America.
- Baker, C.S. and L.M. Herman. 1989. Behavioural responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. Final report to the National Park Service, Alaska Regional Office, Anchorage, Alaska.
- Bass, J. 2000. Variations in gray whale feeding behaviour in the presence of whale-watching vessels in Clayoquot Sound, 1993-1995. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- B.C. Parks. 2002. Clayoquot Sound Provincial Parks. Brochure by the Ministry of Water, Land and Air Protection. 3pp.
- B.C. Parks. 2007. Provincial Marine Protected Areas in British Columbia. 4pp.
- Bejder, L., Samuels, A., Whitehead, H. and N. Gales. 2006. Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour*, 72:1149-1158.
- Biosphere Reserves. 2013. Biosphere reserves – learning sites for sustainable development. Ecological Sciences for Sustainable Development, UNESCO. Retrieved on December

- 11, 2013, from <http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/>
- Blane, J.M. and R. Jaakson. 1994. The impact of ecotourism boats on the St. Lawrence beluga whales. *Environmental Conservation*, 21(3):267-269.
- Bryant, L. 1994. *Report to Congress on results of feeding wild dolphins: 1989-1994*. United States National Marine Fisheries Service.
- Burd, B.J. 2002. Evaluation of mine tailings effects on a benthic marine infaunal community over 29 years. *Marine Environmental Research*, 52(5):681-519.
- Canada Gazette. 2012. Regulations Amending the Marine Mammal Regulations. 146(12). Retrieved February 7, 2014, from <http://www.gazette.gc.ca/rp-pr/p1/2012/2012-03-24/html/reg2-eng.html>
- Carlson, C. 2011a. A review of whalewatch guidelines and regulations around the world. Retrieved April 20, 2013, from [http://iwcoffice.org/\\_documents/sci\\_com/WWREGS%202011.pdf](http://iwcoffice.org/_documents/sci_com/WWREGS%202011.pdf). 210pp.
- Carlson, C. 2011b. An analysis of whalewatch guidelines and regulations around the world. Retrieved April 20, 2013, from <http://iwc.int/cache/downloads/52vivsa7zxsskocsc0ckokok8/SC-64-WW5.pdf>. 6pp.
- Carr, R.S. Nipper, M. and G.S. Plumlee. 2003. Survey of marine contamination from mining-related activities on Marinduque Island, Philippines: porewater toxicity and chemistry. *Aquatic Ecosystem Health & Management*, 6(4):369-379.
- CBC. 2013. Killer whale conviction in Campbell River. Retrieved April 16, 2013, from <http://www.cbc.ca/news/canada/british-columbia/story/2013/01/10/bc-whale-harass-sentence.html>
- Chen, C.L. 2011. From catching to watching: Moving towards quality assurance of whale/dolphin watching tourism in Taiwan. *Marine Policy*, 35:10-17.
- Choi, M.A. 2010. Whale-watching or whaling-watching? Contradictory perceptions of whale-watching tourism in Jangsaengpo, South Korea. Unpublished M.Sc. thesis, King's College, London.
- Christiansen, F. Rasmussen, M. and D. Lusseau. 2013. Whale watching disrupts feeding activities of minke whales on a feeding ground. *Marine Ecology Progress Series*, 478:239-251.

- Christiansen, F. and D. Lusseau. 2014. Understanding the ecological effects of whale-watching on cetaceans. In *Whale-Watching: Sustainable Tourism and Ecological Management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: New York, New York, United States of America. 177-192.
- Clarkson, P. 2001. Applying precautionary principles to marine wildlife viewing in Pacific Rim National Park. In *Viewing Marine Mammals in the Wild*, a collection of summaries by Spradlin, Nitta, Lewandowski, Barre, Brix and Norberg, from the pre-conference workshop at the 14<sup>th</sup> Biennial Conference on the Biology of Marine Mammals.
- Condit, C. and P. Jones. 2013. Watching gray whales. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1):52-60.
- Constantine, R. 2001. Increased avoidance of swimmers by wild bottlenose dolphins (*Tursiops truncatus*) due to long-term exposure to swim-with-dolphin tourism. *Marine Mammal Science*, 17(4):689-702.
- Constantine, R. 2014. Whale-watching and behavioural ecology. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 193-205.
- Constantine, R., Brunton, D.H. and T. Dennis. 2004. Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behaviour. *Biological Conservation*, 117:299-307.
- Corkeron, P.J. 2006. How shall we watch whales? In *Gaining Ground: In Pursuit of Ecological Sustainability*. (Ed. D.M. Lavigne). International Fund for Animal Welfare. Guelph, Canada, and the University of Limerick, Limerick, Ireland. 161-170.
- Corkeron, P.J. 2014. Human attitudes and values: tradition and transformation and zombies. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 193-205.
- Crawford-Brown, D. and S. Crawford-Brown. 2011. The precautionary principle in environmental regulations for drinking water. *Environmental Science & Policy*, 14:379-387.

- Croll, D.A., Clark, C.W., Calambokidis, J., Ellison, W.T. and B.R. Tershy. 2001. Effect of anthropogenic low-frequency noise on the foraging ecology of *Balaenoptera* whales. *Animal Conservation*, 4:13-27.
- Cunningham, P.A., Huijbens, E.H. and S.L. Wearing. 2012. From whaling to whale-watching: Examining sustainability and cultural rhetoric. *Journal of Sustainable Tourism*, 20(1):143-161.
- Davies, P.E. and M. Nelson. 1994. Relationships between riparian buffer widths and the effects of logging on stream habitat, invertebrate community composition and fish abundance. *Australian Journal of Marine and Freshwater Research*, 45(7):1289-1305.
- Douglas, K. 2013. 'High probability' of disturbing whales in Discovery Passage enough to convict boater. Retrieved April 20, 2013, from <http://www.campbellrivermirror.com/news/166176346.html>
- Draheim, M., Bonnely, I., Bloom, T., Rose, N. and E.C.M. Parsons. 2010. Tourist attitudes towards marine mammal tourism: An example from the Dominican Republic. *Tourism in Marine Environments*, 6(4):175-183.
- Duffus, D.A. 1989. Non-consumptive use and management of cetaceans in British Columbia coastal waters. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Duffus, D.A. 1996. The recreational use of grey whales in southern Clayoquot Sound, Canada. *Applied Geography*, 16(3):179-190.
- Duffus, D.A. and P. Dearden. 1989. *A Perspective on Whale-Watching and Tourism in British Columbia*. Unpublished contract report to the B.C. Ministry of Tourism, Victoria, B.C.
- Duffus, D.A. and P. Dearden. 1990. Non-consumptive wildlife-oriented recreation: a conceptual framework. *Biological Conservation*, 53:213-231.
- Duffus, D.A. and P. Dearden. 1992. Whales, science, and protected area management in British Columbia, Canada. *The George Wright Forum*, 9(3-4):79-87.
- Dunham, J.S., Zacharias, M.A., Biffard, D.R., Westmacott, S.E., Dunham, K.A. and C. Ogorne. 2002. Provincial Marine Protected Areas in British Columbia. Decision Support Services Ministry of Sustainable Resource Management, Victoria, B.C.



- Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science*, 18(2):394-418.
- Fisheries and Oceans Canada. 2010. Management plan for the Eastern Pacific Grey Whale (*Eschrichtius robustus*) in Canada [Final]. *Species at Risk Act Management Plan Series*. Fisheries and Oceans Canada, Ottawa. 69pp.
- Fisheries and Oceans Canada. 2013. Be whale wise: Marine wildlife guidelines for boaters, paddlers and viewers. Retrieved February 7, 2014, from <http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/mammals-mammiferes/view-observer-eng.htm>
- Ford, J.K.B. and R.R. Reeves. 2008. Fight or flight: Antipredator strategies of baleen whales. *Mammal Review*, 38(1):50-86.
- Forestell, P.H. 1990. Marine education and ocean tourism: Replacing parasitism with symbiosis. In *Proceedings of the 1990 Congress on Coastal and Marine Tourism Vol. 1*. (Eds. M.L. Miller and J. Auyong). National Coastal Resources Research Institute: Corvallis, OR, United States of America.
- Fortuna, C.M. 2006. Ecology and conservation of bottlenose dolphins (*Tursiops truncatus*) in the North-Eastern Adriatic Sea. Ph.D. thesis, University of St. Andrews, United Kingdom.
- Friends of Clayoquot Sound 2014. *Friends of Clayoquot Sound Winter News 2014*. Retrieved Dec 23, 2014 from [http://focs.ca/wp-content/uploads/2014/11/FOCS\\_Winter\\_News\\_2014.pdf](http://focs.ca/wp-content/uploads/2014/11/FOCS_Winter_News_2014.pdf)
- Fuchs, S.A., Hinch, S.G. and E. Mellina. 2003. Effects of stream-side logging on stream macroinvertebrate communities and habitat in the sub-boreal forests of British Columbia, Canada. *Canadian Journal of Forest Research*, 33(8):1408-1415.
- Giles, D.A. and K.L. Koski. 2012. Managing vessel-based killer whale watching: a critical assessment of the evolution from voluntary guidelines to regulations in the Salish Sea. *Journal of International Wildlife Law & Policy*, 15:125-151.
- Gormley, A.M, Slooten, E., Dawson, S., Barker, R.J., Rayment, W., du Fresne, S. and S. Bäger. 2012. First evidence that marine protected areas can work for marine mammals. *Journal of Applied Ecology*, 49:474-480.

- Hall, K.D. 1990. The convention on international trade in endangered species: fifteen years later. *Loyola of Los Angeles International and Comparative Law Review*, 13(2):231-278.
- Harrigan, K.R. 1985. Vertical integration and corporate strategy. *Academy of Management Journal*, 28(2), 397-425.
- Higham, J.E.S. and D. Lusseau. 2007. Urgent need for empirical research into whaling and whale watching. *Conservation Biology*, 21:554-558.
- Higham, J.E.S. and L. Bejder. 2008. Managing wildlife-based tourism: edging slowly towards sustainability? *Current Issues in Tourism*, 11(1):75-83.
- Higham, J.E.S. and D. Lusseau. 2008. Slaughtering the goose that lays the golden egg: are whaling and whale-watching mutually exclusive? *Current Issues in Tourism*, 11(1):63-74.
- Higham, J.E.S., Bejder, L. and D. Lusseau. 2009. An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. *Environmental Conservation*, 35(4):294-302.
- Higham, J.E.S. and E.J. Shelton. 2011. Tourism and wildlife habituation: reduced population fitness or cessation of impact? *Tourism Management*, 32:1290-1298.
- Higham, J.E.S., Bejder, L. and R. Williams. 2014. Time to rethink: fostering the nascent 'sustainability paradigm'. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 365-378.
- Horsfield, M. 2008. *Voices from the Sound: Chronicles of Clayoquot Sound and Tofino, 1899-1929*. Salal Books: Sechelt, British Columbia, Canada. 365pp.
- Hoyt, E. 2001. Whale watching 2001. World wide tourism numbers, expenditures and expanding socioeconomic benefits. IFAW.
- Hoyt, E. 2011. *Marine Protected Areas for Whales, Dolphins, and Porpoises: A World Handbook for cetacean habitat conservation and planning*. Routledge: London, United Kingdom. 492pp.
- IWC. 2012. Five Year Strategic Plan for Whalewatching 2011-2016. Last updated October 2012, retrieved on March 8, 2014 from <http://iwc.int/cache/downloads/61pp7v1qdn4sss40ow88kgso4/AC->

- Jamieson, G.S. and C.O. Levings. 2001. Marine protected areas in Canada – implications for both conservation and fisheries management. *Canadian Journal of Fisheries and Aquatic Sciences*, 58:138-156.
- Jett, J., Thapa, B. and R. Swett. 2013. Boater speed compliance in manatee zones: Examining a proposed predictive model. *Society and Natural Resources*, 26:95-104.
- Johnson, G. and C. McInnis. 2014. Whale-watching: an effective education program is no fluke. In *Whale-Watching: Sustainable Tourism and Ecological Management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: New York, New York, United States of America. 128-146.
- Kessler, M. and R. Harcourt. 2010. Aligning tourist, industry and government expectations: a case study from the swim with whales industry in Tonga. *Marine Policy*, 34:1350-1356.
- Kessler, M. and R. Harcourt. 2013. Whale watching regulation compliance trends and the implications for management off Sydney, Australia. *Marine Policy*, 42:14-19.
- Kuo, H.-I., Chen, C.-C. and M. McAleer. 2012. Estimating the impact of whaling on global whale-watching. *Tourism Management*, 33(6):1321-1328.
- Lachmuth, C.L., Barrett-Lennard, L.G., Steyn, D.Q. and W.K. Milsom. 2011. Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. *Marine Pollution Bulletin*, 62:792-805.
- Lien, J. 2001. The conservation basis for the regulation of whale watching Canada by the Department of Fisheries and Oceans: A precautionary approach. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2363.
- Lusseau, D. 2003. Male and female bottlenose dolphins *Tursiops* spp. In Milford Sound, New Zealand, is related to boat traffic. *Marine Ecology Progress Series*, 295:265-272.
- Lusseau, D. 2004. The hidden cost of tourism: Detecting long-term effects of tourism using behavioral information. *Ecology and Society*, 9(1). Retrieved July 15, 2010, from <http://www.ecologyandsociety.org/vol9/iss1/art2>

- Lusseau, D. 2005. Residency pattern of bottlenose dolphins *Tursiops* spp. In Milford Sound, New Zealand, is related to boat traffic. *Marine Ecology Progress Series*, 295:265-272.
- Lusseau, D. and J.E.S. Higham. 2004. Managing the impacts of dolphin-based tourism through the definition of critical habitats: The case of bottlenose dolphins (*Tursiops* spp.) in Doubtful Sound, New Zealand. *Tourism Management*, 25(5):657-667.
- Lusseau, D., Slooten, L. and R.J.C. Currey. 2006. Unsustainable dolphin-watching tourism in Fiordland, New Zealand. *Tourism in Marine Environments*, 3(2):173-178.
- Malcolm, C.D. 2003. The current state and future prospects of whale-watching management, with special emphasis on whale-watching in British Columbia. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Malcolm, C.D. and E. Lochbaum 1999. *Human /marine mammal interaction workshop proceedings*, University of Victoria, April 13-15. Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C.
- Malcolm, C.D. and H.C. Penner. 2011. Behaviour of belugas in the presence of whale-watching vessels in Churchill, Manitoba and recommendations for local beluga watching activities. In: *Polar tourism: Environmental, political and social dimensions*. (Eds. P.T. Maher, E.J. Stewart & M. Lück). Cognizant Communications: New York, United States of America. 54-79.
- Marsden, A.D. and R.E. DeWreede. 2000. Marine macroalgal community structure, metal content and reproductive function near an acid mine drainage outflow. *Environmental Pollution*, 110(3):431-440.
- Mitchell, B. 2002. *Resource and Environmental Management*. (2<sup>nd</sup> ed.). Pearson Education Limited: Essex, England.
- Marine Mammal Working Group (MMWG). 2012. Retrieved Jan 22, 2013, from <http://www.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/publications/2-eng.htm>
- Moring, J.R. 1982. Decrease in stream gravel permeability after clear-cut logging: an indication of intragravel conditions for developing salmonid eggs and alevins. *Hydrobiologia*, 88(3):295-298.

- NOAA. 2013. Public Display of Marine Mammals. Last updated December 17, 2013, and retrieved March 8, 2014, from [http://www.nmfs.noaa.gov/pr/permits/public\\_display.htm](http://www.nmfs.noaa.gov/pr/permits/public_display.htm)
- Nowacek, S.M., Wells, R.S. and A.R. Solow. 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. *Marine Mammal Science*, 17:672-688.
- O'Connor, S., Campbell, R., Cortes, H. and T. Knowles. 2009. Whale watching worldwide: tourism numbers, expenditures and expanding economic benefits. Special Report from the International Fund for Animal Welfare. Economists at Large: Yarmouth, Massachusetts, United States of America.
- Orams, M.B. 1996a. A conceptual model of tourist-wildlife interaction: the case for education as a management strategy. *Australian Geographer*, 27:39-51.
- Orams, M.B. 1996b. Using interpretation to manage nature-based tourism. *Journal of Sustainable Tourism*, 4(2):81-94.
- Orams, M.B. 2000. Tourists getting close to whales, is it what whale-watching is all about? *Tourism Management*, 21:561-569.
- Orams, M.B. 2001. From whale hunting to whale watching in Tonga: a sustainable future? *Journal of Sustainable Tourism*, 9(2):128-146.
- Orams, M.B. 2002. Humpback whales in Tonga: a economic resource for tourism. *Coastal Management*, 30:361-80.
- Orams, M.B. and G.J.E. Hill. 1998. Controlling the ecotourist in a wild dolphin feeding program: is education the answer? *Journal of Environmental Education*, 29(3):33-38.
- Parks Canada. 2003. Pacific Rim National Park Reserve Marine Mammal Viewing Regulations. The National Parks and National Historic Sites of Canada. Parks Canada, Ottawa, Ontario, Canada.
- Parks Canada. 2013. Business Licenses. Retrieved February 4, 2014, from <http://www.pc.gc.ca/eng/pn-np/bc/pacificrim/activ/activ13/activ13a.aspx>
- Parsons, E.C.M., Fortuna, C.M., Ritter, F., Rose, N.A., Simmonds, M.P., Weinrich, M., Williams, R. and S. Panigada. 2006. Glossary of whalewatching terms. *Journal of Cetacean Research and Management*, 8(Suppl.):249-251.

- Pike, G.C. 1962. Migration and feeding of the gray whale (*Eschrichtius gibbosus*). *Journal of the Fisheries Research Board of Canada*. 19:815-838.
- Powell, R.B. and S.H. Ham. 2008. Can ecotourism interpretation really lead to pro-conservation knowledge, attitudes and behaviour? Evidence from the Galapagos Islands. *Journal of Sustainable Tourism*, 16(4):467-489.
- Richter, C. 2002. Sperm whales at Kaikoura and the effects of whale-watching on their surface and vocal behaviour. Ph.D. thesis, University of Otago, Dunedin, New Zealand.
- Richter, C., S. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. *Marine Mammal Science*, 22(1):46-63.
- Rural B.C. 2013. Resort Municipality Initiative Funding Program. Ministry of Jobs tourism and Skills Training, Economic Development Division. Retrieved February 4, 2014, from [http://www.ruralbc.gov.bc.ca/about/RMI/RMI\\_Funding.html](http://www.ruralbc.gov.bc.ca/about/RMI/RMI_Funding.html)
- Schaffar, A., Madon, B., Garrigue, C. and R. Constantine. 2009. Avoidance of whale watching boats by humpback whales in their main breeding ground in New Caledonia. Scientific Committee of the International Whaling Commission, Madeira.
- Schaffar, A., Garrigue, C. and R. Constantine. 2010. Exposure of humpback whales to unregulated whale-watching activities in their main reproductive area in New Caledonia. *Journal of Cetacean Research and Management*, 11(2):147-152.
- Scheer, M. 2010. A review of self-initiated behaviors of free-ranging cetaceans directed towards human swimmers and waders during open water encounters. *Interaction Studies*, 11(3):442-466.
- Schindler, D. E. 2014. *Prediction, the precautionary principle, and managing ecosystems under global change*. Presentation in the Department of Biology 2013-2014 Seminar Series, March 7, 2014.
- Schofield, G., Scott, R., Dimadi, A., Fossette, S., Katselidis, K.A., Koutsoubas, D., Lilley, M.K.S., Pantis, J.D., Karagouni, A.D. and G.C. Hays. 2013. Evidence-based marine protected area planning for a highly mobile endangered marine vertebrate. *Biological Conservation*, 161:101-109.
- Short, C.J. 2005. A multiple trophic level approach to assess ecological connectivity and boundary function in marine protected areas: a British Columbia example. M.Sc. thesis, University of British Columbia, Canada.

- Species at Risk Act. 2013. S.C. 2002, c. 29. Last updated on March 8, 2013. Retrieved November 11, 2014, from the Department of Justice Canada website <http://laws-lois.justice.gc.ca/eng/acts/S-15.3/>
- Spradlin, T.R., Nitta, E.T., Lewandoski, J.K., Barre, L.M., Brix, K. and B. Norberg. 2001. Viewing marine mammals in the wild: a workshop to discuss responsible guidelines and regulations for minimizing disturbance. A pre-conference workshop held before the 14<sup>th</sup> Biennial Conference on the Biology of Marine Mammals. Vancouver, British Columbia, Canada.
- Statistics Canada. 2011. Census Profile of Tofino. Statistics Canada. Retrieved February 4, 2014, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=5923025&Geo2=CD&Code2=5923&Data=Count&SearchText=tofino&SearchType=Begins&SearchPR=01&B1=All&Custom=&TABID=1>
- Strawberry Isle Research. 1995. *Tofino Whale Watching Operators' Voluntary Guidelines*. Tofino, B.C., Canada.
- Tilt, W. 1985. *Whalewatching in California: an industry profile*. Yale School of Forestry and Environmental Studies: New Haven, Connecticut, United States of America.
- Tremblay, P. 2001. Wildlife tourism consumption: consumptive or non-consumptive? *International Journal of Tourism Research*, 3, 81-86.
- Trites, A., Hopchaka, W. and S. Carter. 1996. *Killer whales and vessel activity in Robson Bight from 1991 to 1994*. Unpublished Report to B.C. Parks, Marine Mammal Research Unit, University of British Columbia.
- Tseng, Y., Huang, Y., Kyle, G.T. and M. Yang. 2011. Modeling the impacts of cetacean-focused tourism in Taiwan: Observations from cetacean watching boats: 2002-2005. *Environmental Management*, 47:56-66.
- Tyne, J., Loneragan, N. and L. Bejder. 2014. The use of area-time closures as a tool to manage cetacean-watch tourism. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 242-260.
- UNESCO. 2007. Biosphere Reserve Information – Canada – Clayoquot Sound. MAP Biosphere Reserves Directory, United Nations Educational, Scientific and Cultural

Organization. Last updated May 10, 2007. Retrieved August 18, 2014, from <http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=all&code=CAN+07>

- Visser, F., Hartmann, K.L., Rood, E.J.J., Hendricks, A.J.E., Zult, D.B., Wolff, W.J., Huisman, J. and G.J. Pierce. 2010. Risso's dolphins alter daily resting pattern in response to whale watching at the Azores. *Marine Mammal Science*, 27(2):366-381.
- Wiley, D.N., Moller, J.C., Pace III, R.M. and C. Carlson. 2008. Effectiveness of voluntary conservation agreements: Case study of endangered whales and commercial whale watching. *Conservation Biology*, 22(2):450-457.
- Williams, R., Trites, A.W. and D.E. Bain. 2002. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology*, 256:255-270.
- Williams, R., Lusseau, D. and P.S. Hammond. 2009. The role of social aggregations and protected areas in killer whale conservation: the mixed blessing of critical habitat. *Biological Conservation*, 142:709-719.
- Zeppel, H. and S. Muloin. 2014. Green messengers or nature's spectacle: understanding visitor experiences of wild cetacean tours. In *Whale-Watching: Sustainable Tourism and Ecological Management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: New York, NY, United States of America. 110-127.



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## CHAPTER THREE

### **How the ecological scenario affects whale-watching practices: a case study in Clayoquot Sound, British Columbia**

#### **INTRODUCTION**

Whale-watching has been a major tourist venture in Tofino and Ucluelet for over three decades. Research into combining social and ecological aspects management of wildlife viewing has been stressed since the early 1970s, including the effects of whale-watching (Duffus & Dearden 1990, Forestell & Kaufman 1993, Reynolds & Braithwaite 2001). The two main components of whale-watching are the social dimension and the ecological dimension. The integration of these dimensions is the central purpose of managing wildlife tourism activities. Human dimensions include management, economics, participation, tourism and recreation development, and a socioeconomic profile of the visitor, including demographics, motives, expectations, satisfaction, level of previous experience, and value orientations (Duffus 1989, Malcolm 2003, Christensen *et al.* 2007, Malcolm & Duffus 2008, Mustika *et al.* 2013). Ecological aspects include oceanic factors such as temperature, salinity, upwelling, sunlight, and other regimes that interact with an animal's life history (Duffus 1989, Christiansen *et al.* 2013). Whale-watching is only a viable tourism option and business venture when there is a predictable and accessible occurrence of whales (Duffus & Dearden 1993). The question is, do commercial whale-watching activities change in response to changing ecological factors related to whale presence? If so, should whale-watching practices be managed to reflect this?

A typical whale-watching day has never been examined in this area before, and the purpose of this research was to determine what pressure whales experience from commercial whale-watching, and what vessel behaviour looks like with an ecological perspective. This was tested over a period of two field seasons. First, I review the ecological factors that contribute the gray whale presence in Clayoquot Sound before defining my research goals. From this, trends associated with industry activity that managers may not be aware of are discussed.

## **Ecological Foundations**

Gray whales are capital breeders, feeding and reproducing at two different periods in time and in different latitudes (Costa 1993, Christiansen *et al.* 2013). During summer months, it is critical that whales restore their energy reserves in productive waters at high latitudes in order to successfully breed and calve in lower latitudes through the winter.

The number of gray whales and their micro-scale distribution in Clayoquot Sound is dependent on prey availability. Foraging intensity is very closely linked to mysid abundance (Olsen 2006, Feyrer 2010, Burnham 2012, Feyrer & Duffus 2014), and determines the total number of whales and length of time they can be sustained. The Whale Research Lab (University of Victoria, in British Columbia, Canada) has determined that the mid-trophic level, in contrast to top-down or bottom-up effects, primarily drives the underlying ecological foundation of the local marine system of which gray whales are the apex predator. In a ‘wasp-waisted’ regime such as this, mid-trophic levels regulate the flow of energy between seasonal pulses of primary production and higher trophic-level species (Bakun 2006). However, the production of this system changes both inter-annually and intra-annually, and these fluctuations influence how many whales visit Clayoquot Sound, and for how long (Feyrer 2010, Burnham 2012). Additionally, changes in prey do not affect all individuals equally, and there are eleven whales that have high site-fidelity, or have been identified in the study area at least nine separate years between 1997 and 2013, and are loyal to the area even when prey is suboptimal (Clare in progress). In contrast, single-visit whales are seen more frequently when mysid populations are high, and are possibly taking advantage of a plentiful food source, but in comparison to returning whales, these single visitors spend less time in Clayoquot Sound before moving elsewhere.

Whale-watching activities occur every year regardless of whether whale and subsequently, prey numbers are high, low, or somewhere in between, and guides do not differentiate between single-visit or multiple-year whales (local research has only focused on photo-identification of killer whales, not gray whales). During the high tourist season, there may be as many as 25 whale-watching excursions each day. Despite potential disturbance from long whale-watching seasons lasting from March until October, some whales in Clayoquot Sound exhibit high site fidelity and return year after year, likely driven by the availability of prey.

Studies on the ecological impacts of whale-watching have produced varied results (Bass 2000, Croll *et al.* 2001, Malcolm 2003, Richter *et al.* 2006, Hickie *et al.* 2007), and long-term studies are still lacking, particularly for mysticetes (Christiansen *et al.* 2013). However, this research does not attempt to quantify whale reactions to certain boat behaviours. Instead, I quantify boat behaviours and industry pressure that whales are subjected to, and use these as indicators of changes in fleet behaviour. In this study, boat behaviours are directly linked to compliance of applicable marine mammal viewing regulations, and used as a measure of potentially disturbing behaviour. An overall boater compliance rate of 80% has been suggested as the minimum ‘acceptable’ threshold that may indicate a need for management intervention (Allen *et al.* 2007). Industry pressure is measured by the length of a whale-watching encounter, amount of time spent with industry boats in a given day (in a foraging bay, as well as engaged in an encounter), the population membership of the individual whale is being watched, the number of boats per whale per encounter, and the level of compliance between dedicated and non-dedicated operators. As whale-watching activities in Canada continue to expand without legislation for watching marine mammals, voluntary compliance is increasingly important and managing for the current socioeconomic as well as ecological scenario will be critical.

## **RESEARCH GOALS**

Both foraging and traveling gray whales can become the focus of a whale-watching tour in Clayoquot Sound, and studies on the effects of vessel traffic on gray whales and other mysticetes are lacking (Bass 2000, Christiansen *et al.* 2013). This study does not investigate the effects that boats may have on whales, but rather it presents the daily pressures that whales sustain when the focus of a whale-watching fleet during high tourist season. The purpose of this chapter is to determine what a typical whale-watching day in Clayoquot Sound looks like with an ecological perspective. To do this, two sub-questions were the drivers of this study:

1. What does boat behaviour look like with respect to whales?
2. What industry pressures do whales experience in terms of
  - a. Number of boats present
  - b. Dedicated versus non-dedicated companies
  - c. Length of encounter
  - d. Time spent with boats in foraging locations
  - e. Time spent with boats in a given day
  - f. Population membership

when the focus of commercial whale-watching?

To address the first sub-question, I created a measure of compliance to quantify boat behaviour. Rates of compliance on a scale of 0 to 1 were calculated for each of eight vessel behaviours (as defined in Appendix 3.1). Data were collected during boat-based surveys in 2012 and 2013, and it became apparent that whale presence varied significantly between the two seasons. As a result, I compared compliance variables from 2012 to 2013 to further investigate vessel behaviour and how it varied under different ecological circumstances.

To address the second sub-question, location and whale surveys were used to gain insight into the exposure of gray whales to whale-watching activity. The six variables – number of boats present, company type, length of encounter, time spent with boats in foraging locations, time spent with boats in a given day, and population membership – have been linked to both short-term and long-term changes in cetacean behaviour (Carlson 2011, Christiansen & Lusseau 2014, Constantine 2014). In order to determine whale-watching locations for surveys, within-season transects were used to determine locations of whales within the study area and thus possible whale-watching locations. In addition, VHF marine radio observations of whale sightings were recorded daily. Six indicators of industry pressure were measured and assessed against industry standards as well as compared from 2012 to 2013. These indicators were chosen to represent industry pressure based on associations with disturbance of behaviour in cetaceans (Schaffar *et al.* 2009, Visser *et al.* 2010, Lachmuth *et al.* 2011, Matsuda *et al.* 2011, Carlson 2011, Tseng *et al.* 2011, Fisheries and Oceans Canada 2013).

This study also relied on 17 years of ongoing data that show the average abundance of whales between seasons to demonstrate the availability of whales within range of whale-

watching fleet. The mean number of foraging whales per survey is used as a measure of foraging effort (Figure 3.1). Years of high foraging intensity are followed by at least one year of lower foraging effort, suggesting that mysid populations may take more than one season to recover to the point of being a worthwhile prey source for whales (Feyrer 2010, Burnham 2012). The 2012 season was considered a low whale year, as the mean number of whales (4.7) during the foraging season fell below the overall mean (7.1). In contrast, both the highest recorded number of whales in a single survey (n=38) and the highest mean number of whales, 18.0, occurred in 2013.

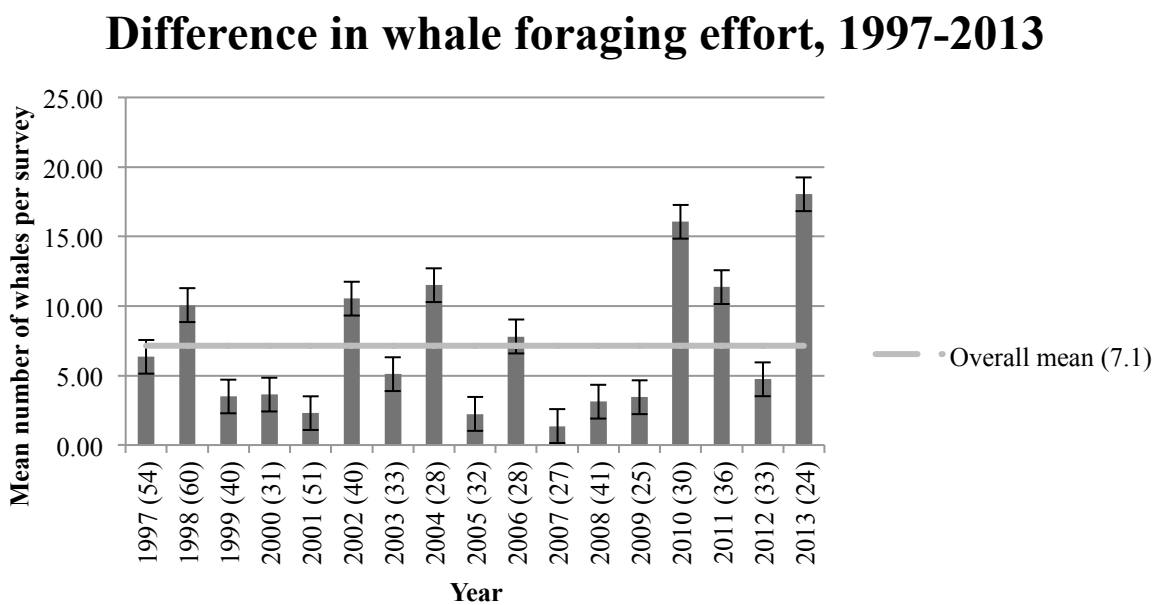


Figure 3.1. Bar chart showing the difference in gray whale foraging effort, 1997-2013. The overall mean number of whales is 7.1 and indicated by the dashed line. The number of surveys is noted in parentheses under each year. Error bars indicate standard error.

## METHODS

### Study Area

#### *Clayoquot Sound*

Clayoquot Sound is located on the mid-west coast of Vancouver Island, British Columbia, from 49°00'N, 125°20'W to 49°30'N, 126°35'W (Figure 3.2).

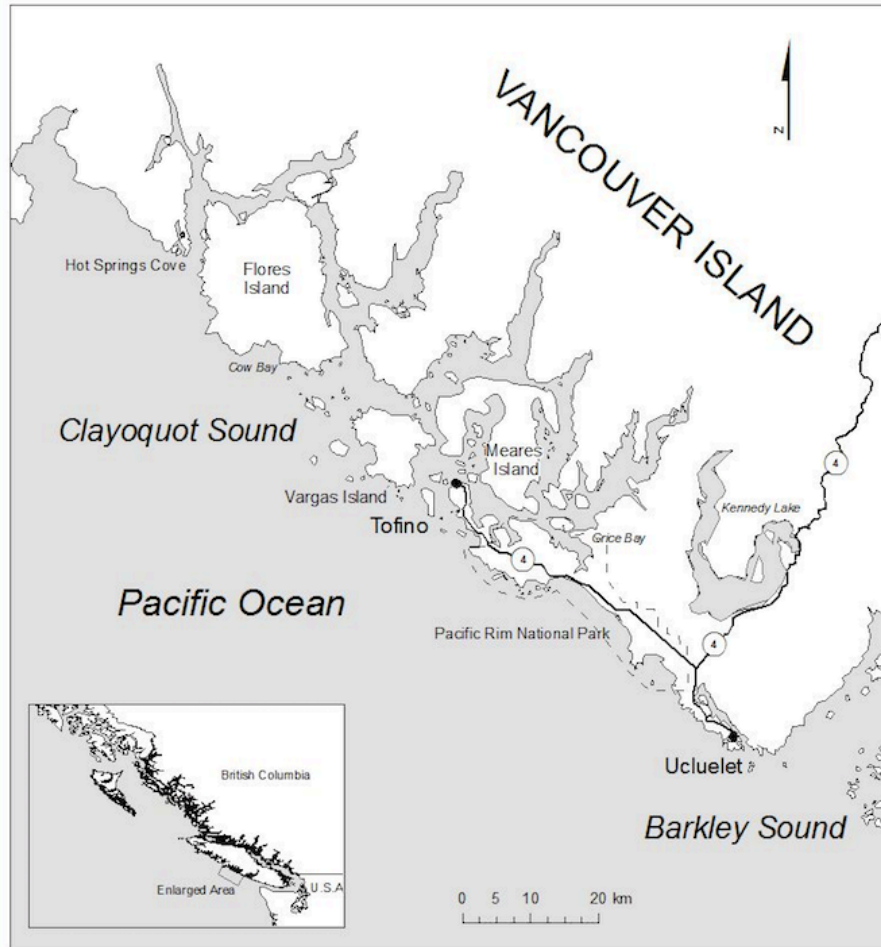


Figure 3.2. The location of Clayoquot Sound in relation to Tofino and Vancouver Island.

Commercial whale-watching boat drivers based in Tofino decide where to guide based on a number of variables including distance from the harbour, length of tour, how many passengers are aboard and their seaworthiness, weather and sea conditions, species and number of whales and their level of activity (*i.e.* behaviour that shows body parts above the surface, or mother and calf pairs), and possible viewing opportunities of supplementary wildlife (other whales, sea lions, sea otters, seals, bears, wolves, sea birds). Decisions are made on the water and after conversing with other drivers who have already taken a tour out that same day. In the summer season of 2013, drivers did not venture further north than Maquinna Marine Park and Hot Springs Cove or further south than Long Beach in Tofino. Until 1992, Ahous Bay at Vargas Island was a major gray whale feeding site, and thus, a major site for whale-watchers (Duffus 1996, Dunham & Duffus 2001). Whales eventually

decimated the amphipod prey population to a point where it has been unable to recover (Dunham & Duffus 2001, 2002, Patterson 2006, Burnham 2012). After whales abandoned amphipods as a primary prey resource, Ahous Bay has only been a sporadic foraging location, but whale-watching boats continue to drive through the area with hopes of finding a whale. Further north, gray whales are now commonly found foraging for mysids over rocky surfaces near the 10m depth contour along Flores Island. Commercial vessels go where the whales are found, and whales are found where prey availability is worth the energy expenditure to forage, or approximately >4,400 mysids per cubic metre (Olsen 2006, Feyrer 2010). Therefore, boats can be found where mysids are high in both quantity and quality, where ideal habitat conditions include rocky reefs and kelp beds in inshore waters.

#### *Flores Island*

Flores island is located in central Clayoquot Sound, British Columbia, Canada (Figure 3.3), between 49°14'36"N, 126° 06'10"W and 49°18'51"N, 126°14'30"W. The area of interest is approximately 20km<sup>2</sup>, bounded by a 30m depth contour to the west and unproductive foraging areas to the north and south. Investigating gray whale foraging behaviour, distribution, and population structure has been the focus of over 25 years of research that has included transects, photo-identification surveys, plankton net tows, time-depth-recordings, sonar samples, sediment grabs, scuba observations, underwater video recordings, and fecal analysis (Kim & Oliver 1989, Malcolm 1997, Dunham & Duffus 2001, 2002, Olsen 2006, Pasztor 2008, Stelle *et al.* 2008, Feyrer 2010, Feyrer & Duffus 2011).



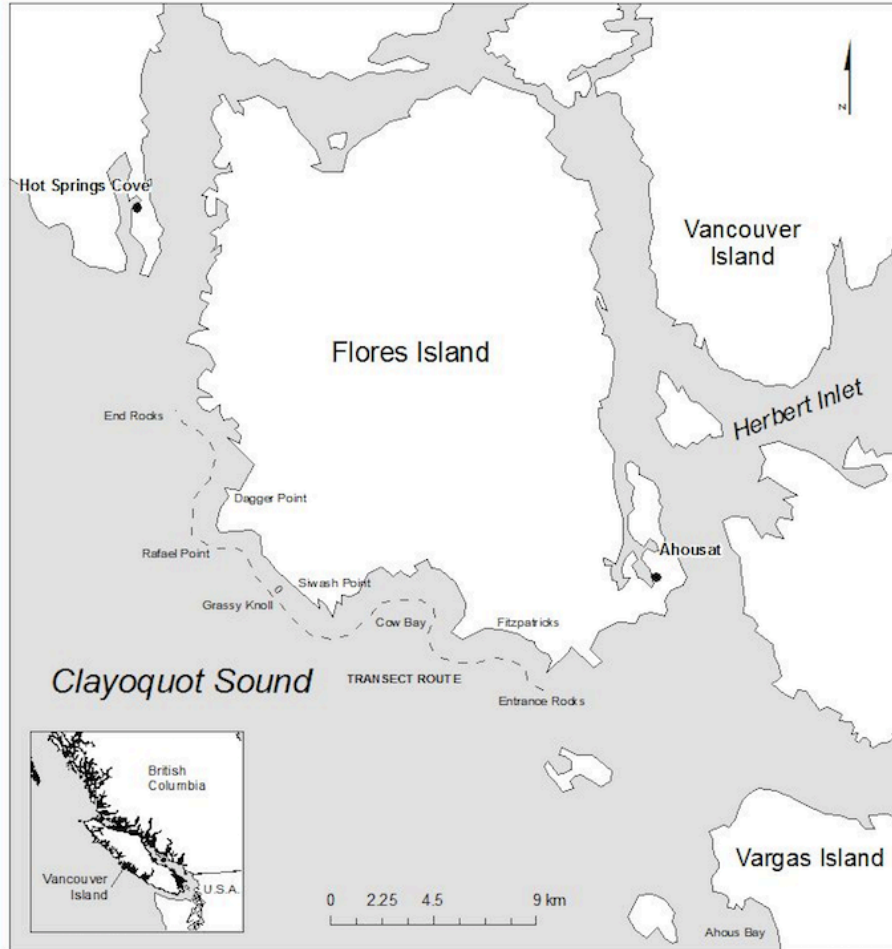


Figure 3.3. The study area along Flores Island in Clayoquot Sound. The dashed line shows the transect route along which whales surveys have been conducted since 1997.

## Data Collection

### *Transects*

These whale surveys are a part of an ongoing census in the Whale Research Lab, and the average number of whales per survey is used here to demonstrate the average number of whales available to be watched by commercial operators. Whale surveys have been conducted along the same route twice a week between May 24 and September 8, from 1997 to 2013, following the 10m depth contour (Figure 3.3). A 7m Lifetimer aluminum research vessel with two 60-hp engines travelled the designated route at 7kn, slightly faster than the speed of a traveling gray whale to prevent double counting. A minimum of four observers searched 360° for whale exhalations, or blows. Once located, the research vessel slowly approached the whale and determined whether it was foraging or not. If so, an observer

recorded a GPS location for its last dive, time of day, and whale identification. Often, it was necessary to take capture-recapture images to compare with the University of Victoria's Whale Research Lab's Gray Whale Catalogue of Clayoquot Sound for photo-identification. Surveys were abandoned if Beaufort Sea state was greater than 3, or if visibility decreased to a point where it was no longer possible to locate blows. Transects were also used to determine where whales were within the study area and when, and therefore where whale-watchers were.

#### *Full-Day Surveys*

Observations were conducted between May 24 and September 8 in 2013. The research vessel was kept between 500-1500 m away from the nearest whale at all times, so as to reduce the possibility of influencing other boater behaviour yet to still maintain an accurate view of the encounter. Full-day surveys lasted nine hours, beginning at 0900 (the departing time out of Tofino for the earliest scheduled whale-watching tour) and ending at 1800 (approximately the time that boats on the last advertised tour of the day, starting at 1630, would have to start heading back to the harbour). Two types of surveys were conducted: whale-based and location-based, each once a week depending on weather and sea conditions. Whale-based surveys were essentially focal follows where researchers recorded capture-recapture images for photo-identification and assessed compliance with eight predetermined boat behaviours when a whale-watching boat engaged in an encounter with the focal whale (Table 3.1). Starting at Entrance Rocks, the research vessel traveled along the transect route towards Siwash Point until a whale was located. Ideal focal whales were ones that were foraging within the study area, were diving for less than 10 minutes at a time, and displayed enough body to obtain identifiable photographs. Searches never had to extend beyond Siwash Point. Location-based surveys involved anchoring in a designated gray whale prey locale along southwest Flores Island and recording capture-recapture images and encounter particulars when a commercial vessel engaged in an encounter with a whale within the locale we were stationed in. Surveys were terminated if visibility decreased to less than 400m, or if sea conditions exceeded 3 on the Beaufort scale.

Due to the nature of the Pacific Ocean, high winds, large swell, and fog were often encountered and caused some surveys to be shorter than nine hours. Any surveys with a minimum of six hours were included in analysis, as it encompassed two average whale-

watching tours (advertised as two to three hours) and was therefore considered an average industry day. Similarly, locales for location-based surveys were limited to only Fitzpatrick Rocks and Cow Bay because sea conditions along Siwash Point, Grassy Knoll, Rafael Point, and End Rocks were very rarely at a Beaufort level of 3 or less for at least six consecutive hours (see Figure 3.3). Whale-based surveys, however, were conducted throughout the study area as long as conditions allowed for safe boating and accurate observations.

Table 3.1. Whale-watching regulations associated with the boat behaviours monitored during this study. Taken from *Be Whale Wise*<sup>1</sup> (Fisheries and Oceans 2013) voluntary regulations applicable to whale-watching and *Tofino Whale-Watching Operators' Voluntary Guidelines*<sup>2</sup> (Strawberry Isle Research 1995).

| Guideline issue                     | Guideline description  |
|-------------------------------------|--|
| Length of viewing time <sup>1</sup> | Limit your viewing time to a recommended maximum of 30 minutes. This will minimize the cumulative impact of many vessels and give consideration to other viewers.  |
| Method of Approach <sup>1</sup>     | Reduce speed to less than 7 knots when within 400 metres/yards of the nearest whale.<br>Avoid abrupt course changes.   |
| Method of Approach <sup>1</sup>     | Do not approach or position your vessel closer than 100 metres/yards to any whale.   |
| Method of Approach <sup>1</sup>     | If your vessel is not in compliance with the 100 metres/yards approach guideline, reduce your speed and cautiously move away from the whales.  |
| Awareness <sup>1,2</sup>            | Approach areas of known or suspected marine wildlife activity with extreme caution <sup>1</sup> .<br>Make radio contact with a vessel on scene to establish the whales' behaviour and location <sup>2</sup> .          |
| Method of Approach <sup>1</sup>     | Do not approach whales from the front or from behind. Always approach and depart whales from the side, moving in a direction parallel to the direction of the whales.  |
| Method of Approach <sup>1</sup>     | Keep clear of whale's path. If whales are approaching you, cautiously move out of the way.   |
| Method of Approach <sup>2</sup>     | 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. |

### *Boat Behaviour and Industry Pressure*

Boater compliance and industry pressure variables were measured both during full-day surveys in 2013 and shorter dedicated (2 to 4 hours) surveys in 2012, where every encounter was recorded. Observations were conducted between May 24 and September 8. Encounters, observed opportunistically were included if within the Flores Island study area,

between the hours of 0900 and 1800, observers saw the beginning and end of the encounter, and boat behaviour was clearly visible throughout the length of the watch.

An encounter was defined as the length of time a commercial whale-watching vessel was engaged in watching a whale, or within 400m. Once an encounter began, eight boat behaviours were monitored and compliance with each regulation was marked as yes (Y) or no (N) (Table 3.1). Encounters ended by either the whale or the boat leaving. Boat behaviours of interest included length of encounter, vessel speed, proximity to closest whale as well as how to behave when too close, communication with other vessels in the area, angle of approach or departure, keeping whale path clear, and placement of boats with respect to one another when more than one vessel is present. These actions have been associated with altering focal species activity in cetacean-watching literature, and are included in the locally applicable guideline, *Be Whale Wise* and the *Tofino Whale-Watching Operators' Voluntary Guidelines* (Strawberry Isle Research 1995, Schaffar *et al.* 2009, Visser *et al.* 2010, Lachmuth *et al.* 2011, Matsuda *et al.* 2011, Tseng *et al.* 2011, Fisheries and Oceans Canada 2013). For a complete list of behaviour definitions, see Appendix 3.1.

During transects, all surveys, and while at the land-based research station, VHF marine radio observations on channels 18 and 19 were recorded as metadata to confirm whale-watching locations, vessel and driver differentiation, and that the species of interest was a gray whale. Capture-recapture methods were included to compare to the Whale Research Lab's photo-identification catalogue of gray whales spotted Clayoquot Sound since 1997 (Whale Research Lab unpublished data). The identification of, or the inability to identify, a whale offers insight on the possible effect of whale-watching vessels on cetaceans by investigating previous annual return rates and inter-season residency times.

## **Data Analysis**

Independent and Welch's t-tests were run to determine if there were significant differences between factors related to whale-watching, particularly if there were variances between the 2012 and 2013 seasons.

### *Whale Surveys*

The mean number of whales per day (or per survey) is the standard measurement by which the Whale Research Lab quantifies whale presence and foraging intensity. By

comparing the average of whales per survey, we observe trends in annual whale foraging effort since 1997 (Figure 3.1). Due to the temporal scope of this study, I am interested in the trends of whale presence in 2012 and 2013. The mean number of foraging whales in 2012 (4.7) was below the overall mean (7.1, n=17) while the number of whales in 2013 (18.0) was well above the average. This was consistent with hypotheses and observed trends of previous years where lower foraging intensity releases predation pressure on mysids until prey populations recover and can support greater foraging efforts. Due to the nature of whale-watching, where business is dependent on whale availability, I hypothesize that the variance of whales present is a driver of differences in both boat behaviour and industry pressure between the two seasons.

#### *Boat Behaviour*

Compliance was measured on a scale of 0 to 1, ranging from 1.0 being total and complete compliance and 0.0 representing complete non-compliance. For each individual boat behaviour, compliance was calculated as a mean (sum of individual trip compliance level by the number of trips – Wiley *et al.* 2008). Between 2012 and 2013, 235 encounters were observed where compliance was assessed. Only encounters with gray whales were included in data analyses. Welch's t-tests were conducted to compare compliance between years and between companies.

#### *Industry Pressure*

There are six key indicators of industry pressure, including number of boats present during encounter, boating behaviour of dedicated and non-dedicated companies during encounters, length of encounters, the amount of time commercial boats spend in whale foraging areas, the amount of time commercial boats spend with whales, and the identity of the individual whales being targeted by whale-watching boats.

The number of boats present per whale depends on the number and proximity of other whales in the area. In Tofino, drivers find “their own whale” to observe when multiple whales are in the area out of consideration (Strawberry Isle Research 1995). Of course, when there are fewer whales available, the number of boats per whale increases, assuming roughly the same number of tourists continue to go on tours both within the high visitor season and from year to year. A Welch's t-test was used to compare the mean number of boats per whale in 2012 to the results in 2013.

I categorize companies that offer whale-watching excursions as one of two types: dedicated and non-dedicated. There are five dedicated companies run businesses that are primarily based on whale-watching tours, and five non-dedicated companies are those that are otherwise focused on other economic endeavors first and foremost, and whale-watching is a supplemental activity to their business (*i.e.* restaurant, lodge, hotel, taxi service). I hypothesize that dedicated companies are more compliant with whale-watching guidelines, due to the importance of continued whale presence to their business. An independent t-test was run to determine if compliance differed between dedicated and non-dedicated companies in both 2012 and 2013.

The length of each encounter is variable and dependent on sea and weather conditions, sea worthiness of passengers, type of wildlife tour, time remaining in tour, distance from the Tofino harbour, and whale activity, although a major consideration is the availability of other whales to watch. When there are fewer accessible whales, drivers have fewer options and may spend an increased amount of time with one or few whales. All types wildlife tours were included (whale-watching, hot springs shuttle, beach drop off), as there was no way to definitively determine what type of tour was in progress. A Welch's t-test was used to determine if there was a significant difference in encounter length in 2012 versus 2013.

Whale foraging and distribution has been closely linked to mysid density and habitat. I assume that whale-watching boats are found where there are whales, and during the summer months, gray whales are found where there is prey. Because of weather constraints, we were limited to the southern half of our study area (Figure 3.3), in Fitzpatrick Rocks and Cow Bay in 2013 only, as full-day surveys were not conducted in 2012.

The amount of time that commercial boats spend with any individual whale in a given day is also dependent on sea and weather conditions, visitor interest, and accessibility of whales. The earliest advertised whale-watching trip on a typical high tourist season day leaves the Tofino harbour at 9:00am, and the latest advertised excursion ends in the harbour between 6:30pm and 7:30pm. Other boat-based trips that also feature whale-watching, such as the Hot Springs Cove tours, leave as early as 8:00am daily, however these trips are often time-constrained and wildlife viewing is shortened compared to full whale-watching outings. Based on this information, whales can be subjected to varying vessel pressure for 10 hours

per day. The mean length of time boats spend with whales per day was calculated from full-day surveys conducted during the 2013 season.

Whales in Clayoquot Sound exhibit signs of site fidelity (Darling 1984, Frasier *et al.* 2011, Clare in progress). Return rates, or number of years re-sighted since 1997, were simplified into three categories. Category 1 indicates a single-year visit, Category 2 is anywhere from two to eight years sighted, and Category 3 represents whales sighted a minimum of nine out of 15 years. This classification by Clare (in progress) is based on criteria by Mahaffy (2012), where aggregated pilot whales with a 60 percent resighting rate were considered core residents and deemed to have a high degree of site fidelity. Similarly, two other categories of whales consisted of resident whales sighted more than once but less often than 60 percent of the time, as well as individuals sighted only once (Mahaffy 2012). During this study period, all 54 different whales that were observed as the focus of whale-watching encounters in both the 2012 and 2013 seasons were identified. Despite potential ramifications from whale-watching activities in foraging grounds, individuals continue to return to the study area. I wanted to further investigate this, and the possibility that returning whales were driven by prey availability, or habituated to human or boat presence. Because of this, I hypothesized that returning whales (Category 2 and 3 whales) spend more time with boats than single-visit whales, including new calves that are sometimes cautious around boats, and cows can be protective of their young. A Welch's one-way ANOVA was used to compare the total time whales spent with boats in both seasons to the category of site fidelity, which is a function of the number of years whales have been sighted in Clayoquot Sound since 1997.

## **RESULTS**

### **Whale Surveys**

The mean number of foraging whales per day for 1997 to 2013 is 7.1. There is no significant relationship between the number of surveys and the mean number of whales recorded (Spearman's  $\rho = -0.125$ ,  $N=17$ ,  $p=0.63$ ). In 2012, the average number of foraging whales was 4.7 ( $n=33$ ,  $SD=3.13$ ), which was significantly lower ( $p<0.001$ ) than the mean number of whales in 2013, 18.0 ( $n=24$ ,  $SD=8.15$ ). Table 3.2 summarizes the surveys efforts from 1997 to 2013.

Table 3.2. Summary of survey efforts, whale presence, and foraging intensity for seasons 1997-2013, with surveys conducted twice weekly between May 24<sup>th</sup> and September 8<sup>th</sup>.

| Year      | Number of surveys | First survey | Last survey | Range of whales per survey | Mean of whales per survey | S.D. |
|-----------|-------------------|--------------|-------------|----------------------------|---------------------------|------|
| 1997      | 54                | 29-Jun       | 04-Sep      | 1-17                       | 6.35                      | 3.39 |
| 1998      | 60                | 06-Jun       | 26-Aug      | 1-25                       | 10.05                     | 5.37 |
| 1999      | 40                | 03-Jun       | 26-Aug      | 1-7                        | 3.50                      | 1.80 |
| 2000      | 31                | 02-Jun       | 08-Sep      | 1-10                       | 3.63                      | 2.68 |
| 2001      | 51                | 25-May       | 05-Sep      | 1-8                        | 2.30                      | 1.60 |
| 2002      | 40                | 24-May       | 07-Sep      | 1-29                       | 10.53                     | 8.01 |
| 2003      | 33                | 27-May       | 26-Aug      | 1-11                       | 5.10                      | 2.78 |
| 2004      | 28                | 24-May       | 07-Sep      | 1-33                       | 11.50                     | 8.78 |
| 2005      | 32                | 31-May       | 03-Sep      | 1-5                        | 2.23                      | 1.21 |
| 2006      | 28                | 25-May       | 08-Sep      | 1-22                       | 7.80                      | 6.73 |
| 2007      | 27                | 26-May       | 02-Aug      | 0-21                       | 1.36                      | 3.15 |
| 2008      | 41                | 01-Jun       | 31-Aug      | 0-12                       | 3.12                      | 3.26 |
| 2009      | 25                | 27-May       | 09-Sep      | 0-13                       | 3.44                      | 3.61 |
| 2010      | 30                | 26-May       | 06-Sep      | 1-28                       | 16.06                     | 7.07 |
| 2011      | 36                | 27-May       | 08-Sep      | 0-22                       | 11.36                     | 6.23 |
| 2012      | 33                | 25-May       | 02-Sep      | 0-14                       | 4.73                      | 3.13 |
| 2013      | 24                | 25-May       | 01-Sep      | 4-38                       | 18.04                     | 8.15 |
| All years | 613               | 24-May       | 08-Sep      | 0-38                       | 7.12                      | 4.53 |

### Boat Behaviour

Over a period of 175 hours, a total of 235 individual encounters were observed in the 2012 and 2013 seasons. Mean compliance scores for all eight individual boat behaviours are summarized in Figure 3.4. Overall, the estimated mean compliance score for all companies in 2012-13 seasons was 0.78. The average compliance rate for all companies in 2012 was 0.77, and in 2013 was 0.79. There was no significant difference between overall compliance rates for the two seasons.



## Average compliance rates of encounters in 2012 and 2013

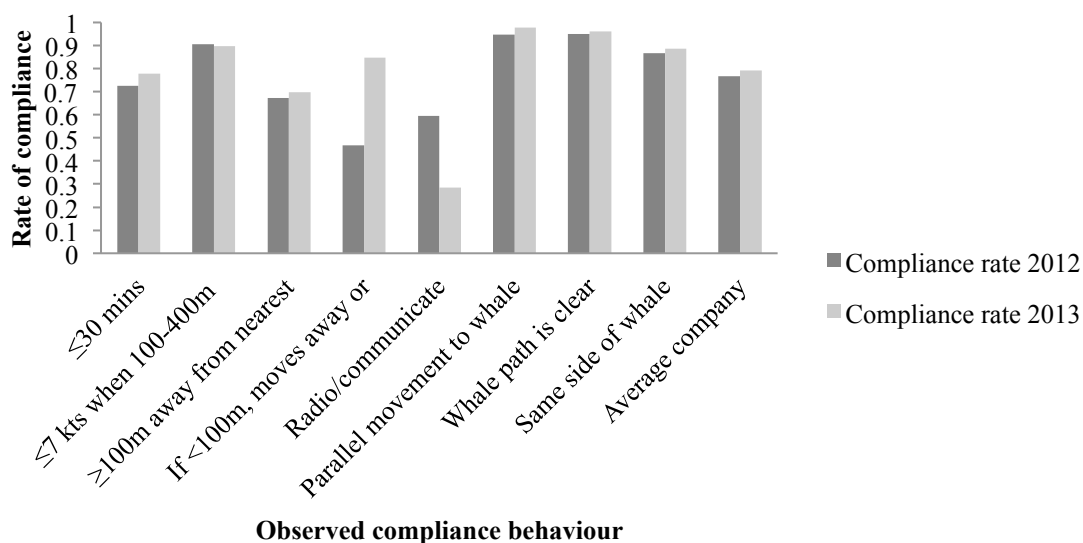


Figure 3.4. Average compliance rates of encounters in 2012 and 2013.

Mean compliance for each boat behaviour was calculated for the Tofino industry to investigate how 2012 results may differ from 2013 results (Figure 3.4). Notably, the difference in compliance of ‘<100m’ (if boats are less than 100m away from the closest whale, they should stop and idle, or turn engines off) was significant, with a 2012 mean of 0.45 and a 2013 mean of 0.85 ( $p=0.001$ ,  $t=-3.59$ ). As well, communication between boats when at least one is already on scene (‘radio’) was significantly different between years, but this time with a higher mean in 2012 (0.60) rather than 2013 (0.28;  $p<0.001$ ,  $t=4.68$ ).

Mean compliances for each company ( $n=10$ ) for both the 2012 and 2013 seasons were calculated to investigate how individual companies may vary in terms of boat behaviour (Figure 3.5). There was a significant variance of compliance between companies for five of the eight boat behaviours (Table 3.3).

## Average compliance rates of boat behaviour for each company code (A-J) in 2012 and 2013

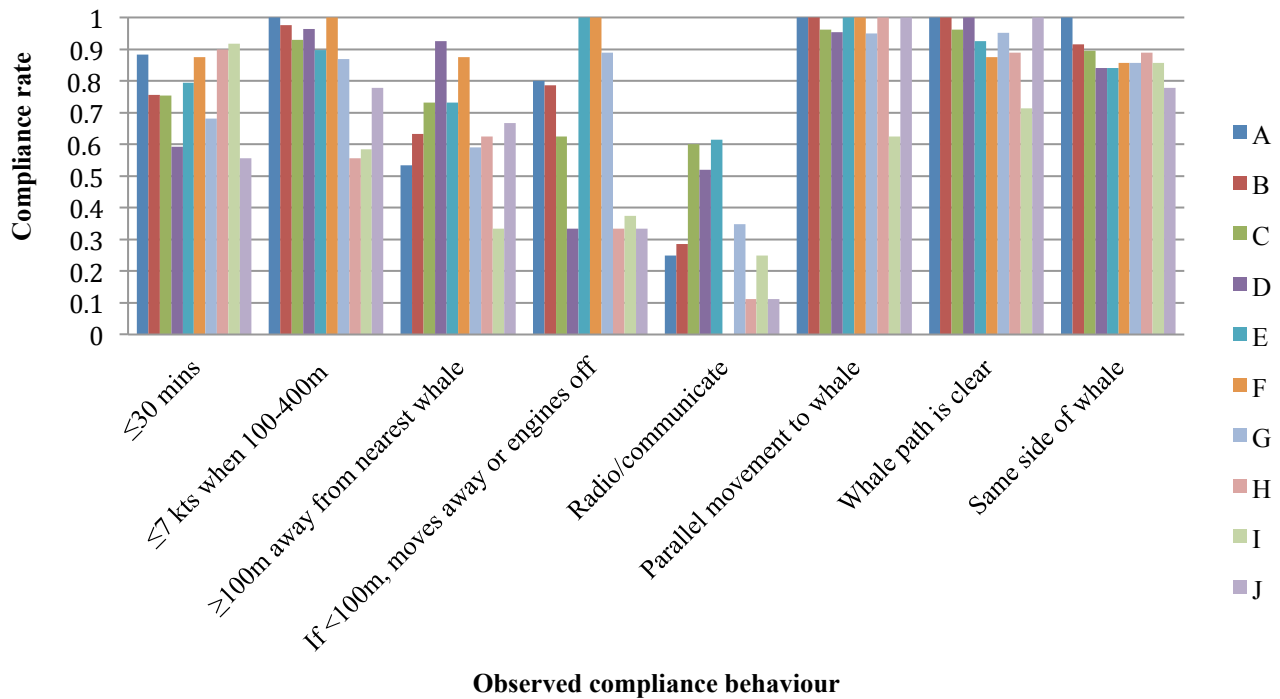


Figure 3.5. Average compliance rates for each company observed in 2012 and 2013.

Table 3.3. Summary of results from one-way ANOVA comparing individual company compliance for 2012-13 for each boat behaviour. Values denoted by an asterisk (\*) were found to be significant ( $p \leq 0.05$ ) using Welch's ANOVA.

| Boat behaviour | F    | df between groups | df within groups | Sig.  |
|----------------|------|-------------------|------------------|-------|
| $\leq 30$ mins | 1.30 | 9                 | 222              | 0.24  |
| $\leq 7$ kts   | 4.29 | 9                 | 222              | 0.00* |
| $\geq 100$ m   | 2.28 | 9                 | 211              | 0.02* |
| If <100m       | 1.77 | 9                 | 58               | 0.09  |
| Radio          | 3.71 | 9                 | 199              | 0.00* |
| Parallel       | 4.04 | 9                 | 196              | 0.00* |
| Path           | 1.91 | 9                 | 197              | 0.05* |
| Same side      | 0.41 | 9                 | 187              | 0.93  |

## **Industry Pressure**

### *Number of Boats*

The number of boats present during an encounter was significantly different in each season. The mean number of boats per encounter in 2012 was 3.8 (n=97, SD=2.39), while the mean number of boats per encounter in 2013 was significantly lower at 1.94 (n=133, SD=1.19);  $t(130.75)=7.1$ ,  $p<0.001$ .

### *Dedicated vs. Non-Dedicated*

Dedicated companies (n=5) had an overall mean compliance rate of 0.81 (SD=0.032) and non-dedicated companies (n=5) had an overall mean compliance rate of 0.69 (SD=0.09). Non-dedicated companies were significantly less compliant than the dedicated counterparts;  $t(8)=2.92$ ,  $p=0.02$ . Specifically, dedicated companies were significantly more compliant at traveling a maximum of 7kts when within 400m of the nearest whale ( $p=0.001$ ) and communicating with on-scene vessels via VHF radio ( $p<0.001$ ).

### *Length of Encounter*

An average encounter lasts 19min 5s, including whale-watching trips, hot springs shuttling, and beach drop-offs. The average 2012 encounter was approximately 21min 11s(n=94) in length. The average 2013 encounter length was 17min 35s (n=134). The length of encounter differs significantly between years ( $F(228, 180.7)=2.73$ ,  $t=1.95$ ,  $p=0.05$ ).

### *Location-Based*

Almost 60 observation hours were logged in foraging bays, observing whale-vessel encounters. The average length of time a location hosted boats engaged in whale encounters was 2hr 21min 17s (n=9), or an average of 28.11% of total survey time. Cow Bay saw boat-whale interactions (n=6) an average of 2hr 28min 53s in a given day, and Fitzpatrick Rocks had boat-whale interactions (n=2) an average of 1hr 44min 7s, although the two sample days differ greatly (Table 3.4). I assume that this is an underestimation of total time boats spend in an area, that may also have engines engaged for searching, traveling, or observing other wildlife or natural scenery.

Table 3.4. Date and length (hours, minutes, seconds) of each location-based survey conducted during the 2013 season.

| Date   | Location      | Start time | End time | Total time in location (hr:min:s) | Length of time boats engaged in encounter (hr:min:s) | % time with boats | % daylight hours (based on 16 hours of daylight) |
|--------|---------------|------------|----------|-----------------------------------|--|-------------------|--|
| 31-May | Cow Bay       | 10:01:50   | 18:00:00 | 07:58:10                          | 02:18:02   | 28.87%            | 14.38%   |
| 4-Jun  | Cow Bay       | 11:43:52   | 15:28:54 | 03:45:02                          | 00:38:00   | 16.89%            | 3.96%  |
| 12-Jun | Fitzpatrick's | 08:48:00   | 18:00:00 | 09:12:00                          | 00:11:00   | 1.99%             | 1.15%  |
| 18-Jun | Fitzpatrick's | 08:59:51   | 18:12:14 | 09:12:23                          | 03:17:15   | 35.71%            | 20.55%   |
| 30-Jun | Cow Bay       | 09:10:00   | 18:00:00 | 08:50:00                          | 05:41:01   | 64.34%            | 35.52%   |
| 12-Jul | Cow Bay       | 09:37:00   | 18:00:00 | 08:23:00                          | 03:25:34   | 40.87%            | 21.41%   |
| 22-Jul | Cow Bay       | 09:12:00   | 18:00:00 | 08:48:00                          | 02:50:39   | 32.32%            | 17.78%   |
| 31-Jul | Cow Bay       | 09:09:00   | 18:00:00 | 08:51:00                          | 02:50:01   | 32.02%            | 17.71%   |
| 2-Sep  | Cow Bay       | 09:11:25   | 15:11:25 | 06:00:00                          | 0:00:00  | 0.00%             | 0.00%  |

### *Whale-Based*

Based on over 100 hours of whale-based survey data, whales observed for a minimum of six consecutive hours spent an average of 88 minutes each day with commercial whale-watching vessels during the high tourist season in 2013 (Table 3.5). Full-day surveys were not conducted in 2012, so there is no comparable data to investigate if this average varied between seasons. Notably, a mother and calf pair spent zero minutes with whale-watching boats in a given day (Whales E and F, respectively). Also of interest, at least three whales spent significantly more time with commercial boats in a given day (Whale A: 2hr 10min, Whale B: 5hr 41min, and Whale G: 2hr 46min). This may be the result of varying search effort by the fleet, spatial variation in whale foraging effort within a short time frame, or suboptimal weather and sea conditions in nearby sites that may limit the range that the fleet may travel. Nonetheless, the amount of time a given whale spent in the proximity of boats varied.

Table 3.5. Date and length (hours, minutes, seconds) of each whale-based survey conducted during the 2013 season.

<sup>1</sup>Whale E was cow this year

<sup>2</sup>Whale F was calf this year

| Date   | Whale code     | Residency category | Start time | End time | Total time observed (hr:min:s) | Time spent with boats (hr:min:s) | % time with boats |
|--------|----------------|--------------------|------------|----------|--------------------------------|----------------------------------|-------------------|
| 12-Jun | A              | 2                  | 08:48:00   | 18:00:00 | 09:12:00                       | 00:11:00                         | 1.99%             |
| 12-Jun | B              | 2                  | 08:48:00   | 18:00:00 | 09:12:00                       | 00:11:00                         | 1.99%             |
| 18-Jun | A              | 2                  | 11:11:25   | 18:12:14 | 07:00:49                       | 02:10:13                         | 30.94%            |
| 18-Jun | B              | 2                  | 11:11:25   | 18:12:14 | 07:00:49                       | 02:10:13                         | 30.94%            |
| 21-Jun | C              | 1                  | 09:08:10   | 18:00:00 | 08:51:50                       | 00:57:47                         | 10.86%            |
| 30-Jun | B              | 2                  | 09:10:00   | 18:00:00 | 08:50:00                       | 05:41:01                         | 64.34%            |
| 18-Jul | D              | 2                  | 09:21:00   | 18:00:00 | 08:39:00                       | 01:21:52                         | 15.77%            |
| 30-Jul | B              | 2                  | 09:00:00   | 18:00:00 | 09:00:00                       | 00:31:59                         | 5.92%             |
| 2-Aug  | E <sup>1</sup> | 2                  | 09:13:39   | 18:00:00 | 08:46:21                       | 00:00:00                         | 0.00%             |
| 2-Aug  | F <sup>2</sup> | 1                  | 09:13:39   | 18:00:00 | 08:46:21                       | 00:00:00                         | 0.00%             |
| 12-Aug | G              | 2                  | 09:05:00   | 18:14:55 | 09:09:55                       | 02:46:05                         | 30.20%            |
| 25-Aug | H              | 1                  | 10:27:13   | 16:27:13 | 06:00:00                       | 00:12:30                         | 3.47%             |

### *Population Membership of Focal Whales*

Returning whales spent more time with boats than new or single-visit whales (n=54, p=0.008). Though when residency was further refined, there was no significant difference between Categories 1, 2, and 3. The effect of intra-season residency on total amount of time whales spend with whale-watching boats was not significant (p<0.05), but was significant at a p<0.1 level; F(2, 51)=2.74, p=0.07. The mean amount of time that Category 1 whales spent with boats was the lowest (1hr 35min 38s), while Category 2 spent a moderate amount of time with boats (3hr 19min 21s) and Category 3 whales had the highest mean amount of time with boats (5hr 5min 24s).

## **DISCUSSION**

### **Whale Surveys**

The mean number of whales per survey in 2013 was significantly higher than the mean number of whales in 2012 (p<0.001). As a result, it may have been more difficult for drivers to find whales in 2012, whereas in 2013 drivers were able to find whales throughout the season (pers. obs.). As expected, 2012 also saw a significantly higher number of boats per

whale during encounters. This reflects the scarcity of whales during the 2012 season, as individual whales supported a greater number of boats than in 2013. Because of the significantly high correlation between mysid density and whale presence (Feyrer & Duffus 2014), 2012 was likely a low prey year. Consequently, visiting whales may have experienced multiple vessels every day for the extent of the foraging season due to preference for certain foraging locations that overlap with fleet accessibility. Coupled with limited prey, this may result in short-term energetic losses for individual whales. To make inferences about the long-term energy costs of whale-watching on gray whales, the overall rate of exposure to these activities will need to be assessed (Christiansen & Lusseau 2014). This difference in mean number of whales from 2012 and 2013 is key for interpreting other upcoming differences in variables between years.

### **Boat Behaviour**

There was no difference in means of overall industry compliance between 2012 and 2013, and the average for compliance for both years was 0.78. While an acceptable rate of compliance has never been determined for the whale-watching industry, literature has suggested that 80% or greater rates of compliance are acceptable thresholds (Allen *et al.* 2007). Although the overall industry compliance rate may be considered close to acceptable, further investigation of the variation between companies revealed trends. Compliance rates for five of the eight boat behaviours were found to be significantly different from at least one other company, including traveling speed of less than 7kts, keeping at least 100m away from the nearest whale, making contact with other boats in the area, moving parallel to the whale(s), and avoiding crossing a whale's travel path. These significant differences in compliance between operators may be an indication that voluntary guidelines do not ensure compliance for all industry boaters equally (Allen *et al.* 2007).

In 2012, there was a significantly higher rate of communication (usually via VHF radio) between drivers, compared to 2013. This could be due to a lower number of whales in the area and a higher number of boats per whale in 2012. As drivers struggle to find whales for daily tours when whale numbers are low, they may reach out via VHF radio to fellow drivers to locate whales. Tofino drivers are cooperative with one another, commonly sharing location details and often "pass along" whales as finished tours leave to boats just starting their trips

(pers. obs.). Perhaps it is out of necessity that drivers take to the radio more frequently when there are fewer whales in the study area in an attempt to reduce the amount of time spent searching for a whale. Similarly, the significant difference in mean compliance for boats less than 100m away from the closest whale in 2012 (0.45) versus 2013 (0.85) may also be related to the lower number of whales and higher number of boats in 2012. Previous human dimension studies in this area found that whale-watcher satisfaction is inversely proportional to the number of boats engaged in an encounter with the animals. Tofino whale-watchers saw a moderate number of boats on average compared to the two other main whale-watching locations on Vancouver Island, and their satisfaction ratings were lower than those of Telegraph Cove whale-watchers who saw fewer numbers of boats on average, and higher than Victoria whale-watchers who saw many more vessels on their trip and their satisfaction was rated lowest of the three locations (Malcolm & Duffus 2008). Drivers feel pressure to deliver the best experience possible for guests (Kessler & Harcourt 2010), so with a greater number of boats per whale may compel them to get closer to whales to still offer a high-quality excursion.

Rates of compliance may be variable for a number of reasons. Reported low compliance could be the result of an overly critical view, where guidelines are simply not possible to follow (Wiley *et al.* 2008). Some *Be Whale Wise* guidelines are not explicit, and terms are not well defined (*i.e.* what defines an ‘abrupt’ course change; what is a whale ‘path’; what is the definition of the ‘side’ of the whale) or not easily quantifiable (*i.e.* “caution”, “courteous”). High compliance might be the result of some other motive, instead of a direct effort to abide by regulations (Wiley *et al.* 2008). For instance, the speed restriction for boating within 400m of whales is 7kts, though this is faster than the traveling speed of a gray whale. Boats may be inadvertently driving slower than the limited speed to follow a whale, and incidentally complying with the related guideline. There may also be a discrepancy regarding compliance measures where multiple, sometimes conflicting, guidelines exist. For example, the measured variable of minimum approachable distance in this study used the 100m guideline from the *Be Whale Wise* regulations, however older drivers may abide by the *Tofino Whale-Watching Operators’ Voluntary Guidelines* or the *Pacific Rim National Park reserve Marine Mammal Viewing Regulations* (Appendices 2.3, 2.5), which both include an approach distance of 50m. In this case, the compliance rates of both ‘ $\geq 100\text{m}$ ’ and ‘If  $< 100\text{m}$ ’

variables may be overly critical.

## **Industry Pressure**

This study did not produce a single number to quantify the industry pressure associated with boat-based whale-watching activities, but instead quantified six indicators with an emphasis on aspects of whale-watching that have been associated with disturbance (Orams & Hill 1998, Lien 2001, Higham & Bejder 2008, Giles & Koski 2012), including number of boats, company dedication, length of encounter, interaction time in foraging areas, daily interaction time per whale, and population membership of watched whales.

### *Number of Boats*

As mentioned, the mean number of boats present during an encounter was significantly higher in 2012 with 3.8 boats, in contrast to 2013 with 1.9 boats. There was a moderate correlation between number of boats and year (Pearson's  $R = -0.46$ ,  $p = 0.01$ ). When whales are more plentiful, as they were during the 2013 season, boats are able to move along until they find "their own" whale to watch. However, with fewer whales in the area in 2012, boats are forced to share whales. Some academic literature has suggested that multiple vessels in the vicinity of cetaceans can have cumulative and multiplying effects (Richardson *et al.* 1985, Blane & Jaakson 1996, Erbe 2002). This change in number of boats per whale in 2012 versus 2013 indicates altered industry behaviour related to ecological changes that the current regulations do not account for.

### *Dedicated vs. Non-Dedicated*

Dedicated companies were significantly more compliant with their boating behaviour than their non-dedicated counterparts. The discrepancies between individual companies were discussed previously, and this difference between company types further indicates that voluntary regulations may not ensure compliance for all types of industry operators. Four of the five dedicated Tofino whale-watching companies are members of the Pacific Rim Association of Tour Operators (PRATO), a partnership between companies that are dedicated to whale-watching as the primary form of business. It is not unlikely that their commitment to the protection and sustainability of their industry impacts their boat behaviour on the water. The significant difference between dedicated and non-dedicated boating compliance supports this.



### *Length of Encounter*

There was a significant difference in mean encounter length between 2012, 21min 11s, and 2013, 17min 35s ( $p=0.05$ ). Other boat-based nature trips, such as hot springs tours, also include whale-watching but for a shorter time period because of a tight time schedule, and there was no way to definitively differentiate between these hot spring trips and dedicated whale-watching excursions. This may also be a cause for shorter encounter lengths. Longer trips in 2012 are likely the result of fewer whales available in the area, and an unwillingness to abandon known whales in hopes of finding new ones. Despite both seasons' means being below the suggested maximum encounter length of 30 minutes, this does not mean that the length of time whales were exposed to boats for was acceptable. A further investigation of how time is spent during an industry day both with whales and in prime foraging areas in the two following sections.

### *Location-Based*

I investigated trends over a longer time period than a single encounter. One advantage of conducting location-based nine-hour surveys in 2013 was seeing how frequented foraging sites are used by whale-watchers in a given day. The average amount of time all whale-watching boats spent in a foraging area was 2hr 21min, or 28% of total survey time, which represents typical daily hours of operation for the industry. In Tofino, the longest day of the year is approximately 16 hours from sunrise to sunset, so 2hr 21min is a minimum of 15% of daylight hours. Hence, whales spend a minimum of 15% of daylight hours with whale-watching boats during the high tourist season. Lusseau (2004) found that dolphins in Doubtful Sound, NZ would have to spend 35% of daylight hours with boats to significantly alter resting behaviour. Despite a lack of similar studies of behavioural budgets for baleen whales in the presence of whale-watching vessels, Corkeron (2006) suggests that 35% be the maximum proportion of time that cetaceans spend with boats daily, and to use this as a precautionary benchmark until further research becomes available. In our study area, Cow Bay ( $n=6$ ) saw whale-watching vessels with whales for an average of 2hr 28min 53s, or 16% of daylight hours. Fitzpatrick Rocks ( $n=2$ ) saw boats for an average of 1hr 44min 7s, or 11% of daylight hours, although sample size was small and the only two days of observation varied greatly in number of hours boats were engaged in encounters. There was only one day that boats in Cow Bay spent more than 35% of daylight hours watching whales – June 20,

2013, at almost 36%. Given these results, it appears that time spent whale-watching in foraging areas are not at a level that whales' behaviour may be altered. Spatial zoning to limit the impact of whale-watching industry activity in these sensitive areas may not be effective as a sole management avenue.

#### *Whale-Based*

Similar to location-based surveys, whale-based surveys in 2013 provided insight into the daily whale-watching an individual whale is subjected to. Individuals spent an average of 1hr 18min with boats, or 8% of daylight hours. The length of time whales spent with boats greatly varied. For instance, a mother and calf pair spent 0% of their day with commercial boats. Calves are have limited diving and swimming abilities, which can make them more reliant on the mother and subsequently affect her behaviour (Mann & Smuts 1998). Cetacean mothers and calves are more sensitive to whale-watching boat interactions, indicating that females with calves perceive the risk of predation to be higher than other population members (van Parijs & Corkeron 2001, Stensland & Berggren 2007, Stamation *et al.* 2010, Christiansen & Lusseau 2014). Mother-calf pairs may be evasive of boats in this study area, spending time in very shallow waters (<5m) and away from most boats (pers. obs.). In contrast, Whale B spent 36% of daylight hours with commercial vessels one day, and 14% on another. It is clear that there is variation in results in terms of length of time any one whale spends with boats per day. Encounters are staggered throughout the day, from 0900 to 1800, and consecutive encounters with different boats were common. In addition to accessibility of whales, drivers also appeared to consider favourable or predictable behaviour by a whale (*i.e.* lots of time at the water surface, rolling, spy-hopping, breaching) and would also return to the same whale during their second or third trip of the day.

#### *Population Membership of Focal Whales*

To further explore what individual whales were being consistently watched, photo-identification techniques were used to compare annual return rates to the amount of time spent with boats over both 2012 and 2013 seasons. The mean amount of time that whales spent with boats based on their category of residency varied as predicted, despite results not being significant. However, caution must be used when equating statistical significance, or lack thereof, to biological significance. Category 3 whales (sighted along the transect route at least 9 out of the last 17 years) spent the most amount of time with commercial boats at 5hr

5min 24s, followed by Category 2 whales (sighted 2-8 years out of the last 17) with 3hr 19min 21s. Category 1 whales (sighted once out of 17 years) spent the least amount of time with commercial boats, a total of 1hr 35min 38s. Data indicate that returning whales spend more time with whale-watching boats, in contrast to single-visit whales. This is consistent with similar findings by Richter and colleagues (2006), who found that resident and transient sperm whales reacted differently to whale-watching vessels, likely the result of habituation; residents may have adjusted to the presence of boats and learned that they do not pose a significant threat. Habituation involves a reduction in response over time to human presence or activity, as individuals learn over time that there are no benefits or consequences associated with human contact (Bejder *et al.* 2006, Higham & Shelton 2011). Returning whales that spend more time with whale-watching boats experience increased exposure to humans. Whale-watching activities did not deter previously sighted whales from returning to forage in this area. The availability of good prey and the need to replenish energy stocks is a pull-factor for whales to visit, presumably stronger than the potential of whale-watching as a push-factor for whales to not visit. To further investigate these trends, a longitudinal study will be necessary (Bejder *et al.* 2006). The changes in whales' reactions to human activities can be gradual and vary constantly (Watkins 1986). Two years is likely too short of a sampling period to make conclusions on the possible habituation of gray whales to humans in this area. However, further research in this area may determine if returning whales are disturbed by commercial vessels to the point of abandoning Clayoquot Sound foraging grounds, assuming mysid populations continue to rebound.

Seasonal differences in boat behaviour and industry pressure were indicative of how the differing ecological scenario can influence compliance. Two boat behaviours significantly differed when comparing 2012 rates to 2013. In 2012, the year with significantly fewer foraging whales in the study area, boaters were less likely to comply with regulations on boat handling when less than 100m away from a whale, possibly in an attempt to provide a satisfactory tourist experience despite limited numbers of whales for visitors to see. In 2013, there was an abundance of whales for drivers to choose from, allowing them to be the only boat with a whale. Similarly, there were significantly more boats per encounter and the length of each encounter was significantly longer in 2012 than in 2013. A limited number of whales within the range of Tofino-based boats caused drivers to have to “share”

whales out of necessity, and spend more time with fewer whales instead of a variety of different whales, as witnessed during the 2012 season (pers. obs.). The number of whales within the range of Tofino-based boats clearly impacted driver decision-making, boat behaviour, excursion events, and ultimately, compliance with some regulations.

The whale-watching industry is an essential aspect of Tofino tourism, and PRATO companies stress the importance of conservation and responsible wildlife viewing in their mission statements. In Tofino, compliance rates are relatively high (0.78 rate of compliance), particularly when compared to those in other whale-watching epicenters around the world (*i.e.* Allen *et al.* 2007, Wiley *et al.* 2008). In addition to the high rate of compliance for the overall fleet, returning whales are most often the focus of whale-watching tours and continue to return for multiple seasons after 30 consecutive years of whale-watching activity in Clayoquot Sound. Overall, existing management and use of voluntary guidelines in Tofino are effective at maintaining the commercial whale-watching industry. However, continued monitoring of whale-watching activity in conjunction with individual gray whale presence, particularly during low prey years, will be key in keeping regulations current and relevant.

Management of whale-watching activities in Clayoquot Sound currently does not account for year-to-year variation in whale presence. If the industry is to manage activities based on the ecological scenario, limiting the number of boats allowed within a certain vicinity of whales during a “low whale” year, as well as the length of time any one boat can spend with a whale may be relevant tools. This will reduce the compounding effects that multiple vessels may impose on focal animals, especially when there are fewer whales available and a small number of individuals are subjected to the majority of the fleet pressure. Experimenting with management proposals while measuring behavioural responses from whales and visitor satisfaction can reveal the influences of these limits on ecological and social variables.

## **CONCLUSION**

I studied two whale-watching seasons with what equated to two different ecological scenarios in an effort to determine what a typical whale-watching day looked like from an ecological perspective. Results indicate that both the amount of whale-watching and vessel behaviour with respect to whales depends on the season and the ecological factors that contribute to whale presence. This study confirms that as the ecological system shifts, whale-

watching practices also shift. Managers are not aware of this and current management regimes do not account for annual or seasonal changes. The question that begs further consideration is if management needs to be responsible to the changes in industry behaviour that result from fluctuations in local ecology.

Whale surveys were used to measure the number of foraging whales that visit Clayoquot Sound each year, which is directly linked to whale-watching practices in the area. There has been a significant recovery of foraging whales since 2007, when mean numbers were the lowest they have ever been since surveys started in 1997. In 2013, a record high mean number of whales were sighted and provided a clear contrast to the previous season, 2012, where the mean number of whales was significantly lower.

Compliance with eight local and federally standardized boating regulations was higher overall, at a rate of 0.78 that is just short of the suggested industry threshold of 0.80 for acceptable rates (Allen *et al.* 2007). The overall rate of compliance for all Tofino companies (2012-2013) was brought down by significantly lower compliance from non-dedicated operators (versus dedicated operators), which demonstrates that current management techniques do not ensure equal compliance from varying kinds of operators. Lack of compliance can be the result of any number of compounding variables, such as the perceived risk of gain when disobeying the rules versus the risk of being caught, the severity of punishment, and the design of the management system (Read *et al.* 2011). Low or changing rates of compliance may indicate a need for intervening management, but it is likely that operators are unaware that this is happening in the first place. The Tofino whale-watching industry has been essentially self-regulated in terms of boating practices, so the next practical step would include bringing this discrepancy to the attention of both dedicated and non-dedicated companies, and to discuss appropriate actions to take.

The population structure of gray whales in Clayoquot Sound is not yet fully understood, but research indicates that some individuals show high levels of site fidelity (*e.g.* Clare in progress). This study demonstrated that whale-watching may be linked to site fidelity. Returning whales spent significantly more time with commercial boats, compared to single-visit whales. Since boat drivers do not identify gray whale individuals before deciding to watch them, returning whales may be favourable for viewing compared to single-year whales that are otherwise recorded as present in the area. It is possible that returning whales

may be habituated to these activities, and likewise, single-year whales may display avoidance. To further explore this idea, a multiple-season study would need to encompass both behavioural variances of whales and as well as commercial boats. It is important that management bodies prevent any behaviour-altering disturbance of returning whales, since these individuals support the majority of whale-watching interactions in this area.

Ecological drivers affect how whale-watching is executed in Clayoquot Sound, controlled by mid-trophic level of mysids that acts as a regulatory mechanism in a 'wasp-waist' marine ecosystem (Burnham 2012). Whale numbers are directly related to mysid density (Feyrer 2010). The drive to forage and the amount of prey dictates the number of whales that visit the area in a given season, and the number of whales dictates how the industry behaves. This study was an example of how a social system is influenced by the ecological system upon which it is based, and further stresses the importance of looking at both social and ecological aspects when managing wildlife tourism activities. The challenge will be determining if management should be adjusted to reflect ecological fluctuations, and if so, the logistics associated with this.

## LITERATURE CITED

- Allen, S., Smith, H., Waples, K. and R. Harcourt. 2007. The voluntary code of conduct for dolphin watching in Port Stephens, Australia: is self-regulation an effective management tool? *Journal of Cetacean Resource Management*, 9(2):159-166.
- Bakun, A. 2006. Wasp-waist populations and marine ecosystem dynamics: navigating the “predator pit” topographies. *Progress in Oceanography*, 68:271-288.
- Bass, J. 2000. Variations in gray whale feeding behaviour in the presence of whale-watching vessels in Clayoquot Sound, 1993-1995. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Bejder, L., Samuels, A., Whitehead, H. and N. Gales. 2006. Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour*, 72:1149-1158.
- Blane, J.M. and R. Jaakson. 1996. The impact of ecotourism boats on the St. Lawrence beluga whales. *Environmental Conservation*, 21(3):267-269.
- Burnham, R.E. 2012. The importance of the mid-tropic layers in ecosystem structure, process and function: the relationship between the Eastern Pacific Gray Whale (*Eschrichtius robustus*) and mysids (order *Mysidacea*) in Clayoquot Sound. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Carlson, C. 2011. A review of whalewatch guidelines and regulations around the world. Retrieved April 20, 2013, from [http://iwcoffice.org/\\_documents/sci\\_com/WWREGS%202011.pdf](http://iwcoffice.org/_documents/sci_com/WWREGS%202011.pdf). 210pp.
- Christensen, A., Rowe, S. and M.D. Needham. 2007. Value orientations, awareness of consequences, and participation in a whale watching education program in Oregon, *Human Dimensions of Wildlife: an International Journal*, 12(4):289-293.
- Christiansen, F. Rasmussen, M. and D. Lusseau. 2013. Whale watching disrupts feeding activities of minke whales on a feeding ground. *Marine Ecology Progress Series*, 478:239-251.
- Christiansen, F. and D. Lusseau. 2014. Understanding the ecological effects of whale-watching on cetaceans. In *Whale-Watching: Sustainable Tourism and Ecological Management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: New York, New York, United States of America. 177-192.

- Clare, J.A. In progress. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Constantine, R. 2014. Whale-watching and behavioural ecology. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 193-205.
- Corkeron, P.J. 2006. How shall we watch whales? In *Gaining Ground: In Pursuit of Ecological Sustainability*. (Ed. D.M. Lavigne). International Fund for Animal Welfare. Guelph, Canada, and the University of Limerick, Limerick, Ireland. 161-170.
- Costa, D.P. 1993. The relationship between reproductive and foraging energetics and the evolution of the Pinnipedia. *Symposia of the Zoological Society of London*, 66:293-314.
- Croll, D.A., Clark, C.W., Calambokidis, J., Ellison, W.T. and B.R. Tershy. 2001. Effect of anthropogenic low-frequency noise on the foraging ecology of *Balaenoptera* whales. *Animal Conservation*, 4:13-27.
- Darling, J.D. 1984. Gray whales off Vancouver Island, British Columbia. In: *The Gray Whale*. (Eds. M.L. Jones, S.L. Swartz and S. Leatherwood. Academic Press: London, United Kingdom. 267-287.
- Duffus, D.A. 1989. Non-consumptive use and management of cetaceans in British Columbia coastal waters. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Duffus, D. A. 1996. The recreational use of grey whales in southern Clayoquot Sound, Canada. *Applied Geography*, 16(3):179-190.
- Duffus, D.A. and P. Dearden. 1990. Non-consumptive wildlife-oriented recreation: a conceptual framework. *Biological Conservation*, 53:213-231.
- Duffus, D.A. and P. Dearden. 1993. Recreational use, valuation, and management of killer whales (*Orcinus orca*) on Canada's Pacific Coast. *Environmental Conservation*, 20:149-156.
- Dunham, J.S. and D.A. Duffus. 2001. Foraging patterns of gray whales in central Clayoquot Sound, British Columbia, Canada. *Marine Ecology Progress Series*, 223:299-310.
- Dunham, J.S. and D.A. Duffus. 2002. Diet of gray whales (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia, Canada. *Marine Mammal Science*, 18(2):419-437.



- Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science*, 18(2):394-418.
- Feyrer, L.J. 2010. The foraging ecology of gray whales in Clayoquot Sound: interactions between predator and prey across a continuum of scales. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Feyrer, L.J. and D.A. Duffus. 2011. Predatory disturbance and prey species diversity: the case of gray whale (*Eschrichtius robustus*) foraging on a multi-species mysid (family *Mysidae*) community. *Hydrobiologia*, 678:37-47.
- Feyrer, L.J. and D.A. Duffus. 2014. Threshold foraging by gray whales in response to fine scale variations in mysid density. *Marine Mammal Science*. Early View published online on October 16, 2014.
- Fisheries and Oceans Canada. 2013. Be whale wise: Marine wildlife guidelines for boaters, paddlers and viewers. Retrieved March 28, 2014, from <http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/mammals-mammiferes/view-observer-eng.htm>
- Forestell, P. H. and G.D. Kaufman. 1993. Resource managers and field researchers: Allies or adversaries? In *Encounters with Whales '93*. (Eds. D. Postle and M. Simmons). Great Barrier Reef Marine Park Authority: Townsville, Queensland, Australia. 17-26.
- Frasier, T.R., Koroscil, S.M., White, B.N. and J.D. Darling. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. *Endangered Species Research*, 14:39-48.
- Giles, D.A. and K.L. Koski. 2012. Managing vessel-based killer whale watching: a critical assessment of the evolution from voluntary guidelines to regulations in the Salish Sea. *Journal of International Wildlife Law & Policy*, 15:125-151.
- Hickie, B.E., P.S. Ross, R.W. MacDonald and J.K.B. Ford. 2007. Killer whales (*Orcinus orca*) face protracted health risks associated with lifetime exposure to PCBs. *Environmental Science Technology*, 41:6613-6619.
- Higham, J.E.S. and L. Bejder. 2008. Managing wildlife-based tourism: edging slowly towards sustainability? *Current Issues in Tourism*, 11(1):75-83.
- Higham, J.E.S. and E.J. Shelton. 2011. Tourism and wildlife habituation: reduced population fitness or cessation of impact? *Tourism Management*, 32:1290-1298.

- Kessler, M. and R. Harcourt. 2010. Aligning tourist, industry and government expectations: a case study from the swim with whales industry in Tonga. *Marine Policy*, 34:1350-1356.
- Kim, S.L. and J.S. Oliver. 1989. Swarming benthic crustaceans in the Bering and Chukchi Seas and their relation to geographic patterns in grey whale feeding. *Canadian Journal of Zoology*, 67:1531-1543.
- Lachmuth, C.L., Barrett-Lennard, L.G., Steyn, D.Q. and W.K. Milsom. 2011. Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. *Marine Pollution Bulletin*, 62:792-805.
- Lien, J. 2001. The conservation basis for the regulation of whale watching Canada by the Department of Fisheries and Oceans: A precautionary approach. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2363.
- Lusseau D. 2004. The hidden cost of tourism: Effects of interactions with tour boats on the behavioural budget of two populations of bottlenose dolphins in Fiordland, New Zealand. *Ecology and Society*, 9(1):2.
- Mahaffy, S.D. 2012. Site fidelity, associations and long-term bonds of short-finned pilot whales off the island of Hawai'i. M.Sc. thesis. Portland State University, Portland, United States of America.
- Malcolm, C.D. 1997. Micro-scale spatial behaviour of a foraging grey whale (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia, Canada. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Malcolm, C.D. 2003. The current state and future prospects of whale-watching management, with special emphasis on whale-watching in British Columbia. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Malcolm, C.D. and D.A. Duffus. 2008. Specialization of whale watchers in British Columbia coastal waters. In: *Marine Wildlife and Tourism Management*. (Eds. J.E.S. Higham and M. Lück). CABI: Oxfordshire, United Kingdom. 109-129.
- Mann, J. and B.B. Smuts. 1998. Natal attraction: allomaternal care and mother-infant separations in wild bottlenose dolphins. *Animal Behaviour*, 55:1097-1113.

- Matsuda, N., Shirakihara, M. and K. Shirakihara. 2011. Effect of dolphin watching boats on the behavior of Indo-Pacific bottlenose dolphins off Amakusa-Shinoshima Island, Japan. *Nippon Suisan Gakkaishi*, 77(1):8-14.
- Mustika, P.L.K.M., Birtles, A., Everingham, Y. and H. Marsh. 2013. The human dimensions of wildlife tourism in a developing country: watching spinner dolphins at Lovina, Bali, Indonesia. *Journal of Sustainable Tourism*, 21(2):229-251.
- Olsen, S.S. 2006. Gray whales (*Eschrichtius robustus*) and mysids (family Mysidae): the predator-prey relationship and a new approach to prey quantification in Clayoquot Sound, British Columbia. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Orams, M.B. and G.J.E. Hill. 1998. Controlling the ecotourist in a wild dolphin feeding program: is education the answer? *Journal of Environmental Education*, 29(3):33-38.
- Pasztor, C. J. 2008. The dynamic relationship between foraging gray whales (*Eschrichtius robustus*) and their mysid prey (Mysidae), along the southwest coast of Vancouver Island, British Columbia. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Patterson, A. 2006. Benthic ecology and gray whale foraging in Clayoquot Sound, British Columbia. B.Sc. Honours essay. University of Victoria, British Columbia, Canada.
- Read, A.D., West, R.J., Haste, M. and A. Jordan. 2011. Optimizing voluntary compliance in marine protected areas: a comparison of recreational fisher and enforcement officer perspectives using multi-criteria analysis. *Journal of Environmental Management*, 92:2558-2567.
- Reynolds, P.C. and D. Braithwaite. 2001. Towards a conceptual framework for wildlife tourism. *Tourism Management*, 22:31-42.
- Richardson, W.J., Fraker, M.A., Würsig, B. and R. Wells. 1985. Behaviour of bowhead whales (*Baleaena mysticetus*) summering in the Beaufort Sea: reactions to industrial activity. *Biological Conservation*, 32:195-230.
- Richter, C., S. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. *Marine Mammal Science*, 22(1):46-63.

- Schaffar, A., Madon, B., Garrigue, C. and R. Constantine. 2009. Avoidance of whale watching boats by humpback whales in their main breeding ground in New Caledonia. Scientific Committee of the International Whaling Commission, Madeira.
- Stamation, K.A., Croft, D.B., Shaughnessy, P.D., Waples, K.A. and S.V. Briggs. 2010. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to whale-watching vessels on the southeastern coast of Australia. *Marine Mammal Science*, 26(1):98-122.
- Stelle, L.L., Megill, W.M. and M.R. Kinzel. 2008. Activity budget and diving behavior of gray whales (*Eschrichtius robustus*) in feeding grounds off coastal British Columbia. *Marine Mammal Science*, 24(3):462-478.
- Strawberry Isle Research. 1995. *Tofino Whale Watching Operators' Voluntary Guidelines*. Tofino, B.C., Canada.
- Tseng, Y., Huang, Y., Kyle, G.T. and M. Yang. 2011. Modeling the impacts of cetacean-focused tourism in Taiwan: Observations from cetacean watching boats: 2002-2005. *Environmental Management*, 47:56-66.
- van Parijs, S.M. and P.J. Corkeron. 2001. Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, *Sousa chinensis*. *Journal of the Marine Association U.K.*, 81:533-538.
- Visser, F., Hartmann, K.L., Rood, E.J.J., Hendricks, A.J.E., Zult, D.B., Wolff, W.J., Huisman, J. and G.J. Pierce. 2010. Risso's dolphins alter daily resting pattern in response to whale watching at the Azores. *Marine Mammal Science*, 27(2):366-381.
- Watkins, W.A. 1986. Whale reactions to human activities in Cape Cod waters. *Marine Mammal Science*, 2(4):251-262.
- Wiley, D.N., Moller, J.C., Pace III, R.M. and C. Carlson. 2008. Effectiveness of voluntary conservation agreements: Case study of endangered whales and commercial whale watching. *Conservation Biology*, 22(2):450-457.

## CHAPTER FOUR

### **A summary of research on the gray whale (*Eschrichtius robustus*) in Clayoquot Sound and the management implications**

#### **INTRODUCTION**

The Whale Research Lab of the University of Victoria has studied gray whales in Clayoquot Sound on the west coast of Vancouver Island, British Columbia for over 25 years. Gray whales are of critical importance to the local tourism industry in Clayoquot Sound. Understanding how gray whale presence varies over space and time is key in sustaining and managing the whale-watching industry (Duffus 1996). This integration of ecology and resource management has been stressed since the early 1970s, and our long-term research can provide the ecological knowledge that is often lacking from wildlife tourism scenarios. With a greater understanding of the ecological conditions of gray whale presence, we can better manage the interactions between humans and wildlife in a dynamic coastal environment (Duffus 1996).

This chapter reviews the most recent Whale Research Lab projects and publications regarding the ecology of the eastern North Pacific gray whale in Clayoquot Sound, addressing questions relevant to managing the local whale-watching industry: why are gray whales there (and why they are not), what is the nature of human interactions with whales, and what ecological knowledge is relevant to managers of tourism and natural resource use. First, the life history of the eastern North Pacific gray whale is presented. The conditions of gray whale presence in Clayoquot Sound are discussed using supporting ecological concepts and theories. Following this, the nature of human-whale interactions in this area is reviewed, including the effects of vessels on gray whales, the profile of Tofino-based whale-watchers, and the makeup of the local whale-watching industry. The chapter concludes with a review of ecological knowledge that may be appropriate when making management decisions. The availability of long-term ecological science is uncommon, and reviewing this information was invaluable in forming the basis for five management recommendations presented at the end of the paper. This study serves as an example of the intersection of ecology and social science, where biologically appropriate management decisions can be made.

## THE EASTERN NORTH PACIFIC GRAY WHALE

The gray whale is a benthic-feeding mysticete that can reach a maximum of 15m in length (Evans 1987) and is characterized by the lack of dorsal fin. Instead, they have seven to ten humps, or “knuckles”, down the back towards the fluke (Sumich 2013). Skin colour ranges from light to dark gray, mottled with light patches unique to individual whales. Gray whale baleen cream or pale yellow in colour, and thicker and coarser than other baleen whales, and it is the only large whale to have an upper jaw that extends past the lower jaw (Fisheries and Oceans 2010). Due to the slow moving nature of this species, it is common for gray whales to carry barnacles and whale lice that live in a commensalistic relationship, where the parasite benefits from the relationship but the whale is not affected in a positive or negative way (Slijper 1962).

There are two distinct populations of gray whales in the North Pacific Ocean, the western Pacific and eastern Pacific. In the 19<sup>th</sup> century, both populations of gray whales were commercially hunted to the point of extirpation until they were internationally protected in 1937 (Brownell Jr. & Swartz 2006). Today, the western North Pacific population is critically endangered, with approximately 140 individuals (Weller *et al.* 2013). These animals are prone to low reproduction rates, poor calf survival, nutritional stress, and habitat loss resulting from increasing development of offshore oil and gas projects (Clapham *et al.* 1999, Weller *et al.* 2013). In contrast, the eastern Pacific group recovered to estimated pre-whaling levels of 15,000-20,000 animals by the 1980s (Highsmith *et al.* 2006). Evidence suggests that this population could be approaching or has reached carry capacity at 19,000 individuals (Highsmith *et al.* 2006, Laake *et al.* 2009).

The eastern North Pacific gray whale undertakes an annual migration between mating and calving regions in Baja California, Mexico, to feeding areas in the Arctic Bering and Chukchi Seas – a 20,000km round-trip (Rice & Wolman 1971, Highsmith *et al.* 2006). Whales mate in November and December in the warm southern lagoons, and after a gestation period of 11 to 13 months, (Jones & Swartz 2002) calves are born here in these lagoons along the Baja California peninsula or just before arrival. Most births occur in January and February, and mothers and calves remain in the lagoons until the end of March before following the males and recently impregnated females northward (Sumich 2013). Mothers nurse calves until they are weaned and can forage on their own in July or August. At this

point, calves have reached 8m in length and weigh 5,000kg, and cows can then restore their energy reserves (Sumich 2013).

Ocean waters at high latitudes are highly productive. Whales forage intensively during summer months to build an energy reserve to compensate for time spent in lagoons during the winter. Most of the population reaches the shallow waters of the Bering and Chukchi seas by May and June (Pike 1962) and forage along the sea floor continuously, feeding on a variety of marine invertebrates primarily benthic amphipods (Highsmith & Coyle 1992). A smaller number of individuals show site fidelity to tertiary foraging areas between north California and southeastern Alaska, including waters along Vancouver Island, British Columbia (Calambokidis *et al.* 2010, 2012). This group is referred to as the Pacific Coast Feeding Group (PCFG), consisting of 150 to 200 individuals that return year after year and may also remain for the entire length of the feeding season into the winter (Darling 1984, Lang *et al.* 2011, Sumich 2013, Calambokidis 2013). Unlike with the western gray whale population, the PCFG is not completely genetically distinct from the greater eastern population. Genetic studies have revealed that there are some significant genetic differences between the PCFG and the overall population, but these were small and did not explain the degree of outside recruitment (Calambokidis 2013). The level of distinction of the PCFG is still unclear, but the possibility of designation as a separate population has management implications. The protection of a population of whales (such as the PCFG) is generally dependent on population estimates, as opposed to ecology (Kareiva *et al.* 2006). Accurately determining abundance can be challenging, and genetic analysis can be skewed by sampling design, location, and season (Clare in progress). The Makah Tribe in the state of Washington has proposed the resumption of the traditional subsistence gray whale hunt, and the removal of a PCFG whale would have a greater effect on this population than if the whale removed was from the overall eastern population (Lang 2013).

In Clayoquot Sound, gray whales fit the spatial and temporal description of PCFG whales. They show evidence of site fidelity, returning for multiple years; within-season residency, or how many days an individual forages in a given season, is high, with many staying until the end of the summer and sometimes beyond the beginning of the southbound migration (Sumich 2013). Current research foci include quantifying the abundance of the PCFG, the mechanism and level of external recruitment, and the level of genetic distinction

between the PCFG and the remaining eastern population (Calambokidis *et al.* 2010, Lang *et al.* 2011), and there is interest in similar work for Clayoquot Sound whales (Clare in progress).

## GRAY WHALE PRESENCE IN CLAYOQUOT SOUND

Members of the Whale Research Lab (University of Victoria, British Columbia, Canada) have been researching the spatial and temporal distribution and ecology of gray whales in Clayoquot Sound since the mid-1980s. The recording of gray whale location and behaviour began in 1986, with daily searches beginning in 1991, searching for individuals closest to Tofino and then beyond. The following years – 1992, 1993, and 1994 – qualitative sampling of benthic and planktonic prey was used to design quantitative methods for measuring prey species. In 1994, a photo-identification program began but effort has been variable from season to season. The same year, a time-depth recorder was attached to a gray whale via suction cup and used to create dive profiles from 651 recorded dives. From this data, accounts of inter-ventilation dives (short, shallow, for oxygen recharge) and feeding dives (long, deep dives, at least twice as long as the second-longest dive type) (Duffus 1996, Malcolm & Duffus 2000) were classified and these descriptions have been used to discern foraging behaviour from traveling or searching in other projects (Figure 4.1).

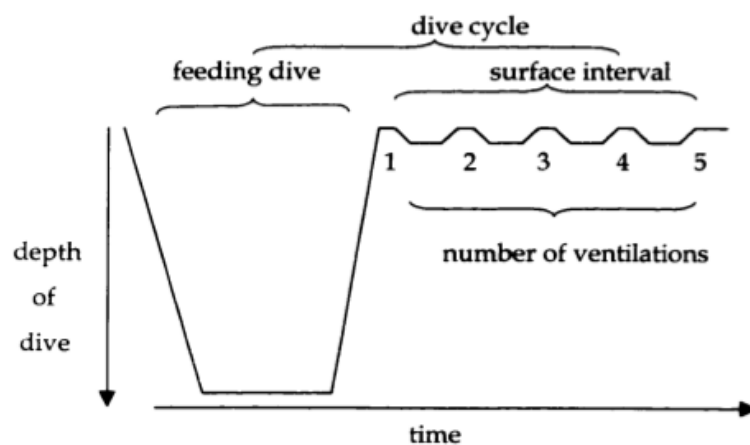


Figure 4.1. Typical dive pattern of a foraging gray whale (Bass 2000).

In 1997, a transect route was established along the south and west coastline of Flores Island to measure foraging intensity, passing through three major prey habitats: mysids along



the shore, amphipods in Cow Bay, and porcelain crab larvae near Rafael Point (Dunham & Duffus 2001) (Figure 4.2). These sites are distinct, and have been defined by the distance from shore, substrate type, and depth (Dunham & Duffus 2001). The area is approximately 20km<sup>2</sup>, with unproductive foraging areas to the immediate north and south, and bound by the 30m depth contour to the west (Pasztor 2008, Feyrer 2010). Annual whale surveys have been conducted along this route bi-weekly between May 24<sup>th</sup> to September 8<sup>th</sup>, from 1997 to 2013. This same course has also been used as a basis for sampling designs involving prey quantification, foraging behaviour, dive profiling, and observation of interaction between commercial whale-watching boats and whales.

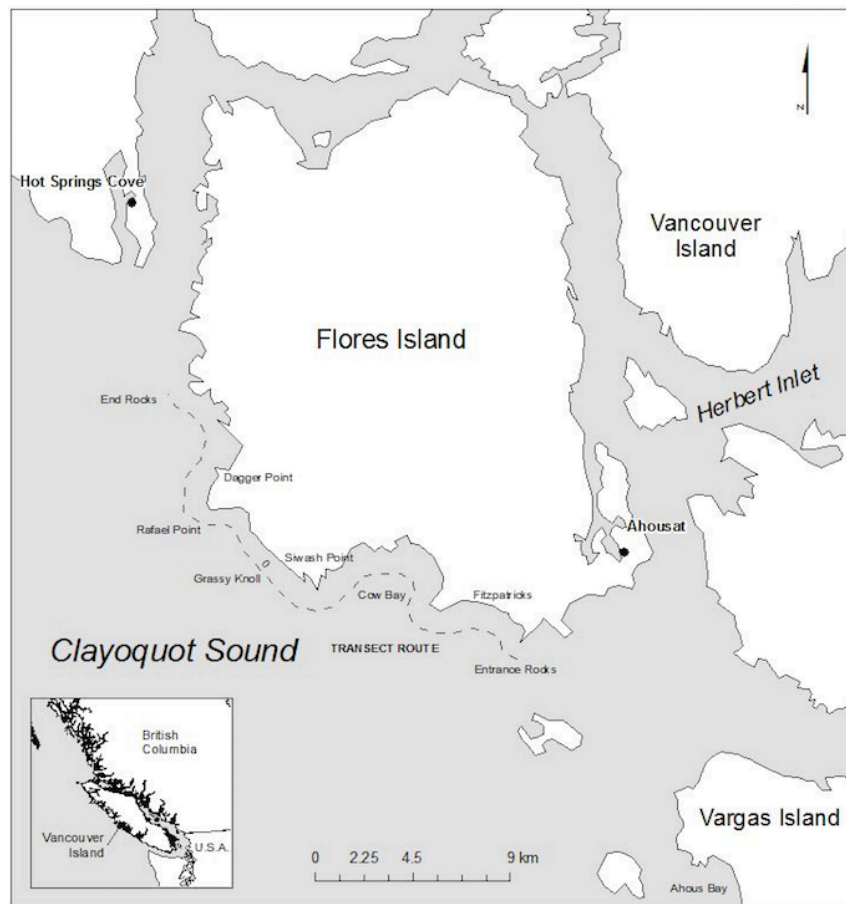


Figure 4.2. Study area with transect route for whale surveys along Flores Island, British Columbia, between 49°14'36"N, 126°06'10"W and 49°18'51"N, 126°14'30"W.

Over the past twenty years, various sampling techniques have been used to quantify gray whale foraging behaviour and prey presence. Fecal analysis, sonar surveys, SCUBA surveys, plankton net tows, benthic sediment sampling, core sampling, underwater video

recordings, and continued field observations have revealed clear spatial and temporal links between gray whales and their prey (Dunham & Duffus 2001, Feyrer & Duffus 2011). The Whale Research Lab has examined the ecological role that gray whales have in the marine environment as well as the dimensions of the human interactions with wildlife in this area, mostly through local whale-watching experiences. The visual model (Figures 4.3a, 4.3b) displays how wildlife users may generate a top-down impact and species ecology has a bottom-up effect that determines the availability of whales. The balance of the two pyramids at their apexes is meant to emphasize the precarious, non-static nature of whale aggregations, a point that has been difficult to deliver to user groups. The influences of knowledge of the wildlife user and species ecology on whale presence (Figure 4.3a). In combination, these elements are the foundation of a whale-watching industry, and can each be directly or indirectly managed. Detailed research on the wildlife user and focal species ecology will provides a knowledge base of the conditions of the focal species' presence, and which, if any, aspects of human use create pressure that may alter the whales' presence. Research thus far, however, indicates that whale-watching activities do not deter some gray whales from returning to Clayoquot Sound to forage (see Chapter 3). This suggests that the level of influence from the top pyramid is not well understood, but it is less influential than the bottom-up drivers of whale presence. 'Wildlife user' and 'ecology' triangles are further broken down into subjects that the Whale Research Lab has focused on over time. These categories feed into each other, and each one is a potential area for management interventions (Figure 4.3b). This diagram is not an exhaustive list of research interests and generalizes a number of projects for the sake of creating a simple visual.

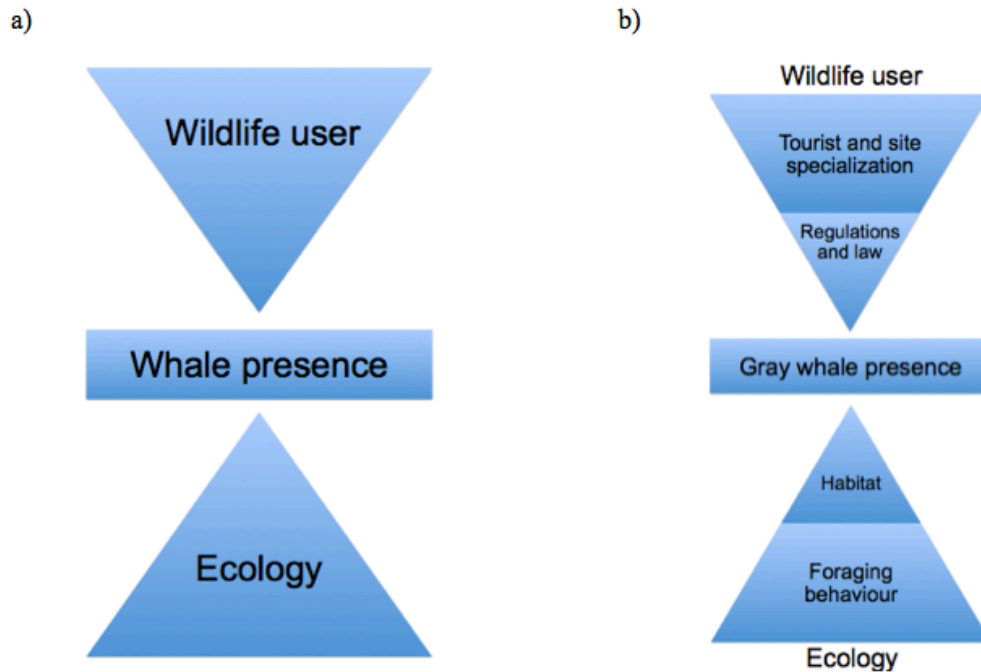


Figure 4.3 a) Influences of knowledge of the wildlife user and species ecology on whale presence; b) Wildlife user and ecology triangles are further broken down into subjects that the Whale Research Lab has focused on over time regarding gray whales. Each is a potential area for management interventions.

### Supporting Concepts and Theories

The hypotheses investigated by the Whale Research Lab have been based on a series of subjects and theories founded in ecology. Ecology involves using physical processes to explain the composition, structure, and organization of ecosystems (Terborgh *et al.* 2010). In ecology, phenomena occur at various scales of space, time, and ecological organization, and these themes are interconnected (Levin 1992). The concept of scale is an underlying component of all science. It is essential to address scale when exploring the dynamics of populations and ecosystems, as there is explicit bias involved in researcher's choice of scale. The scale at which a phenomenon is observed affects the description of any patterns that may be present. There is no single correct scale at which to describe a system, and scales are not equally relevant or appropriate.

### *Niche and Habitat*

Every species has a role in the greater ecological community. This role, or niche, is a particular combination of physical, chemical, and biological factors that is necessary for life. This includes where it lives, what it consumes, and the relationships between other biotic and abiotic factors (Dearden & Mitchell 2012). Investigating why gray whales are located here, or why they are absent, involves looking at the species' fundamental role in the community and the relationship between this niche and the habitat.

### *Top-down and Bottom-up Trophic Forces*

In the study area, the gray whale is the apex predator of a short trophic system, preying primarily on hyper-benthic mysids. In turn, mysids are the primary consumers that prey on phytoplankton and a variety of zooplankton (Short 2005) (Figure 4.4). These small invertebrates have been the main prey item of gray whales since 1997, but this has not always been the case.

Killer whales (*Orcinus orca*) prey on gray whales of all ages, but particularly calves while their mothers accompany them during the northward migration from the breeding lagoons to the foraging grounds (Reeves *et al.* 2006). However, the scale of these attacks is not well understood. At the spatial and temporal scale we are interested in, the gray whale in Clayoquot Sound operates as the apex predator in its food web. Although trophic interactions are very complex (Jackson *et al.* 2001), the relatively short food chain decreases the complexity of the food web dynamics (Dunham & Duffus 2001, Short 2005).

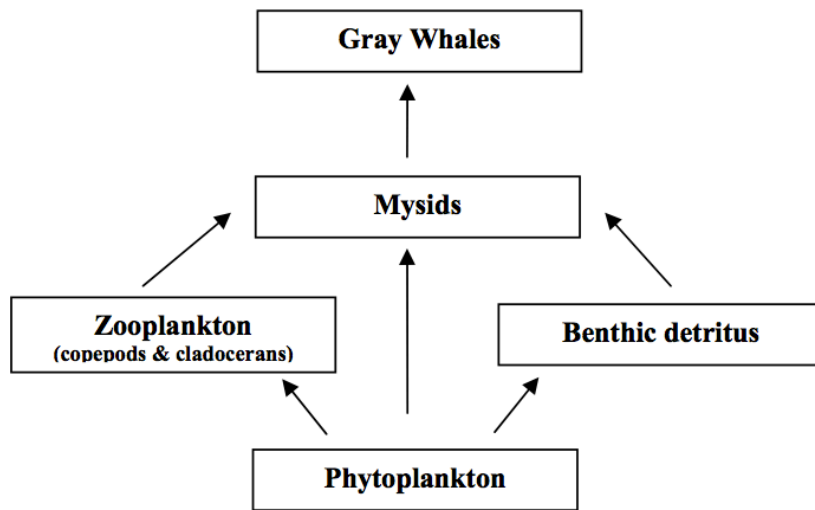


Figure 4.4. Trophic diagram of a gray whale food chain that highlights the relationship with primary production and mysids, the preferred prey item in Clayoquot Sound (Short 2005).

Each trophic level is influenced by both bottom-up (sunlight, nutrients) and top-down (consumption by herbivores and carnivores) forces (Terborgh *et al.* 2010). These forces are intrinsically linked and work in tandem to structure the ecosystem and determine population size (Hunt & McKinnell 2006). Bottom-up controls affect a population by limiting the availability of food, while top-down controls impose force by predation. The amount and timing of phytoplankton blooms in Clayoquot Sound are the result of forces acting from the bottom-up, such as sunlight, temperature, and nutrient upwelling, and from the top-down (consumers, grazers), and it forms the basis of most marine food webs. The system is complicated by time lags that may exist between environmental forcing variables and organisms (Garside 2009). Time lags can vary in length, from hours to years, depending on the trophic level and scale of the stimulus and response of interest (Duarte 1990, Andrade & Garcia 1999, Weimerskirch *et al.* 2003).

The top-down pressure of gray whale predation on prey species can profoundly affect the community structure, distribution, and abundance of ecological populations (Feyrer 2010). Investigating the top-down and bottom-up effects on population size and ecosystem structure has been emphasized, in an effort to understand how ecosystem changes may influence the various species involved (Hunt & McKinnell 2006). The short trophic structure of the gray whale most likely has a third mechanism at the primary consumer level that acts

as a regulatory force in a ‘wasp-waist’ manner. As the primary consumer, mysids exert a bottom-up control on higher trophic level gray whales while simultaneously applying top-down pressure on phytoplankton as a predator, exhibiting a structure like a wasp abdomen (Rice 1995, Bakun 2006, Hunt & McKinnell 2006, Burnham 2012). When considering all trophic inputs, it is important to review not only bottom-up or top-down forces, but instead ‘both up and down and from the middle’ (Hunt & McKinnell 2006), as Burnham (2012) has done.

### *Foraging and Prey Switching*

An average sized gray whale requires between  $2.7 \times 10^5$  to  $5.2 \times 10^5$  kcal per year, keeping in mind that they only forage for about six months a year (Highsmith & Coyle 1992). Other estimates suggest between 379 and 2,496 kg of benthic prey per day (Tomilin 1946). The dominant prey has traditionally been amphipods, but whales have been observed feeding on various organisms located throughout the water column (Nerini 1984, Guerrero 1989, Dunham & Duffus 2001, 2002).

In our study area, gray whales have demonstrated their flexibility as a predator. Fecal samples, SCUBA surveys, and field observations have revealed that whales fed on a wide variety of planktonic and benthic prey, the predominant being hyper-benthic mysids (family Mysidae), benthic amphipods (family Ampeliscidae), benthic ghost shrimp (*Callinassa californiensis*), and pelagic porcelain crab larvae (family Porcellanidae) (Dunham 1999, Dunham & Duffus 2001). Research by Dunham (1999), Carruthers (2000), and Feyrer (2010) found strong evidence that prey selection is a function of prey size, density, and biomass in conjunction with the caloric value, associated search time, and energy expenditure, demonstrating that at some point whales switch prey types. The optimal foraging theory states that predators choose the prey that provide the greatest amount of energy gain with the least amount of energy expenditure (Stephens & Krebs 1986). When food is available in a patchy habitat, the predator must allocate time to travel between patches, deciding when to leave a patch and which to travel to next (Charnov 1976). Optimal predators aim to maximize caloric intake while minimizing energy expenditure. The longer the predator spends in a particular patch, the amount of food gained decreases. The most efficient predator should leave a patch when the marginal rate of prey intake drops to be equal to the average prey intake rate. Based on this theory, we would assume that whales would switch prey types or

prey patches when foraging efforts did not deliver high energy returns. Dunham (1999) found evidence of this in 1997, when gray whales were observed foraging on hyper-benthic mysids along the west shores of Flores Island, then switching to another mysid habitat 10km further north and benthic prey in Cow Bay. After prey sampling, it was evident that foraging whales had decimated mysid populations at one sampling location, when earlier in the season feeding had been recorded in the same location. In sum, gray whales alter their foraging behaviour to align with overall prey quality, based on density, energy profitability, and dependability (Dunham & Duffus 2001, Feyrer 2010).

### **Prey Types in Clayoquot Sound**

#### *Ghost Shrimp*

Ghost shrimp (*Callinassa californiensis*) are a crustacean that burrow in sandy mud flats in estuaries found along the west coast of North America (MacGinitie 1934). Between one and five gray whales were observed simultaneously foraging for ghost shrimp in Grice Bay in 1996, but abandoned the area after exhausting the prey resource (Dunham & Duffus 2001).

#### *Porcelain Crab Larvae*

Porcelain crabs are intertidal crustaceans, reliant on currents to bring plankton in to their rocky habitats (Knudsen 1964). Possibly linked to tide cycles, larval release of prezoa from one female may last between 10 and 20 hours and produce 2,000-3,000 larvae (Knudsen 1964, Kerr 2005, Kerr & Duffus 2006). Gray whales were observed sporadically feeding on dense patches of porcelain crab larvae (family Porcellanidae) for short periods of time over a number of summers (Dunham & Duffus 2001, 2002, Kerr 2005). Similar to ghost shrimp, foraging ceased when prey density was insufficient (Dunham & Duffus 2001). The opportunistic nature of this foraging demonstrates the plasticity of gray whale foraging behaviour.

#### *Amphipods*

Ampeliscid amphipods form mucous tubes in sandy bottom environments, only centimeters below the surface (Rice & Wolman 1971, Nerini 1984). Specifically in Clayoquot Sound, amphipods are found in subtidal areas, spanning from the surf zone to as deep as 30m in sandy bays (Dunham 1999). Gray whales significantly impact the structure

and composition of amphipod communities through foraging activity (Johnson & Nelson 1984, Oliver & Slattery 1985, Kvitek & Oliver 1986, Nerini & Oliver 1983, Highsmith & Coyle 1992, Coyle & Highsmith 1994, Coyle *et al.* 2007, Moore *et al.* 2007, Burnham 2012, Duffus *et al.* 2013). In primary feeding grounds, gray whales can disturb up to 1,000m<sup>3</sup> of benthos in a single day, and an estimated 1.2 X 10<sup>9</sup>m<sup>3</sup> of sediment is resuspended in the water column every year as a result of foraging (Kvitek & Oliver 1986, Johnson & Nelson 1984, Patterson 2006). In Clayoquot Sound's Ahous Bay, feeding excavations disturbed 19% of the amphipod tube mats in 1983 (Kvitek & Oliver 1986) and 17% in 1997 (Dunham 1999). Dunham (1999) estimated that foraging activity during 1997 removed 160,956kg of prey biomass in a single season (Patterson 2006).

Gray whales release nutrients by mixing sediments in benthic substrates and expelling waste in the water column (Oliver & Slattery 1985). Benthic feeding activity can stir unconsumed prey to subsurface levels where other predators, such as marine birds (*i.e.* marbled murrelets, Muirhead *et al.* 2013) and fish, can also forage (Obst & Hunt 1990, Grebmeier & Harrison 1992)

Beginning in 1983, benthic prey measurements began in Clayoquot Sound and have been continued with varying degrees of dedication. Data collection methods involved core samples, sediment grabs, side scan sonar, and SCUBA diver observations. Since then, 194 samples were taken from both Ahous Bay and Cow Bay. Initially (in 1983-1984), Ahous Bay had a dense homogeneous amphipod tube mat that ranged from the surf zone to a depth of 22m, where the benthos changed to a mixture of coarse sand and gravel (Guerrero 1989). Whale foraging was correlated with the 12m depth contour, where the prey resource was greatest (Guerrero 1989). The dominant species in both bays were *Ampelisca agassizi* and *A. careyi* (Dunham & Duffus 2001, 2002).

Amphipod measurements were recorded for 11 seasons over a 25-year period (1983-2008) that showed 58.9% decline in mean amphipod biomass in Ahous Bay, and 77% in Cow Bay (Dunham 1999, Patterson 2006), density of amphipods declined 32% in Ahous Bay and 76% in Cow Bay, and a decline in the caloric value of amphipods per square metre to the point that it was too low to meet daily energy requirements for gray whales (Carruthers 2000). Dunham (1999) found that it takes two years for amphipods to reach a length of at least 6mm, the minimum size for prey to be caught in gray whale baleen. However, dedicated



foraging efforts in the sandy bays ended in 1992, when amphipods were abandoned as the primary prey resource and prey-switching behaviour was first observed (Duffus 1996, Dunham & Duffus 2001).

Since 1997, only sporadic foraging on benthic habitats has been observed and amphipod foraging has become increasingly uncommon (Carruthers 2000, Patterson 2006). Gray whales have demonstrated efficiency in locating dense prey accumulations, so periodic foraging on amphipods may still occur (Patterson 2006), assuming that amphipod populations can recover. Thus far, despite release from intense foraging, amphipods have not recovered in either Ahous or Cow Bays. A possible explanation is they have been forced past the point of recovery by intense top-down pressure from gray whale foraging, and now something else has filled the niche space previously occupied by amphipods. Other factors may be the insular nature of amphipod tube mats, life history characteristics (*e.g.* slow growth rates, long generation times, absence of larvae, low dispersion, low fecundity), or distance from other populations that could supply recruits to either of the bays (Coyle *et al.* 2007, Burnham 2012, Burnham in press).

Typically, the pulse perturbation of gray whale predation on prey species can greatly impact the structure of benthic communities. The boom-bust cycle of predator-prey interactions predicts that when predation pressure is removed, prey populations can recover without extinction (Bakun 2006, Terborgh *et al.* 2010), however this has not been the case with amphipods in Clayoquot Sound. This decline in amphipod numbers mirrors Highsmith and Coyle's (1992) prediction that the Chirikov Basin, a major gray whale feeding sight in the Bering Sea, would reach its gray whale carrying capacity by the year 2000. Coyle and colleagues (2007) found that amphipod distribution was patchier, very few whales were sighted, densities were lower overall when compared to data from the 1980s. These authors connected this amphipod biomass decline with top-down control by gray whales, eliminating the possibility of temperature, nutrient supply, water mass changes, or fluxes in primary production (Coyle *et al.* 2007). As seen in Clayoquot Sound, amphipods may not return despite relief from gray whale predation, and with the loss of primary foraging sites such as the Chirikov Basin, secondary and tertiary feeding areas will become increasingly important.

## *Mysids*

Mysids are small, shrimp-like crustaceans (8-15 mm) found up to 1m above the sea floor (Mauchline 1980, Guerrero 1989, Kim & Oliver 1989). They have been associated with rocky substrate and kelp forests, feeding on phytoplankton, small zooplankton, kelp, or detritus, depending on prey availability and time of year (Kim & Oliver 1989, Stelle 2001). Echograms confirm a complex topographical sea floor in the Flores Island study area, influencing currents and possibly concentrating mysids by providing areas for mating, refuge from predators, and protection against current speeds that exceed their swimming capabilities (Pasztor 2008, Feyrer & Duffus 2011). There are 48 species of mysids in the northeastern Pacific Ocean, with twelve confirmed species in Clayoquot Sound. Burnham (2012) discovered a possible new species, waiting to be confirmed through genetic work with Kenneth Meland at University of Bergen in Norway.

Numerous studies found mysids to be the main prey of gray whales in Clayoquot Sound over the last 30 years (Murison *et al.* 1984, Dunham & Duffus 2001, 2002, Patterson 2004, Stelle *et al.* 2008, Feyrer 2010, Burnham 2012). Unlike other prey, multiple species of mysids are present at various levels of patchiness (Steele 1976). Olsen (2006) successfully used acoustic sonar to quantify mysid swarm biomass to further examine the relationship between patch location, biomass density, and gray whale foraging at a fine spatial scale. Some areas within the survey route (Figure 4.2) were found to consistently have mysid patches throughout the season (Olsen 2006, Nelson *et al.* 2008). Within the season, the location of prey biomass shifts, and whales follow (Dunham & Duffus 2001, 2002, Meier 2003, Patterson 2004, Short 2005, Olsen 2006, Feyrer 2010, Burnham 2012). On average, whales foraged at sites with a higher density of prey than study wide biomass estimates (Feyrer & Duffus 2014). However, the areas with the highest biomass did not exactly match whale distribution. According to prey-predator relationship models such as the linear Lotka-Volterra, there may be a lag present and the relationship between gray whales and patchy prey is more complex (Olsen 2006).

Nonetheless, the strength of the relationship between gray whales and mysids is strong; whale foraging is strongly correlated to average mysid density per year from 2004 – 2008 (Spearman's  $\rho = 0.90$ ,  $p=0.037$ ). Garside (2009) and Feyrer (2010) also investigated the effects of two bottom-up, primary drivers, spring sunlight and upwelling strength, on

average whale foraging effort, but these relationships were not found to be as strong as the link between mysid density and gray whale presence (Figure 4.5).

### Average mysid density (/m<sup>3</sup>) and average number of whales (/km) in the study area

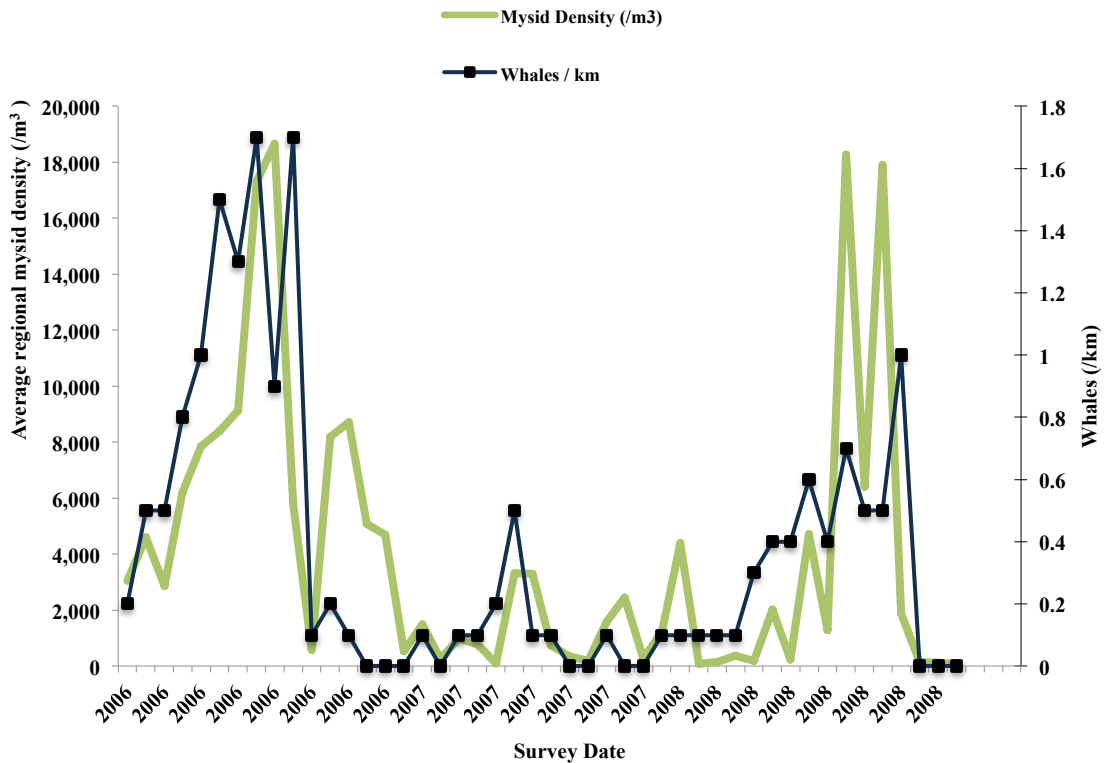


Figure 4.5. Average mysid density (per m<sup>3</sup>) summarized from biweekly overall hydroacoustic surveys of the study area, and average number of whales, recorded from weekly whale census, 2006 -2008 (Feyrer 2010).

The number of mysid species is perplexing, as competitive exclusion theory states that two species cannot occupy the same ecological niche (Hardin 1960). A possible explanation may result from the intermediate disturbance hypothesis, that higher levels of species diversity is the result of moderate scales of disturbance, and recolonization has not yet become so dense as to allow for competitive exclusion to reduce diversity (Connell 1978). Every year, gray whale predation affects mysid community composition and density. However, it is not severe enough to completely remove the local mysid population, allowing for recovery between foraging seasons, which is the basis of the theory that gray whales impose an intermediate disturbance on the mysid community in Clayoquot Sound (Feyrer &

Duffus 2011, Burnham 2012). Mysid species diversity significantly increased between 1996 and 2008, thus the cumulative effect of whales foraging within a small area in a seasonal manner was concluded to have had an intermediate disturbance effect on the overall mysid population (Feyrer & Duffus 2011).

The dominant mysid species in six out of seven years was *Holmesimysis sculpta*. This is concurrent with the findings of other studies in this study area (Dunham & Duffus 2001, Stelle 2001, Patterson 2004, Olsen 2006, Feyrer 2010, Burnham 2012). *H. sculpta* likely has life history characteristics that allow it a resiliency, or some competitive advantage in comparison to other species (Feyrer 2010). Feyrer (2010) ruled out summer brood size as a possible means for advantage, after comparing embryo production of five northwest Pacific mysid species found along Flores Island. To further investigate the possible life history strategies that may explain *H. sculpta*'s dominance, Burnham (2012) sampled mysid populations through the winter months when gray whale predation is removed and confirmed that species success is the result of superior reproductive-related traits. The Clayoquot Sound mysid species have three distinct broods, in late spring, mid-summer, and late summer, but *H. sculpta* displayed a steady rate of reproduction throughout the year, with a fourth brood in November (Burnham 2012). This ability to grow and reproduce during the winter months when predation pressure is absent is a critical mechanism by which mysids recover and continue to be a primary prey resource for gray whales in the area.

### **Whale Presence with Clear Links to Prey**

Since 1997, 613 whale surveys have been conducted during the 17 consecutive seasons, along the previously described transect route (Figure 4.2). The mean number of foraging whales per survey is used as a measure of foraging effort (Figure 4.6). Between 1997 and 2005, 53% of foraging occurred within 250m of the 10m bathymetric contour (Nelson *et al.* 2008). There is a dynamic but general declining trend between 1997 and 2008, with a significant recovery in foraging effort in 2010 (Feyrer 2010, Burnham 2012). Both the highest recorded number of whales in a single survey (n=38) and the highest mean number of whales, 18.0, occurred in 2013. Years of high foraging intensity are followed by at least one year of lower foraging effort, suggesting that mysid populations may take more than one season to recover to the point of being a worthwhile prey source for whales (Feyrer 2010,

Burnham 2012). Reduced number of foraging whales release prey from predator pressure, allowing mysid populations to reach higher numbers that can support a greater number of whales in the following season (Burnham 2012).

### Difference in whale foraging effort, 1997-2013

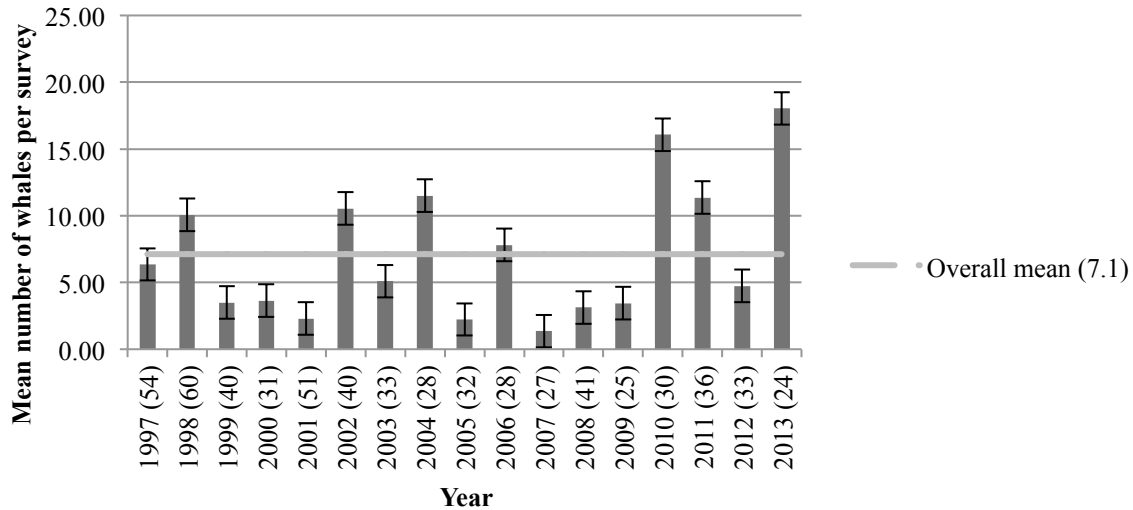


Figure 4.6. Bar chart of the difference in gray whale foraging effort, 1997-2013. The overall mean number of whales is 7.1 and indicated by the dashed line. Error bars show standard error. The number of surveys is noted in parentheses under each year.

#### Other Influences

The relationships between possible environmental forcing factors that may explain gray whale abundance in Clayoquot Sound were explored by Garside (2009). Changes in atmospheric and oceanic conditions, including temperature, salinity, wind speed, upwelling, and sunlight can affect the spatial distribution and abundance of organisms at all trophic levels of a food web (Garside 2009). Garside (2009) used a multiple regression model that explained 89.6% of whale foraging variation ( $p=0.004$ ) when combining wind speed and upwelling lagged two years. The results of this work were inconclusive, and indicated that multiple environmental variables affect primary production and prey populations to the point of altering annual gray whale abundance.

## **THE NATURE OF HUMAN-WHALE INTERACTIONS IN CLAYOQUOT SOUND**

The majority of whale-vessel interaction research in B.C. has focused on the effects on killer whales (Malcolm 2003 – *e.g.* Bain 2002, Erbe 2002, Jelinski *et al.* 2002, Williams *et al.* 2002, 2006, 2009, Bain *et al.* 2006, Hickie *et al.* 2007, Lusseau *et al.* 2009, Lachmuth *et al.* 2011), likely due to the growth of whale-watching and designation by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Malcolm 2003). The southern resident killer whale population, the focus of whale-watching out of Victoria, B.C. and the San Juan Islands, W.A. is listed as “endangered”, and the northern resident population in the Johnstone Strait and Telegraph Cove is listed as “threatened” (COSEWIC 2008). Eastern north Pacific gray whales are designated as “special concern”, due to activity in breeding lagoons, possible disruption from underwater noise developments, and subsistence hunting of a smaller summering group in Washington state waters, most likely members of the PCFG (COSEWIC 2004).

### **Gray Whales in Relation to Vessels**

Due to their coastal traveling and foraging behaviour, gray whales have been the focus of numerous research initiatives in Clayoquot Sound since the 1960s (Pike 1962). Bass (2000) conducted the only study of gray whale reactions to whale-watching vessels in B.C., involving the observation of gray whales for 280 hours under a variety of conditions. The foraging behaviour of gray whales in Clayoquot Sound varied mainly by location and depth, and at times, with vessel activity. Bass (2000) points out that, despite variation due to boat activity being statistically significant, this may not equate to biological significance. The affect of vessel traffic on whales’ behaviour was also a product of the location, with some evidence of strong effects by boats when in shallow locations, but the interaction between location and the vessel effect was complex (Bass 2000). While isolated incidents of disturbance occasionally occurred, the data did not display a clear, continuous disturbance effect (Bass 2000). When this study is coupled with the findings of Chapter Three in this thesis and Clare (in progress), the demonstrations of high site fidelity that whales exhibit in this area may indicate that the long-term health of these individuals has not been compromised by whale-watching practices, and that the profits to be gained by foraging here outweigh any energetic losses.

## **The Profile of a Whale-Watcher**

In addition to ecological research, the Whale Research Lab has explored the human dimensions of whale-watching on Vancouver Island (Duffus 1989, 1996, Duffus & Dearden 1993, Malcolm 2003). Aldo Leopold was influential in stressing the importance of understanding the human aspect of human-wildlife interactions, stating that wildlife management was actually a “problem of human management” (Leopold 1966, p. 197). Wildlife tourism appeals to a diverse group with varying socioeconomic backgrounds, motivations, and attitudes (Reynolds & Braithwaite 2001). For wildlife management to be effective, understanding the expectations, motivations, and levels of satisfaction of the user will allow for more specific manipulation of the human component in wildlife interactions, with the ultimate goal of protecting the wildlife (Duffus & Dearden 1990).

A questionnaire in 2000 surveyed participants on previous whale-watching experiences, expectations for the trip, opinions regarding the trip, views on whale management, general views on the environment, and general demographics to determine what motivates and satisfies visitors. Whale-watchers in Tofino are primarily from Canada, the United States, and the United Kingdom. 40% of respondents were male while 60% were female, most were highly educated, and between the ages of 30 and 59 (Malcolm & Duffus 2008).

Motivation bridges together perception, attitude, and satisfaction (Malcolm 2003). The two main motivations of whale-watchers in British Columbia were to encounter whales and close observation of whales (Duffus 1989, Duffus & Dearden 1993). Other incentives such as viewing other wildlife, learning from a guide or naturalist, socializing, and scenery were less important. 87.2% of viewers had planned whale-watching as a vacation activity, though only 18.1% of people travelled to Tofino specifically to view whales (Malcolm & Duffus 2008). The majority of respondents, 57.9%, had never seen whales in the wild before (Malcolm & Duffus 2008).

Satisfaction is the result of expectation and attitude before the experience in combination with the experience itself (Malcolm 2003), and can be a direct indicator of management gaps. The majority of whale-watchers are highly satisfied. In the 1980s, 86% of Tofino participants found the experience either met or exceeded expectations (Duffus 1988). However, in 2003, Tofino whale-watchers were the least satisfied compared to Victoria and Telegraph Cove visitors. The three lowest satisfaction items were number of whales seen, distance from

which whales were observed, and opportunities to take pictures (Malcolm & Duffus 2008). One factor that diminished satisfaction was the distribution of other whale-watching boats, whether obstructing sight lines, perceived to be too close to the whales, or large number of boats (Duffus 1988, Finkler 2001). These low satisfaction ratings could possibly be related to the species watched as well as vessel placement. Comparative findings were also recorded in Victoria and Johnstone Strait, where the focal species for whale-watching is the iconic killer whale, often observed in groups performing above-surface behaviours such as spy-hopping and breaching. In Clayoquot Sound, the whale-watching industry is based upon the gray whale, a solitary and slower-moving animal that spends most of its time close to the shore line and displays little of its body at a time. Despite a desire to see whales in their natural habitats, Tofino participants may have been disappointed with the passive behaviour of whales in this area. Additionally, Tofino whale-watching operators can be generous in their boating practices, often remaining farther away than the voluntary minimum 100m viewing distance (Malcolm 2003, pers. obs.).

Specialization refers to the composition of the tourist population, that they are not one homogenous group but possibly a number of sub-groups that may have important management ramifications (Bryan 1977, Duffus & Dearden 1990, Malcolm & Duffus 2008). There are different types of tourists, and each type has a varying degree of specialization related to the tourism activity (Figure 4.7). Level of specialization dictates site and activity choice (Duffus & Dearden 1990). Initially, users are considered “wildlife specialists”, commonly adventurous and have a pre-existing knowledge base about the location and the wildlife. Wildlife specialists are few in number, require little infrastructure or facilitating, their presence is negligible to the social and ecological systems of the site, and require little management intervention. As awareness of the wildlife activity increases, a less motivated type of user will dominate the site requiring increased facilitation and mediation. The pressure on the social and ecological systems increases and the host area must absorb this. At the most mature end of a system, the general tourist dominates, heavily relying on developed infrastructure and interpretation. At this point, the host society and ecosystem may be stressed and in need of management intervention (Duffus & Dearden 1990).



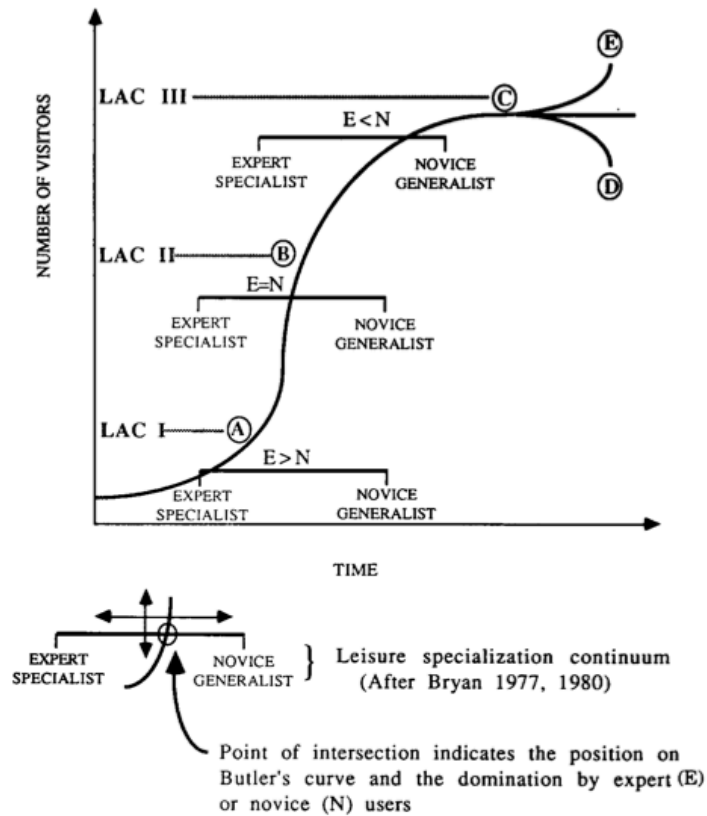


Figure 4.7. Duffus & Dearden's (1990) relationship between user specialization and site evolution.

Tofino was the second most specialized whale-watching area on Vancouver Island, after Johnstone Strait, with 14.1% of respondents self-reporting as Advanced or Expert. The size, urban development, and generalist nature of the whale-watching industry in Victoria may have motivated more experienced whale-watchers to travel to other areas, including Tofino and Johnstone Strait (Malcolm & Duffus 2008). For these more specialized tourists, Victoria may have passed the limits of acceptable change (Malcolm & Duffus 2008). It is important to note that 85.9% of visitors were generalist, with little to no previous knowledge or experience, and that this corresponds with B.C.'s overall whale-watching demographic as generalists. The attraction of whale-watching to the generalist may be that it requires no special skills, no physically demanding involvement, and no prior education, and is thus very accessible and appealing to a great number of people (Malcolm & Duffus 2008).

In Tofino today, there are five main dedicated companies with large vessel fleets in addition to at least seven motels, lodges, and water taxi services that offer guests wildlife

tours on their company boats. Internet advertising has allowed every company to reach previous and future guests around the world through numerous online outlets, including websites like tripadvisor, Facebook, Twitter, YouTube, Google Circle, Vimeo, Yelp, GoTofino, Tourism Tofino, My Destination, Groupon, and Island Daily Deals. The motivations and details of marketing effectiveness of Internet advertising are beyond the scope of this study and will not be discussed in detail.

The industry has matured and now offers a diverse number of options for tourism types, including free dog kennels, wheel-chair accessible boats, complimentary hot beverages, traditional uncovered boats as well as covered boats with viewing decks and heated cabins, on-board restrooms, and hydrophones. Businesses have also diversified tours to take advantage of the other natural landscapes and wildlife, as predicted by Duffus and Dearden (1989, 1990). During the summer high season, bear watching is popular with one to two trips leaving daily to see Vancouver Island black bears (*Ursus americanus*) along coastal inlets. The main focal species of Clayoquot Sound whale-watching continues to be the gray whale, though various other species of marine animals are commonly seen, such as harbour seals (*Phoca vitulina*), Steller and California sea lions (*Eumetopias jubatus* and *Zalophus californianus*, respectively), harbour porpoises (*Phocoena phocoena*), sea otters (*Enhydra lutris*) and bald eagles (*Haliaeetus leucocephalus*). Inconsistently, humpback whales (*Megaptera novaeangliae*) and transient killer whales (*Orcinus orca*) follow prey close enough to shore for whale-watching boats to reach them, and tufted puffins (*Fratercula cirrhata*) come ashore to breed and nest in summer months. One of the longest standing companies, Jamie's Whaling Station and Adventure Centres (opened in 1983), has even purchased a previously existing 40-room lodge and restaurant, reopening in 2013 under the name Jamie's Rainforest Inn. This is an example of vertical integration, where a company acquires a business that is directly related to its original industry (Harrigan 1985). In this instance, Jamie's Whaling Station expanded beyond collecting only direct expenditures (whale-watching admissions) to benefiting from indirect expenditures that support the whale-watching trip, including accommodation, food, transportation, and promotional rates for wildlife tours.

Maquinna Marine Provincial Park is home to the Hot Springs Cove, a natural hot spring accessible by boat and float plane all year round. All companies offer day trips

(approximately six hours) to the springs, regularly incorporating shortened whale-watching and other marine wildlife viewing depending on the ocean conditions. Other day trip options can also be accessed by boat, including drop offs to Meares Island for two hikes of varying difficulty, Vargas or Flores Island for hiking, camping, and surfing, fishing charters, and kayak trips. Some companies have even partnered with floatplane businesses to offer whale-watching by air. Customers can often save money when booking online, combining multiple types of trips, and also booking accommodation dining options through related or partnered businesses and participating in online coupon services such as Groupon or Island Daily Deals (Table 4.1).

Table 4.1. Indicators of diversification for five main dedicated whale-watching companies in Tofino, B.C. All information collected from online resources, personal observations and communications, and in-store advertising by companies. Each company is assigned a code to maintain anonymity.

| Company | Hot Springs | Bear watching | Website | Email | Book online | Facebook | Twitter | Videos | Private charter, group rate | Online coupon | Discount book online | Discount multiple tours | Guaranteed sightings | Online award |
|---------|-------------|---------------|---------|-------|-------------|----------|---------|--------|-----------------------------|---------------|----------------------|-------------------------|----------------------|--------------|
| A       | ✓           | ✓             | ✓       | ✓     | ✓           | ✓        | ✓       | ✓      | ✓                           | ✓             | ✓                    | ✓                       | ✗                    | ✓            |
| B       | ✓           | ✓             | ✓       | ✓     | ✓           | ✓        | ✓       | ✓      | ✓                           | ✓             | ✓                    | ✓                       | ✓                    | ✓            |
| C       | ✓           | ✓             | ✓       | ✓     | ✓           | ✓        | ✓       | ✓      | ✓                           | ✓             | ✗                    | ✗                       | ✓                    | ✓            |
| D       | ✓           | ✓             | ✓       | ✓     | ✓           | ✓        | ✓       | ✓      | ✓                           | ✗             | ✗                    | ✗                       | ✗                    | ✗            |
| E       | ✓           | ✓             | ✓       | ✓     | ✓           | ✓        | ✓       | ✓      | ✓                           | ✓             | ✓                    | ✗                       | ✓                    | ✗            |

In addition to the five main whale-watching companies in Tofino, there are at least seven local companies that either focus primarily on other business endeavors (*i.e.* hotel, marina, resort), or offer infrequent or chartered tours. Of the main five companies, all offer bear watching tours and day trips to Hot Springs Cove. All five also have email addresses, websites with the ability to book online, Facebook pages, Twitter accounts, private charter or group rates, and videos of wildlife seen on tours. All but one company has taken advantage

of the online coupon website, Groupon, where buyers saved approximately 50% on tours by purchasing them in advance. Most, but not all, offer discounts for booking tours online via company websites, booking multiple wildlife tours, advertising online excellence awards (TripAdvisor, My Destination), and a guaranteed sighting policy. The increase in online resources for booking tours demonstrates a diversification from previous methods of booking and an increase in communication efficiency, allowing reach potential visitors outside of anywhere in the world with Internet access. While operators promote a 95% success rate at viewing whales (K. Martini pers. com.), most businesses provide a raincheck with no expiry date, where guests can go on future tours until whales are sighted, although tickets are not refundable.

### **The Local Whale-Watching Industry: Tofino**

Tofino-based whale-watching operators have unique management strengths. We know that whale-watching is conducted through a self-regulated network in Clayoquot Sound, where most operators are local residents (Malcolm 2003). No formal operator association exists, but drivers and operators meet before the season, and during the season as needed (R. Palm pers. comm.). The whale-watching season opens with Pacific Rim Whale Fest in March, where the city celebrates the first sightings of gray whales on their northward migration. Drivers are cooperative with one another, communicate with on open VHF marine radio channels to aid in locating wildlife, describing weather conditions, and for contacting their land-based offices on their location and intended route of travel (Malcolm 2003, pers. obs.). The industry has been willing to communicate and cooperate with researchers in the past (Malcolm 2003), including with Strawberry Isle Marine Research Society, Pacific WildLife Foundation, and the University of Victoria Whale Research Lab. Drivers are often curious about our research methods, findings, and whale behaviour, and we have supplied them with samples of mysids to enhance their on-board education programs and tourist experience (pers. obs., Olsen pers. comm., Tombach pers. comm., Duffus pers. comm.).

Despite the dedication to and intention of protecting marine mammals through regulation, whale-watching guidelines lack the scientific knowledge regarding cetaceans. This has been a major weakness of whale-watching management. As an example, minimum approach distances are arbitrary and are not based on actual biological thresholds that prevent

vessels from negatively impacting animals (Malcolm 2003). There is no conclusive cause-effect evidence that boats in close proximity to whales will result in a negative long-term biological impact in B.C. (Malcolm 2003), although research efforts have begun to attempt to connect short-term behaviour changes to long-term effects on individual and population-level health (Bejder *et al.* 2006, Williams *et al.* 2009). So despite guidelines being promoted as precautionary, the effects of vessels on marine mammals are not fully understood and thus there is no evidence to support that regulations actually are precautionary, but are instead “pseudo-precautionary” (Malcolm 2003). However, results from Chapter Three indicate that existing management and use of voluntary guidelines in Tofino are effective at maintaining the commercial whale-watching industry. This suggests that regulations may indeed be precautionary in this study area, though research on the effects of vessel exposure on gray whales is still lacking.

The primary objective of operator regulations should be the sustainability of focal populations, followed by effectively organizing whale-watching activities and safety, and then for the promotion or recognition of environmental dedication (Malcolm 2003). If the guidelines do not serve a biological purpose, then the primary objective is not met, and guidelines are not useful (Malcolm 2003). Research involving the integration of social and ecological dimensions for management purposes is lacking, but this study may serve as an example of how long-term ecology-based research can benefit wildlife tourism management.

Over the 2012 and 2013 summer seasons, industry pressure and commercial boater compliance were measured to establish what a typical whale-watching encounter in Clayoquot Sound looked like from a biological perspective. The two whale-watching seasons equated to two different sets of ecological conditions, and both industry pressure associated with whale-watching as well as vessel behaviour with respect to whales depends on the season and the biological factors that influence whale presence (Chapter Three this thesis). Currently, management practices do not account for this variation, which ultimately affected boater decision-making, route-planning, boat behaviour, and compliance of regulations. Additionally, returning whales spent significantly more time with commercial whale-watching boats than single-visit whales, indicating that whales that display signs of site fidelity may experience greater industry pressure.

### *Current Methods of Local Management*

Drivers abide by the *Be Whale Wise* guidelines established by Fisheries and Oceans Canada in conjunction with NOAA. Some long-standing drivers also conduct themselves according to the *Tofino Whale Watching Operators' Voluntary Guidelines (TWWOVG)*, another set of voluntary guidelines produced by Strawberry Isle Research in 1995. The main difference between the two protocols is the *TWWOVG* take into account that approaches to wildlife can vary depending on the conditions of the encounter, such as the number of whales or boats, location, or weather (Strawberry Isle Research 1995). As well, the approach distance in the *TWWOVG* is 50m, rather than the 100m minimum distance in the *Be Whale Wise* regulations. Additionally, Parks Canada (2003) produced the Pacific Rim National Park Reserve Marine Mammal Viewing Guidelines for boaters operating within and around the national park boundaries (Appendix 2.5). Parks Canada expanded upon the *TWWOVG* to include more species and site-specific regulations. The jurisdiction is vague, but encompasses the marine ecological reserve, Cleland Island, which is located more than 16km from the northernmost point of Pacific Rim National Park.

The grassroots nature of whale-watching in Tofino is evident, and there has been a noticeable absence of government influence. Operators cooperate and have a genuine interest and concern for how their operations may affect the animals. This industry's ability to successfully self-regulate boating behaviour is rare, but has limitations: it cannot restrict access to animals (anyone can start a whale-watching company), the resource cannot be isolated to establish control zones or distinguish normal baseline behaviours, and guidelines cannot be enforced (Malcolm 2003). Successful management in the future will depend on how these limitations are addressed. As a response to the lack of management, Malcolm (2003) suggested a formal co-management agreement between Fisheries and Oceans, industry operators, the scientific community, and experienced NGOs. Research that includes the variety of interests produces results that stakeholders support, considering them more credible and appropriate (Wiley *et al.* 2013). Operators would have their work as self-regulators legitimized, and a process can be established to work towards technical and logistically appropriate solutions that can be supported by law.

A useful tool for the protection of marine mammals around the world is the definition of critical habitat (Dawson & Slooten 1993, Halpern 2003, Lusseau & Higham 2004). Marine

protected areas (MPAs) in B.C. encompass important terrestrial and marine components and have been effectively implemented as a management option for the protection of various fauna and flora. Due to the mobility of marine species and life history characteristics that can change over space and time (seasonality), it can be difficult for MPAs to effectively protect wide-ranging animals such as whales. There are few studies that demonstrate the efficacy of MPAs for improving marine mammal populations, though Gormley and colleagues (2012) saw an increase in annual survival of Hector's dolphins since the creation of the Banks Peninsula Marine Mammal Sanctuary in 1988, indicating that the restrictions on commercial gillnetting have reduced dolphin bycatch. Although the specifics of this case study are not directly transferable to B.C. coasts, it demonstrates the capability of management to create biologically significant change at a population level over an extended period of time (21 years) (Gormley *et al.* 2012). Similarly, cooperation between scientists and stakeholders within the Stellerwagen Bank National Marine Sanctuary was another example of the successful application of marine spatial planning to resolve resource use conflicts and conserve species biodiversity (Wiley *et al.* 2013). Broadly applicable lessons that resulted in this success include the use of high quality data, specific to the particular problem, location, and period of time; collaboration with stakeholders; presenting accessible data, where results are clear and concise; a regulatory drive for action in a timely manner (Wiley *et al.* 2013).

The top-down pressure that gray whales exert on mysid communities indicates that they may require multiple ecologically connected habitats over large spatial scales for foraging during the summer months (Short 2005, Nelson *et al.* 2008). Thus, the location of MPAs should reflect this. Short (2005) used a multi-trophic level approach to assess connectivity within and surrounding multiple marine parks in Clayoquot Sound, using chlorophyll *a* (primary production is the foundation for upper trophic levels) as an indicator of connectivity. Results showed that depending on what temporal scale was used to view chlorophyll *a* distribution, there may or may not be a connection in the boundary delineation of marine reserves, since the study found no significant difference in phytoplankton levels inside or outside reserves (Short 2005). To investigate connectivity at the mid-level of a gray whale food chain, the genetic markers in spatially distant (~80km) *H. sculpta* mysid populations was used as to imply connectivity between existing marine reserves, similar to Hellberg and colleagues in 2002. Estimates of gene flow showed limited dispersal and

suppressed population exchange, a consequence of life history characteristics and habitat preferences. Since movement is limited depending in the life stage the species is in, and their inclination towards highly dynamic nearshore environments, the dispersal abilities of *H. sculpta* do not display connectivity between MPAs (Short 2005). The suppressed dispersion of mysids highlights the importance of placing marine reserves in areas associated with *H. sculpta* habitats, since mysids have been a primary prey item for gray whales in this area (Dunham & Duffus 2001) and *H. sculpta* continues to persist as the dominant species (Feyrer 2010, Burnham 2012).

There are six provincially designated MPAs within Clayoquot Sound: Vargas Island, Flores Island, Maquinna, Catala Island, and Nuchatlitz. From 2002 to 2004, 73% of whales spotted were found within current boundaries of existing marine parks, revealing how existing park configurations can work to protect a network of gray whale foraging habitats (Short 2005). With an additional MPA added at the west coast of Nootka Island and reconfiguring the park boundaries at three existing parks based on a 500m buffer around the 10m bathymetric contour, the proportion of foraging whale encounters within protected areas could increase to 97% (Short 2005) (Figure 4.8). Using a multi-trophic approach, Short (2005) demonstrated the ecological relevance of current MPA networks, and how they can be used to protect seasonally important habitats for a highly migratory marine species such as the gray whale.



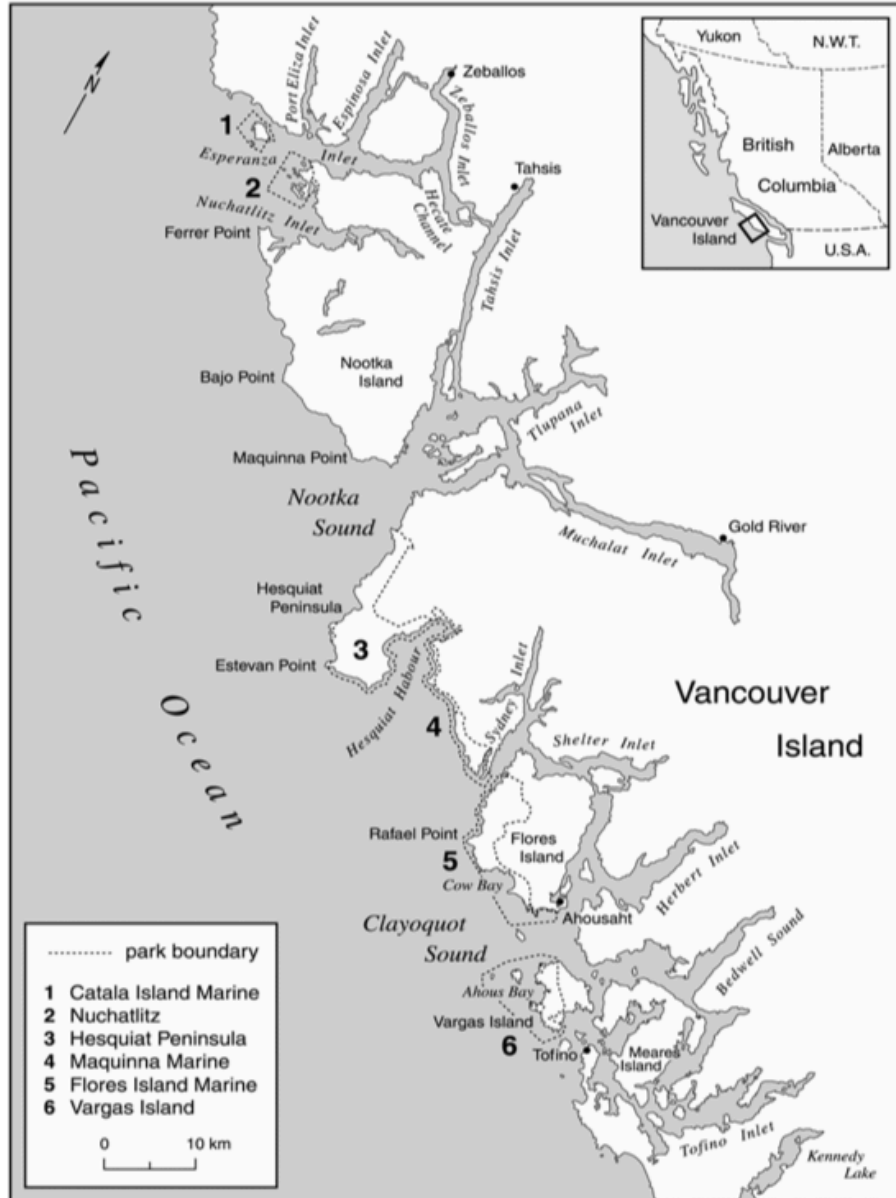


Figure 4.8. Clayoquot Sound study area highlighting park and non-park areas (Short 2005).

Education has been considered an important facet of whale-watching management, but research demonstrates no established educational benefit to whale-watching and few studies have focused on ecological data using systematic data collection methods over a long time period (Duffus 1989, Duffus & Dearden 1990, Hoyt 1995, 2001, Finkler 2001, Malcolm 2003). Despite this, education remains a critical aspect of ecotourism experiences (Forestell 1990, Orams & Hill 1998, Orams & Taylor 2005). The purpose of stressing learning experiences for ecotourism visitors is to motivate environmentally conscientious behaviour

from tourists (Orams & Hill 1998). This can increase the visitor compliance in ecotourism scenarios, and education has been accepted as a valuable tool ensuring rules and regulations are followed (Forestell & Kaufman 1993, Orams & Hill 1998). When Malcolm (2003) investigated the specialization of whale-watchers in Tofino, he found that the majority of tourists were generalists and that education may not have occurred during whale-watching, despite positive attitudes towards cetacean conservation. As a result, education should create a knowledge base of basic marine and whale ecology, so that visitors have some sort of context that allows for discussions on more complex and in-depth conservation issues (Malcolm 2003).

## **DISCUSSION**

Whale-watching in Tofino is based on the presence of gray whales, and the continued success of this industry is dependent on the continued presence of these whales. The inherent difficulty in managing ecological aspects leads to the importance of controlling the more malleable human dimension. Regulating human interactions with wildlife is necessary to reduce the possibility of detrimental impacts on focal populations that are the foundation of established tourism activities. Additionally, effective management would aim to protect habitats essential to various life processes, particularly those linked to prey. Since we have established that foraging drives gray whale behaviour in our study area, the protection of prey habitat is of critical importance and may allow foraging on mysids to persist.

### **Use of Ecological Knowledge in Management**

The connection between gray whales and prey density is very clear (Feyrer 2010, Burnham 2012). Higher densities of mysids attract whales in greater numbers, and are positively correlated with the length of in-season residency of individual whales. Years with greater prey density also have higher number of whales per survey and greater foraging effort. Whales that visit even in poor prey years are often returning whales, displaying signs of high site fidelity and loyalty to this location. On a micro-scale, whales travel within the Flores Island study area, following patches of prey. Over time, mysid swarms are mostly consumed or dispersed, and after swam density falls below 4,400 mysids per m<sup>3</sup>, whales move to the next prey patch (Olsen 2006, Feyrer 2010). As the season progresses, swarms

recover by regrouping and producing summer broods and whales are spotted returning to previously exploited areas (Nelson *et al.* 2008).

Because of the close tie between gray whales and their prey, mysid habitat has also been investigated. Mysids were associated with kelp forests and rocky substrates along the 10m bathymetric contour (Pasztor 2008). As gray whales exert a top-down force on mysid populations, localized prey patches are diminished and whales move to areas where feeding results in net energy gain. On a micro-scale, the within-season movement is generally northbound from Fitzpatrick Rocks to End Rocks, and as mysid populations recover from mid- and late-summer broods, whales return to Fitzpatrick Rocks.

The industry pressure and boater compliance associated with commercial whale-watching activities in Clayoquot Sound indicated that pressures such as length of encounter, number of boats per whale, and focus on resident versus single-visit whales vary depending on the ecological situation. This increased time pressure on resident whales may be related to habituation, similar to findings by Richter and colleagues (2006) that show resident groups of whales off Kaikoura (whales that remain closer to shore, return for more than two seasons, and remain in the area for longer) respond differently to whale-watching when compared to transient whales. They hypothesize that resident sperm whales may have learned whale-watching vessels do not pose a significant threat to their livelihood (Richter *et al.* 2006). These results may signify resilience and adaptability in local gray whales, but could mean an increase in the occurrence of potentially dangerous interactions, including lack of avoidance or close approaches to boat propellers (Lien 2001, Richter *et al.* 2006). With a greater understanding of the structure of the apparent sub-population of gray whales present in Clayoquot Sound during the summer will provide insight on the timeliness and extent of management efforts to mitigate any negative effects or their removal through proposed subsistence hunting by the Makah Tribe. Precaution should be taken in any expansion of whale-watching practices in Clayoquot Sound, so as to minimize the negative impacts that this habituation may have on whales that exhibit high site fidelity.

The best resource management decision in the interest of continuing whale-watching activities in Clayoquot Sound would involve the protection of important gray whale foraging areas and prime mysid habitat. To do this, changes in land and water use that have the potential to alter local ecosystems should be avoided. Resource extraction activities,

particularly forestry and mining operations, have the potential to change the substrate and water chemistry of nearshore habitats. Forestry practices that involve log sorting and barging can change the sediment discharge in coastal streams and estuaries, as has already been the case in the Atleo River within Clayoquot Sound where heavy logging has destroyed previously productive salmon habitat (George 2003). Similarly, the mine development company, Imperial Metals, was granted an exploration permit for Clayoquot Sound in 2013. Mining activity can cause water chemistry, increased sedimentation, and stream flow issues, even when mines comply with industry regulations (Hunt 2014). Increased ship traffic associated with these activities is a resulting consequence, and with it comes the risks of vessel strikes, underwater noise disturbance, and energy budget variations that may have individual and population-level consequences over time.

Allocating areas for legislated protection is a common method used to reduce impacts on marine mammals (Hoyt 2005). The design and implementation of marine reserves should reflect the ecological requirements of the species of interest. For this area, the most appropriate placement would involve several reserves in known feeding locations of gray whales (Short 2005). The configuration of six existing MPAs in Clayoquot Sound coincidentally includes important foraging areas for gray whales, despite the haphazard allocation of boundaries accompanied by unclear objectives and limited ecological insight (Dunham *et al.* 2002, Short 2005). Of equal importance is the protection of above-tidal level habitats. Land characteristics including streams, soils, and vegetation are intimately connected to the ecosystem health of the subtidal regions of gray whale feeding sites in this area (Bass 2000). Using networks of protected areas can provide resilience for gray whales by managing human activities in these areas while simultaneously allowing B.C. Parks to fulfill all of its mandates related to management and design (Short 2005). With political will and scientific certainty, the designation of marine parks provides a route for future management and possible enforcement.

Using education as a form of whale-watching management has been stressed as a way to encourage environmentally conscious and conservative behaviours in tourists. Malcolm (2003) suggested that education programs in the Clayoquot Sound should focus on increasing visitor's knowledge from a generalist level to that of a specialist. To do this, naturalists need to act as the facilitator of ecological information and corresponding conservation messages to

catalyze a change in how guests understand and approach the world (Malcolm 2003). The Whale Research Lab has been involved in increasing the quality of the educational experience that local operators can offer guests by training naturalists and boat drivers through intensive naturalist courses that have been offered in Victoria, Tofino, and Ahousat. By understanding the local ecological and social context in which whale-watching occurs, tourists are able to critically analyze information they may receive in future interactions with cetaceans, and then transfer that knowledge to others. At this point, more in-depth conservation issues can be discussed. In order for whale-watchers to reach a point where they can become part of the management solution, education platforms should aim to increase the level of whale-watcher specialization.

### **Implications for Future Whale-Watching Management**

Management of wildlife tourism activities needs to be based on ecological information derived from long-term data. The Whale Research Lab has studied the presence of gray whales in an ecological context since 1997, producing projects and published work on topics including foraging activity, prey preference, population structure, connectivity, and effects of vessel traffic.

Whale-watching activities do not appear to alter gray whale behaviour to the point of negatively affecting foraging efforts in Clayoquot Sound. However, the behaviour of the Tofino whale-watching fleet changes depending on the local ecological scenario. Assuming mysids continue to persist, and that directly managing the ecological components of the system is unlikely, the continuation of whale-based industries will be dependent on the ability to manage potentially detrimental human influences. While it is unlikely that commercial whale-watching activities in this small part of the gray whale range have an impact on the overall eastern Pacific population (Duffus 1996), the discovery of the PCFG and the possibility of even further distinction of whales loyal to Clayoquot Sound begs for further research on the potential effects of tourism practices on whales in this area. Results from Chapter Three of this thesis indicate that whales that exhibit evidence of high site fidelity (within-season residency, between-season return rates) spend more time with boats and therefore may be subjected to more industry-related pressure. A conservative approach in management efforts should be continued, and boating behaviours that visibly disrupt foraging

activity should be consistently deterred in order to prevent long-term, cumulative effects on individual whales that have demonstrated high site fidelity and supported the majority of the whale-watching encounters in 2012 and 2013. Given their life history, long-distance travel is necessary when traveling to summer foraging grounds, and even an additional 10km north to the next bay is likely negligible to overall energy budgets. However, this extra distance may be beyond the range of some boats in the fleet, where others will be forced to reduce the number of daily trips per vessel and per operator, which questions the overall viability of whale-watching in this area (Duffus 1996, Duffus *et al.* 2013).

### **Management Recommendations**

After reviewing the research specific to whales in this study area, I am proposing five management recommendations to regional, provincial, and federal levels of government, as well as local First Nations groups, environmental nongovernmental organizations (NGOs), local residents, and dedicated stakeholders. The goal of these suggestions is to promote sustainable whale-watching practices in Clayoquot Sound. These recommendations are based on previous suggestions put forward by Duffus and Dearden (1989) and Malcolm and Lochbaum (1999) (Appendices 2.2 and 2.4, respectively), and the available ecological information pertaining to gray whale presence in Clayoquot Sound. This list of suggestions is not exhaustive, and may be adapted as new science becomes available.

1. **Maintenance of the integrity of the resource base upon which the industry is based.** For whale-watching to continue to be a viable business in Clayoquot Sound, detrimental impacts on gray whale foraging habitats must be prevented. This applies to both the practices of the tourism industry, as well as the potential activities of other interests that may alter the substrate, including resource extraction such as logging, mining, and fish farming. Key foraging areas have been identified through longitudinal whale surveys, and locations include Cow Bay and Rafael Point. Existing legislation such as the allocation of marine protected areas and national parks may be used or altered to prevent damage to the local marine and terrestrial ecosystems.

2. **Precautionary whale-watching practices.** It is in the industry's best interest to not disturb the resource upon which their business is based, although the scientific evidence of disturbance is variable. Current whale-watching activities do not appear to deter whales from returning to this foraging location, so precautionary practices should now focus on reducing the potentially cumulative effects of vessels on gray whales and possible habituation to humans. Additional regulations may include creating use and non-use areas, or limiting the number of boats per whale, especially during years where whale numbers are lower (as discussed in Chapter Two). The continued monitoring of the interactions between commercial boats and whales may offer insights into the long-term effects of whale-watching in this area.
3. **Creation of a formal industry association of British Columbia operators.** A formal organization can act as an advisory body to government, the scientific community, and general public (Malcolm 2003). An association may be responsible for supporting numerous companies around the province, and ensuring that information on regulations, workshops, new research on harassment or behaviour of whales is widely and systematically available to operators (Duffus & Dearden 1989). In future management initiatives, an association could provide valuable input with their perspective. This could also be a platform for increasing boater compliance with existing guidelines, both for commercial and leisure operators. Tofino operators have been successful with self-regulated voluntary compliance, and may serve as a best-practices example for other operators within and outside of the province.
4. **Complete the development of regulations and laws pertinent to marine mammal viewing in British Columbia.** Despite the self-policing of the Tofino industry, the use of legislated regulations produces higher rates of compliance (Corkeron 2006, Higham *et al.* 2009, Constantine 2014). Allen and colleagues (2007) have suggested that the minimum acceptable compliance rate is at least 0.8 or higher. With improved compliance rates, the risk of disruptive behaviour decreases. In an effort to increase compliance of both recreational and commercial operators, educating boaters about how to behave when near marine mammals may be beneficial. The existence of marine mammal viewing legislation alone will likely not be sufficient for increasing

compliance rates. An increase DFO enforcement, at least during the initial implementation period, is strongly recommended.

5. **Education.** Whale-watching tours are an opportunity to teach visitors about ecology and conservation. To do this, naturalists must be trained to develop a strong knowledge base and the ability to communicate this information to others. In order to reduce pressure on tour operators to violate marine mammal-viewing guidelines, unrealistic visitor expectations should be addressed. Finkler (2014) has proposed an audiovisual marketing tool, where video is used to communicate science-based information on sustainable and appropriate whale-watching practices. Managing expectations may be key in maximizing guest satisfaction while minimizing negative effects on focal species. If a goal of whale-watching management is to promote respectful and sustainable behaviour around marine mammals, education is critical.

### **Limitations of Management**

No level of management could address natural food supply, and the largest influence on resources for the whales is the whales themselves. There is also the possibility of the whales foraging in this site to the point of altering ecosystem structure, similar to the effect of predation upon amphipods in the area. Since their depletion, benthic amphipods have not been able to recover to a point where they can support the foraging whales that continue to visit the area each summer (Duffus *et al.* 2013). This leads us to question if gray whale disturbance via foraging can have a similarly devastating impact on mysid populations, where numbers are reduced to a point where prey are unable to rebound. While there may be other mechanisms by which mysids can recover where amphipods could not (*i.e.* better at re-colonizing), the future of mysids in Clayoquot Sound is unclear. Continued research over an extended period of time will be necessary to determine if and by what mechanisms mysids continue to support whales in this tertiary foraging area.

### **CONCLUSION**

The ecological scenario of gray whales in Clayoquot Sound is not fully understood, but aspects have been revealed after nearly 30 years of dedicated field-based research. Whale-watching is a major tourism venture here, and its continuation will depend on the



continued presence of gray whales within range of the port of Tofino. To avoid negatively affecting the whales that visit during the summer months, management initiatives will need to have an ecological foundation to be relevant.

Gray whale presence is not a static phenomenon, but a dynamic balance of ecological and social factors. In this Chapter, I discussed the main drivers for gray whale presence over different temporal scales, including mysids as the current primary prey item and the mechanisms by which they recover after disturbance through foraging whales. I discussed the nature of human interactions with whales in this area, and the importance of gray whales to the local tourism industry in Tofino and Ucluelet. The current methods of managing these activities were briefly mentioned (and discussed more in-depth in Chapter Two). Finally, I reviewed what ecological information maybe relevant and useful to management bodies, with a special focus on whale-watching management. I created a list of five management recommendations to all levels of government, decision-makers, and stakeholders that support long-term, sustainable whale-watching operations in Clayoquot Sound.

This study demonstrates the importance of understanding ecological systems when approaching the management of human-wildlife interactions. Though the results may not be directly relatable to other study areas, the methods by which these results were found could be replicated anywhere. Longitudinal, science-based research can be applied to join biological and socioeconomic fields in locations where whale-watching or wildlife tourism occurs. The ecological processes described in this Chapter may mirror what is occurring at other tertiary foraging sites for gray whales, or may be a representation of similar processes that may be occurring on differing spatial or temporal scales. The continuation of consistent research may further reveal why gray whales do or do not visit, why they leave, and what role whale-watching plays in this system.

## LITERATURE CITED

- Allen, S., Smith, H., Waples, K. and R. Harcourt. 2007. The voluntary code of conduct for dolphin watching in Port Stephens, Australia: is self-regulation an effective management tool? *Journal of Cetacean Resource Management*, 9(2):159-166.
- Andrade, H.A. and C.A.E. Garcia. 1999. Skipjack tuna fishery in relation to sea surface temperature off the southern Brazilian coast. *Fisheries Oceanography*, 8(4):245-254.
- Bain, D.E. 2002. A model linking energetic effects of whale watching to killer whale (*Orcinus orca*) populations. Friday harbor Laboratories, University of Washington, Friday Harbor, Washington, United States of America. 24pp.
- Bain, D.E., Smith, J.C., Williams, R and D. Lusseau. 2006. Effects of vessels on behavior of southern resident killer whales (*Orcinus spp.*). (NMFS Contract Report No. AB133F03SE0959 and AB133F04CN0040). National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Washington, United States of America. 62 pp.
- Bakun, A. 2006. Wasp-waist populations and marine ecosystem dynamics: navigating the “predator pit” topographies. *Progress in Oceanography*, 68:271-288.
- Bass, J. 2000. Variations in gray whale feeding behaviour in the presence of whale-watching vessels in Clayoquot Sound, 1993-1995. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Bejder, L., Samuels, A., Whitehead, H. and N. Gales. 2006. Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour*, 72:1149-1158.
- Brownell Jr., R. L. and Swartz, S. L. 2006. The floating factory ship California operations in Californian waters, 1932-1937. *International Whaling Commission, Scientific Committee*.
- Bryan, H. 1977. Leisure value systems and recreation specialisation. *Journal of Leisure Research*, 9:174–187.
- Burnham, R.E. 2012. The importance of the mid-tropic layers in ecosystem structure, process and function: the relationship between the Eastern Pacific Gray Whale (*Eschrichtius robustus*) and mysids (order *Mysidacea*) in Clayoquot Sound. M.Sc. thesis, University of Victoria, British Columbia, Canada.

- Calambokidis, J. 2013. PCFG, PCFA, or seasonal resident: an important but debated subgroup by any name. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1):21-23.
- Calambokidis, J., J.L. Laake and A. Klimek. 2010. Abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998-2008. Paper IWC/62/BRG32 submitted to the International Whaling Commission Scientific Committee. 50pp.
- Calambokidis, J., Laake, J. L. and A, Klimek. 2012. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998-2010. Paper SC/M12/AWMP2.
- Carruthers, E.H. 2000. Habitat, population structure and energy value of benthic amphipods, and implications for gray whale foraging in Clayoquot Sound, British Columbia. M.Sc. thesis, Queens University, Ontario, Canada.
- Charnov, E.L. 1974. Optimal foraging, the marginal value theorem. *Theoretical Population Biology*, 9(2):129-136.
- Clapham, P.J., Young, S.B. and R.L. Brownell, Jr. 1999. Baleen whales: conservation issues and the status of the most endangered populations. *Mammal review*, 29:35-60.
- Clare, J.A. In progress. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Connell, J.H. 1978. Diversity in tropical rain forests and coral reefs. *Science*, New Series, 199(4335):1302-1310.
- Constantine, R. 2014. Whale-watching and behavioural ecology. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. Higham, J., Bejder, L. and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 193-205.
- Corkeron, P.J. 2006. How shall we watch whales? In *Gaining Ground: In Pursuit of Ecological Sustainability*. (Ed. D.M. Lavigne) International Fund for Animal Welfare. Guelph, Canada, and the University of Limerick, Limerick, Ireland. 161-170.
- COSEWIC. 2004. Eastern North Pacific population of gray whales (*Eschrichtius robustus*). Wildlife Species Search, Committee on the Status of Endangered Wildlife in Canada. Retrieved March 17, 2014 from [http://www.cosewic.gc.ca/eng/sct1/searchdetail\\_e.cfm](http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm)

- COSEWIC. 2008. Northeast Pacific southern resident population of killer whales (*Orcinus orca*). Wildlife Species Search, Committee on the Status of Endangered Wildlife in Canada. Retrieved March 17, 2014 from [http://www.cosewic.gc.ca/eng/sct1/SearchResult\\_e.cfm](http://www.cosewic.gc.ca/eng/sct1/SearchResult_e.cfm)
- Coyle, K.O. and R.C. Highsmith. 1994. Benthic amphipod community in the northern Bering Sea: analysis of potential structuring mechanisms. *Marine Ecology Progress Series*, 107:233-244.
- Coyle, K.O., Bluhm, B.A., Konar, B., Blanchard, A.L. and R.C. Highsmith. 2007. Amphipod prey of gray whales in the northern Bering Sea: comparison of biomass and distribution between the 1980s and 2002 - 2003. *Deep Sea Research II*. 54:2906-2918
- Darling, J. D. 1984. Gray whales off Vancouver Island, British Columbia. In: *The Gray Whale* (Ed. by Jones, M. L., Swartz, S. L. and S. Leatherwood), 267-287. Academic Press: London, United Kingdom
- Dawson, S.M. and E. Slooten. 1993. Conservation of Hector's dolphins: the case and process which led to establishment of the Banks Peninsula Marine Mammal Sanctuary. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 3:207-221.
- Dearden, P. and B. Mitchell. 2012. *Environmental Change and Challenge* 4<sup>th</sup> ed. Oxford University Press Canada: Doc Mills, Ontario, Canada. 624pp.
- Duarte, C.M. 1990. Time labs in algal growth: generality, causes and consequences. *Journal of Plankton Research*, 12(4):873-883.
- Duffus, D.A. 1988. Robson Bight: Reserved for Killer Whales. *Park News*, 22(4):15-18.
- Duffus, D.A. 1989. Non-consumptive use and management of cetaceans in British Columbia coastal waters. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Duffus, D. A. 1996. The recreational use of grey whales in southern Clayoquot Sound, Canada. *Applied Geography*, 16(3):179-190.
- Duffus, D.A. and P. Dearden. 1989. *A Perspective on Whale-Watching and Tourism in British Columbia*. Unpublished contract report to the B.C. Ministry of Tourism, Victoria, B.C.
- Duffus, D.A. and P. Dearden. 1990. Non-consumptive wildlife-oriented recreation: a conceptual framework. *Biological Conservation*, 53:213-231.

- Duffus, D.A. and P. Dearden. 1993. Recreational use, valuation, and management of killer whales (*Orcinus orca*) on Canada's Pacific Coast. *Environmental Conservation*, 20:149-156.
- Duffus, D.A., Burnham, R.E. and L.J. Feyrer. 2013. Ecology, scales, and gray whales. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1), 24-28.
- Dunham, J.S. 1999. Gray whale prey and whale distributions in Clayoquot Sound, British Columbia, Canada (1996-97). M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Dunham, J.S. and D.A. Duffus. 2001. Foraging patterns of gray whales in central Clayoquot Sound, British Columbia, Canada. *Marine Ecology Progress Series*, 223:299-310.
- Dunham, J.S. and D.A. Duffus. 2002. Diet of gray whales (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia, Canada. *Marine Mammal Science*, 18(2):419-437.
- Dunham, J.S., Zacharias, M.A., Biffard, D.R., Westmacott, S.E, Dunham, K.A., and C. Osborne. 2002. Provincial Marine Protected Areas in British Columbia. Decision Support Services Ministry of Sustainable Resource Management, Victoria, B.C.
- Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science*, 18(2):394-418.
- Evans, P.G.H. 1987. The natural history of whales and dolphins. Christopher Helm: London, United Kingdom.
- Feyrer, L.J. 2010. The foraging ecology of gray whales in Clayoquot Sound: interactions between predator and prey across a continuum of scales. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Feyrer, L.J. and D.A. Duffus. 2011. Predatory disturbance and prey species diversity: the case of gray whale (*Eschrichtius robustus*) foraging on a multi-species mysid (family *Mysidae*) community. *Hydrobiologia*, 678:37-47.

- Feyrer, L.J. and D.A. Duffus. 2014. Threshold foraging by gray whales in response to fine scale variations in mysid density. *Marine Mammal Science*. Early View published online on October 16, 2014.
- Finkler, W. 2001. The experiential impact of whale watching: Implications for management in the case of the San Juan Islands, USA. M.Sc. thesis. University of Otago, New Zealand.
- Finkler, W. 2014. Save the whales Part II: A new science advocacy communication framework. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 352-364.
- Fisheries and Oceans Canada. 2010. Management plan for the Eastern Pacific Grey Whale (*Eschrichtius robustus*) in Canada [Final]. *Species at Risk Act Management Plan Series*. Fisheries and Oceans Canada, Ottawa. 69pp.
- Forestell, P.H. 1990. Marine education and ocean tourism: Replacing parasitism with symbiosis. In: *Proceedings of the 1990 Congress on Coastal and Marine Tourism Vol. 1*. (Eds. M.L. Miller and J. Auyong). National Coastal Resources Research Institute: Corvallis, Oregon, United States of America.
- Forestell, P. H. and G.D. Kaufman. 1993. Resource managers and field researchers: Allies or adversaries? In: *Encounters with Whales '93*, (Eds. D. Postle and M. Simmons). Great Barrier Reef Marine Park Authority: Townsville, Queensland, Australia. 17–26.
- Garside, C.F. 2009. Relating gray whale abundance to environmental variables. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- George, E.M. 2003. *Living on the Edge: Nuu-chah-nulth history from an Ahousaht Chief's perspective*. Sono Nis Press: Winlaw, British Columbia, Canada.
- Gormley, A.M, Slooten, E., Dawson, S., Barker, R.J., Rayment, W., du Fresne, S. and S. Bäger. 2012. First evidence that marine protected areas can work for marine mammals. *Journal of Applied Ecology*, 49:474-480.
- Grebmeier, J.M. and N.M. Harrison. 1992. Seabird feeding on benthic amphipods facilitated by gray whale activity in the northern Bering Sea. *Marine Ecology Progress Series*, 80:125-133.

- Guerrero, J.A. 1989. Feeding behaviour of gray whales in relation to patch dynamics of their benthic prey. M.Sc. thesis. San Jose University, San Jose, California, United States of California.
- Halpern, B.S. 2003. The impact of marine reserves: do reserves work and does reserve size matter? *Ecological Applications*, 13, S117-S137.
- Hardin, G. 1960. The competitive exclusion principle. *Science*, New Series, 131(3409):1292-1297.
- Hellberg, M.E., Burton, R.S., Neigel, J.E. and S.R. Palumbi. 2002. Genetic assessment of connectivity among marine populations. *Bulletin of Marine Science*, 70(1):273-290.
- Hickie, B.E., P.S. Ross, R.W. MacDonald and J.K.B. Ford. 2007. Killer whales (*Orcinus orca*) face protracted health risks associated with lifetime exposure to PCBs. *Environmental Science Technology*, 41:6613-6619.
- Higham, J.E.S., Bejder, L. and D. Lusseau. 2009. An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. *Environmental Conservation*, 35(4):294-302.
- Highsmith, R.C. and K.O. Coyle. 1992. Productivity of arctic amphipods relative to gray whale energy requirements. *Marine Ecology Progress Series*, 83:141-150.
- Highsmith R.C., Coyle, K.O., Bluhm, B.A., Konar, B. 2006. Gray Whales in the Bering and Chukchi Seas. In: *Whales, Whaling and Ocean Ecosystems*. (Eds. J.A. Estes, D.P. DeMaster, D.F. Doak, T.M. Williams and R.L. Brownell, Jr.). University of California Press: Berkeley and Los Angeles, California, United States of America. 303-313.
- Hoyt, E. 1995. The worldwide value and extent of whale watching. Bath, UK: Whale and Dolphin Conservation Society.
- Hoyt, E. 2001. Whale watching 2001. World wide tourism numbers, expenditures and expanding socioeconomic benefits. IFAW.
- Hoyt, E. 2005. Marine Protected Areas for Whales, Dolphins and Porpoises. Earthscan, London.
- Hunt, G.L., Jr. and S. McKinnell. 2006. Interplay between top-down, bottom-up and wasp-waist control in marine ecosystems. *Progress in Oceanography*, 68:115-124.
- Hunt, R. 2014. Impacts of mining on freshwater and marine ecosystems. Fandora News.

- Jackson, J.B.C., Kifby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.W., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A., Hughes, T.P., Kidwell, S., Lange, C.B., Lenihan, H.S., Pandolfi, J.M., Peterson, C.H., Steneck, R.S., Tegner, M.J., and R.R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science*, 293:629-638.
- Jelinski, D.E., Krueger, C.C. and D.A. Duffus. 2002. Geostatistical analyses of interactions between killer whales (*Orcinus orca*) and recreational whale-watching boats. *Applied Geography*, 22:393-411.
- Johnson, K. R., and C. H. Nelson. 1984. Side-scan assessments of gray whale feeding in the Bering Sea. *Science*, 225:1150-1152.
- Jones, M.J. and S.L. Swartz. 2002. Gray whale *Eschrichtius robustus*. In: *Encyclopedia of marine mammals* (Eds. W.F. Perrin, B. Würsig and J.G.M. Thewissen). Academic Press: San Diego, California, United States of America. 524-536.
- Kareiva, P., Yuan-Farrell, C. and C. O'Connor. 2006. Whales are big and it matters. In: *Whales, Whaling and Ocean Ecosystems*. (Eds. J.A. Estes, D.P. DeMaster, D.F. Doak, T.M. Williams and R.L. Brownell, Jr.). University of California Press: Berkeley and Los Angeles, California, United States of America. 379-387.
- Kerr, K.A. 2005. Nearshore oceanography and planktonic prey (family Porcellanidae) of gray whales, *Eschrichtius robustus*, in Clayoquot Sound, British Columbia. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Kerr, K.A. and D.A. Duffus. 2006. Timing of larval release in the porcelain crab, *Petrolisthes cinctipes* (Decapoda, Anomura), in Clayoquot Sound, British Columbia. *Crustaceana*, 78(9):1041-1051.
- Kim, S.L. and J.S. Oliver, 1989. Swarming benthic crustaceans in the Bering and Chukchi Seas and their relation to geographic patterns in grey whale feeding. *Canadian Journal of Zoology*, 67:1531-1543.
- Knudsen, J.W. 1964. Observations of the reproductive cycles and ecology of the common Brachyura and crablike Anomura of Puget Sound, Washington. *Pacific Science*, 18:3-33.



- Kvitek, R. G. and J. S. Oliver. 1986. Side-scan sonar estimates of the utilization of gray whale feeding grounds along Vancouver Island, Canada. *Continental Shelf Research*, 6:639-654.
- Laake, J., Punt A., Hobbs, R., Ferguson, M., Rugh, D. and J. Breiwick. 2009. Re-analysis of Gray Whale Southbound Migration Surveys 1967-2006. U.S. Department of Commerce. NOAA Tech. Memo. NMFS-AFSC-203, 55.
- Lachmuth, C.L., Barrett-Lennard, L.G., Steyn, D.Q. and W.K. Milsom. 2011. Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. *Marine Pollution Bulletin*, 62:792-805.
- Lang, A.R., Weller, D.W., LeDuc, R., Burdin, A.M., V.L. Pease, Litovka, D., Burkanov, V. and R.L. Brownell, Jr. 2011. Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG10 presented to the International Whaling Commission Scientific Committee.
- Lang, A.R. 2013. Insights into the behavior of gray whales using genetics. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1), 36-41.
- Leopold, A. 1966. A Sand County Almanac. Ballantine: New York, New York, United States of America.
- Levin, S.A. 1992. The problem of pattern and scale in ecology. *Ecology*, 73(6):1943-1967.
- Lien, J. 2001. The conservation basis for the regulation of whale watching Canada by the Department of Fisheries and Oceans: A precautionary approach. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2363.
- Lusseau, D. and J.E.S. Higham. 2004. Managing the impacts of dolphin-based tourism through the definition of critical habitats: the case of bottlenose dolphins (*Tursiops* spp.) in Doubtful Sound, New Zealand. *Tourism Management*, 25:657-667.
- Lusseau, D., Bain, D.E., Williams, R. and J.C. Smith. 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. *Endangered Species Research*, 6:211-221.
- MacGinitie, G.E. 1934. The natural history of *Callinassa californiensis* Dana. *American Midland Naturalist*, 15:155-177.

- Malcolm, C.D. 2003. The current state and future prospects of whale-watching management, with special emphasis on whale-watching in British Columbia. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Malcolm, C.D. and E. Lochbaum 1999. *Human /marine mammal interaction workshop proceedings*, University of Victoria, April 13-15. Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C.
- Malcolm, C.D. and D.A. Duffus. 2000. Comparison of subjective and statistical methods of dive classification using data from a time-depth recorder attached to a gray whale (*Eschrichtius robustus*). *Journal of Cetacean Resource Management*, 2(3):177-182.
- Malcolm, C.D. and D.A. Duffus. 2008. Specialization of whale watchers in British Columbia coastal waters. In: *Marine Wildlife and Tourism Management*. (Eds. J.E.S. Higham and M. Lück). CABI: Oxfordshire, United Kingdom. 109-129.
- Mauchline, J. 1980. The biology of mysids and euphausiids. In: *Advances in Marine Biology*. (Eds. J.H.S. Blaxter, F.S. Russell and M. Yonge). 18:1-444.
- Meier, S.K. 2003. A multi-scale analysis of habitat use by gray whales (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia, 1997-99. M.Sc. thesis. University of Victoria, British Columbia, Canada.
- Moore, S.E., Wyne, K.M., Kinney, J.C. and J.M. Grebmeier. 2007. Gray whale occurrence and forage southeast of Kodiak Island, Alaska. *Marine Mammal Science*, 23(2):419-428.
- Muirhead, K.A., Malcolm, C.D. and D.A. Duffus. 2013. Marbled murrelets (*Brachyramphus marmoratus*) foraging with gray whales (*Eschrichtius robustus*) off Vancouver Island, British Columbia. *Canadian Journal of Zoology*, 91(12):847-852.
- Murison, L.D., Murie, D.J., Morin, K.R. and J. da Silva Curiel. 1984. Foraging of the gray whale along the west coast of Vancouver Island, British Columbia. In: *The gray whale, Eschrichtius robustus*. (Eds. M.L. Jones, S.L. Swartz and S. Leatherwood). Academic Press: New York, New York, United States of America. 451-464.
- Nelson, T.A., Duffus, D.A., Robertson, C. and L.J. Feyrer. 2008. Spatial-temporal patterns in intra-annual gray whale foraging: characterizing interactions between predators and prey in Clayoquot Sound, British Columbia, Canada. *Marine Mammal Science*, 24(2):356-370.

- Nerini, M. 1984. A Review of Gray Whale Feeding Ecology. In: The gray whale, *Eschrichtius robustus*. (Eds. M.L. Jones, S.L. Swartz and S. Leatherwood). Academic Press: New York, New York, United States of America. 423-459.
- Nerini, M. K. and J. S. Oliver. 1983. Gray whales and the structure of the Bering Sea benthos. *Oecologia*, 59: 224-225.
- Obst, B. S. and G.L. Hunt. 1990. Marine birds feed at gray whale mud plumes in the Bering Sea. *The Auk*, 107(4):678-688.
- Oliver, J. S. and P. N. Slattery. 1985. Destruction and opportunity on the sea floor: effects of gray whale feeding. *Ecology*, 66:1965-1975.
- Olsen, S.S. 2006. Gray whales (*Eschrichtius robustus*) and mysids (family Mysidae): the predator-prey relationship and a new approach to prey quantification in Clayoquot Sound, British Columbia. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Orams, M.B. and G.J.E. Hill. 1998. Controlling the ecotourist in a wild dolphin feeding program: is education the answer? *Journal of Environmental Education*, 29(3):33-38.
- Orams, M.B. and A. Taylor. 2005. Making ecotourism work: An assessment of the value of an environmental education programme on a marine mammal Tour in New Zealand. In: *Taking tourism to the limits: Issues, concepts and managerial perspectives - Advances in tourism research*. (Eds. Ryan, C., Page, S.J. and M. Aicken). Elsevier Science: Oxford, United Kingdom. 83-98.
- Parks Canada. 2003. Pacific Rim National Park Reserve Marine Mammal Viewing Regulations. The National Parks and National Historic Sites of Canada. Parks Canada, Ottawa, Ontario, Canada.
- Pasztor, C. J. 2008. The dynamic relationship between foraging gray whales (*Eschrichtius robustus*) and their mysid prey (Mysidae), along the southwest coast of Vancouver Island, British Columbia. M.Sc. thesis, University of Victoria, British Columbia, Canada.
- Patterson, H.M. 2004. Small-scale distributions and dynamics of the mysid prey of gray whales (*Eschrichtius robustus*) in Clayoquot Sound, British Columbia, Canada. M.Sc. thesis. University of Victoria, British Columbia, Canada.

- Patterson, A. 2006. Benthic ecology and gray whale foraging in Clayoquot Sound, British Columbia. B.Sc. Honours essay. University of Victoria, British Columbia, Canada.
- Pike, G.C. 1962. Migration and feeding of the gray whale (*Eschrichtius gibbosus*). *Journal of the Fisheries Research Board of Canada*, 19:815-838.
- Reeves, R.R., Berger, J. and P.J. Clapham. 2006. Killer whales as predators of large baleen whales and sperm whales. In: *Whales, Whaling and Ocean Ecosystems*. (Eds. J.A. Estes, D.P. DeMaster, D.F. Doak, T.M. Williams and R.L. Brownell, Jr.). University of California Press: Berkeley and Los Angeles, California, United States of America. 174-187.
- Reynolds, P.C. and D. Braithwaite. 2001. Towards a conceptual framework for wildlife tourism. *Tourism Management*, 22:31-42.
- Rice, J. 1995. Food web theory, marine food webs and what climate change may do to northern marine fish populations. In: *Climate change and northern fish populations*. (Ed. R.J. Beamish). *Canadian Special Publication of Fisheries and Aquatic Sciences*. 561-568.
- Rice, D.W. and A.A. Wolman. 1971. The life history of the gray whale (*Eschrichtius robustus*). *American Society of Mammalogists, Special Publication 3*. 142.
- Richter, C., Dawson, S. and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. *Marine Mammal Science*, 22(1):46-63.
- Short, C.J. 2005. A multiple trophic level approach to assess ecological connectivity and boundary function in marine protected areas: a British Columbia example. M.Sc. thesis, University of British Columbia, Canada.
- Slijper, E.J. 1962. *Whales*. Basic Books, Inc.: New York, New York, United States of America. 475pp.
- Steele, J.H. 1976. Patchiness. In: *The ecology of the seas*. (Eds. D.H. Cushing and J.J. Walsh.). W.B. Saunders Company: Philadelphia, Pennsylvania, United States of America. 98-115.
- Stelle, L.L. 2001. Behavioral ecology of gray whales (*Eschrichtius robustus*) feeding on mysids in British Columbia, Canada. Ph.D. thesis. University of California Los Angeles, California, United States of America.

- Stelle, L.L., Megill, W.M. and M.R. Kinzel. 2008. Activity budget and diving behavior of gray whales (*Eschrichtius robustus*) in feeding grounds off coastal British Columbia. *Marine Mammal Science*, 24(3):462-478.
- Stephens, D. W. and J.R. Krebs. 1986. *Foraging Theory*. Princeton University Press: Princeton, New Jersey, United States of America. 247pp.
- Strawberry Isle Research. 1995. *Tofino Whale Watching Operators' Voluntary Guidelines*. Tofino, B.C., Canada.
- Sumich, J. 2013. Gray whale: from devilfish to gentle giant. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1), 21-23.
- Terborgh, J., Holt, R.D. and J.A. Estes. 2010. Trophic Cascades: what they are, how they work, and why they matter. In: *Trophic Cascades*. (Eds. J. Holt and J.A. Estes.). Island Press: Washington, D.C., United States of America.
- Tomilin, A.G. 1946. Problem of lactation and nourishment in Cetacea. *Byulleten' Moskofskoe obsgcgestvo ispytatelei prirody, Biologicheskii Otdel*. 51:44-57.
- Weimerskirch, H., Inchausti, P., Guinet, C. and C. Barbraud. 2003. Trends in bird and seal populations as indicators of a system shift in the Southern Ocean. *Antarctic Science*, 15(2):249-256.
- Weller, D.W., Burdin, A.M. and R.L. Brownell, Jr. 2013. A gray area: on the matter of gray whales in the Western North Pacific. In: Whalewatcher gray whale: from devilfish to gentle giants, *Journal of the American Cetacean Society*, 42(1), 29-35.
- Wiley, D., Hatch, L., Schwehr, K., Thompson, M. and C. MacDonald. 2013. Marine sanctuaries and marine planning: protecting endangered marine life. United States Coast Guard *Proceedings*. Fall 2013:15-20.
- Williams, R., Trites, A.W. and D.E. Bain. 2002. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology*, 256:255-270.
- Williams, R., Lusseau, D. and P.A. Hammond. 2006. Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). *Biological Conservation*, 133:301-311.
- Williams, R., Bain, D.E., Smith, J.C. and D. Lusseau. 2009. Effect of vessels on behaviour

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## CHAPTER FIVE

### Final Conclusions

Whale-watching is a nonconsumptive form of wildlife tourism that can be difficult to manage because of the nature of the highly mobile and migratory animals upon which the industry is based. The socioeconomic and ecological factors of wildlife tourism activities should be considered in tandem, yet there has been little research using long-term biological data.

This thesis uses ecological research collected over 25 years as the basis for management planning of whale-watching practices. Ideal management suggestions proactively work to maintain the ecological integrity of the natural resources upon which local marine tourism is based. Before I proposed five recommendations for whale-watching related management, I addressed how whale-watching is managed in Clayoquot Sound, what a typical whale-watching encounter in this location involves, and the most recent research pertaining to the ecology of the eastern North Pacific gray whale (*Eschrichtius robustus*).

In Chapters One and Two, I reviewed the history of human interactions with cetaceans and how this relationship has evolved, and examined the current literature on the nature of these interactions, particularly how these actions can affect focal species. The way humans interact with whales has changed dramatically over the past century, and the indirect and long-term effects are not yet fully understood. In Clayoquot Sound, the effect that vessels have on gray whales is variable, and interconnected with specific feeding sites (Bass 2000). While further research is frequently championed, obstacles include lack of sufficient time, resources, background information, and research methods typically focus on short-term, behavioural measures that can be easily or readily recorded and directly connected to the source of disturbance (Bejder *et al.* 2006).

In Chapter Two, the management of whale-watching in Clayoquot Sound was reviewed, including the legislation and voluntary guidelines that are currently in place, and previous recommendations that have been made. Whale-watching developed along the west coast in the 1970s, and the expansion of the industry has mirrored that of ecotourism on a global scale. Tourism based on gray whales in Tofino and Ucluelet has been a tourist interest for over 30 years, where most whale-watching operators and company owners are local



residents. A DFO presence is lacking and there is no formal association for operators. Whale-vessel interactions are largely self-regulated by the industry. Most companies pledge to support responsible boating behaviour to minimize the disturbance to marine mammals and birds, having a vested interest in the long-term viability of the wildlife-based tourism activity with an interest in local research.

The primary goal of whale-watching management is to minimize the adverse impacts that activities have on cetacean species. The Tofino based whale-watching industry has successfully implemented and abided by a number of management suggestions from the academic literature but is lacking in other areas. I reviewed management measures that have been effective for other coastal operations and isolated those that were applicable to this location. Potentially useful management options may include the prohibition of resource extraction activities that have the potential to alter terrestrial and coastal ecosystems, spatial and temporal constraints, and formal legislation allowing for licensing. Site-specific solutions are key, and it is critical that management decisions remain flexible, adaptive, and based on the most recent available science with an ecological foundation.

In order to gain insight into what specific recommendations may be applicable in this study area, an analysis of current whale-watching practices had to be conducted. In Chapter Three, I presented a case study that investigated the commercial whale-watching pressure on gray whales, and what vessel behaviour looks like with respect to whales. Six indicators of industry pressure were used, including number of boats present during an encounter, boating behaviour of dedicated versus non-dedicated companies during encounters, length of encounters, the amount of time boats spend in whale foraging areas, the amount of time whales spend with boats, and the identity of the whales targeted by whale-watching boats. The 2012 and 2013 seasons had significantly different numbers of whales present, and this was reflected in the fleet behaviour. Whale-watching activities do not appear to alter gray whale foraging efforts between seasons. Results indicated that both industry pressure and vessel behaviour with respect to whales changes depending on the season and the biological dynamics that influence whale presence. This has been considered as a possible source of error for other vessel compliance studies (*e.g.* Wiley *et al.* 2008) but a comparative study of low whale years versus high whale years has never been done before now.

In Chapter Four, I reviewed the 25 years of ecology-based research that the Whale Research Lab has produced and determined what findings are applicable for resource managers and whale-watching operators. Whale-watching is an important tourism activity in Clayoquot Sound, based on the predictable presence of gray whales. A viable whale-watching industry depends on whales in close proximity to the main port, Tofino. The Whale Research Lab has established that foraging drives gray whale behaviour in this study area, and so the protection of prime prey habitat is essential for the continuation of commercial whale-watching practices. This involves avoiding the land and water use changes that can potentially change the substrate and water chemistry in nearshore environments. At the end of the chapter, I proposed five management recommendations to all stakeholders interested in promoting sustainable whale-watching practices in Clayoquot Sound. The recommendations are as follows:

1. Maintenance of the integrity of the resource base upon which the industry is based
2. Precautionary whale-watching practices
3. Creation of a formal industry association of British Columbia operators
4. Complete the development of regulations and laws pertinent to marine mammal viewing in British Columbia
5. Education

## **CONCLUDING THOUGHTS**

The University of Victoria's Whale Research Lab has studied the ecology of gray whales in Clayoquot Sound, Vancouver Island for over 25 years. The overall purpose of this thesis is to use the work of the Whale Research Lab to promote ecologically sustainable whale-watching practices and ultimately, sustainable resource use in Clayoquot Sound. Gray whales are the foundational basis for whale-watching here, and their presence is not a static phenomenon but a dynamic balance of ecological and social factors. This study demonstrates the importance of understanding ecological systems when approaching the management of human-wildlife interactions. The ecological processes described in this research may mirror what is occurring at other foraging sites for migrating whales, or may be a representation of similar processes that may be occurring on differing spatial or temporal scales. While

management decisions can often be made before sufficient scientific data is available, this is an opportunity for long-term, quantitative data based in ecology to be combined with social and economic information and incorporated into an adaptive management regime.


## LITERATURE CITED

- Allen, S., Smith, H., Waples, K. and R. Harcourt. 2007. The voluntary code of conduct for dolphin watching in Port Stephens, Australia: is self-regulation an effective management tool? *Journal of Cetacean Resource Management*, 9(2):159-166.
- Bejder, L., Samuels, A., Whitehead, H. and N. Gales. 2006. Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour*, 72:1149-1158.
- Constantine, R. 2014. Whale-watching and behavioural ecology. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. Higham, J., Bejder, L. and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 193-205.
- Corkeron, P.J. 2006. How shall we watch whales? In *Gaining Ground: In Pursuit of Ecological Sustainability*. (Ed. D.M. Lavigne) International Fund for Animal Welfare. Guelph, Canada, and the University of Limerick, Limerick, Ireland. 161-170.
- Duffus, D.A. and P. Dearden. 1989. *A Perspective on Whale-Watching and Tourism in British Columbia*. Unpublished contract report to the B.C. Ministry of Tourism, Victoria, B.C.
- Finkler, W. 2014. Save the whales Part II: A new science advocacy communication framework. In: *Whale-watching: sustainable tourism and ecological management*. (Eds. J.E.S. Higham, L. Bejder and R. Williams). Cambridge University Press: Cambridge, United Kingdom. 352-364.
- Higham, J.E.S., Bejder, L. and D. Lusseau. 2009. An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. *Environmental Conservation*, 35(4):294-302.
- Malcolm, C.D. 2003. The current state and future prospects of whale-watching management, with special emphasis on whale-watching in British Columbia. Ph.D. thesis, University of Victoria, British Columbia, Canada.
- Wiley, D.N., Moller, J.C., Pace III, R.M. and C. Carlson. 2008. Effectiveness of voluntary conservation agreements: case study of endangered whales and commercial whale watching. *Conservation Biology*, 22(2):450-457.

## APPENDICES

### Appendix 2.1. Be Whale Wise Marine Wildlife Guidelines for Boaters, Paddlers and Viewers. Last updated 2011.

# Be Whale Wise



**MARINE WILDLIFE  
GUIDELINES FOR BOATERS,  
PADDLERS AND VIEWERS**  
*(Revised 2011)*

**ALERT:**  
Check out updated  
guidelines and new  
regulations!

**Guidelines for whales, porpoises and dolphins:**

1. BE CAUTIOUS and COURTEOUS: approach areas of known or suspected marine wildlife activity with extreme caution. Look in all directions before planning your approach or departure.
2. SLOW DOWN: reduce speed to less than 7 knots when within 400 metres/yards of the nearest whale, porpoise or dolphin. Avoid abrupt course changes.
3. KEEP CLEAR of the whales' path. If whales are approaching you, cautiously move out of the way.
4. DO NOT APPROACH from the front or from behind. Always approach and depart from the side, moving in a direction parallel to the direction of the whales, porpoises or dolphins.
5. DO NOT APPROACH or position your vessel closer than 100 metres/yards to any whale, porpoise or dolphin.\*
6. If your vessel is not in compliance with the 100 metres/yards approach guideline (#5), place engine in neutral and allow whales to pass.
7. STAY on the OFFSHORE side of the whales when they are traveling close to shore.
8. LIMIT your viewing time to a recommended maximum of 30 minutes. This will minimize the cumulative impact of many vessels and give consideration to other viewers.
9. DO NOT swim with, touch or feed marine wildlife.
10. DO NOT drive through groups of porpoises or dolphins to encourage bow or stern-riding.
11. Should dolphins or porpoises choose to ride the bow wave of your vessel, avoid sudden course changes. Hold course & speed or reduce speed gradually.

**Seals, sea lions and birds on land:**

1. BE CAUTIOUS AND QUIET when around haul-outs and bird colonies, especially during breeding, nesting and pupping seasons (generally May to September).
2. REDUCE SPEED, minimize wake, wash and noise, and then slowly pass without stopping.
3. AVOID approaching closer than 100 metres/ yards to any marine mammals or birds.
4. PAY ATTENTION and move away, slowly and cautiously, at the first sign of disturbance or agitation.
5. DO NOT disturb, move, feed or touch any marine wildlife, including seal pups. If you are concerned about a potentially sick or stranded animal, contact your local stranding network where available.

**Killer Whales:**

\* Killer whales have special protection in Canadian and U.S. waters. Be sure to educate yourself about new protections, including regulations with specific distances and recommendations for viewing killer whales.

**Marine Protected Areas, Wildlife Refuges, Ecological Reserves & Parks:**

1. CHECK your nautical charts for the location of various protected areas.
2. ABIDE by posted restrictions or contact a local authority for further information.

**The Laws:**

Regulations in Canada and the U.S. prohibit the harassment and disturbance of marine mammals. Many species are threatened or endangered and subject to additional protections under the Endangered Species Act (U.S.) and the Species at Risk Act (Canada).

**Learn about and follow all local laws.**

**What is a disturbance?**

Disturbance is when we interfere with an animal's ability to hunt, feed, communicate, socialize, rest, breed, or care for its young. These are critical life processes, necessary for healthy marine wildlife populations.

**To report a marine mammal disturbance or harassment:**

**CANADA:**  
Fisheries and Oceans Canada:  
1-800-465-4336

**US:**  
NOAA Fisheries, Office for Law Enforcement:  
1-800-853-1964  
[www.bewhalewise.org](http://www.bewhalewise.org)

**To report marine mammal sightings:**

BC Cetacean Sightings Network (BC)  
[www.wildwhales.org](http://www.wildwhales.org) or 1-866-1SAW ONE

The Whale Museum Hotline (WA state):  
[hotline@whalemuseum.org](mailto:hotline@whalemuseum.org)  
or 1-800-562-8832

Orcas Network (WA state)  
[info@orcaneetwork.org](mailto:info@orcaneetwork.org)  
or 1-866-ORCANET

**Need more information?**

**CANADA:**  
Victoria and Southern Gulf Islands, Johnstone Strait and Northern Vancouver Island, West Coast Vancouver Island: Straitwatch  
[www.straitwatch.org](http://www.straitwatch.org) or 250-590-7723

Robson Bight (Michael Bigg) Ecological Reserve:  
[www.enr.gov.bc.ca/bcparks/eco\\_reserve/robson\\_b\\_e.html](http://www.enr.gov.bc.ca/bcparks/eco_reserve/robson_b_e.html)

Fisheries and Oceans Canada:  
[www.dfo-mpo.gc.ca](http://www.dfo-mpo.gc.ca)

North Island Marine Mammal Stewardship Association:  
[www.nimmsa.org](http://www.nimmsa.org)

**US:**  
Washington State, Haro Strait Region: Soundwatch Boater Education Program  
[www.whalemuseum.org](http://www.whalemuseum.org) or 360-378-4710

Washington Department of Fish and Wildlife:  
[www.wdfr.wa.gov/conservation/orca/](http://www.wdfr.wa.gov/conservation/orca/)

NOAA Fisheries, Northwest Region:  
[www.nwr.noaa.gov](http://www.nwr.noaa.gov)

NOAA Fisheries, Office of Protected Resources:  
[www.nmfs.noaa.gov/pr/education/viewing.htm](http://www.nmfs.noaa.gov/pr/education/viewing.htm)

Pacific Whale Watch Association:  
[www.pacificwhalewatch.org](http://www.pacificwhalewatch.org)







**Appendix 2.2.** Duffus and Dearden's (1989) management recommendations for the future of whale-watching.

1. **Maintenance of the integrity of the resource base upon which the industry is based.** This is obviously of critical concern. It dictates that the industry must develop cautiously so as not to have a detrimental impact upon the whales. An ongoing monitoring programme should be established to detect and assess possible negative interactions over a longer time period.
2. **There should be a foundation laid for increased enforcement of regulations.** At the moment, the industry is largely self-policing. It is in the interests of the industry as a whole not to disturb the resource upon which their businesses are based. Most infractions of whale-watching regulations detected in the field work reported in this study were by private boats and new charter operators. Some of the violations were quite severe. Overall, the current system is adequate but there needs to be an ongoing awareness programme directed at new operators and those with consistently bad records in this regard. Enforcement personnel from fisheries and Oceans Canada should be specifically made aware of the problem and their enforcement role. Signage and brochures explaining the regulations should be available not only at the site, but at surrounding ports of embarkation.
3. **There needs to be ongoing co-operation and communication.** Government agencies involved (particularly Fisheries and Oceans and the Ministries of Tourism and Parks), the operators and knowledgeable personnel in the area must further enhance the existing lines of communication to ensure the coordinated development of industry potential without compromising the resource base.
4. **There is a need to continue to integrate and develop the industry within the context of the growing interest in nature and marine tourism as a whole.** Although whales constitute the main source of satisfaction on the trips, other nature and wildlife opportunities were also sources of considerable satisfaction, such as seeing sea lions and various marine bird species.
5. **To maximize satisfactions it is important to minimize negative effects.** The main detraction to satisfaction at both sites was scenic destruction by logging activities. Increased co-ordination should be requested of the Ministry of Forests in coming to terms with the desires of users.
6. **Marketing has to address the different aspects of the market and the different products available.** Two specific targets would be to promote in the prairie provinces, market the gray whale migration in March and April at Pacific rim and to help develop the specialist whale-watching market in California for summer killer whale-watching at Robson Bight.
7. **The development of new sites as well as new markets should be encouraged.** Locations such as Victoria and the Queen Charlotte Islands offer new sites for whale-watching that will fulfill customer needs at the opposite ends of the spectrum in terms of visitor commitment.
8. **Government should provide organizational and coordinating assistance to ensure that the Pacific Rim Whale Festival becomes an annual and well-advertised event.** This could be tied to the promotion of the prairie market suggested above.

9. **The Ministry of Tourism should use wild whales with an explicit whale-watching theme in some of its promotional material.** Both Quebec and Newfoundland are using or plan to use whale-watching to spearhead tourist promotions and this should be considered in British Columbia.
10. **Promotional material on other nature and wildlife related opportunities should be made available at whale-watching sites.** Whale and whale-watching, as pointed out by the Wildlife Viewing study, are a good entry point for wildlife viewing as a whole. Consideration should be given to the formation of a Wildlife Viewing Coordinating Committee representing involved agencies, operators, The Wilderness Tourism Council and knowledgeable research personnel. This would advise on the marketing and development, management, integration and technical aspects of the resource base of the wildlife viewing segment of the tourism industry as a whole.
11. **The Ministry, possible in conjunction with the industry, should consider the development of a special promotional brochure on whale-watching that could be distributed at specific outlets.** Locations such as Oakland California's Whale Center attract people who would be considered specialists, a market not fully tapped. A video on whale-watching in British Columbia could also be produced to show to particular markets such as members of nature-oriented societies. This same market can also be reached by advertisements and stories in magazines such as Equinox, Sierra, Audubon, Canadian Geographic, Oceans and Whalewatcher.
12. **It may be advantageous for charter operators to form an industry association to facilitate marketing and product development and present a strong position in the future management planning for whale-watching.** Such items as new research on harassment and behaviour of whales, changing Coast Guard regulations, workshops and other items of interest should be available on a systematic basis to operators. As well, an industry association could provide valuable input into management planning with their perspective.
13. **It is recommended that operators, both current and potential, should avail themselves of the government programs that are in place to aid in tourism industry development.** This may be done through a seminar for whale-watching operators, or as part of the presentation of this report.

## **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 Island.

It is 1/4 mile to Arnet Island.

It is 50 meters to the 3 pile dolphin on the Sea Prime foreshore.



## 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.

**Appendix 2.4.** Malcolm and Lochbaum's (1999) management recommendations to guide future management of the B.C. whale-watching industry.

1. Facilitate the development of a B.C. forum/association/council to act as a formal advisory body to government, the scientific community and the general public.
2. In concert with the above, develop guidelines, regulations and laws pertinent to marine mammal-viewing in B.C.
3. Develop research protocols and processes to maintain healthy environments and protect marine mammals in the province.
4. Establish a formal communications and public education process to profile and protect marine mammals in the province.
5. Develop and intensive campaign for training commercial and public boat operators in matters of safety and behaviour around marine mammals.

**Appendix 2.5.** Pacific Rim National Park Reserve Marine Mammal Viewing Regulations (Parks Canada 2003).

THE NATIONAL PARKS AND  
NATIONAL HISTORIC SITES OF CANADA



LES PARCS NATIONAUX ET LES  
LIEUX HISTORIQUES NATIONAUX DU CANADA

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## 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 m 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
-

- 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 of 1000 feet  
Helicopters should maintain a minimum of 1000 feet

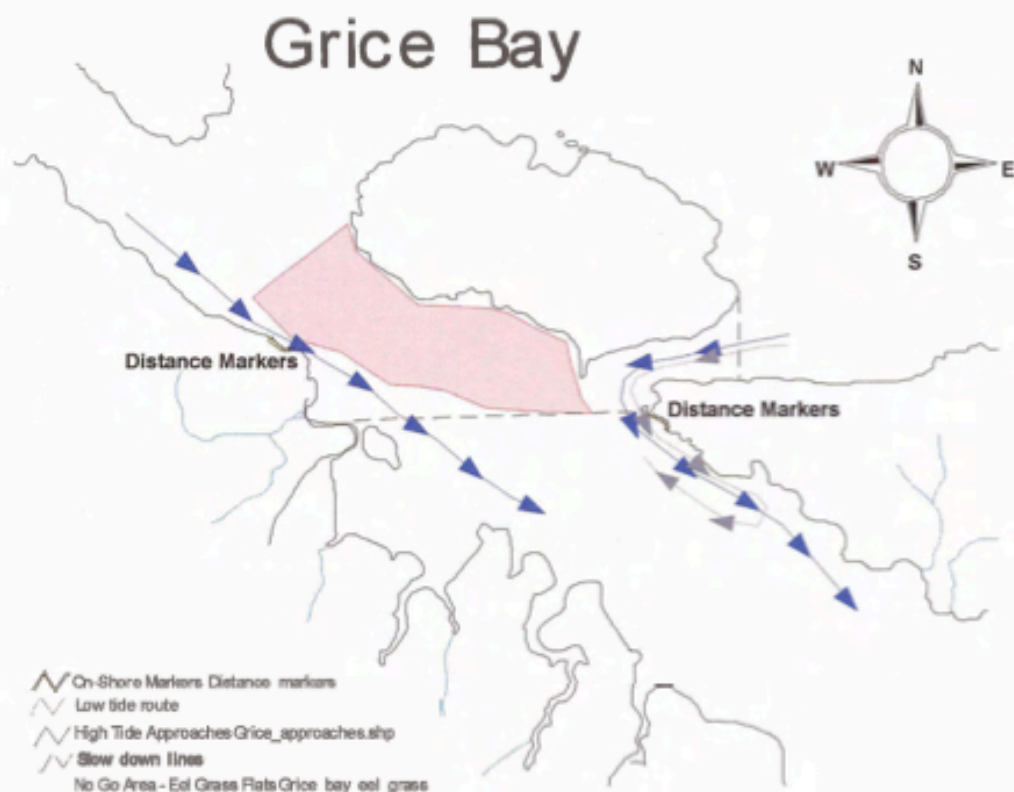
### KILLER WHALE GUIDELINES

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

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## PINNIPED VIEWING GUIDELINES

### APPROACH GUIDELINES

- Vessel behaviour should be based on the most sensitive or easily disturbed species on 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 or birds
- Move closer gradually
- Monitor behaviour on approach. Watch for signs of agitation and increase your angle *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, which 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 early in the season. Later in the season animals may become more accustomed to boats, allowing closer viewing
- 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 may 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



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## SEABIRD AND SHORLINE VIEWING GUIDELINES

### APPROACH GUIDELINES

- Vessel behaviour should be based on the most sensitive or easily disturbed species on 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 or birds
- Move closer gradually
- Monitor behaviour on approach. Watch for signs of agitation and increase your angle *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 berth
- 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

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## 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).

### **Appendix 3.1.** Encounter definitions.

Encounter: the period of time when a boat is engaged in watching at least one whale within 400m of the commercial boat. Distance was estimated using a Bushnell laser range finder as well as approximate number of vessel lengths. Decisions were made as a group. The length of an encounter is dictated by the start time and end time.

Start Time: when a boat is close enough to see a whale blow and tourists can see it (approximately 400m) and is therefore partaking in a whale-vessel encounter, OR when a boat is approximately 400m away from a congregation of whale watching boats already engaged in (a) whale(s).

End Time: when a boat is no longer engaged in a whale-watching encounter. Boat is leaving area, and encounter ends when vessel is approximately 400m away from whale or congregation of whale watching boats still engaged in encounter(s).

Length of Encounter: the length of time a boat was engaged in a whale-watching encounter; the length of time between the Start Time and End Time. *Be Whale Wise* regulations suggest a maximum encounter of 30 minutes.

Boats Present: the number of boats engaged in an encounter and within at least 400m of at least one whale, not including the research vessel, Drifter. When one boat leaving and one boat arriving occurs at the same time, shall not count as first boat present (*i.e.* if Sun Raven left at 11:30 and Close Encounters arrived at 11:30, do not count Close Encounters as a boat that was present during Sun Raven's encounter).

Less than or equal to 30 minutes: from start time to end time, encounter lasted less than or equal to 30 minutes. Vessels are compliant (1) with this regulation if the length of time between the Start Time and End Time is equal to or less than 30 minutes; if encounter is longer than 30 minutes, vessels are marked as non-compliant (0).

Less than or equal to 7 knots when within 100-400m of nearest whale: once boat is within 400m of the nearest whale and encounter has begun, vessels are compliant (1) if traveling at 7 knots or less, while staying the minimum distance of 100m away from nearest whale. Vessels are non-compliant (0) if traveling faster than 7 knots when between 100m-400m away from the nearest whale. Distance was estimated using a Bushnell laser range finder as well as approximate number of vessel lengths. Decisions were made as a group.

Greater than or equal to 100m away from nearest whale: boats are compliant (1) when they position themselves a minimum distance of 100m away from nearest whale. Vessels are non-compliant (0) when less than 100m away from the nearest whale. Distance was estimated using a Bushnell laser range finder as well as approximate number of vessel lengths. Decisions were made as a group.

If less than 100m: if for some reason boats come within 100m of a whale (whether due to whale coming close, or drivers too close), boats are compliant (1) if they either remain

stationary, or turn off engines, or move away. Boats are non-compliant (0) if they move towards whale. Distance was estimated using a Bushnell laser range finder as well as approximate number of vessel lengths. Decisions were made as a group.

Radio/communicate: when approaching to begin an encounter, compliance (1) occurs when boat/driver makes contact with at least one vessel already engaged in an encounter. Because of distance, contact was most often made via VHF radio, but on occasion drivers in close proximity were witnessed speaking to each other in person. Non-compliance (0) occurs when the boat/driver fails to make contact with a vessel already engaged in an encounter.

Parallel to whale: vessels are compliant (1) when approaching whale from side; does not approach from head or behind. Vessels are non-compliant (0) when approaching whale head-on or from behind.

Whale path clear: vessels are compliant (1) when they do not cut off whale; do not “leap frog”, or position themselves in the whale’s direction of travel in an attempt to get the whale to come to the boat. Vessels are non-compliant (0) when they cut off a whale.

Stays on same side of whale: a compliant vessel (1) maintains a heading that places him/her on the same side of whale(s) as boat(s) already present, including the research vessel Drifter. A non-compliant vessel (0) is one that maintains a heading that places themselves on the opposite side of a whale from at least one other vessel.