Master's Thesis

Whale Watching in Iceland:

An Assessment of Whale Watching Activities on Skjálfandi Bay

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Declaration

I hereby confirm that I am the sole author of this thesis and it is a product of my own academic research.

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Abstract

The whale watching industry has experienced much growth and development throughout the world. In addition to the numerous benefits resulting from this wildlife-based tourism activity, there is also concern that there may be negative impacts on the environment as well. Management has been implemented in many places worldwide to promote what may be more sustainable whale watching practices. In Iceland, where whale watching started in 1991, management is quite limited. There are few guidelines or regulations in place attempting to manage the behaviour of whale watching boats, and the efficacy of the guidelines that do exist is currently unknown. This study utilizes data collected between 2009 and 2011 to assess whale watching activities on Skjálfandi Bay, Northeast Iceland. Both land and boat-based observations were used to monitor three aspects of the whale watching activities: approach density, i.e, the number of boats viewing a particular animal or pod; the distance of approach; and the speed of the approaching boat. The greatest number of boats viewing the same animal or pod was 4, however this was only observed in approximately 4% of the total tracks. The greatest approach density was observed in July of 2009, with an average of 1.95 boats accompanying the animals. The results suggest that the boats are approaching closer to the whales, as an increase in approaches within 50m of the animal(s) was observed between the years, for each species, with exception of the minke whale in 2011. Also in 2011, 24% of the total humpback tracking sessions reveal a boat approached to within 10m, and in 10 tracking sessions to within 4m. The number of boats approaching at higher speeds increased greatly throughout the 300-50m distance range from the animal(s) in 2011. When within 50m, 33% of the tracks revealed boats travelling slower than 2km/hr or idling, the remainder of the boats travelling at speeds ranging up to approximately 17km/hr. The observed approach distances are closer, and the approach speeds greater, than those advocated by the guidelines specific to Skjálfandi Bay, and are inconsistent with approach distances and speeds advocated in other whale watching areas where guidelines and regulations have been adopted. Future management efforts might, therefore, consider the utility of guidelines and stronger enforcement to reduce the potential disturbance caused by approaching whale watching boats.

Keywords: Whale watching, Iceland, management, theodolite, photogrammetry.

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List of Definitions

Whale Watching - the viewing of any cetacean species from a commercially operated boat tour with the primary purpose of providing passengers with the opportunity to see cetaceans in the wild.

Total Expenditure – term utilized to report the economic contributions of whale watching tourists, including both direct and indirect expenditures.

Direct Expenditure – tourist expenditures directly related to whale watching activities, such as ticket purchases.

Indirect Expenditure – tourist expenditures that can be attributed to, but not directly related to, whale watching activities, such as accommodation and food costs.

Code of Conduct (CoC) – consisting of multiple whale watching guidelines, whale watching CoCs are typically informal attempts to manage the manner in which whale watching activities are conducted.

Track – individual cetacean surfacing event utilized in data collection. For each track, data was collected on the density of approach, distance of approach, and speed of approach.

Tracking Session – made up of individual tracks, including: the first recorded track when the animal was approached or surfaced; the last recorded track before the animal dove or the boat departed; and all tracks made in between. The same individual or pod is tracked throughout the entire session.

Density of Approach – the number of whale watching boats observed viewing the same animal or pod, at the time the track was made. In the 2009 and 2010 season, this count included all whale watching boats within 1000m. In 2011, whale watching boats within 500m were include to determine density of approach.

Distance of Approach – the distance between the whale watching boat viewing the animal(s) and the animal(s) being viewed, for each recorded track. Numerous distances of approach are reported for one approaching whale watching boat in one tracking session.

Speed of Approach – the speed at which the whale watching boat was travelling at the time the track was made.

1.0 Introduction

The perception of value of marine resources, like all natural resources, differs between user groups and is quite varied. In 1986, when nations were debating the consequences of a global ban on the commercial harvest of whales, the value of cetacean species was beginning to shift to a rather different arena: nature based tourism (Herrera & Hoagland, 2006). Whale watching, in particular, has experienced tremendous growth and development since its beginnings in the 1950s (O'Connor et al., 2009; Hoyt, 2001). Iceland, like many coastal countries, has realized in recent years just how valuable its cetacean resources are, as a result of a growing whale watching industry (Magnúsdóttir et al., 2011; O'Connor et al., 2009; Guðmundsdóttir & Ívarsson, 2008). The influence that whale watching can have on a local economy has been realized in various places throughout Iceland, including in the northeast. Here, on the shores of Skjálfandi Bay, Húsavík has been dubbed the whale watching capital of Iceland and, as a result, the area has undergone a whale watching induced transformation (Guðmundsdóttir & Ívarsson, 2008).

With the hopes of ensuring lasting benefits from the industry, decades of studies have investigated the socio-economic impacts (Cisneros-Montemayor et al., 2010; Hoyt & Iñíguez, 2008; IFAW, 2005; Hoyt, 2001) as well as the possibly adverse environmental impacts of whale watching (Stamation et al., 2010; Lusseau & Bejder, 2007; Constantine et al., 2004; Corkeron, 1995; Acevedo, 1991). In addition to the documented socio-economic benefits, whale watching has proven valuable for the educational, research and conservation opportunities it provides as well (Hoyt, 2001). However, impact studies reveal that whale watching activities can have potential negative impacts on the animals involved, at the individual level and perhaps within the population (Barr & Slooten, 1999; Williams, Trites, & Bain, 2002; Lusseau and Bejder, 2007; Christiansen et al., 2011; Parsons & Scarpaci, 2011).

In an effort to reduce the potentially negative impacts, management has been implemented, or at least attempted, for many tourism operations involved in whale watching throughout the world (Carlson, 2009; Garrod & Fennell, 2004). Such management typically involves Codes of Conduct (CoCs), which are comprised of individual guidelines targeting the various aspects of the whale watching activity. Although much variation has been reported amongst these guidelines (Carlson, 2009), due to the diversity of whale watching activities, there appear to be certain whale watching aspects and themes that are more commonly managed (Garrod & Fennell, 2004). Limiting the number of viewing boats within a certain distance of the animal(s) and regulating the manner in which boats approach the animal(s) are examples of aspects managed by the CoCs.

The whale watching activities occurring on Skjálfandi Bay, and elsewhere in Iceland, remain largely unregulated, as the existing informal whale watching guidelines do not appear to be effectively managing the activities. As there is much debate within the scientific community regarding the impacts of whale watching, it is poorly understood how sustainable these activities are. The goal of this study is to gain some insight into the sustainability of the Icelandic industry, by determining how the whale watching activities on Skjálfandi Bay compare to those of other countries and how better management might promote more sustainable practices. Three aspects of the whale watching activity, in particular, were chosen for investigation and include: the number of viewing boats; the distance of approach; and the speed of approach. Data collection was conducted from a land based platform, with the use of a theodolite, in 2009 and 2010, while photogrammetric methods were utilized from a boat platform in the 2011 data collection season. Whale watching guidelines and regulations from around the world were then reviewed and compared to the observed behaviours of the boats on Skjálfandi Bay. This assessment will help to determine whether or not there is a need for greater management and enforcement, and assist in identifying what guidelines or Codes of Conduct may be potentially most effective in making the whale watching activities in this region more sustainable.

The following report will provide an overview of the theoretical foundations of the study, introduce and explain the methods utilized, and present the findings of the conducted research. The results are then discussed in relation to other whale watching management initiatives, and the limitations and potential sources of error in the study are identified. In closing, some concluding remarks are given, along with recommendations for future studies.

2.0 Theoretical Overview

2.1 Whale Watching Definition

As whale watching is an activity that encompasses many species and many methods of viewing, various definitions of the term exist (O'Connor et al., 2009; IFAW, 2005; Hoyt, 2001). Typically, 'whale watching' includes the viewing of all cetaceans, including whales, dolphins, and porpoises. However, swimming with, and/or listening to, cetacean species is also considered whale watching in some cases (IFAW, 2005; Hoyt, 2001). Although whale watching activities usually involve boat-based tours, it is possible to experience whale watching from land and air as well (IFAW, 2005). Despite the variations that exist amongst whale watching definitions, most support the idea that there is at least some commercial aspect to the activity. For the purpose of this study, whale watching is defined as the viewing of any cetacean species from a commercially operated boat tour providing passengers with the opportunity to see cetaceans. Whale watching trips utilized for data collection were dedicated trips, meaning that the primary purpose of the trip was to view whales, dolphins, and/or porpoises (O'Connor et al., 2009). Any participant on this kind of a trip is referred to as a whale watcher.

2.2 Economics of Whale Watching

Overall economic contributions of whale watching are highlighted through total tourism expenditures, that is, the direct and indirect expenditures paid by tourists to go whale watching. Direct expenditures are the expenditures directly related to the whale watching trip itself, such as tickets, while indirect expenditures are any other expenditures into the local economy that can be attributed to the person participating in a whale watching activity (O'Connor et al., 2009). Costs associated with accommodations, transportation, and food, for example, are indirect expenditures.

When discussing the economic contributions of whale watching, values of economic activity are reported in US dollars (USD), based on the 2009 currency rate, unless mentioned otherwise. One exception occurs, when assessing the role that whale watching has played in the Icelandic economy. These figures are first reported in Icelandic Kronur (ISK), then in the equivalent USD, according to the currency rates of July 2008 when the devaluation of the Icelandic Kronur was occurring.

2.3 The Global Whale Watching Scene

Whale watching, an integral part of the wildlife tourism sector, is experiencing much growth worldwide. It emerged as a new ecotourism industry in 1986 when the global moratorium on whaling came into effect (Herrera & Hoagland, 2006). Erich Hoyt, a highly regarded researcher and author, has effectively documented development within the global whale watching environment for many years (Hoyt & Iñíguez, 2008; Hoyt, 2005a; Hoyt, 2005b; Hoyt, 2001). The most recent review of the global whale watching industry reported an increase in whale watchers, from 9 million in 1998 to 13 million in 2008, and an additional 32 participating countries for a total of 119 whale watching countries around the globe (O'Connor et al., 2009). This report also states that total expenditures in 1998 were $1 billion, whereas in 2008 the whale watching industry generated $2.1 billion in total expenditures. Figure 1 illustrates the growth of whale watching from its early beginnings in the mid 1950s until 1998 when it was gaining momentum as an ecotourism industry (Hoyt, 2001).

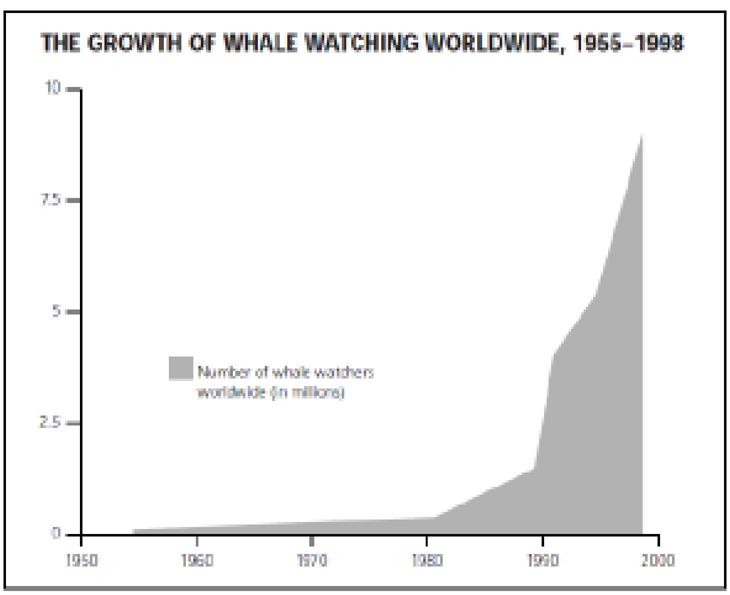

Figure 1. Global growth of whale watching (Hoyt, 2001).

Due to the migratory behaviour of whales, whale watching is an activity that can occur in almost any coastal country and, therefore, the potential for growth and development within the industry is great (Cisneros-Montemayor et al., 2010). Although O'Connor et al. (2009) report that the global whale watching industry has grown at an average rate of 3.7% per annum, one should keep in mind that such growth and development is occurring more noticeably in certain regions of the world than others. The following information on the various regions was provided by: *Whale Watching Worldwide: Tourism numbers, expenditures and economic benefits.* A special report from IFAW – the International Fund for Animal Welfare. (O'Connor et al., 2009).

North America

North America remains the world's largest whale watching destination, as over 6.2 million whale watchers, nearly 50% of global whale watchers, took to the water in various locations throughout North America in 2008. Accounting for $1.2 billion in expenditures, the industry in North America is mature and has spread to all corners of the continent. An annual growth rate of 1.2% has been observed within the established North American industry.

Oceania and Antarctica

Oceania is comprised of four regions: Polynesia; Micronesia; Melanesia; and Australasia. In 2008, together with Antarctica, the region hosted around 20% of the global whale watchers. Growth within this region was reported at just under 10% per annum, with the largest industries existing in Australia and New Zealand. Currently 17 countries and territories in the region offer whale watching, resulting in nearly $330 million in total expenditures.

Africa and Middle East

"Africa and the Middle East region is also now a substantial player in the global whale watching industry, accounting for over 1.3 million whale watchers (approximately 10% of global whale watchers) and $164 million total expenditure" (p. 24). The number of participating countries has grown from 13 to 22, however the number of whale watchers has decreased at -1.3% per year, since 1998. This decrease has been attributed to the large reduction in the number of whale watchers observed in the Canary Islands, which was once one of the top 3 whale watching destinations in the world, along with the USA and Canada.

Asia

Growing five-fold, from 220,000 whale watchers in 1998 to over 1 million in 2008 (8% of global whale watchers), Asia is proving to be a new, important destination for whale watching. Increasing from 13 countries to 20 countries during that same time period, an impressive annual growth rate of 17% resulted in $66 million total expenditure in 2008.

Europe

The number of whale watchers in Europe has doubled since 1998, averaging 7% growth per annum. There are now a total of 22 European countries involved in whale watching, ranging from Cyprus to Greenland, and generating a total of nearly $100 million in expenditures. Whale watchers in Europe account for 6% of the global clientele.

South America

Growth within the South American industry is occurring at 10% per year. In 2008, 11 countries accommodated nearly 700,000 whale watchers (5% of global whale watchers).

Central America and Caribbean

Although whale watching in Central America and the Caribbean represents a smaller portion of the industry, as only 2% of global whale watchers (300,000 watchers) were counted in 2008, there has been substantial growth in the industry over the last decade. Growing at 13% every year, the number of participating countries in 2008 totalled 23.

The above information is summarized in Table 1. The industry is no longer servicing a select niche tourism market, as it has grown into a mainstream tourism industry in many parts of the world, with great potential for further development and growth (O'Connor et al., 2009).

2.4 Values of Whale Watching

2.4.1 Socio-economic

Cisneros-Montemayor et al. (2010) investigated the socio-economic implications of such growth and development for the nations involved, and made predictions for countries that may, in the future, enter the scene. Through an analysis of 144 maritime countries, 68 already invested in the whale watching industry, they effectively demonstrated how the industry enhances, or could enhance, the employment and local economy of whale watching nations.

Table 1. Summary of regional whale watching industries (O'Connor et al., 2009).

Region	Whale watchers		Regional AAGR	Number of countries		2008 Direct Expenditure	2008 Total Expenditure
	1998	2008		1998	2008	millions	millions
Africa and Middle East	1,552,250	1,361,330	-1.3%	13	22	$31.7	$163.5
Europe	418,332	828,115	7.1%	18	22	$32.3	$97.6
Asia	215,465	1,055,781	17.2%	13	20	$21.6	$65.9
Oceania, Pacific Islands and Antarctica	976,063	2,477,200	9.8%	12	17	$117.2	$327.9
North America	5,500,654	6,256,277	1.3%	4	4	$566.2	$1,192.6
Central America and Caribbean	90,720	301,616	12.8%	19	23	$19.5	$53.8
South America	266,712	696,900	10.1%	8	11	$84.2	$211.8
GLOBAL TOTAL:	9,020,196	12,977,218	3.7%	87	119	$872.7	$2,113.1

* Regional AAGR = Regional Annual Average Growth Rate

As of 2008, more than 3,000 whale watching operations throughout the world directly employed an estimated 13,200 people (O'Connor et al., 2009). It was noted that such employment consists of both seasonal and permanent positions, depending on whether the whale watching activities involve migratory species or resident animals. Table 2 illustrates the direct employment, supported by whale watching, for the regions discussed above. The study by Cisneros-Montemayor et al. (2010) suggested that an additional $413 million and 5,700 jobs could potentially be generated if whale watching operations were to begin in countries that currently are not involved. The authors conclude that these estimates would bring the total benefits from whale watching to over $2.5 billion a year, supporting approximately 19,000 jobs around the world. A key finding of the study is that half of these estimated potential benefits would be captured by developing countries. Furthermore, it was suggested that,

> "Although whale watching can evolve into a very large commercial enterprise, in many developing countries it can be launched with little initial investment and can be carried out by local fishers who are already familiar with the area" (p.1276).

Thus, whale watching may provide an opportunity for the expansion and diversification of income sources in developing coastal countries where livelihoods might be threatened by declining fisheries.

Table 2. Regional employment, including seasonal and permanent positions, within the whale watching industry (O'Connor et al., 2009).

Region	Number of jobs supported by whale watching	Number of whale watchers per employee
Africa and Middle East	1,065	1,060
Europe	794	867
Asia	2,191	1,078
Oceania and the Pacific Islands	1,868	543
North America	6,278	750
Central America and Caribbean	393	2,051
South America	615	1,272
GLOBAL	13,205	1,183

The value of whale watching to the participating operator is suggested in the direct and total expenditure. However, there is even greater benefit to the local community and region, as this direct expenditure is re-spent and spreads beyond the whale watching operators (IFAW, 2005). Many examples exist, throughout the world, illustrating how the socio-economic benefits of whale watching can truly transform a community, village, city, region, or even a country. Such transformations have occurred in various communities throughout New Zealand, the United States, Canada, Japan, Norway, South Africa, Argentina, Australia, Ireland, and Mexico, among others (Hoyt, 2001).

Hoyt and Iñíguez (2008) provide a chronology of whale related events in Puerto Lopez, Ecuador to demonstrate how regional transformations can be attributed to whale watching. The authors note that prior to the early 1990s, Puerto Lopez was a quiet fishing town that saw up to 3,000 visitors a year coming to this area and near-by Machalila National Park. To illustrate the beginning of the transformation, they discuss how an increase in humpback whale watching in 1994 resulted in 5 hotels, 4 restaurants and 7 whale watch operators in Puerto Lopez by 1997. The humpback whale festival, beginning in Puerto Lopez in 1999, was highlighted as a contribution to the continued increase in the number of visitors to the area. Finally, they report that as of 2008 there were 32 hotels, 13 restaurants and 22 whale watching operators, with 30 boats, in Puerto Lopez, accommodating the approximate 30,000 visitors to the area each year. This is but one example of how influential whale watching can be in enhancing local economies.

2.4.2 Education

The benefits of the industry, however, are far reaching and go beyond those of socio-economics. Hoyt (2001) highlighted the reasons for the overall support of the industry:

> "Whale watching educates children and adults about our ocean planet, the magnificent creatures that share our world, and the importance of maintaining their habitat; it provides a method for scientists to gain substantial information and monitoring capability with whales and dolphins and thereby contributes to their conservation." (p. 1)

It has been suggested that the most valuable aspect of whale watching is its potential to educate people, of all ages and from all backgrounds, to appreciate, value and understand marine mammals and the system they live in (IFAW et al., 1997). Whale watching is believed to be highly educational, providing an opportunity for those participating to connect with nature. In May of 1997, 34 whale watching experts and observers from 16 countries met in Massachusetts to quantify and evaluate the educational value of whale watching (IFAW et al., 1997).

The Workshop on the Educational Values of Whale Watching discussed the kind of educational information whale watching trips provide, along with the various tools utilized to educate. Some of the educational values identified during the Workshop are listed in Figure 2. The workshop report (IFAW et al., 1997) suggests that the most obvious education the passengers receive is on the animals encountered and the ecosystem in which these animals are found. The findings of the Workshop participants conclude that this education begins with outreach material, such as brochures, and continues throughout the remainder of the whale watching experience. The participants further discussed, in detail, the educational role that the whale watching guides play throughout the tour. It was highlighted that in addition to relaying information about cetacean species and their behaviours, the guides often educate whale watchers on other aspects of the environment as well. Some of these aspects mentioned during the Workshop include other wildlife and geographical features in the area, along with the coastal cultures of the people coexisting in the same environment.

Passengers may receive information on research and conservation efforts in the area as well. The Workshop report states that such information can entail what kind of research has been done and why, what some of the results may be, how the research contributes to conservation, and the role that marine protected areas play in conservation. It was also noted that further education on the conservation of cetaceans and their habitats is typically achieved through discussions about regulations and/or Codes of Conduct. One important underlying message that the passengers take away from hearing about such management efforts is that the conservation of marine mammals and their critical habitat is important.

EDUCATIONAL VALUES OF WHALE WATCHING:

1. Whales are emblems for promoting awareness of endangered species and habitat protection.
2. Whale watching provides the opportunity for people across all ages and cultures to become familiar with environmental issues and to become involved in conservation efforts on a personal, local, regional, national and international level.
3. The development of education programs forges links between the whale watching industry and local communities as well as building bridges between the general public and scientific communities.
4. Natural history knowledge gained through whale watching has intrinsic value.
5. Whale watching provides an opportunity to observe animals in the wild, transmitting factual information and dispelling myths.
6. Whale watching is a model for marine educational programs in adventure travel and ecotourism.
7. Whale watching provides the opportunity for appreciation and understanding of local history, culture and environment.

Figure 2. List of educational values identified at the Workshop on the Educational Values of Whale Watching (IFAW et al., 1997).

It is also possible for whale watching experiences to be integrated with academic programs. The Workshop participants discussed how whale watching, as an extension of the classroom, can be considered academically useful. Whale watching was identified as an educational tool that can effectively teach children about the natural world, along with the importance of conserving and protecting it. For students in higher levels of education, the applications of whale watching in a range of disciplines were highlighted, including cetology, oceanography, ecology, and conservation biology.

2.4.3 Research

Whale watching vessels can provide a platform from which scientists may conduct research. The majority of this research falls under the natural science fields, but opportunities also exist for social scientists to gather information from the passengers.

Discussions have taken place within the Scientific Committee of the International Whaling Committee (IWC), as well as at various workshops and conferences, on just how whale watching contributes to scientific research. In order to better understand the relationship between whale watching and scientific research, during its 2002 and 2003 meetings, the Whale Watching Sub-Committee of the Scientific Committee requested summaries of scientific research involving whale watching, both as the main subject and any studies simply utilizing the boats as research platforms (Palazzo et al., 2004).

Palazzo et al. (2004) presented one of these summaries, reporting on the research of 80 projects occurring in a total of 22 countries throughout the world. Projects identified by the authors represent a wide range of studies, in addition to those investigating the impacts of whale watching, including: photo identification studies; acoustics studies; behavioural studies; studies contributing to management issues; abundance and distribution studies; studies investigating environmental influence on distribution; studies contributing to population biology and conservation; studies on social structure, ecology, life history and habitat use; and much more. Their report clearly indicates that the extent of scientific research resulting from the use of whale watching vessels is considerable and widespread.

Studies investigating the impacts of whale watching have also been occurring from whale watching vessels for many years. This research is important and useful for its management implications, as it may reveal how whale watching activities affect the animals and how disturbances might be minimized. Whale watching management initiatives including scientific input are more likely to promote and ensure sustainable whale watching practices than those disregarding the scientific information (Palazzo et al., 2004).

Research involving whale watching tourists has proven useful for evaluating various aspects of a country's or region's tourism industry, and has contributed to greater economic investigations (Guðmundsdóttir & Ívarsson, 2008; Herrera & Hoagland, 2006; Parsons & Rawles, 2003). Also, knowing what kind of tourist is interested in whale watching activities, along with what their motivations and concerns are, is important information for the management and development of the whale watching industry (Parsons et al., 2003).

2.4.4 Conservation

Whale watching can contribute not only to the conservation and protection of cetacean species, but to the marine system as a whole. As discussed above, research occurring as a result of whale watching plays a crucial role in promoting and contributing to conservation. Information about the species and their marine environment, gained through research, can reveal what efforts would best conserve the required habitat and the animals themselves.

Public opinion towards environmental issues has been changing since the 1980s, as efforts to raise awareness and educate the public have become more common (Dunlap, 1991; Arnold, 2004). The education that passengers often receive while participating on a whale watching tour may be useful in further increasing awareness of the current threats faced by life in the oceans and the importance of a healthy marine ecosystem. Miller (2005) discusses how the general disconnect of the world's people from nature is an obstacle in overcoming and reversing certain conservation issues. Thus, it is possible that after experiencing an encounter with whales or dolphins, whale watchers will play a more active role in conservation efforts than someone who has not had a similar experience.

As whale watching has many economic benefits, the local community may play a more active role in conservation to protect their cetacean-related livelihoods. One such example, where conservation resulted from an economic incentive, comes from the dolphin watching industry at Samadai reef, on the Red Sea in Egypt (O'Connor et al., 2009). The horseshoe-shaped reef, providing shelter for spinner dolphins during the day, became a popular dolphin watching location in 2001. However, the authors explain that tourist activities exerted much pressure on the dolphins and disturbed their day-time resting behaviour. As a result, the dolphins dispersed and sightings were greatly reduced. It was reported that in 2003 local authorities suspended all visits to the reef until a management plan was put into place, which occurred quite rapidly with the implementation of a marine protected area (MPA) in 2004. Included in the implemented management plan was a zoning plan, a monitoring program, enforcement strategies, and a service fee which raises over $500,000 a year for the local government, further contributing to the maintenance and conservation of the reef. It was noted that in addition to successfully enabling dolphins to return to the area, the management plan has also lead to the creation of 200 direct jobs in the field of conservation. This case study of dolphin watching at Samadai reef is a great example of how marine and cetacean conservation can truly benefit not only cetaceans and the environment, but also those who are willing to engage in such efforts.

It is apparent that whale watching offers many advantages and benefits. Understanding the many values of whale watching is important as it may help to explain why whale watching is not only heavily supported, but also encouraged as an acceptable use of cetacean resources, despite the possible negative impacts to the environment and the animals themselves.

2.5 Negative Impacts

Although the rapidly developing and growing whale watching industry has met little resistance, concern does exist regarding the welfare of the targeted subjects. As a result, decades of studies have been conducted to investigate the potential impacts of whale watching activities on cetaceans, with the hopes of understanding how to promote more sustainable practices.

These studies have documented many short-term behavioural responses as a result of whale watching. Scheidat et al. (2004) successfully measured the short-term reactions of humpback whales to vessel activity in Ecuador. They observed a decrease in linear swim patterns and an increase in swim speeds of humpbacks approached by whale watching boats. Such behavioural observations are supported by studies that have been conducted throughout the world and are characteristic of many cetacean species (Williams, Trites, & Bain, 2002; Blane & Jaakson, 1995; Corkeron, 1995). Dolphin behavioural responses typically involve changes between behavioural states (Arcangeli & Crosti, 2009; Lusseau, 2003; Barr & Slooten, 1999). In an assessment of how dolphin-watching tour boats affect the behaviour of bottlenose dolphins, Constantine et al. (2004) concluded that perhaps the most concerning change was a reduction in resting behaviour. Their findings suggest that the number and type of boats present influences dolphin behaviour, as resting appeared to decrease significantly with an increase in boat numbers.

There has been much debate within the scientific community as to whether or not these short-term behavioural responses of individuals, such as altered swim and dive patterns, reduced rest times, and behavioural displays, will lead to any long-term impacts within the population. Lusseau and Bejder (2007) discussed the long-term consequences of short-term responses to disturbance resulting from whale watching. They highlighted the findings of various studies (Bejder, 2005; Lusseau et al., 2006; Williams et al., 2006) that identified how short-term avoidance tactics can lead to biologically significant events, having long-term consequences on cetacean populations. The authors proved that increased energetic challenges, due to added travelling costs or reduced foraging opportunities, may result from whale watching activities. They discuss and explain that if these challenges occur too often, they are accompanied by a reduction in individual fitness, which could lead to decreased calf survival and a shift into long-term avoidance strategies. Figure 3 illustrates their proposal of how short-term behavioural responses can result in changes at the population level.

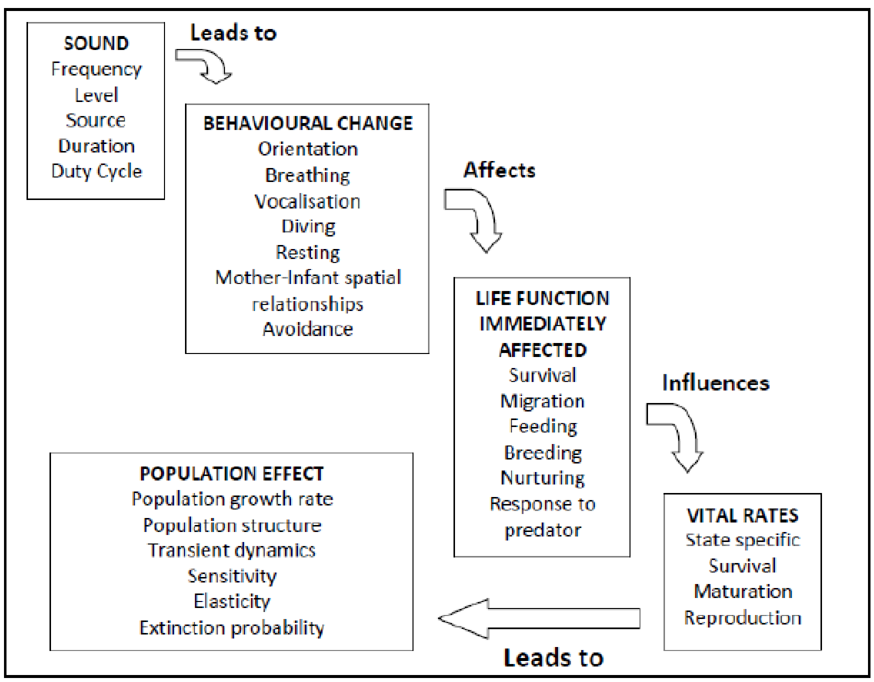

Figure 3. How whale watching activities can induce individual short term behavioural responses of cetaceans, potentially leading to population level impacts (Lusseau & Bejder, 2007).

However, as the authors point out, it is important to realize that the extent to which whale watching will have long-term consequences on a population will vary between populations. It is suggested that small populations, with restricted immigration and/or emigration will likely be impacted the most.

In order to keep up to date on the wealth of research regarding the impacts of whale watching activities, a yearly written summary has been presented to the Whale Watching Sub-Committee of the IWC Scientific Committee since 2004 (Parsons et al., 2004; Parsons, Lewandowski & Lück, 2006; Parsons, Lück, & Lewandowski, 2006; Scarpaci et al, 2008; Scarpaci, Parsons & Lück, 2009; Scarpaci, Lück & Parsons, 2009). These summaries (six in total) highlight the whale watching research that has been published throughout the year. The following is a brief summary of the most recent account of research related to whale watching impacts (Parsons & Scarpaci, 2011):

Orcinus orca (Killer Whale)

The population of "southern resident" killer whales off the San Juan Islands, Washington State has declined to fewer than 90 individuals and was listed as "endangered" in the United States and Canada in 2001 (Parsons & Scarpaci, 2011). To determine what impact the commercial and non-commercial whale watching activities in the area might be having on the population, Lusseau et al. (2009) carried out a study. Their results demonstrated reduced foraging behaviour from 76% of the time to 60% of the time when boats were within 400m. These findings are significant as a reduction in foraging could lead to a deterioration of health (Parsons & Scarpaci, 2011).

Another study (Williams et al., 2009) analyzed "southern resident" orca swimming speed, surfacing intervals and the path taken by the whales, in response to boat traffic. They reported increased dive times and swim speeds with an increasing number of vessels, along with more erratic movements. The authors conclude that the crowding of boats could, therefore, result in increased energetic costs.

Noren et al. (2009) conducted a third study on "southern resident" killer whales, investigating the prevalence of "surface active behaviours" (such as breaches, spy hops, fin slaps and tail slaps). Their findings revealed that surface active behaviours generally increased when boats were closer, with the most common observed behaviour being the tail slap. This particular behaviour has been interpreted differently in various studies, but it is believed that the tail slap is used as either a prey herding tactic or to signal warning or annoyance (Marsh, 2008).

Tursiops spp. (Bottlenose Dolphin)

A study conducted on the Australian bottlenose dolphin (*Tursiops truncatus*) demonstrated a decrease in biologically important behaviours in response to boat traffic (Arcangeli & Crosti, 2009). The researchers observed that when boats were present within 350m, the amount of time the dolphins were engaged in diving, milling, or travelling behaviour increased. As a result, they estimated that the amount of time spent resting decreased from 31% of the time to 20%, while the time spent foraging decreased from 20% of the time to 7.6% of the time. Even though care was taken to conduct the research in the least disturbing manner possible, with the vessel's engine turned off, this decrease in time spent foraging is one of the greatest decreases observed to date (Parsons & Scarpaci, 2011).

Similar behavioural changes were noted for a small population of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) off the coast of Zanzibar, Tanzania (Christiansen et al., 2010). Again, the authors report that biologically important behaviours, such as resting, foraging, and socializing, tended to decrease in the presence of boats. A decrease in socializing is important as it could mean a decrease in courtship behaviour which would, through lower reproductive success, affect the population (Parsons & Scarpaci, 2011).

Megaptera novaeangliae (Humpback Whale)

The behaviour of humpback whale groups was monitored off the coast of Queensland, Australia (Stamation et al., 2010). The findings of this study revealed that almost half (46%) of the groups observed from the whale watching vessels showed no detectable response, 23% approached the vessels, and 17% moved away. The authors noted that there did not appear to be any relationship between the behaviour of the group and their response, however certain behaviours, such as spy-hops, trumpet blows, and tail swishes, were more frequently exhibited by whales approaching the vessels. It is possible that the latter two behaviours may serve as signs of aggression (Parsons & Scarpaci, 2011). Stamation et al. (2010) reported that the avoidance behaviour, amongst those who did move away, was more likely the closer the boat approached and resulted in the whale spending more time submerged.

The impact of whale watching activities on calving rates, or calf survival, was investigated by Weinrich & Corbelli (2009) in Southern New England humpbacks. The results indicated a mean calving rate of 0.35+/- 0.24 calves per year, showing no correlation to exposure rate or the number of boat interactions. In fact, the study revealed that females with calves had significantly more exposure to whale watching in both the year prior to and during a possible pregnancy, and that no significant difference was observed in calf survival based on the mother's whale watching exposure. The authors therefore concluded that no negative impacts, resulting from whale watching exposure, were documented on calving rate or calf survival.

Sotalia guianensis (The Costero or Guyana Dolphin)

Filla & Monteiro (2009) investigated the effects that dolphin watching operations may have on estuarine dolphins in southeast Brazil. They documented dolphin responses as either positive (movement towards vessel), negative (movement away), or neutral (no change in behaviour or orientation) in relation to the length of interactions. The results of the study showed that the dolphins' response was influenced by interaction time, with longer exposures producing less negative effects. The authors reported that aggressive approaches, i.e where the dolphins were approached directly or chased, resulted in negative responses 100% of the time, whereas the cases in which the dolphins responded positively, the vessels were moving slowly and remained a certain distance away.

Underwater Noise

Jensen et al. (2009) investigated the impact of motorboat noise on cetacean communication using both 2 and 4 stroke outboard motors. Acoustic tags were attached to common bottlenose dolphins and short-finned pilot whales (*Globicephala macrorhynchus)* to assess the level of disturbance. The results of the study showed a 70% decrease in communication distance for both species when boats were at 200m. While at 50m, a boat travelling a speed of 5 knots (9.3 km/hr) was observed to reduce the communication ranges of pilot whales by 58% and by 26% for bottlenose dolphins. At this same distance, but travelling at a speed of 10 knots (18.5 km/hr), the boat noise induced an even greater reduction in communication, with a 90% decrease for pilot whales and a decrease of over 80% for bottlenose dolphins. The investigation revealed that noise levels from boats at 50m, travelling at a speed of 2.5 knots (4.6 km/hr), interfered very little with communication calls. This study has management implications for whale watching activities involving vessels with outboard motors as well as for research activities occurring from smaller watercraft (Parsons & Scarpaci, 2011).

Impact studies have been conducted in Iceland, as well, investigating the response of minke whales to whale watching activities. Magnúsdóttir et al. (2011) analysed the swimming behaviour of minke whales in Skjálfandi Bay in relation to whale watching vessel traffic. The results of the study indicate that an increase in vessel traffic induced greater swim speeds, that an increase in vessel speed resulted in a greater directness index (that is, the whales swam in a more linear fashion), and that when vessels approached within 100m of the animal, it had a tendency to keep its swimming course and re-orientate less. A similar study was carried out by Christiansen et al. (2011) in Faxaflói Bay, Southwest Iceland. The results report that whale activities in this region affect minke whales in the following ways: to avoid whale watching boats, minke whales decreased their inter-breath intervals, performing shorter dives, and decreased their directness index displaying a more circular swimming pattern. The authors suggest that these whale watching induced changes in swim patterns may lead to an increase in energy expenditure and could indicate the disruption of foraging behaviour.

The degree to which whale watching impacts cetaceans varies between species, regions of the world, and the ways in which whale watching activities are conducted. There is a great need for continued research to better our knowledge and understanding of how severe the discussed impacts are. Little documentation exists on how the above mentioned disturbances differ between habitats, yet it is quite likely that the degree of sensitivity to disturbance differs between cetaceans in feeding grounds versus breeding and calving grounds. For example, in assessing the impacts of boat noise, Au and Green (2000) reported that during the peak whale season in breeding and calving grounds around the island of Maui, the noise made by chorusing humpback whales was so great that a second set of measurements, made later in the year, was required for a more accurate assessment. Although they concluded it is unlikely that boat sounds would have any grave effects on the auditory system of humpback whales in this setting, it is possible that in other areas of the world, where whales are not congregating and communicating to the same extent, boat noise may be more disruptive. Also, there is little research supporting the notion that whale watching can lead to population level impacts. Further investigations will hopefully clarify the extent to which whale watching is affecting the animals so that proper management can be implemented. In the meantime, regardless of whether impacts are seen at the individual or population level, it is generally accepted that whale watching activities have the potential to affect the animals involved. Every study investigating the impacts of whale watching can help to reveal how disturbances to cetaceans can be minimized.

2.6 Promoting Sustainable Whale Watching

As a result of growth within the industry, and an increasing knowledge of the potential negative environmental impacts, the sustainability of whale watching is a topic that has received much attention. In Hoyt's Blueprint for Whale and Dolphin Watching Development (2007), he discusses whether or not whale watching has become mass tourism, or if it is still capable of being ecotourism, which is sustainable by definition. He suggests that the answer to this question depends on how the whale watching is set up, and then carried out (Hoyt, 2007).

Hoyt (2005) discusses the terms "ecotourism" and "sustainability" in relation to whale watching and presents a framework for the sustainable development of the industry. In this discussion he offers the suggestion that applying a cost-benefit analysis (CBA) to individual whale watching cases can improve the quality of whale watching and lead to more sustainable practices. The principle is quite simple: increase benefits and reduce costs. He further offers that if disturbance to cetaceans and other wildlife is considered a cost, the use of guidelines to encourage the best whale watching practices may be useful. While recommending that CBA is an appropriate measurement tool, he stipulates that it cannot be used in isolation to achieve sustainability. To do this, effective implementation and management plans are required, supported by appropriate legal frameworks.

Various workshops and conferences have been dedicated to the sustainability issue of whale watching. In the year 2000, sustainable whale watching was addressed at the Council of Europe conference on "Sustainable Tourism, Environment and Employment" held in Germany; The International Whale Watching Conference, held in the Canary Islands in 2003, addressed sustainable practices as well; a two-day workshop was held in Puerto Pirámide, in September of 2004, analysing sustainability within the Argentinean industry; and The Workshop on the Science of Sustainable Whale Watching was held in Cape Town, South Africa, in 2004. This is by no means an exhaustive list of the meetings which have tackled the issue of sustainable whale watching, however this list helps to demonstrate the complexity of the issue and the worldwide involvement in this issue.

Discussions held at The Workshop on the Science of Sustainable Whale Watching (the Workshop) revolved around why management is needed and how effective management can be achieved. The Report from the Workshop (Brownell & Oosthuizen,

2004) highlights the discussions held by the participants, along with their conclusions. When assessing the impacts of whale watching as the basis for management, there was a general consensus that both the science and management needs to be species- and location-specific. The Report also states that scientists have an important role to play, as research will inform proper management of whale watching, and most importantly, the identification of whale watching interaction characteristics most significantly impacting the animals will enable the risk of potential disturbances to be minimized. Gaps in the current science and management of whale watching were discussed, along with ways in which management can be strengthened. In conclusion, the Workshop reviewed how the utilization of MPAs, monitoring, education, impact assessments, and the use of case-specific approaches could lead to sustainable development within the industry.

As far as case-specific management is concerned, progress has been quite substantial. Most management bodies, whether national, regional, or local, do understand the urgency of developing more sustainable whale watching and, like Hoyt, they recognize that if it is to be achieved, effective management initiatives must be implemented (Gjerdalen and Williams 2000). As a result, tourism operators participating in whale watching are expected to do so in an appropriate manner and, more often than not, in accordance with national rules and regulations. Such rules and regulations are usually presented in the form of CoCs which consist of individual whale watching guidelines. Much variation exists amongst these guidelines throughout the world, as no two whale watching operations are exactly the same. In some countries, the guidelines are incorporated into national legislation and become part of the law (e.g., Australia, various locations in the USA), in other cases (e.g., Galapagos Islands, Hong Kong) the guidelines simply act as voluntary measures (Garrod & Fennell, 2004; Carlson, 2009).

Regardless of what management form is chosen, many countries participating in the industry have, or are in the process of developing, guidelines to manage whale watching activities. Garrod and Fennell (2004) completed an analysis of whale watching CoCs from around the world. Their sample consisted of 17 CoCs from North America, 14 from South and Central America, 14 from Europe, 5 from Asia, 4 from Africa, 3 from Australia and New Zealand, and 1 Global CoC. Of these, 27 CoCs were developed by Government, 13 by non-governmental organizations (NGOs), 4 by Industry, and 13 by an "unknown" source due to unavailable data. The analysis illustrates how widespread whale watching CoCs are and how various stakeholders are involved in whale watching management.

Carlson (2009) also analysed whale watching guidelines and regulations from around the world. Her analysis includes 82 countries and, in detail, she outlines the management initiatives for each. Once again, there are noticeable differences in the level of compliance expected between specific countries and, sometimes more specifically, between various operations within a country. However, there is less variation amongst the elements of whale watching addressed. Guidelines or regulations are implemented with the goal of minimizing, as best as possible, the degree to which cetaceans are disturbed by whale watching activities. Thus, it makes sense that regardless of the operation or the country in which it is occurring, certain aspects of whale watching are commonly and repeatedly targeted by the various management initiatives. In fact, individual guidelines have been categorized within one of four themes, as shown in Table 3 (Garrod & Fennell, 2004).

If continued growth of the whale watching industry is expected, the importance of effective management cannot be over emphasised. In order for the socio-economic benefits and other values associated with whale watching to continue into the future, whale watching development needs to occur sustainably. Understanding and minimizing the potential sources of disturbance would seem an appropriate first step towards the goal of sustainability.

Table 3. Themes and corresponding characteristics of the whale watching activity targeted by whale watching guidelines (Garrod & Fennel, 2004).

Approach Data	Interaction Data	Management Orientation Data	General Information
Aircraft allowances Aircraft approach distance Boat allowances Boat approach distance Number of boats at a time	Swimming Touching Feeding Noise Dwell time for specific species Dwell time/minutes	Permit requirements Control of pollution Restrictions on viewing pods with calves Specific basis of rule Application of rule Marine park protection Ethical orientation	Region of Code Code developed for Code developed by Date put in use

2.7 The Icelandic Industry

2.7.1 Growth and Development

Beginning in 1991, whale watching is now the fastest growing industry in Iceland (Magnúsdóttir et al., 2011). An explosion occurred in the Icelandic industry from 1994 to 1998, where an annual growth rate of 251% was observed (O'Connor et al., 2009). This growth rate, from the mid to late 1990s, was the highest ever annual growth rate within the whale watching industry, and in 1998, one in every eight visitors to Iceland was going whale watching, resulting in approximately $9 - $12 million total expenditures (Hoyt, 2001). Since then, growth has continued at a more modest, but still significant, annual average of 14% with an increase from 30,330 whale watchers in 1998 to 114,500 in 2008 and a resulting $17 million in total expenditures (O'Connor et al., 2009). Table 4 summarizes the growth within the Icelandic industry from 1991 to 2008.

Table 4. Growth within the Icelandic whale watching industry since its beginning. Total expenditures in USD, based on the 2009 currency rate (O'Connor et al., 2009).

Year	No. of Whale Watchers	Average Annual Growth	No. of Operators	Total Expenditure
1991	100	NA	1	$60,000
1994	200	26%	4	$146,000
1998	30,330	251%	12	$6,470,000
2008	114,500	14%	10	$16,708,987

Although dedicated whale watching trips run from April – October, the best time to see cetaceans in Icelandic waters is from June – August (O'Connor et al., 2009). To date, 22 species of cetaceans have been found in the waters surrounding Iceland, the majority of which are migratory, coming to the cold North Atlantic waters in the summer to feed (Hersteinsson, 2004). Among these, the most common are the minke whales (*Balaenoptera acutorostrata)*, fin whales (*Balaenoptera physalus*), and sei whales (*Balaenoptera borealis)*, while the minke whales, humpback whales (*Megaptera novaeangliae)*, blue whales (*Balaenoptera musculus)*, white-beaked dolphins (*Lagenorhynchus albirostris)*, killer whales (*Orcinus orca*), and the harbour porpoise (*Phocoena phocoena*) are the main targets of whale watching operations (Víkingsson, 1999 cited by Hunt & Drinkwater, 2005; Parsons & Rawles, 2003).

Whale watching activities are concentrated around the Reykjavík area in the southwest and Húsavík in the northeast (O'Connor et al., 2009). Smaller whale watching operations also occur at various locations along Iceland's coast, including Ólafsfjörður in the north and Vestmannaeyjar (the Vestmann Islands) in the south. The growth in whale watchers by location in Iceland is shown in Figure 4.

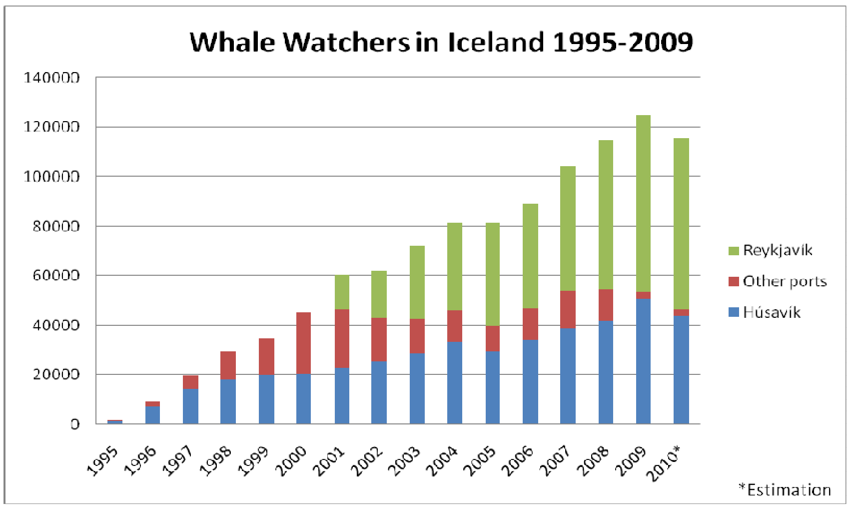

Figure 4. The observed increase in whale watchers in Iceland (Personal Communication with Marianne Rasmussen, 2011).

Húsavík, a small town in northeast Iceland, provides an example of how the transformation of a small coastal community can be attributed to whale watching. Starting in 1995, whale watching companies operating out of Húsavík have been taking passengers onto Skjálfandi Bay (the Bay) for an opportunity to encounter various cetacean species (Figure 5). Since then, whale watching in this part of Iceland has gained much momentum, and in 2007, 40% of all whale watchers in Iceland departed on their whale watching tour from Húsavík (Guðmundsdóttir & Ívarsson, 2008). In 2010, the two companies, North Sailing and Gentle Giants, accommodated approximately 50,000 whale watchers in total. (Magnúsdóttir et al., 2011). The peak of the season is observed in July, and in 2011 there were a total of 18 daily trips occurring on Skjálfandi Bay, between the two companies. A visit to the rather famous Húsavík Whale Museum is often a part of the whale experience in Húsavík. Opening in 1997, the museum was a great success and it was soon realized that more space was required. In 2002, the museum moved to a bigger building, and in recent years has been accommodating around 20,000 annual visitors (Hvalasafnið á Húsavík, 2008). It is for good reason that Húsavík has been titled "the whale watching capital of Iceland" (Hoyt, 2003).

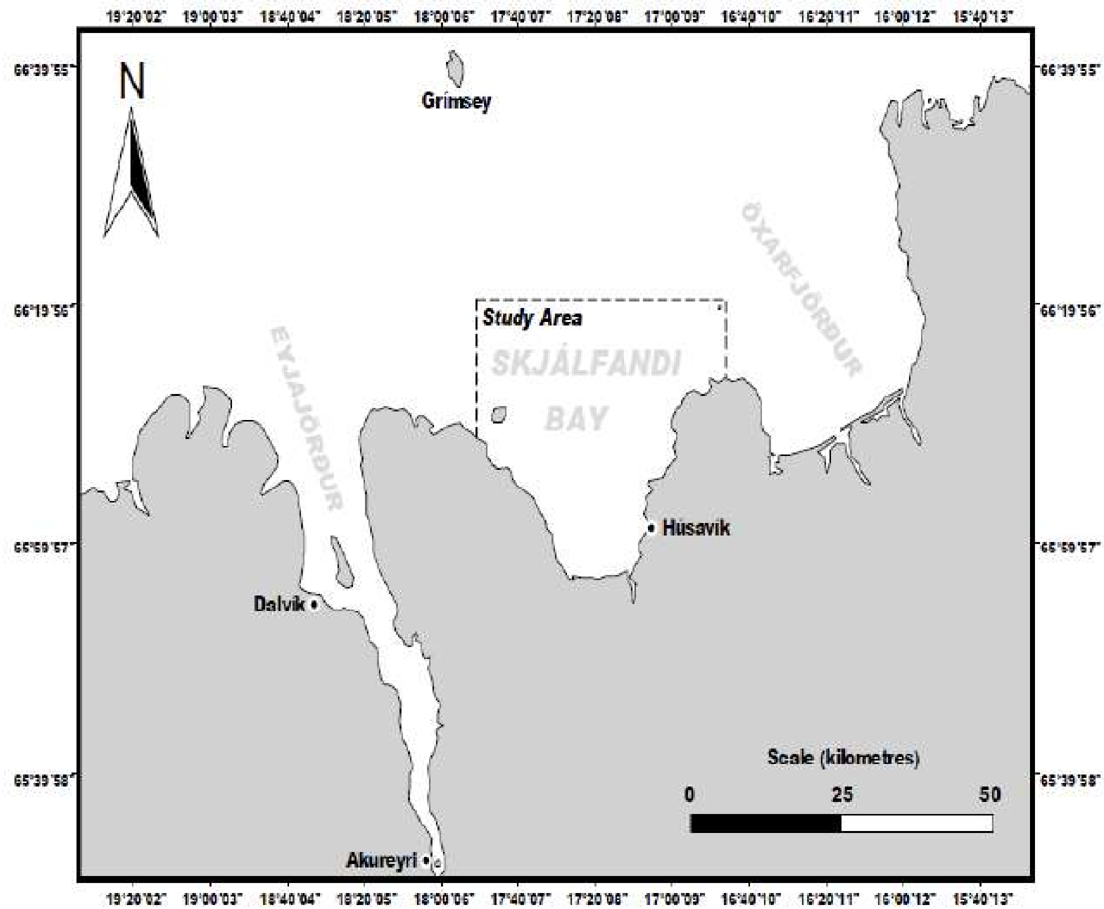

Figure 5. Location of Skjálfandi Bay, and Húsavík, in northeast Iceland (Cecchetti, 2006).

2.7.2 Húsavík's Transformation

In the study conducted by Guðmundsdóttir and Ívarsson (2008), an assessment was conducted of the impact of tourism on the economy of Húsavík. Although it was illustrated how the direct spending of whale watchers has had an impact on the economy of Húsavík, it was also noted that whale watching played another role in strengthening the town's economy. The whale-related experience that Húsavík offers was found to be largely responsible for putting Húsavík on the map, so to speak. During the assessment it was revealed that the town now has a strong image, both domestically and externally, as a great destination to experience Iceland's nature. In particular, near-by islands are known for their bird watching potential, the mountains on the west side of the Bay are becoming more popular for hiking, and horseback riding in the countryside around Húsavík is becoming more appealing to tourists. Regardless of whether whale watching is on the itinerary, many more tourists are now aware of what the area has to offer and appear to be visiting Húsavík, the main service center, as a result.

With regards to tourist spending in Húsavík, the study (Guðmundsdóttir & Ívarsson, 2008) reported considerable variation in the amounts. Excluding whale-related spending (that is the buying of tickets for whale watching tours and admittance into the museum) the average amount of money spent in one day (24 hours) by a tourist was calculated to be approximately 8.000 ISK (read as eight thousand ISK, which is approximately equal to $102 USD) and is summarized in Table 5. However, in contributing to the study, a survey was conducted and revealed that 78% of tourists surveyed in Húsavík participated in whale watching activities and that the whale-related experience was the reason 85% of tourists visited Húsavík. Therefore, as most visitors to Húsavík experience whale-related costs, the contribution to the local economy from these particular tourists is most likely greater than the average 8.000 ISK mentioned above. This is supported by the study, which reported that the spending of those participating in whale watching was observed to be higher in many of the categories listed in Table 5, resulting in an estimated total individual expenditure of 13.000 ISK ($166 USD) per day.

Table 5. Tourist expenditures into Húsavík's economy. Expenditures reported in ISK, based on the July 2008 currency rate (Guðmundsdóttir & Ívarsson, 2008).

Spending Category	No. of People Surveyed	Average Individual Expenditure (excludes camping)
Accommodations	507	2.107
Food and Beverages	509	1.066
Activities / Entertainment	509	2.603
Culture / Sport	508	483
Gasoline / Oil	508	471
Retail	509	1.029
Other Spending	510	161
Total		**7.920**

It was estimated that in 2007 and 2008 there were approximately 150,000 visitors to Húsavík throughout the year (Guðmundsson, 2008). The amount of money spent in Húsavík in one year, based on 150,000 tourists, is broken down in Table 6. In conclusion, the study assessing the impact of tourism on Húsavík's economy reported an estimated contribution of 1.057.950.000 ISK ($13 million USD) in 2008.

Table 6. Yearly contribution of tourism into Húsavík's economy. Expenditures reported in ISK, based on the July 2008 currency rate (Guðmundsdóttir & Ívarsson, 2008).

Spending Category	Estimated total expenditure (based on 150,000 tourists/year)
Accommodations	186.000.000
Food and Beverages	159.900.000
Activities / Entertainment	390.450.000
Culture / Sport	72.450.000
Gasoline / Oil	70.650.000
Retail	154.350.000
Other Spending	24.150.000
Total	1.057.950.000

Guðmundsdóttir and Ívarsson (2008) also discuss how this increase in Húsavík's tourism has resulted in more employment within tourism related companies and services. They state that in 2007, tourism supported 15% of the work force through 150 jobs. The transformation to Húsavík has, in many ways, also been quite visible. The town center and marina have changed in many ways, improvements and renovations have been made to many buildings, and new buildings have been built to accommodate various tourism services and the increasing number of people. In summing up the assessment, the authors state that "the town has received a substantial uplift" (p.16). Thus, the growing Icelandic whale watching industry has played a major role in the transformation of Húsavík, leading to the diversification and expansion of the local economy.

2.7.3 Management

Although whale watching management initiatives are lacking at the national level, informal guidelines aiming to mitigate potential disturbances resulting from the whale watching activities on Skjálfandi Bay do exist. Figure 6 illustrates the guidelines adopted by North Sailing, the original whale watching company operating on the Bay, while Figure 7 shows the guidelines listed in the Carlson (2009) document from the Húsavík Whale Museum. However, the efficacy of these voluntary guidelines has not been determined. Operators involved in whale watching in Iceland, in general, are aware of the practices and guidelines that exist in other countries. Although it is possible that foreign management policies are considered in operating procedures, it is not required, nor expected, that companies comply with such management efforts.

Guidelines for operating vessels around cetaceans

1. Approach the area of marine mammal activity with extreme caution. Look in all directions before planning your approach or departure.
2. Reduce speed to less than 5 knots when within 200 meters of the nearest cetacean. Avoid sudden course or speed changes.
3. Avoid driving towards any cetacean closer than 100 meters while the engine is in gear, unless you are approaching from the right angle.
4. Aim to approach and depart from whales from the side, following the direction of travel of the animal. Never approach from the front or from the behind. See figure.
5. If you are approached by a whale or dolphin you should:
   a. Continue on your course with little change in direction or speed
   b. Stop the vessel to allow the animal to interact with you or move away.
6. Limit your time engaged in viewing to a maximum of 30 minutes, to minimize the cumulative impact of many vessels.
7. Limit the number of boats around an animal to 2 and try to stay on the same side where possible.
8. Keep clear of the path of the animals.
9. Do not attempt to drive through groups of porpoises or dolphins for the purpose of bow riding. Should these animals choose to ride the bow wave of your vessel, gradually reduce speed and avoid sudden course changes.

Figure 6. Whale watching guidelines adopted by North Sailing, one of the Húsavík – based whale watching companies (available through info@northsailing.is)

A fairly recent international management initiative, called the Wild North Project, is attempting to develop and deliver a Code of Conduct to various operators involved in wildlife- based tourism. The main objective of this initiative is to promote the sustainable development of wildlife tourism in the "Northern Periphery", working with various stakeholders in Iceland, Norway, Greenland, and the Faroe Islands (Wild North Project, 2011). Recognizing the importance of such an initiative, North Sailing and Gentle Giants have partnered with the project. In collaboration with various scientists, managers, and tour operators, these two companies from Húsavík will help to develop, over the next two years, guidelines for whale watching in all of Iceland.

ICELAND - GUIDELINES
The Húsavík Whale Centre

Approaching the whales:
When a boat approaches a whale, the main engines should be cut back and let idle.

If a whale-watching boat is already near the whale or whales, the approaching boat should not come closer than 2-300 meters until the first boat leaves or indicates that it is safe to approach.

Do not approach a whale head on or from directly behind.

The best approach to a whale is slowly from the side and slightly behind.

When a boat approaches a whale it should not go closer to it than 50 meters.

If the whale approaches the boat, the propeller should be stopped while the whale is near the boat.

Cause as little noise and disturbance for the animals as possible.

A good idea is to let the engines idle and let the boat drift when approaching the whale. It might be good to turn the engines completely off if the whale wishes to approach the boat. (Passengers can appreciate the quietude better and listen to the whale blowing)

Do not run the engine and propeller at full power in the vicinity of whales nor make sudden directional changes.

Avoid chasing the whales. If a whale shies away from the boat, then cease (following this whale) and look elsewhere.

If dolphins come under the boat and in front of the bow, it is alright to maintain speed 4-6 mph (miles per hour) to let the dolphins play in the wave from the bow. Point out to the passengers to look under the bow when dolphins are in front of the boat.

Do not throw trash to the whales or into the sea.

Avoid sudden changes in direction when the animals are close to the boat.

Memorise landmarks or locations on land to pinpoint the whales better.

Do not stay too long near the whales, it may be good to seek other grounds to find other animals.

Figure 7. Whale watching guidelines outlined by the The Húsavík Whale Museum (Carlson, 2009)

2.8 Tracking Cetaceans in the Wild

Research involving cetaceans at sea presents several methodological and practical challenges. Many cetaceans swim rapidly, swim great distances on a daily basis, and migrate seasonally thousands of kilometres (Mann, 1999). Furthermore, even if you know where they are, cetaceans are difficult to follow as they disappear during dives, leaving no trace behind (Mann, 1999). Because of these challenges, many studies utilize data that can be collected from surfacing events and behaviour. In such studies, for example those investigating behaviour or the distribution and abundance of cetaceans, accurate measurements of the location of the surfacing animal(s) are essential (Leaper & Gordon, 2001). There are two widely accepted methods, both utilized in this study, for tracking and measuring the distance to surfacing cetaceans at sea: theodolite tracking and photogrammetric methods.

2.8.1 Theodolite Tracking

The challenges mentioned above have lead to an increasing use of a theodolite, used primarily as a land surveying instrument, to track animals from land in a non-invasive manner (Bailey & Lusseau, 2004). This method, if feasible, is popular as it provides an opportunity for research to be conducted in a manner that is less likely to disturb the animals being studied and alter their behaviours. These instruments have been used, successfully, since the 1970s, in a variety of cetacean-related studies throughout the world (Würsig & Würsig, 1979; Harzen, 1989; Acevedo, 1991; Goodson & Mayo, 1995; Bejder et al., 1999; Williams, Bain, Ford & Trites, 2002).

The surveying instrument is capable of measuring angles with great accuracy, usually 10 or 20 seconds of arc (Harzen, 2002). The theodolite measures vertical angles, relative to gravity, the earth's curvature and changing tides (Figure 8), along with horizontal angles from a selected reference point (Barr & Slooten, 1999). Once the height above sea level is known, the instrument provides both of these angles to the surfacing target and, using trigonometric equations, the position of the target is calculated in (x,y) coordinates (Bailey & Lusseau, 2004). The distance and direction of movement of the target can then be calculated. The horizontal angle from the reference point, a point of known coordinates, will allow for the direction of the target to be measured, while the vertical angle from the observation site is used to measure distance to the target (Wursig et al., 1991). More information on the trigonometric equations can be found in Wursig et al., 1991.

A computer running an appropriate tracking program, such as Cyclops Tracker, developed by E. Kniest from the University of Newcastle, is connected to the theodolite allowing for the transfer and viewing of the data. The theodolite, therefore, produces real time mapping of cetacean movement, enabling more accurate and quicker observations of current positions, directions and speeds of movement (Magnúsdóttir, 2011).

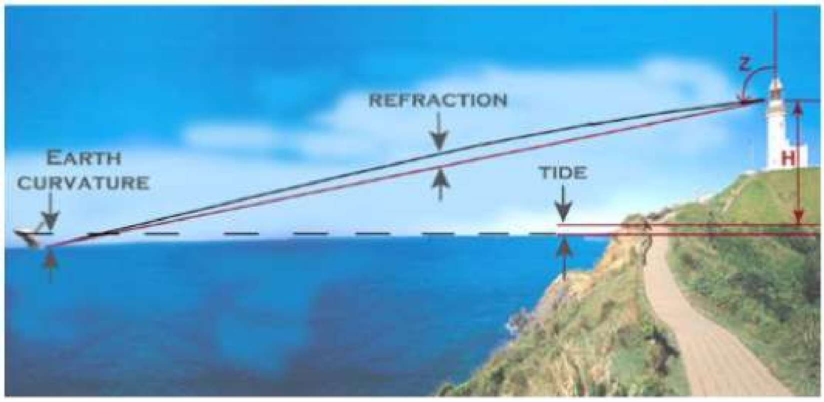

Figure 8. Taking into consideration the curvature of the Earth, refraction, and tidal changes, the theodolite measures the vertical angle (Z) in order to calculate the distance to tracked subjects (Revery, 2011).

2.8.2 Photogrammetric Methods

The accurate measurement of the location of a surfacing cetacean is even more difficult to achieve while on the water (Gordon, 2001). As a result, photogrammetry has been adopted as a practical system to determine the distance of a surfacing animal from a moving or still boat. These methods have been relied upon, and utilized successfully, in many studies over the years (Best et al., 1996; Gordon, 2001; Jaquet, 2006; William et al., 2007). This system involves the photogrammetric analysis of digital images to measure the angle of dip between the surfacing subject and the horizon (Leaper & Gordon, 2001). It is therefore essential to acquire images that capture the animal at the surface along with a clear horizon, or a shoreline of a known distance (Gordon, 2001). The height from which the photograph is taken, as well as certain camera and lens specifications, must also be known. Once the angle of dip is determined from the photograph (equation 1), the distance between a vessel and object at sea can be calculated using a trigonometric formula (equation 2) as follows:

$$\tan(\theta) = \frac{\frac{V}{H} * S}{F * C} \quad \text{(eqn 1)}$$

V = Distance between horizon and animal (pixels)
H = Picture height (pixels)
F = focal length of camera lens (mm)
S = Image sensor height (mm)
C = Crop factor of the camera (Gordon, 2001)

$$D = he * \sin(\theta + \alpha) - \sqrt{Re^2 - (he * \cos(\theta + \alpha))^2} \quad \text{(eqn 2)}$$

where:
θ = angle below the horizon to the sighting, in radians;
α = angle above the horizon to the horizontal tangent = atan $\sqrt{2Reh + h^2}/Re$
h = eye height above sea level, in km;
Re = radius of earth (6, 371 km);
$he = Re + h$ (Kinzey & Gerrodette, 2003)

2.8.3 Limitations and Error

Despite the great utility of both theodolite tracking and photogrammetric methods in cetacean research, there are errors associated with both techniques. When using a theodolite to track cetaceans, the accuracy of the (x,y) coordinates marking the position of the target depends on two things: the accuracy inherent to the particular theodolite being utilized; and the accuracy to which the altitude of the theodolite is known (Bailey & Lusseau, 2004). Wursig et al. (1991) investigated theodolite error and reported that incorrect tidal height measurements may lead to an overall incorrect height measurement of the theodolite, which can then result in inaccurate calculations of distance and speed. Therefore, the authors summarize that the degree of error in theodolite measurements is directly proportional to the height of the theodolite, with higher observation sites being more forgiving of such error (Table 7). Regardless of the theodolite's altitude, however, findings from the study revealed that the distance of the theodolite from the subject being tracked also influences the amount of error in the measurements. As illustrated in Table 7, the errors were greatest for the targets furthest away.

Table 7. Error in distance and speed measurements by theodolite due to inaccurate theodolite height measurements (Wursig et al., 1991).

Theodolite height (m)	Error in height (%)	Actual distance (m)	Distance underestimate (m)	(%)	Estimated speed (m/sec)	Speed underestimate (m/sec)	(%)
15	6.7	500	30	6.0	1.88	0.12	6.0
		2,500	172	6.9	1.86	0.14	6.9
		5,000	379	7.6	1.85	0.15	7.6
30	3.3	500	17	3.4	1.93	0.07	3.4
		2,500	85	3.4	1.93	0.07	3.4
		5,000	177	3.5	1.93	0.07	3.4
45	2.2	500	11	2.2	1.96	0.04	2.2
		2,500	56	2.2	1.96	0.04	2.2
		5,000	116	2.3	1.95	0.05	2.3
100	1	500	5	1.0	1.98	0.02	1.0
		2,500	25	1.0	1.98	0.02	1.0
		5,000	51	1.0	1.98	0.02	1.0

Regarding photogrammetric methods, there are many stages in the process of taking and analysing photographs that can introduce error. Gordon (2001) suggests that as the equations utilized to calculate the various angles and final distances encompass so many variables, there are many potential sources of error, including: the measuring of distance between points on the photograph; the measuring of the focal length of the lens; or the measuring of the actual camera height. In his discussion, incorrect camera height measurements were identified as the most important potential source of error when using photogrammetric methods. Expanding on how sea conditions may affect the accuracy of measurements, he explains that waves and swell can raise and lower the observer, and the animal being tracked, above and below the waterline introducing error that cannot be measured. However, it was noted that some errors can be measured, such as those in camera height, and that when these errors are expressed as a proportion of camera height, an equal proportional error occurs in range. For example, with a camera height of 10m, a 0.2m error in height will cause a 2% error in range.

A lesser, but still potential, source of error is the refraction of light travelling through the atmosphere (Gordon, 2001). Equation 2 (pg. 29) assumes that light travels in a straight line and does not account for possible bending due to environmental conditions that cause refraction (Kinzey & Gerrodette, 2003). However, the effects of refraction were revealed to be insignificant when the subject of the measurement was relatively close, or the height of the camera was less than 10 meters. Regardless, all these factors influence the accuracy of distance measurements resulting from photogrammetric methods.

In addition to these errors, the use of photogrammetry for tracking cetaceans also has some limitations. One of the main limitations of these methods, identified by Leaper and Gordon (2001), is the need for a clear true, or apparent horizon, i.e., the intersection of the Earth and sky, for an accurate distance measurement. In an attempt to reduce this limitation, it was suggested that a shoreline of known distance could be used as a substitute for the horizon. However, this does not fully overcome the obstacle, as the close proximity of land and/or poor visibility may in some cases obscure the "horizon", rendering tracking impossible. Another horizon-related limitation exists as well. As mentioned, if the photograph is to be used for photogrammetric analysis, both the animal and horizon (or shoreline) must be present. This means that when the animal is within a certain distance of the photographer, depending on the focal length of the lens being used, tracking will not be possible.

2.8.4 Research Utility

Even though these limitations and potential sources of error exist, theodolite tracking and photogrammetric methods have been used successfully in many studies to overcome the challenges associated with collecting data on cetaceans (Bejder et al., 2006; Williams, Bain, Ford & Trites, 2002; Gordon, 1990; Best et al., 1996).

When investigating the short-term behavioural responses of Indo-Pacific bottlenose dolphins to vessel approaches, Bejder et al. (2006) used theodolite tracking to obtain information about the animals' movements and behaviours. Observations were made from an approximate height of 29m which translated into a 10cm height measurement error. The authors reported that such an error in height provided accuracy to within 9m for targets at 2500m, and to within 2m for targets at 500m. Theodolite tracking was used in a similar investigation by Williams, Bain, Ford and Trites (2002), on how vessel approaches affect the behaviour of killer whales. In this study, a measurement error of approximately 3.5% in terms of accuracy and less than 1% in terms of precision was reported. As errors in measurements are proportional to inaccurate theodolite height measurements, Bailey and Lusseau (2004) presented a modified version of the technique provided by Wursig et al. (1991) to calculate the altitude of a theodolite station. Using this technique, they advocate that obtaining required measurements for altitude estimates will be easier and less prone to errors. If this technique is utilized in the future, an increase in the accuracy and precision of theodolite measurements may be observed.

Gordon (2001) conducted three trials to measure the discrepancies between photogrammetric estimates and independent estimates (obtained with a GPS) of distance. He reported a mean discrepancy of 3.4% with a standard deviation of 4.5%, indicating a useful level of precision. Providing useful measurements, he suggests that photogrammetric methods can successfully be utilized in line transect surveys, in behavioural studies, in studies measuring the length of individual animals, and in studies where is it useful to know the distance to which animals are from various objects or activities.

3.0 Research Methods

After a brief analysis of some of the existing worldwide whale watching CoCs and guidelines, it was apparent that certain aspects and characteristics of whale watching are more commonly, or strictly, targeted by such management initiatives. The following three characteristics of whale watching interactions were chosen for investigation: the number of viewing boats, i.e, the number of boats viewing the same animal or pod within 1000m (2009 and 2010) or within 500m (2011); the distance of approach; and the speed of approach. Data utilized in this study was collected from both land based and boat based platforms from 2009-2011.

3.1 Whale Watching Characteristics

A review of whale watching CoCs from the literature revealed that one compilation in particular (Carlson, 2009) was sufficiently comprehensive for analysing the various guidelines found throughout the world. Within whale watching CoCs, guidelines can generally be categorized according to common themes, as Garrod and Fennell (2004) illustrated. Those guidelines concerning the approach of vessels underwent further review to determine which aspects would be investigated in this study. Many characteristics of the approach were repeatedly targeted by the various CoCs, but approach distance and speed were amongst the most commonly mentioned. Also, there exists a vast array of guidelines regarding interactions of whale watching vessels with the animals themselves. Often such guidelines focus upon management of the number of viewing boats within a certain distance. Based on the review of this compilation, it was determined, for the purpose of this study, that data would be collected on the distances related to the approach of the whale watching boats to the animal(s), the speed at which they approach, and the number of boats within a certain distance of the animal(s).

3.2 The Study Area

Skjálfandi Bay (the Bay) is situated in the northeast of Iceland, close to the Arctic Circle near latitude 66° N (Figure 5). The Bay extends for 10km at its base and for 51km at its mouth, between capes. Productivity within the Bay is high, which can likely be linked to the circulation patterns in the area, as well as to the influences of both a freshwater and glacial river flowing into the Bay in the south (Cecchetti, 2006). As a result, many cetacean species spend the summer months feeding in these rich waters. The most common species encountered within Skjálfandi Bay include the migratory minke (*Balaenoptera acutorostrata*) and humpback whales (*Megaptera novaeangliae*), along with the white-beaked dolphin (*Lagenorhynchus albirostris*) and harbour porpoise (*Phocoena phocoena*) which are present year round. Other visitors to the Bay include the blue whale (*Balaenoptera musculus*), the fin whale (*Balaenoptera physalus*), the sei whale (*Balaenoptera borealis*), the orca (*Orcinus orca*), the northern bottlenose whale (*Hyperoodon ampullatus*), and the long finned pilot whale (*Globicephala melas*).

3.3 Land Based Observations

3.3.1 Data Collection

Theodolite model Geodimeter 640 was used to track both animals and boats from the Húsavík lighthouse, situated at approximately 66°3.100´N and 17°21.800´W. Standing at 49m above sea level, the lighthouse overlooks the entire Bay and is, therefore, in good position to capture the interactions between boats and cetaceans. The Lundey lighthouse, seven kilometers north of the Húsavík lighthouse (Figure 9) provided the reference point needed for the calculations mentioned above. Although illustrated in Figure 9, Flatey Island was not used as a reference point in this particular study.

A three person team made observations from the lighthouse every day, weather permitting, throughout the 2009 and 2010 whale watching seasons. On days when the visibility was poor and/or the seas were at a Beaufort Scale of 3 or higher, observations were not conducted from land. If waves were large enough that crests were beginning to break, the sea state was considered to be a 3 on the Beaufort Scale. During the 2009 whale watching season, data collection began on the 5th of June and continued until the 4th of September. The 2010 field season was shorter, with data collection occurring between June 7th and August 8th. On days of data collection, observers rotated between three stations during an 8 hour shift, including: theodolite observer, data recorder, and binocular scanner.

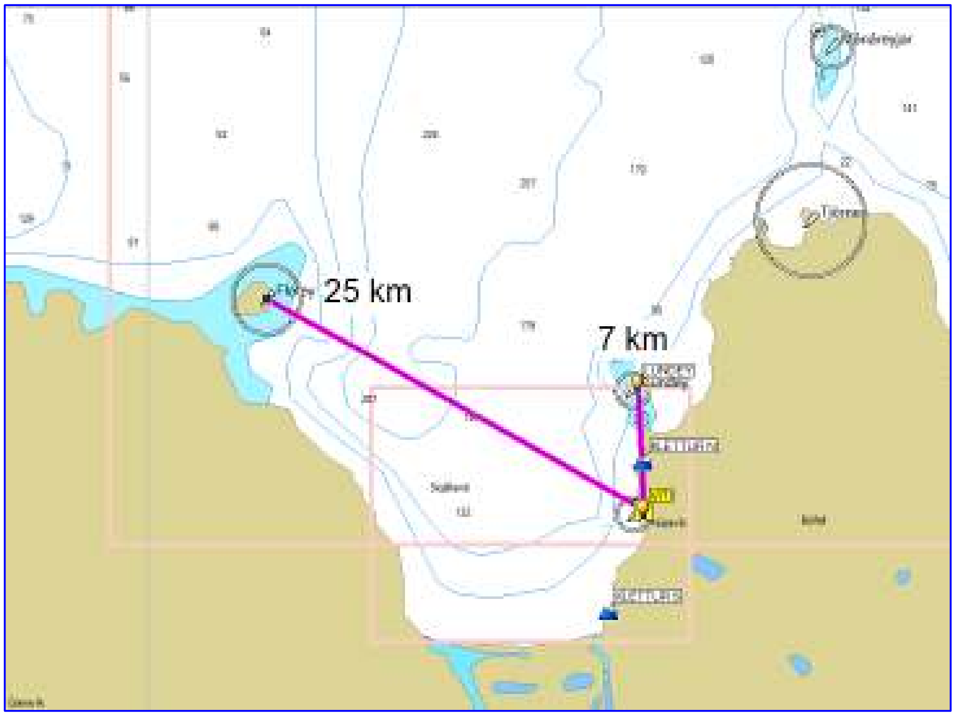

Figure 9. Position and distances between Húsavík lighthouse and reference points, Lundey lighthouse and Flatey Island, used in the land based data collection.

The theodolite observer tracked boat and cetacean movements during encounters, that is, when boats were actively involved in whale watching activities. Each encounter was tracked as long as possible, however, if the animal(s) involved dove for more than five minutes it was challenging for the observer to determine if the same animal resurfaced. In this situation a new track was started. If a pod of animals was being tracked, the theodolite observer would track a point in the center of the group. The theodolite observer tracked, as best as possible, every boat involved in an encounter with an animal or group of animals.

A laptop running Cyclops Tracker Version 1.3.1 was connected to the theodolite. Tracked points automatically were logged on the screen and saved. Upon receiving verbal information from the theodolite observer, the data recorder would edit each registered track point to identify what object was being tracked. The software then calculated the tracks of individual animals, pods and boats allowing for certain details of the encounter to be measured, such as the distance between tracked subjects and the direction and speed of movements. Thus, these methods allow for continuous, real-time data collection.

While the theodolite observer and data recorder were occupied tracking a particular encounter, the third member of the team was constantly scanning the Bay with binoculars. This observer would point out other encounters between boats and cetaceans occurring on the Bay. If the theodolite observer was not occupied with the theodolite, he or she would help with the binocular scans as well. In this case, one person would scan the inner section of the Bay while the other would scan the outer section.

3.3.2 Data Analysis

As briefly mentioned above, when tracking an animal or boat, the Cyclops Tracker program automatically calculates various factors including: speed, course, re-orientation, bearing, linearity, and distance of the object from the observer. For each tracked cetacean, the program also reports what vessels were nearby, within three minutes from the time the animal was tracked, and once again calculates these variables for each vessel, based on the information received from the theodolite. Upon review of the database, every tracked encounter that involved a vessel within 1000m of an animal, or group of animals, was exported to Excel. Once the data was organized in Excel, it was possible to analyse the distance track of each boat to determine whether or not it was approaching or departing the area with the animal(s). Departing boats were only included in the data analysis if they were within 300m, while approaching boats were included up to 1000m from the target of the whale watching activities.

To report on the number of boats viewing the same animal or pod, a couple of analyses were conducted. The average number of boats within 1000m of an animal or pod was plotted for each month, along with standard error bars. In order to determine the standard error, the standard deviation first had to be calculated for each month. The standard deviation of a sample or dataset is the square root of its variance, i.e., the difference between each number in the sample and the sample mean. Dividing the standard deviation by the square root of the sample size will reveal the standard error, which helps to indicate how much variation exists amongst the data. As the average number of viewing boats was plotted for each month, the standard error bars allow the reader to realize the range in the number of viewing boats for that month, without such information actually being stated. The percentage of tracked encounters involving one, two, three, or four boats within 1000m of an animal was also computed for each year. Additionally, the data was reviewed to determine how often two or more boats were viewing the same animal or pod from within 300m.

When assessing the distance to which boats approach the animal(s), observations reported are based on data collected from the time tracking commenced until the boat's closest approach. Thus, an approaching boat had many recorded distances of approach. The distances were then analysed separately, each year, for the humpback whale, minke whale, and white-beaked dolphin. Data was placed into the following categories: 0-50 meters; 50-100 meters; 100-300 meters; 300-1000 meters. These categories were chosen with the hopes that they would later enable a more efficient and convenient comparison between the results and various guidelines. The lower limit of each category, in reality, is the number stated plus 0.1. A distance of 50m would thus be placed in the 0-50m category, while a distance of 50.1m would be the first value appearing in the 50-100m category. Pie charts were created to illustrate, for each species, what percent of the encounters occurred from these various distances. The closest approach distances to each species were also tabulated.

The data utilized to investigate the speed at which boats approached the animal(s) was not considered separately for each species, but was categorized according to distance. The same distance categories were used as in the approach distance analyses. Within each distance category the data was grouped according to speed, as follows: 0-5 km/hr; 5-10 km/hr; 10-15 km/hr; and 15-20 km/hr. Again, the same rule was followed for grouping speeds as was used for the distance data. A speed of 10km/hr was placed in the 5-10km/hr category, while 10.1km/hr was placed in the subsequent category. A graph was then created for each distance category to show what percentage of the boats, at that particular distance, were travelling within the above speed ranges. The minimum and maximum speeds recorded for each distance category over the three seasons were also reported.

3.4 Boat Based Observations

3.4.1 Data Collection

During the 2011 whale watching season, a two person team collected data from boats belonging to the North Sailing and Gentle Giants fleet. Starting on August 6th, data collection occurred on at least one three hour trip daily, until September 1st. Once again, data collection was dependent on the weather. If conditions at sea were unfavourable for data collection, i.e., a Beaufort Scale of 3 or higher and/or poor visibility, boat based observations did not occur. On occasion, data collection was carried out on more than one trip a day to make up for the days when poor weather conditions prevented the collection of data.

At the beginning of each trip, one person was designated photographer while the other was deemed responsible for recording and handling the GPS. Data was collected only when the boat was engaged in whale watching activities. Whether or not the boat was 'whale watching' was up to the discretion of the data collectors. Generally, if the boat was approaching or in pursuit of an animal, or group of animals, it was determined to be actively whale watching.

When an animal surfaced the photographer took a picture and estimated the distance from the animal to other nearby boats. The photographer then reported the photo number, along with how many boats were within approximately 500m of the animal being tracked. If more than one animal was present in the photo, the photographer specified which animal was being tracked or indicated if group tracking was taking place. This information was recorded, along with what species was being tracked. The photographer also relayed information regarding any interesting behaviour, of either the animal or boat (including other near-by boats) to the recorder. Behaviours reported often included the direction of movements, the positioning of boats, and the surface behaviours of whales. Additionally, the speed at which the boat was travelling at the time the photograph was taken was observed on the GPS and recorded. The name of the Captain was also noted for each trip to ensure that the data utilized in this study was not based on the whale watching activities characteristic of a select few. In an attempt to accurately represent the whale watching activities occurring on the Bay, trips used for data collection were chosen in such a manner that minimized this risk, as best as possible. The data sheet utilized is shown in Appendix A. Each photograph represented a separate track.

As photogrammetric methods were utilized for the boat based observations, data collection was only possible once the photographer was confident that both the animal(s) and true horizon were detectable in the photo. It was often impossible to capture both the surfacing animal and the true horizon due to the positioning of the boat and the surrounding landscape. To overcome this issue, a shoreline was considered to be a true horizon if it was at a distance equal to or greater than that of the true horizon. The distance of the true horizon was dependent on the height of the observer and, therefore, it varied slightly with the boat. The following formula was used to calculate the distance of the true horizon:

$$\sqrt{2ReH + H^2}$$

Where:
Re = radius of the earth (6,371 kms)
H = height of observer above sea level (kms)

The distance of the true horizon was recorded on the data sheet for each data collection trip. If a photograph was taken with shoreline as the horizon, a waypoint was made with the GPS to mark the location where the photograph was taken. It was also impossible to capture both the horizon and animal in the photograph at times when the boat was within a certain distance of the animal. These instances were recorded, along with the estimated distance.

The height of the observer was also required for the photogrammetric analyses of the photographs. To determine this height, the photographer's height was measured and added to the height of the observation platform above sea level. The height of the observation platform on the boat was measured through a series of steps. First, one person stood on the platform and held out 1 meter of measuring tape, while the other person on land took a photo of the subject. It was crucial for the feet of the subject to be visible in the photo, along with the waterline. Secondly, the photo was uploaded in Paint.NET v3.5.8, where a pixel count allowed for the determination of the height (in meters) of the data collection platform from the waterline.

3.4.2 Data Analysis

Photogrammetric analyses of the photographs were completed using methods similar to those utilized for determining the height of the observation platform. The photograph of each track was uploaded into Paint.NET v3.5.8, where the number of pixels from the horizon down to waterline of the surfacing animal was counted (Figure 10). If photographs were taken during group tracking, the pixel count was between the horizon and some point in the middle of the group. As mentioned above, the true horizon was often obscured by land in the photographs. The waypoints from the GPS, marking such situations, were opened in Google Earth™. The distance of the shoreline in question, from the area of data collection, could then be measured. If the distance was less than the distance of the true horizon for that particular trip, the corresponding track was not utilized in the analyses.

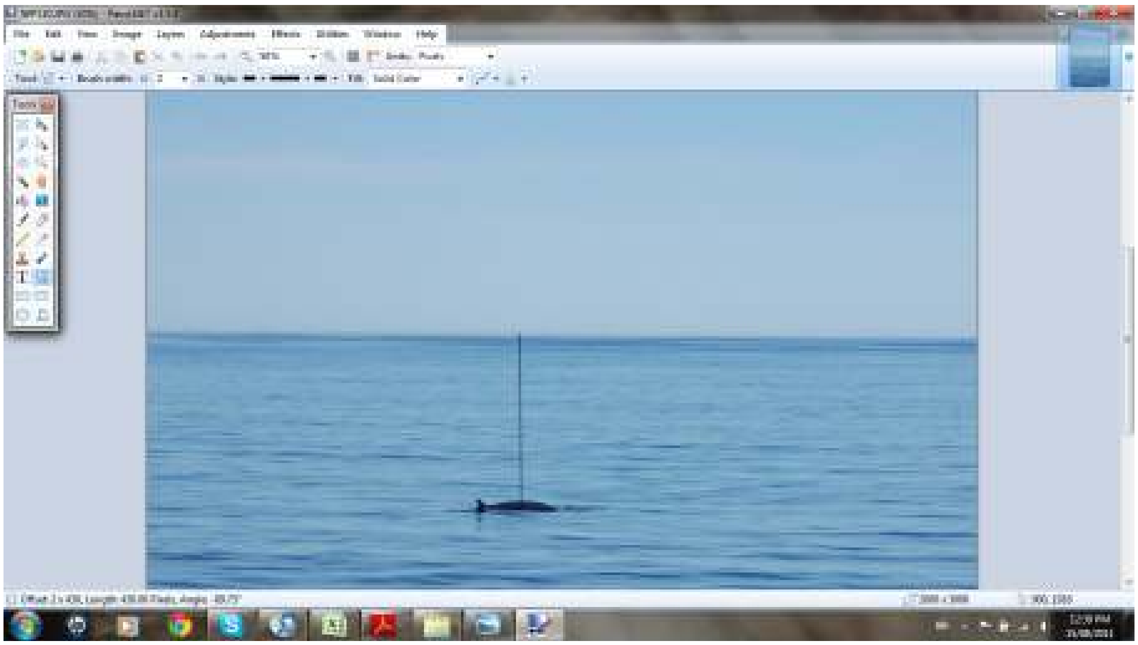

Figure 10. The pixel count performed in Paint. NET (v3.5.8) required for the distance estimation when using photogrammetric methods.

An Excel spreadsheet containing the proper trigonometric equation formulae, along with the required camera specifications, was then used to compute the distances of the animal(s) from the observer (Figure 11). Distances were automatically calculated for each track, once the pixel count of the corresponding photo was entered into the spreadsheet. Due to an unforeseen issue with the calculations, likely related to the camera height measurements, the distances computed by the spreadsheet were far greater than the estimated distances recorded in the field. Therefore, it was necessary to add a correction factor to the distance calculation. To determine the correction factor, photos were taken of another boat at sea using the same methods used for data collection. At the time when the photo was taken, GPS waypoints were created to mark the actual position of both boats on the water. The real distance between the boats was then measured between the waypoints in Google Earth™ , whereas the estimated distance was computed by the spreadsheet once photogrammetric analyses were complete. In the statistical program, the R Project v2.13.0, the real and estimated distances were plotted against each other. Through trial and error, correction factors were added until the regression line had a slope of 1 and intercept of 0. The appropriate correction factor was then applied to the distance calculation in the spreadsheet.

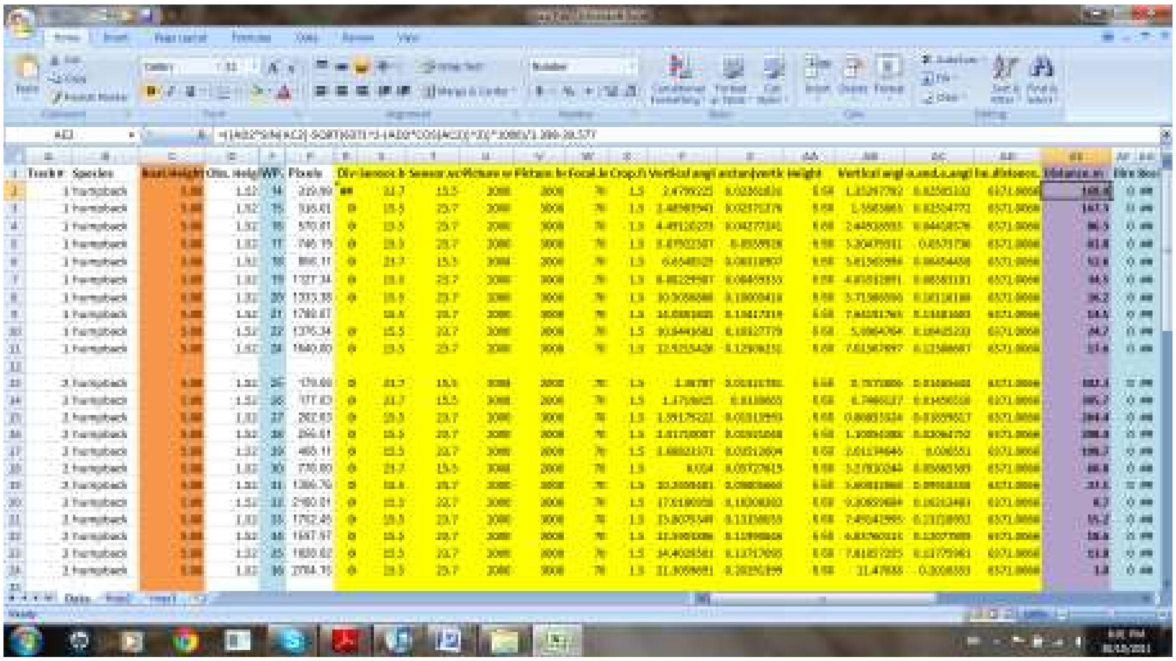

Figure 11. Snapshot of the Excel spreadsheet utilized to calculate the distance between the whale watching boat and the tracked animal, using photogrammetric methods.

Data analyses, similar to those performed on the 2009 and 2010 data, were then carried out on the 2011 data. There were some differences between certain analyses, however. When assessing the number of viewing boats on the same animal or pod, in 2009 and 2010 boats within 1000m were included in the count, whereas in 2011 boats within 500m were counted. Also, instead of determining how often two or three boats were viewing the same animal from within 300m, as was done in 2009 and 2010, the number of tracking sessions in 2011 were reported where two or three boats were within 100m. The latter analyses only involved humpback data, while the 2009 and 2010 analysis was carried out on humpback, minke and dolphin data.

Unlike in 2009 and 2010, the 2011 data collection involved recording comments on whale and boat behaviour, making it possible to determine if the boat was approaching the animal(s) or vice versa. As a result, a few additional analyses were conducted on the humpback distance of approach data from the 2011 season. In addition to reporting the percentage of encounters involving boats from 0-50m, 50-100m, 100-300m and 300-1000m, the approaches within 50m were analysed further. This analysis showed how often boats approached to a distance of 0-5m, 5-10m, 10-20m, or 20-50m. The data was then reviewed to determine what percent of the tracks within 50m resulted from the animal surfacing near the boat, or approaching the boat itself, rather than the whale watching boat approaching the animal(s).

Due to the different methodology utilized for data collection during the 2011 season, it was impossible to track animals that were approached within a certain distance, as capturing both the horizon and animal in the photograph then became too difficult. Therefore, although the closest approaches were reported for each species, the boats did occasionally get closer than those reported distances. The number of tracking sessions where this was the case was also determined for 2011.

Upon completion of the data analysis, the results from both the land and boat based observations were compared to the number of viewing boats, distance of approaches, and speed of approaches advocated by the various guidelines found throughout the world. As Skjálfandi Bay is a feeding ground for some cetacean species, guidelines specific to whale watching operations occurring in higher latitude feeding grounds were then reviewed separately to determine the differences in, what might be, acceptable or appropriate whale watching behaviour.

4.0 Results

4.1 Effort

The 2009 data collection season began on June 5th and ended on September 4th. In total, 19 days of tracking were utilized in this study from the 2009 season. In 2010, 26 days of tracking occurred between June 6th and August 30th while in 2011, data collection commenced on August 6th and finished on September 1st resulting in 21 days of data collection. These results, including the number of hours of tracking, are summarized in Table 8. The number of hours represents the cumulative amount of time between the first and last track of each tracking session.

Table 8. The amount of tracking conducted in each of the three data collection season.

Year	Dates	Number of days of tracking	Number of hours of tracking
2009	5 June - 4 September	19	8.8
2010	6 June - 30 August	26	5.6
2011	6 August - 1 September	21	4.8
Total		**68**	**19.2**

Figure 12 illustrates the percentage of tracking sessions that occurred for each tracked species over the three years of data collection. As tracking sessions were largely dominated by minke whales, humpback whales and white beaked dolphins, the remainder of the data analyses were conducted on data relevant to these three species. The total number of tracking sessions for the minke, humpback, and white beaked dolphin are shown in Table 9. A tracking session consists of many individual tracks, as in one session a particular animal or group was tracked until it either dove or the whale watching boat moved on. The total number of utilized tracks, per species, is shown in Table 10. The majority of the tracking data involved minke whales, in 2009 and 2010, but in 2011 the humpback whale was most often the target of the tracking efforts.

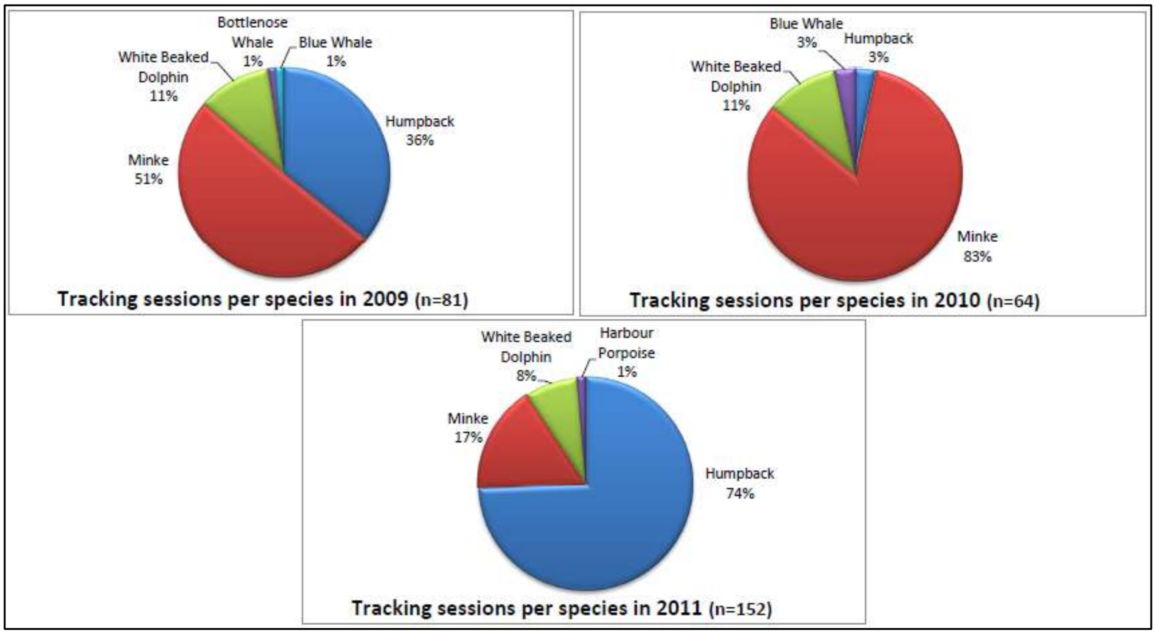

Figure 12. Tracked species and the corresponding percentage of tracking sessions conducted in 2009, 2010, and 2011.

Table 9. The number of tracking sessions involving the humpback whale, the minke whale, and the white-beaked dolphin, throughout the course of the study.

Year	Humpback	Minke	White Beaked Dolphin	**TOTAL**
2009	29	41	9	**79**
2010	2	53	7	**62**
2011	113	25	12	**150**
Total	**144**	**119**	**28**	**291**

Table 10. The number of tracks resulting from the humpback whale, the minke whale, and the white-beaked dolphin tracking sessions.

Year	Humpback	Minke	White Beaked Dolphin	**TOTAL**
2009	153	259	63	**475**
2010	10	311	100	**421**
2011	754	133	113	**1000**
Total	**917**	**703**	**276**	**1896**

4.2 Approach Density

The average number of boats involved in viewing a particular animal or pod at the same time is illustrated on a monthly basis in Figure 13. July of 2009 showed the greatest boat pressure with a monthly average of 1.95 boats accompanying the same animal or pod. The highest standard error value was also observed for this month, at 0.134. This means that between all the months, the greatest amount of dispersion amongst the data from the monthly average occurred in July. In this month there were tracks that captured encounters involving three or four boats, as well.

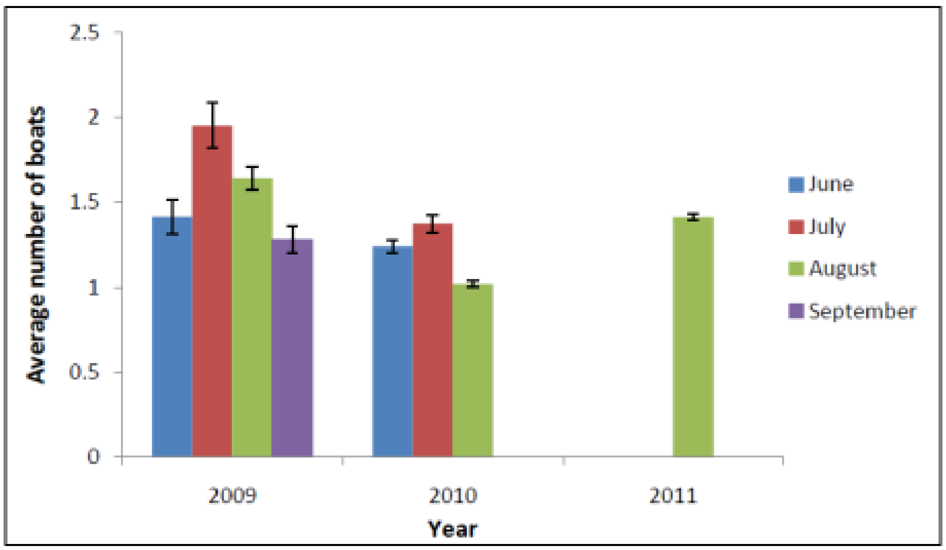

Figure 13. The monthly average number of whale watching boats viewing the same animal or pod (within 1000m in 2009 and 2010, within 500m in 2011), along with standard error bars.

The percentage of tracks where one, two, three, or four boats were viewing the same animal, or pod, are shown for each of the three years in Figure 14. The majority of the time there was only one boat viewing the animal being tracked: 58% of the tracks in 2009; 78% of the tracks in 2010; and 57% of the tracks in 2011. An increase was observed, from 2009 (28%) and 2010 (19%) to 2011 (41%), in the percentage of tracks involving 2 boats. In 2011 the fewest number of tracks were observed involving three boats, and there were no tracks showing four boats around the same animal or pod.

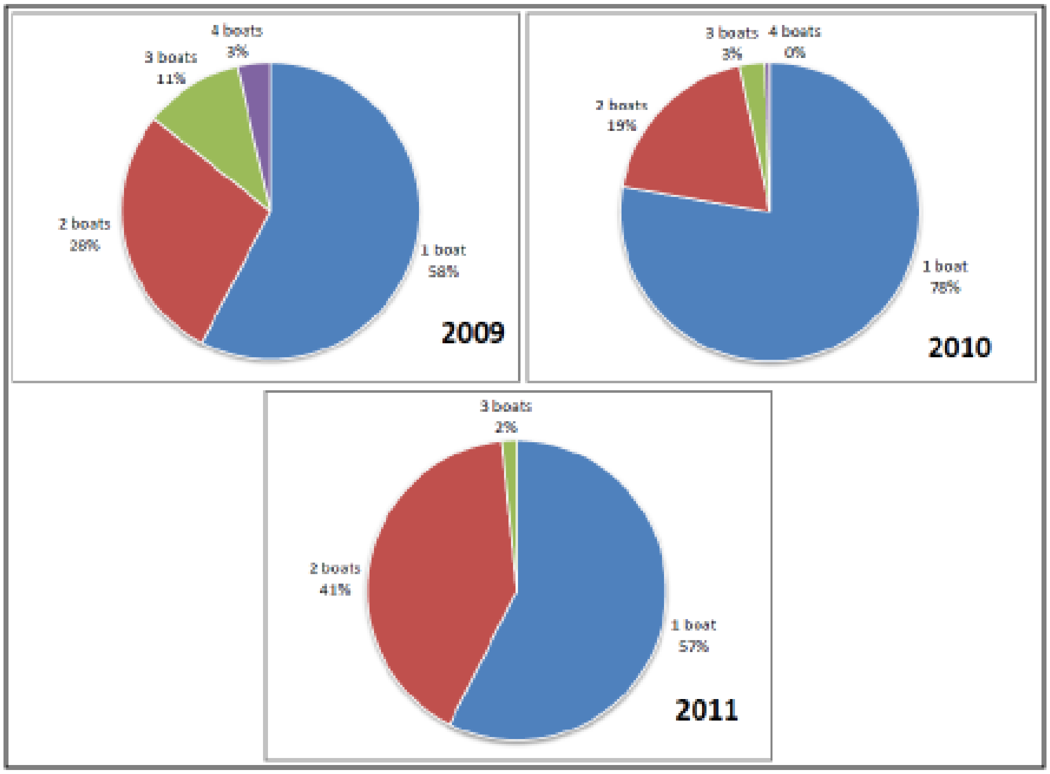

Figure 14. Percentage of tracks where one, two, three, or four whale watching boats were viewing the same animal or pod (within 1000m in 2009 and 2010, within 500m in 2011).

Table 11 summarizes the number of tracks where two or three boats were within 300m, 200m, and 100m of a particular animal or pod, from the 2009 and 2010 data. Few tracks, a total of six, show that three boats were viewing the same humpback from within 300m over the two years. The number of tracks that reveal two boats were viewing the same humpback from within 300m is more numerous, at a total of 20. Similarly for the minke whale, fewer tracks (20) revealed three boats within 300m of the same animal than two boats (47). In 2011, 24 of the humpback tracking sessions involved 2 boats within 100m.

Table 11. Summary of whale watching boat counts from 2009 and 2010 involving two or more viewing boats within 300m of an animal or pod.

	3 boats:			2 boats:		
	200-300m	100-199m	<100m	200-300m	100-199m	<100m
# of humpback tracks	3	2	1	11	6	3
# of minke tracks	6	11	3	12	25	10
# of dolphin tracks	-	-	-	-	1	2

4.3 Distance of Approach

The distance to which the boats approached the animal(s) in 2009 is illustrated, separately for each species, in Figure 15. The tracks reveal boats most commonly approached between 300-1000m. Figure 16 shows that in 2010, most of the approach data consisted of boats between 100-300m for the humpback whale and white beaked dolphin. As for the minke whale, the percentage of tracks involving boats from within the various approach distances was quite even: 23% within 50m; 21% between 50-100m; 27% between 100-300m; and 29% between 300-1000m. In 2011, the greatest percent of boat approaches towards humpback whales were within 50m, 100-300m for minke whales, and 50-100m for white beaked dolphins (Figure 17). Of the 39% of approaches occurring within 50m of a humpback whale, 12.6% of these approaches resulted from the whale either surfacing near the boat or approaching the boat itself. The 2011 humpback approach distances within 50m are reported in Figure 18, which shows that most of these approaches (60%) occurred from 20-50m. Humpback whales were approached to within 10m on 24% of the total humpback tracking sessions in 2011.

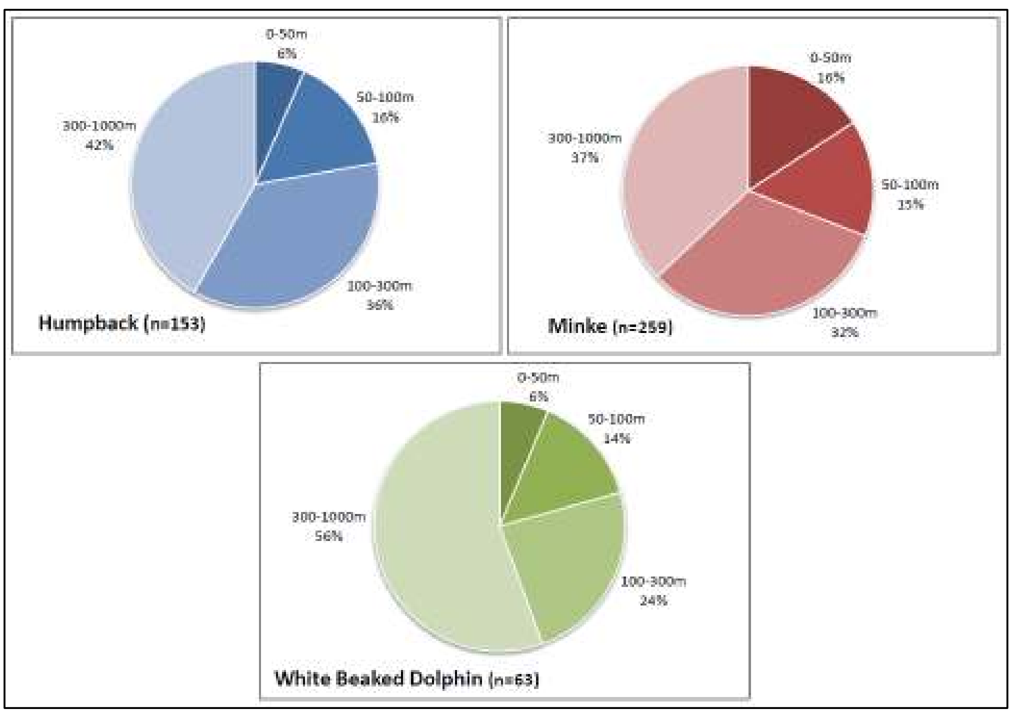

Figure 15. Percentage of whale watching boat approaches, in 2009, within various distances of the animal(s) being viewed.

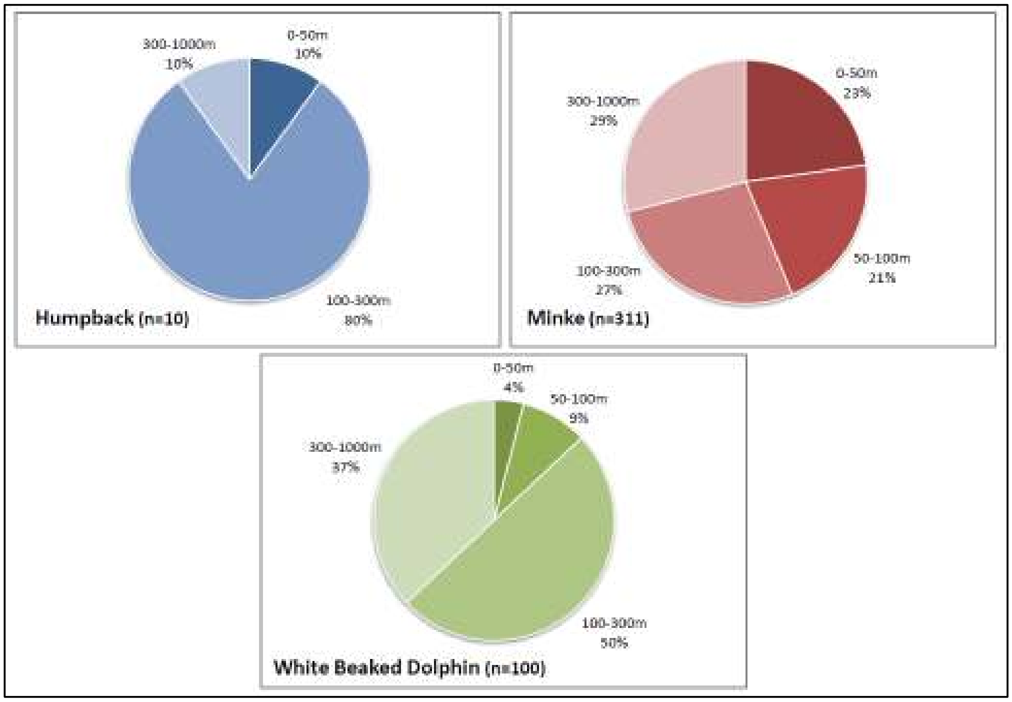

Figure 16. Percentage of whale watching boat approaches, in 2010, within various distances of the animal(s) being viewed.

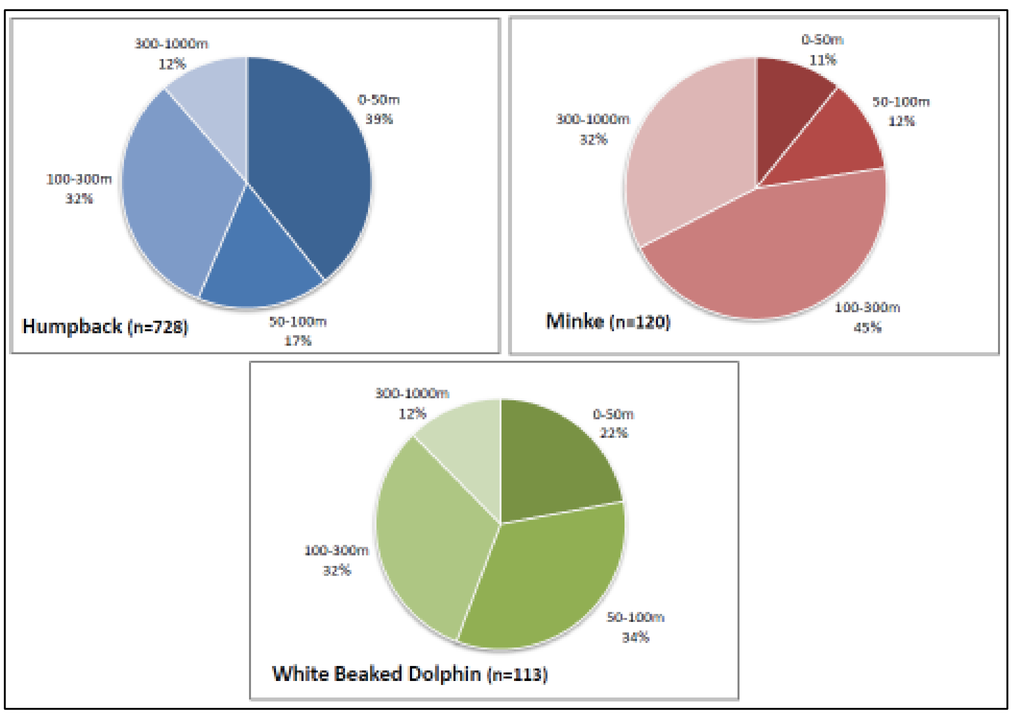

Figure 17. Percentage of whale watching boat approaches, in 2011, within various distances of the animal(s) being viewed.

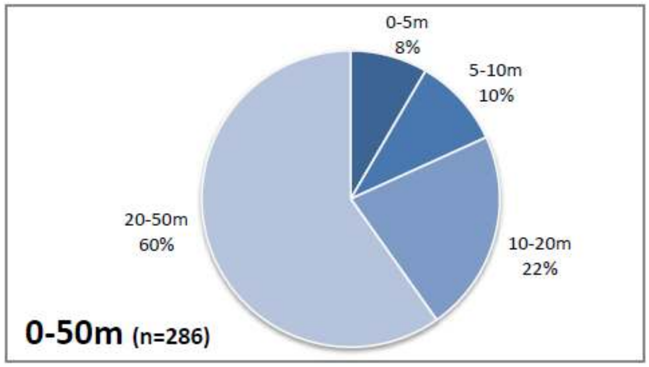

Figure 18. Whale watching boat approaches within 50m of humpback whales in 2011.

The distances of approach for the humpback whale over the three years are summarized in Figure 19a, while Figure 19b summarizes the same data for the minke whale.

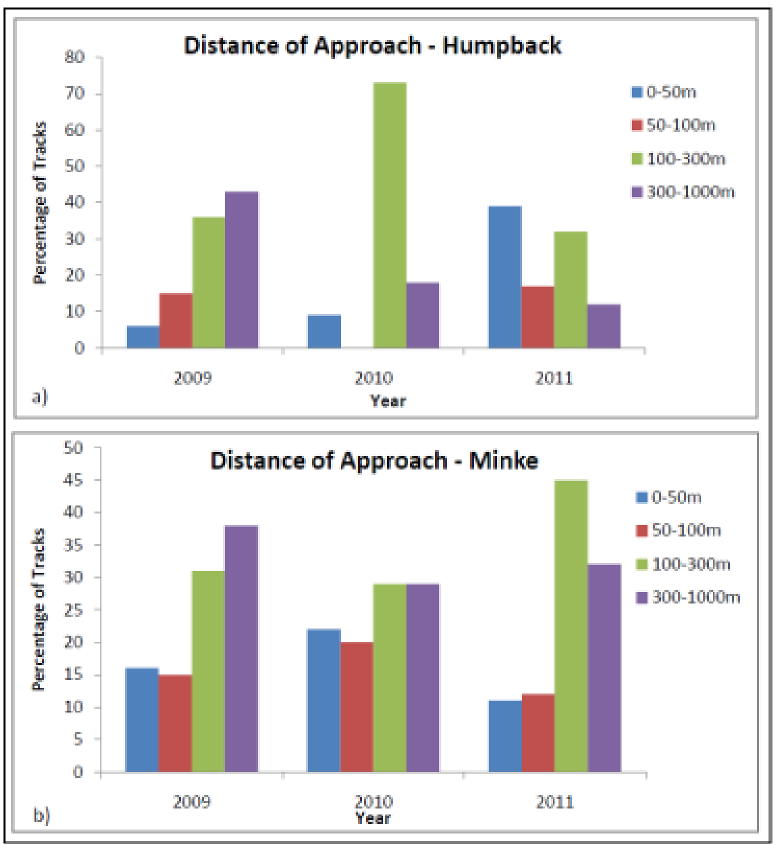

Figure 19. Distance of approach towards humpback (a) and minke (b) whales over the three data collection seasons.

The closest approach distances are illustrated in Table 12. The humpback whale and white beaked dolphin were approached the closest in 2011 to the respective distances of 4m and 5.7m. The closest approach to the minke whale occurred in 2010 at 4m. As discussed earlier, due to the methodologies used in 2011, taking pictures successfully for tracking was sometimes impossible due to the proximity of the boat to the animal. These instances, where the boat was within 4m of the animal, are summarized in Table 13.

Table 12. Closest whale watching boat approaches (in meters) according to the collected data.

Year	Humpback	Minke	White Beaked Dolphin
2009	10	8	27
2010	48	4	21
2011	4	6.5	5.7

Table 13. Occurrences when the whale watching boat was too close to the animal for tracking, due to the limitations of photogrammetric methods.

2011	# of Sessions
Humpback	10
Minke	1
White Beaked Dolphin	1

4.4 Speed of Approach

Figure 20 presents the breakdown of boat speed within 50m for all three data collection seasons. In 2009, 66% of boats within 50m of the animal(s) travelled between 5-10km/hr. In 2010 the majority (58%) of boats at this distance from the animal(s) travelled slower, between 0-5km/hr. Similar to 2009, the most commonly observed speed within 50m in 2011 was between 5-10km/hr, with 61% of boats travelling in this speed category. The speed range for each year within 50m is shown in Table 14.

The speed at which boats travelled when 50-100m from the animal(s) is illustrated in Figure 21. A great reduction was observed in the percentage of boats travelling slowly in 2011 with a corresponding increase in the number of boats travelling quickly. While 39% and 47% of boats travelled 0-5km/hr when within 50-100m in 2009 and 2010, respectively, only 10% of boats were observed at these speeds in 2011. Meanwhile, 34% of boats in 2011 had recorded speeds of 10-15km/hr, while in 2009 only 11% of boats travelled within this speed range and in 2010 only 5% of boats. A fourth, and quicker speed range, was observed in 2011 as 3% of tracks reported boats travelling between 15-20km/hr. Table 15 summarizes the minimum and maximum speeds observed for boats within 50-100m of the animal(s).

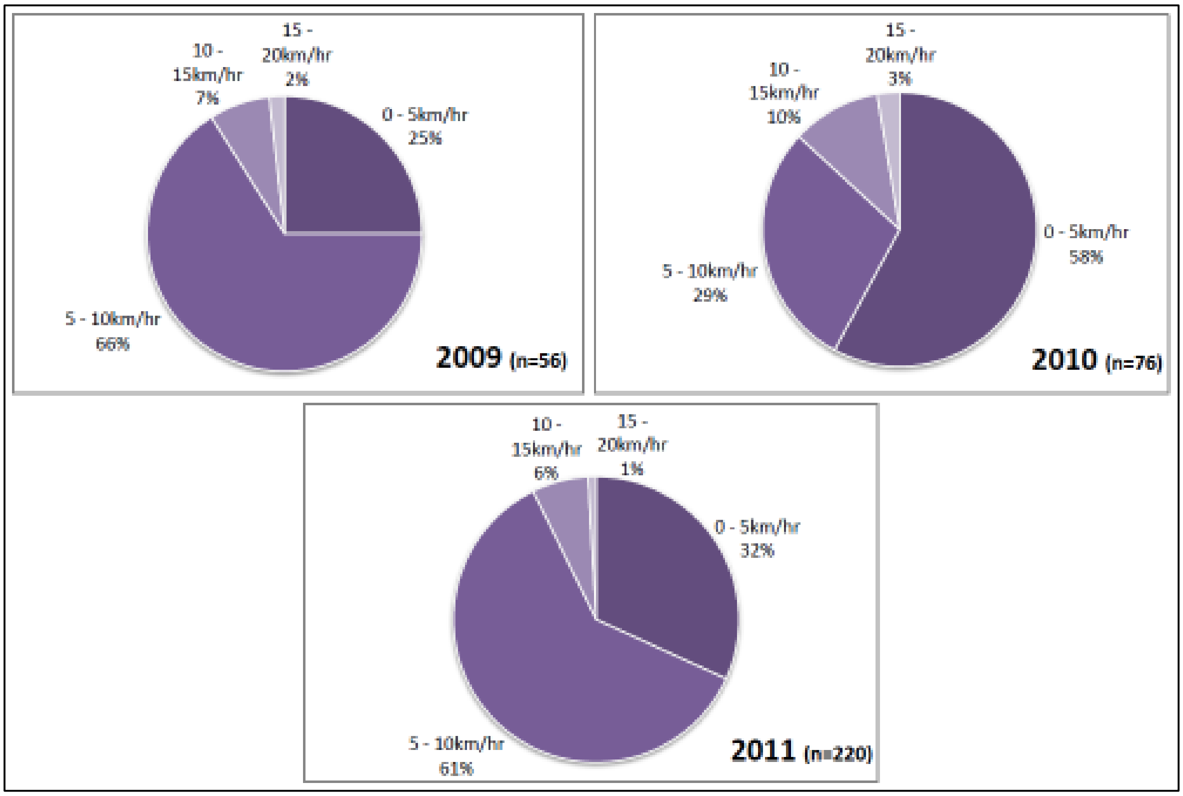

Figure 20. Breakdown of whale watching boat approaches occurring at various speeds within 50m of the animal or pod.

Table 14. Speed ranges of whale watching boats approaching within 50m of the animal or pod.

Year	Speed range (km/hr)	Average speed (km/hr)
2009	0.6-17.1	6.8
2010	0.6-16.4	5.6
2011	2.1-16.3	6.3

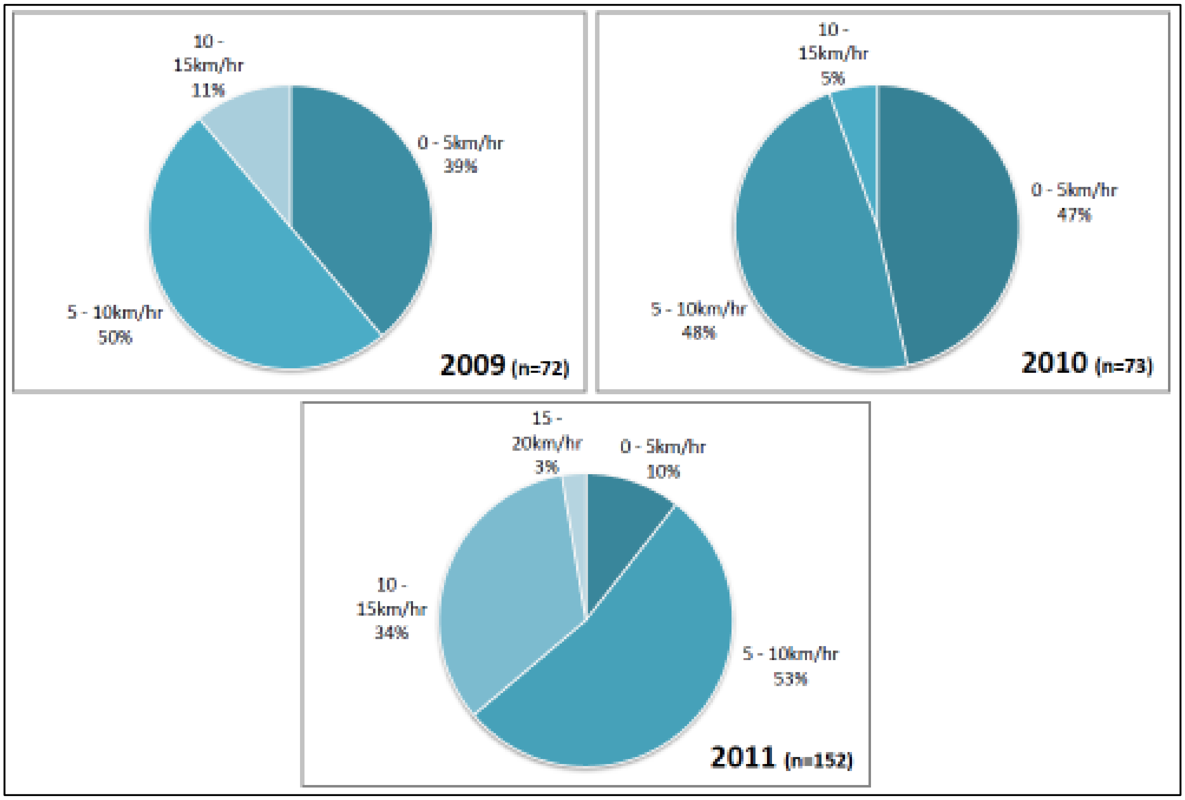

Figure 21. Breakdown of whale watching boat approaches occurring at various speeds within 50-100m of the animal or pod.

Table 15. Speed ranges of whale watching boats approaching within 50-100m of the animal or pod.

Year	Speed range (km/hr)	Average speed (km/hr)
2009	1.5-12.3	6.1
2010	0.8-13.3	5.3
2011	2.9-16	9.2

The speed of boat travel within 100-300m of the animal(s) increased noticeably in 2011 (Figure 22). Up from 10% in 2009 and 14% in 2010, 47% of the boats in 2011 were observed travelling between 10-15km/hr. There was also a noticeable increase in the number of boats travelling from 15-20km/hr as 4% of boats travelled within this speed range in both 2009 and 2010, while 27% of boats were observed within this speed range in 2011. In 2009, the number of boats travelling 10km/hr or less made up 86% of the total observations. This number went down slightly to 82% in 2010, but in 2011 only 26% of the tracks for boats within 100-300m of the animal(s) reported a speed of 10km/hr or less. The speed ranges for the 100-300m distance category are shown in Table 16.

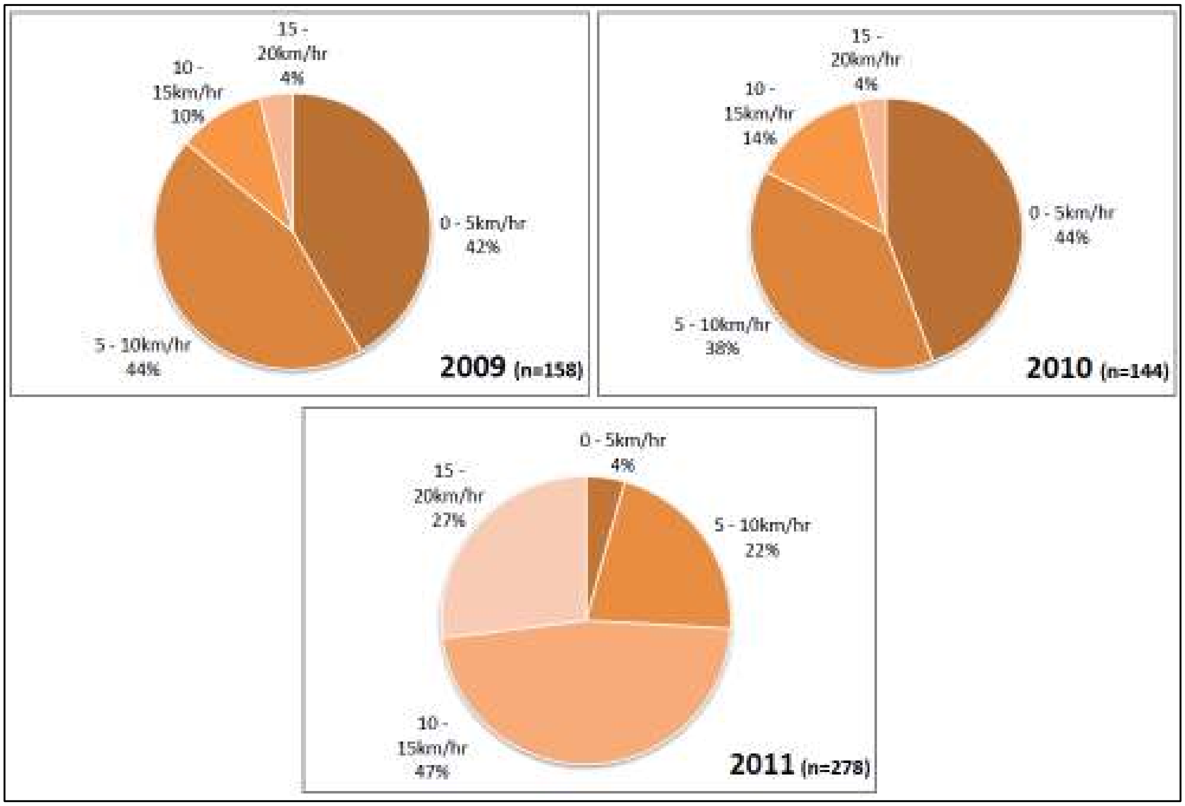

Figure 22. Breakdown of whale watching boat approaches occurring at various speeds within 100-300m of the animal or pod.

Table 16. Speed ranges of whale watching boats approaching within 100-300m of the animal or pod.

Year	Speed range (km/hr)	Average speed (km/hr)
2009	0.6-17.1	6.7
2010	0.2-19.1	6.3
2011	2-18.2	12.4

During data collection in 2011, there were times when the boat was travelling too slowly for the GPS to report an accurate speed. These times included when the boat was idling. Table 17 summarizes the number of tracks within 50m of a humpback that had a reported speed of “NA”. It should also be noted that three of the tracks within 50m of a humpback occurred with engines turned off. Although speeds of NA at close range mainly occurred with humpback encounters, on one occasion engines were also turned off within 10m of a minke whale.

Table 17. Tracks within 50m of a humpback, in 2011, where the whale watching boat was travelling at a speed of 'NA', i.e, travelling less than 2km/hr or idling with engines in neutral.

	0-5m	5-10m	10-20m	20-50m
No. of tracks	24	28	63	171
Tracks with speed NA	12	13	19	51
Percentage with speed NA	50	46	30	30

5.0 Discussion

5.1 Approach Density

The months with greatest approach density, according to the results, were July of 2009 and September of 2011. In these months, animals being viewed were accompanied by an average of 1.95 and 2.07 boats respectively. However, it should be taken into consideration that the September, 2011 data was collected in just one day. The sample size for this data is, therefore, much smaller than those for the other months and does not report a reliable monthly average. After excluding the September 2011 data point, the greatest approach density, that is the number of vessels viewing the same animal or pod, was observed in the month of July, in 2009.

There were important differences between the methodologies of the 2009/2010 data collection seasons and the 2011 season, which influenced the approach density data. During the 2009 and 2010 seasons, all boats within 1000m of an animal, or pod, were included in the boat count, whereas in the 2011 season, only boats considered to be actively watching the animal(s) were included in the count. If all boats within 1000m were included in the count in the 2011 season, there may have been a greater number of encounters involving more boats. Also, the timing of the 2011 data collection season reduced the likelihood of capturing encounters involving more than two boats. As data collection was only carried out through the month of August, the busiest whale watching month was not included in the data collection. At the beginning of August one of the North Sailing schooners was docked, in preparation for an expedition, and the other North Sailing schooner ended its tours in the middle of the month. Without the schooners on the water, it was much less likely that there would have been three or more boats viewing the same animal, or pod, due to the way the remaining tours were scheduled.

The scheduling of tours and the number of boats comprising the Gentle Giants and North Sailing whale watching fleets are operational issues that affect the density approach data of each year, as they limit the number of boats available to be whale watching at the same time. In all three years, scheduled tours were approximately three hours from the time of departure until return but there was some variation in the number of trips per day, from one season to the next, during the peak season. The whale watching fleet of North Sailing was consistently larger than that of the Gentle Giants fleet (Table 18, Figures 23-24) and, as a result, North Sailing was able to offer the greater number of daily trips each year. The extent of scheduling variation over the three years is not known for the Gentle Giants tours but some of this variation is illustrated in Table 19 for the North Sailing tours. The 2011 whale watching tour schedules for both Gentle Giants and North Sailing are shown in Table 20. Despite schedule and fleet changes, the maximum number of North Sailing boats observed on the water at the same time, over the three years, was three. This occurred for 4.5 and 6 hours per day from July 1st to August 10th in 2009 and 2010, respectively, while in 2011 it occurred in the following situations: for 3 hours per day in the month of June; for 6.5 hours per day from July 1st to August 10th; and for 3.5 hours per day from August 11th to August 20th. During this same period, the maximum number of Gentle Giants boats observed on the water at any given time was two. This occurred in 2011 for 3 hours per day throughout the month of June and approximately 6 hours per day from July 1st to August 31st. As only two Gentle Giants whale watching boats were in operation in 2009 and 2010, the amount of time where two boats were on the water was likely much shorter. Thus, in total, it was possible for five whale watching boats to be operating on the Bay, simultaneously, during the three data collection seasons. However, the amount of time possible for these boats to overlap the viewing of the same animal or pod was often much less than that stated above, due to the required travelling times to and from the viewing areas.

Table 18. The number of boats comprising the whale watching fleets operating on Skjálfandi Bay during periods of data collection.

Year	No. of Gentle Giants boats	No. of North Sailing boats
2009	2	4
2010	2	4 / 5*
2011	3	5

* 4 boats were in operation until June 20th, when one was docked due to engine problems. Towards the end of the summer, 2 boats were added to the fleet.

Top Left: Bjössi Sör (56 PAX, 16.4m, 30GT)
Top Right: Knörrinn (46 PAX, 15.2m, 20GT)
Middle Left: Náttfari (90 PAX, 23m, 57GT)
Middle Right: Garðar (146 PAX, 28m, 109GT)
Bottom: Schooner Hildur (50 PAX, 26m, 35GT) and Schooner Haukur (46 PAX, 21.5m, 20GT)

Figure 23. The 2011 North Sailing whale watching fleet. PAX = passengers, GT = gross tonnage (Photo credit: Sara Martin and North Sailing).

Top Left: Sylvía (60 PAX, 17.5m, 30GT)
Right: Faldur (45 PAX, 14.5m, 26GT)
Bottom Left: Amma Sigga (18 PAX, 11.5m)

Figure 24. The 2011 Gentle Giants whale watching fleet. PAX = passengers, GT = gross tonnage (Photo credit: Sara Martin and Gentle Giants).

Table 19. Variation in the 2009 and 2010 North Sailing whale watching tour schedules.

April 15th – April 30th *	May 1st – May 31st	June 1st – June 30th	July 1st – August 10th	August 11th – Sept 5th	Sept 6th – Sept 30th	Oct 1st – Oct 30th
			0830			
			0900	0900		
	1000	1000	1000	1000	1000	1000
		1200	1200	1200		
			1230**			
1330	1330	1330	1330	1330	1330	
			1530	1530***		
		1700	1700	1700		
		2015	2015			

* April 10th – April 30th in 2010
** 1230 trip in 2009, 1300 trip in 2010
*** 1530 trip added in 2010, until August 25th

Table 20. The 2011 whale watching tour schedules for North Sailing (a) and Gentle Giants (b).

April 1 – April 30	May 1 – May 14	May15 - May 31	June 1 – June 30	July 1 – Aug 10	Aug 11 – Aug 20	Aug 21 – Aug 31	Sept 1 – Sept 5	Sept 6 – Sept 30	Oct 1 – Oct 20
				0850	0850	0850	0850		
		0930	0930	0930	0930				
	1000	1000	1000	1000	1000	1000	1000	1000	1000
			1200	1200	1200	1200	1200		
				1300					
1330	1330	1330	1330	1330	1330	1330	1330	1330	
				1530	1530	1530			
			1630	1630	1630				
			1700	1700	1700	1700			
a)			2015	2015	2015	2015			

April 15th – April 30th	May 1st – May 31st	June 1st – June 30th	July 1st – August 10th	August 11th – Sept 31st	Sept 1st – Sept 20th
			0845	0845	
0945	0945	0945	0945	0945	0945
		1200	1200	1200	
	1315	1315	1315	1315	1315
			1515	1515	
			1645	1645	
			1900	1900	
b)			2015	2015	

Regardless of these limitations and operational issues, two or more boats were observed in 44% of the tracks in 2009, 23% of the tracks in 2010, and 43% of the tracks in the 2011 season. Even though the most accurate maximum average of 1.95 boats compares well to the number of boats most commonly suggested in guidelines, the standard error for the same month suggests that at times there were more boats present. This was actually the case. Encounters involving three and four boats did occur in the month of July, in 2009. In total, 13 tracks (2% of the combined tracks from the 2009 and 2010 seasons) revealed 4 boats, the greatest number of boats observed with the same animal or pod over the three seasons, within 1000m.

Much variation exists in the guidelines regarding approach density. Of the 44 guidelines in Carlson's (2009) collection that discuss limiting or controlling the number of viewing boats, 59% are dependent on distance, 7% are related to vessel size, and 23% do not specify the number of vessels but discuss proper behaviour for multiple vessel viewing situations and report dwell time guidelines, instead. Her analysis reveals that guidelines advocating a maximum of one vessel within a certain distance, usually 100m, make up 18% of the 44 guidelines and that 30% of the guidelines state there should be no more than two vessels viewing the same animal or pod. The guidelines indicate that this two boat allowance, more often than not, is for within a certain distance or "zone", typically between 100 and 300m, or in the 'Caution Zone'. Most of the guidelines (42%) suggest a maximum of three boats within 300 or 500m, and one guideline stated that a maximum of six vessels can be within the general area.

Some of this variation can also be attributed to the particular area where the whale watching is taking place, as different events are supported in different regions of the world. For example, there may be a difference in the number of boats allowed to be in the feeding grounds versus calving grounds of humpback whales. Within the Carlson (2009) analysis, 12 guidelines more specific to feeding grounds exist. These guidelines still exhibit some variation, as different species allow for different boat behaviours. However, the boat allowances were found to be similar to those discussed above. A two vessel maximum was most commonly suggested for close viewing (100-500m) of an animal, or pod, with an allowance of one vessel to be closer for a limited period of time. In the general area, usually referred to as the area within 1000m, three boats appear to be the typical boat allowance. One guideline states that there should never be two boats viewing the same whale and another guideline advised a minimum distance of 200m between boats. These guidelines, therefore, do not suggest that a greater number of boats viewing the same animal or pod is acceptable in feeding grounds versus other areas.

With regards to the number of viewing boats, the Iceland-specific guidelines state the following: if a whale-watching boat is already near the whale or whales, the approaching boat should not come closer than 200-300 meters until the first boat leaves or indicates that it is safe to approach (Húsavík Whale Museum, Figure 7); the number of boats around the same animal should be limited to two (North Sailing, Figure 6).

The results of this study reveal that the number of boats viewing the same animal or pod is, at times, higher than what is recommended by some of the whale watching guidelines throughout the world, including the only two guidelines attempting to manage whale watching activities in Iceland. However, there are some guidelines that allow for a greater number of boats to be viewing animals as well. Some studies reveal that whale watching activities in other countries, where the animals may even be more vulnerable to such activities as they are occurring in reproductive areas, do in fact exert more pressure than that observed on Skjálfandi Bay (Schaffar & Garrigue, 2008). Based on the results of this study, it is difficult to conclude that controlling the number of viewing boats on Skjálfandi Bay should be made a management priority. However, if future management initiatives are implemented with the goal of promoting more sustainable whale watching on Skjálfandi Bay, this aspect of the whale watching activity should be incorporated into the guidelines and/or CoCs.

5.2 Distance of Approach

The results for assessing the distance of approach were presented for each species, separately, due to the differences in approachability between the humpback whale, minke whale, and white-beaked dolphin. Some additional analyses were conducted on the humpback and minke data as they are more approachable than the dolphins. Due to the swimming nature of dolphins, the results of certain distance of approach analyses are perhaps less meaningful.

The study revealed that whale watching boats approach within 50m of both whales and dolphins, quite regularly. It is difficult to determine, however, what percentage of these encounters result from the animal(s) approaching the boats. This is only known for the 2011 humpback data.

Never the less, the percentage of encounters where a boat was within 50m of the animal showed an increase every year for the humpback and white-beaked dolphin. Less time was spent watching minke whales in the 2011 season which likely influenced the distance of approach data, as there was a resulting reduction in effort made to approach the whales. Between the 2009 and 2010 seasons, however, there was an increase in the percentage of boat approaches to within 50m of minke whales, consistent with the other species. Although further review of the 2011 tracks involving boats approaching to within 50m of a humpback whale revealed that the majority of these approaches were from 20-50m, boats did approach to within 10m of the whales quite often, and even to within 5m.

When reviewing Carlson's (2009) report, the guidelines for distance of approach appear to be less varied than those aiming to manage the other aspects of whale watching activities. The implementation of "Zones", such as the Caution Zone, Watching Zone, or

No Approach Zone, supplement many guidelines regarding the distance of approach, as such zones are demarcated by distances. Most commonly, the Caution Zone is noted to be between 100-300m for whales, and 50-150m for dolphins, while the No Approach Zone is closer than 100m for whales and 50m for dolphins.

Of the 46 whale approach guidelines reviewed by Carlson (2009), 48% state that boats should not approach closer than 100m, while 23% allow for boat approaches up to 50m. A couple of guidelines in the collection also mention approaching up to 30m. However, these guidelines enabling close approaches, including most of the 50m approach guidelines, are accompanied by strict speed and boat behaviour guidelines. Although there is still some variation, depending on the species being watched and the type of vessel involved, the guidelines specific to feeding grounds appear to be more lenient regarding the distance of approach. The guidelines mentioned above, allowing approaches up to 30m, are mainly for whale watching activities in feeding grounds where it is noted that one boat can be at this distance from the animal for a specified period of time. Of the 10 guidelines regulating distance of approach in feeding grounds, 20% advocate 100m as the minimum approach distance, while 50% allow boats to approach within 50m, up to a minimum distance of 30m, as discussed. One guideline, concerning whale watching operations in blue whale feeding grounds, limits the distance of approach to 300m.

Regarding dolphin approaches, there are far fewer guidelines that actually specify a distance of approach. Perhaps this is due to the energetic and curious nature of dolphins, which often results in the animals swimming erratically around the boat, including towards it at times. From the Carlson (2009) report, managing the speed and behaviour of the approaching boat appears to be more important for minimizing disturbances. Nevertheless, 14 of the guidelines included in the analysis did mention approach distances for dolphins. Of these, 64% advocate no approaches closer than 50m and 14% suggest a minimum approach distance of 100m. In addition to these guidelines, there are five guidelines in the analysis that suggest a distance of approach but do not specify what species is being approached. The majority of these less specific guidelines (80%) limit the approach distance to 50m. None of these guidelines mention acceptable dolphin watching behaviours specific to dolphin feeding areas.

The existing guidelines in Iceland, regarding the distance to which viewing boats can approach the animal(s), are not species-specific. The Húsavík Whale Museum guidelines recommend that boats do not approach closer than 50m, while the North Sailing guidelines state that the operator should avoid driving within 100m of any cetacean with the engine in gear, unless approaching from a right angle.

Schaffar and Garrigue (2008), studying the unregulated whale watching activities in New Caledonia, also report boats approaching to within 50m of humpback whales. Their results revealed that 14% of boat approaches were to within this distance. Also, a study conducted to investigate compliance with a set of whale watching guidelines in Greenland revealed that 60% of the observed whale watching encounters did not comply (Boye et al., 2011). One of the guidelines was concerning distance of approach, and stated that boats needed to stay at least 50m away from the animal. This report had a special focus on humpback whales, and although it does not clarify which guidelines were not followed, it is likely that some of the 60% non-compliant encounters involved boat approaches within 50m.

The Carlson (2009) report implies that distance of approach guidelines have more utility for certain species. As it appears that humpback whales are often the subject to close approaches, whale watching activities focussed on humpback whales are most likely an appropriate case for the implementation of guidelines regarding the distance of approach. For the same reasons that collisions between ships and whales tend to involve larger whale species (Laist et al., 2001), large whales present great opportunities for whale watching. They move more slowly and spend longer periods of time at the surface, breathing, in between successive dives. Larger whale species may therefore be more vulnerable to close approaches in comparison to smaller whales, such as the minke.

Based on the data, the approach distances of whale watching boats on Skjálfandi Bay are inconsistent with most guidelines and CoC standards. As the majority of whale watching activities on Skjálfandi Bay in 2011 involved humpback whales, and as even larger whale species have been observed spending more time in the Bay throughout the summer months, guidelines attempting to manage the distance to which boats approach animals should be better developed and enforced. The use of species-specific guidelines might also have a utility in attempting to reduce the potential disturbances resulting from the distance of approach. If close approaches are to be allowed, management might be enhanced by additional guidelines attempting to regulate boat behaviour, dwell time, and speed, as well.

In fact, these accompanying guidelines should be considered regardless of whether or not close approaches are advisable, for their utility in managing whale watching activities should the animal approach the boat. Perhaps a result of habituation, the gradual development of ‘vessel friendly’ whales, particularly humpbacks, has been observed in many areas throughout the world (Lien, 2001). Consistent with this observation are the results of this study revealing how some of the close humpback approaches resulted from an approaching whale, rather than boat. In these situations, guidelines suggesting how the operator of the boat should behave could help to minimize the risk of disturbing cetaceans. The guidelines outlined by the Húsavík Whale Museum and North Sailing do give some instruction on how boats are to be operated in the event that an animal approaches, however these guidelines also appear to be insufficient based on observations made throughout the 2011 data collection season.

5.3 Speed of Approach

The speed of approach was analysed according to various distance ranges. The first range, within 50m of the animal or pod, showed similar results between the three years of data collection. In all three years, the majority of boats within 50m of the animal(s) travelled at the slower speeds (0-10km/hr). This is to be expected, as travelling much faster than the animal itself at this range would result in an increase in distance between the boat and animal. However, as the speed range summary suggests, there were times in all three years when boats were travelling above 10km/hr, and even above 15km/hr, within 50m of the animal(s). The results also reveal that one third of the approaches within 50m in 2011 occurred at speeds which the GPS could not accurately measure. In these instances, the boat was either travelling slower than 2km/hr or it was idling, with the engines in neutral.

The guidelines in Carlson’s (2009) review, targeting the speed of approaching boats, most commonly present travel speeds in relation to distance. The majority of guidelines for close approaches (i.e., within 50m) require vessels to be idling with their engines in neutral. The second most common recommendation in the guidelines, within 50m, is for boats to be travelling at a No Wake Speed. However, there is no defined speed for the term ‘No Wake Speed’, as this speed differs from one vessel to the next. The use of No Wake Speed in management initiatives may, therefore, not be the most effective means of managing approach speeds since it is open to the Captain’s interpretation. Other guidelines reviewed by Carlson (2009) allow boats to be within 50m, only if the engines are off. Only one third of the tracks, those with recorded speeds of 'NA', were in accordance with the recommended speeds of travel within 50m. A total of 324 tracks showed boats approaching within 50m in 2011, yet engines were only turned off three times within that distance. In relation to the guidelines reviewed, it appears that the majority of boats approaching within 50m are travelling too quickly.

The speed of approaching boats within 50-100m of the animal or pod showed an increase in 2011, compared to the previous years. In 2009 and 2010, the majority of boats approaching within this distance range were doing so within the middle speed range (5-10km/hr), followed closely by those approaching at even slower speeds. However, in 2011, the majority of boats approaching between 50-100m were doing so at speeds within the quicker speed range (10-15km/hr) and there was a great decrease in the percentage of approaches occurring within the slower speed ranges. The quickest speeds, of boats within 50-100m, were observed in 2011.

The guidelines attempting to manage the speed of approaching vessels within 50-100m of the subject showed similar variation as the close approach speed guidelines (Carlson, 2009). Again, the majority of the guidelines advocate that vessels at this distance should be idling, with engines in neutral. And, similar to the close approaching vessels, travel at a No Wake Speed was the requirement mentioned most commonly by the guidelines, next to those requesting engines in neutral. No tracks revealed a boat speed of 'NA' as a result of idling, within 50-100m, but there were some approaches occurring at a No Wake Speed. However, as these approaches were rather uncommon, and as there is an increasing trend in the percentage of boat approaches at faster speeds, it appears that the speed of boats approaching within 50-100m is greater than what is generally consistent with the recommendations in the guidelines.

A similar story exists for boats approaching within 100-300m, except at this distance range it is even more pronounced. In 2009 the majority of boat approaches occurred between 0-10km/hr (an equal 43% within the two speed ranges), while in 2010 the majority of boats approached at speeds within the slowest speed range. In 2011, only 4% of approaching boats did so at speeds within the slowest speed range. Meanwhile, great increases were observed in 2011 in the percentage of approaching boats travelling at the faster speeds, with the most prominent increase occurring within the increased speed range (15-20km/hr).

The guidelines summarized by Carlson (2009) reveal that as distance increases from the target animal or pod, so too does the variation within the guidelines. With regards to speed guidelines for boats approaching within 100-300m, this was also the case. Some guidelines continue to suggest travelling at a No Wake Speed, idling with engines in neutral, or even matching the speed of the slowest travelling animal, whereas other guidelines specified a speed for the approaching boat. There was some difference in the guidelines depending on whether the boat was within 200m or 300m of the animal(s), as well. The most commonly advocated speed for boats travelling within 200m was 5 knots (9km/hr), but a speed of 7 knots (13km/hr) also appeared in some of the guidelines. These speed restrictions were also mentioned for boats travelling within 300m, with the addition of some guidelines suggesting a maximum speed of 4 knots (7.5 km/hr).

The guidelines on speed of approach for boats operating in feeding grounds do not allow for faster approaches. The same patterns exist amongst the feeding ground specific guidelines as the rest of the guidelines: boats within 100m are to be idling, travelling at a NWS, or have the engines off; and boats within 100-300m should be travelling equal to or less than 5 knots, and shall not exceed a maximum of 7 knots (Carlson, 2009).

The North Sailing guidelines state that an approaching boat should reduce its speed to less than 5 knots when within 200m of the nearest cetacean. The guidelines listed by the Húsavík Whale Museum are less specific regarding the speed of approaching boats, but state the following: when a boat approaches a whale, the main engines should be cut back and let idle; if the whale approaches the boat, the propeller should be stopped while the whale is near the boat; engines and propellers should not be run at full power in the vicinity of whales (Carlson, 2009).

As the greatest speed advocated by the guidelines was approximately 13km/hr (7 knots), it is difficult to conclude that the speed of approaching boats within 100-300m is too fast. In 2009 and 2010, most approaches were below this speed. However, if the increasing trend in approach speed within the 100-300m distance range continues into the future, the majority of boat approaches may occur at speeds above 13km/hr and no longer be in harmony with the guidelines. The results already suggest that boats approaching within 300-50m of the animal or pod, in 2011, were doing so at greater speeds than in the past two seasons. Throughout the course of the study, however, the observed speeds and corresponding boat behaviours within all three distance categories were often inconsistent with the Icelandic guidelines.

The addition of a rigid-hulled inflatable boat, *Amma Sigga* (Figure 24), to the Gentle Giants fleet in 2011 is worthy of mention due to the manner in which it operates. This new addition is the quickest vessel now operating on the Bay, as two 300 horsepower engines enable a maximum speed of 56 knots (approximately 100km/hr) (Gentle Giants, 2011). Unfortunately, this boat is not ideal for data collection and was, therefore, not utilized in the 2011 season. The speed and agility of *Amma Sigga* makes it an efficient whale watching boat, and if included in the current study, would likely have influenced the speed of approach data. Thus, to curb the potential disturbance resulting from faster approaching boats in the future, this aspect of the whale watching activity should be managed through the use of more detailed guidelines and increased enforcement.

5.4 Efficacy of Voluntary Guidelines

Despite a lack of knowledge regarding their value or efficacy, the use of voluntary agreements for conservation is increasing (Wiley et al., 2008). While existing voluntary measures often negate the need for stronger forms of management, such as regulations, it is of great importance to determine whether or not the voluntary agreements are effectively managing the targeted activities (Wiley et al., 2008). Whale watching guidelines and/or CoCs are examples of voluntary agreements which are quite commonly utilized in an attempt to manage the whale watching industry. Compliance studies, throughout the world, have investigated the utility and efficacy of voluntary whale watching guidelines (Allan et al., 2007; Duprey et al., 2008; Wiley et al., 2008). These studies reveal that existing voluntary guidelines appear to be of little value, due to poor compliance by the participants.

Although the primary purpose of this study was not to investigate the compliance of North Sailing and Gentle Giant's operators with existing whale watching guidelines, it was revealed that the voluntary guidelines in Iceland are not effectively managing the whale watching activities on Skjálfandi Bay. The results of this study confirm that the existing guidelines attempting to manage the three whale watching interaction characteristics investigated were not complied with, and during the 2011 data collection season it was observed that guidelines regarding other aspects of the whale watching activities were also ineffective. There may be many reasons for this lack of compliance: it is possible that not all operators are aware of existing guidelines; there may be a greater need for education, to relay the purpose of the guidelines and how their utility may benefit the animals and those involved in the industry; or perhaps the operators simply choose not to comply in order to provide passengers with what they believe would be the best whale watching experience.

After studying the efficacy of voluntary guidelines established for whale watching vessels in Stellwagen Bank National Marine Sanctuary, Wiley et al. (2008) reported that industry compliance was low, and that the voluntary measures probably failed to achieve the desired conservation goals. Through conversations with various operators after the study, it became clear to the authors that conditions during the study period did not allow for normal industry operations due to fewer whales being in the area. Operators claimed that it was difficult to comply with the guidelines, as they were under intense time pressures to show passengers whales that were available, while at the same time adhering to their commercial schedule. The authors then conclude that one reason studies investigating the efficacy of voluntary agreements often reveal failure is because participants ultimately have the flexibility to ignore restrictions when these become inconvenient or interfere with business.

While stricter forms of management, such as regulations, may theoretically not allow for such flexibility, efficacy and compliance studies may still reveal low levels of compliance. Similar to management initiatives utilizing informal voluntary guidelines, more formal management efforts must incorporate monitoring and enforcement programs if the conservation and sustainability goals are to be achieved (Allan et al., 2007; Wiley et al., 2008). Thus, in the case of whale watching in Iceland, the implementation of guidelines as regulations will likely not improve the efficacy of such management initiatives. Instead, existing guidelines should be revised, participants should be educated on the existence and value of these guidelines, and some sort of incentive should be made available to encourage compliance. These steps may help to increase the value of voluntary conservation measures.

5.5 Study Limitations

In addition to the errors associated with the utilized methodologies, which will be discussed below, there were other limitations in this study that should be discussed as well. Due to equipment malfunction of the theodolite, the methods used to collect data in the 2011 season were different than those utilized in the 2009 and 2010 data collection seasons. As a result, it is more difficult to consider the data collected over the three years as a single database, from which analyses can accurately be conducted, and trends reliably observed. These different data collection methods were considered when interpreting the results. Also, the data collection in 2011 was carried out specifically for this study, whereas the data collection in 2009 and 2010 was not. Had the data collection in the first two years been collected consistent with this particular study design, it is possible that the data would have been more evenly distributed between the three main species represented in this study.

Due to the use of photogrammetric methods in 2011, there were additional limitations that were not present in 2009 and 2010. Tracking was impossible during many encounters as the true horizon was obscured, due to either the close proximity of land or poor visibility. In both cases, appropriate photographs were unattainable. As discussed in the methods section, certain actions were taken to diminish these limitations when possible. In accordance with Leaper and Gordon's (2001) suggestion, shoreline was used as a substitute for the true horizon in photographs where the distance between the observer and the shoreline was accurately known.

Since data collection during the 2011 whale watching season was carried out from boats accommodating many passengers, there were times when tracking was difficult due to crowding. It was important for the photographer to be mindful of her position, as the eye height of the photographer is one of the variables utilized in the distance determination (h in equation 2). In certain situations, it was impossible to photograph the surfacing animal while remaining in the proper position. If the photographer was not mindful of this, these situations would introduce error into the distance calculations for that particular track.

One other factor of the 2011 season which greatly limited the amount of data collected was the timing at which data collection occurred. As it has been mentioned, July is the peak whale watching month in Húsavík when the most number of trips are offered.

Since there are more trips and more boats out on the Bay during July, much more data could have been collected regarding encounters and the behaviour of boats. It would have been beneficial to summarize the whale watching activities from the peak of the season.

5.6 Error

A potential source of error in the theodolite data, not previously discussed in Section 2.7, was encountered during the study. When analysing the Cyclops database, it became apparent that the display of boats near an animal was based on any boat track that occurred within three minutes, before or after, the time of the animal track. Since the majority of the distance data was presented in categories, minor errors in the distance of approach data will likely have a minimal impact on the results. However, this three minute window should be kept in mind as a potential source of error.

To analyse error inherent to the theodolite, calibration tests were performed in 2008 to investigate the accuracy of data collected from the Húsavík lighthouse. Estimated distance measurements, made by the theodolite, were compared to actual distances which were obtained through the use of a GPS on board the vessel being tracked (Guðrúnardóttir, 2008). Figure 25 illustrates this comparison. The yellow track shows the measurements made from the theodolite at the lighthouse, while the red track was obtained using the GPS positions. The greatest discrepancy, of 300m, was observed between the sections of tracks furthest (approximately 7km) from the lighthouse. As data utilized in the current study was obtained from shorter distances, the accuracy of the distance measurements made by the theodolite would be more similar to that shown between the tracks occurring closer to the lighthouse.

Similarly, in addition to the errors discussed in Section 2.7 regarding photogrammetric methods, there appeared to be another, unknown, source of error in this study. As a result, a correction factor was determined and applied to the distance calculation in the spreadsheet. A calibration test was performed on the original data, as well as on the data once the correction factor had been applied, to measure the accuracy between the estimated distances computed by the spreadsheet (with an observation height of 5.1m) and the real distances obtained from a GPS. A mean difference of 208.3m, with a standard error of 32, was observed for the original data, while a mean difference of -0.04m with a standard error of 10, resulted from the corrected data. The sample size for the calibration test was unfortunately quite small, which means higher standard errors are expected. However, there is no doubt that the correction factor helped to alleviate some of the error, and made the measurements more accurate.

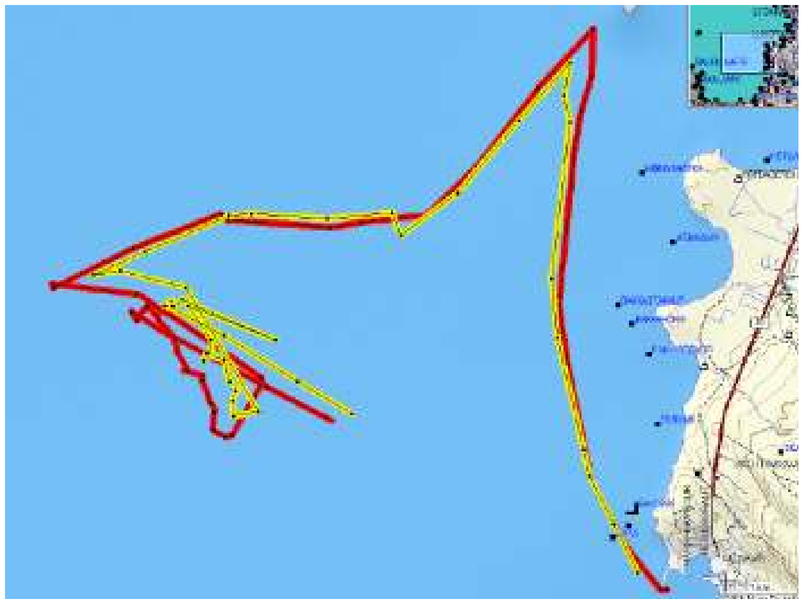

Figure 25. Measuring the accuracy between the theodolite track (yellow) and actual track (red) of tracked vessels from the Húsavík lighthouse (Guðrúnardóttir, 2008).

5.7 Future Studies

Although this study successfully illustrates how certain aspects of the whale watching activities on Skjálfandi Bay are occurring, there are many other aspects that could be analysed as well. This would enable a true understanding of how these activities can be promoted in a more sustainable way. Future assessments of whale watching activities should include data regarding the availability of cetaceans in near-by waters. As mentioned when discussing the efficacy of guidelines, whale watching activities are influenced by the abundance of animals and are likely to be more aggressive when fewer animals are available. As photo-identification studies have revealed, many of the same animals return to Skjálfandi Bay each summer to feed. This means that some animals are repeatedly exposed to the whale watching activities occurring on the Bay, giving rise to the issue of cumulative impact. In addition to further studies investigating the response of various species to boats, the potential effects of repetitive exposure might also be a worthwhile topic to explore. And finally, future studies should continue to monitor and assess the level of compliance with existing guidelines. Such investigations will determine the efficacy of future management initiatives and further reveal how the whale watching activities on Skjálfandi Bay might be managed successfully.

6.0 Conclusion

The whale watching industry in Iceland has gained much momentum in recent years and has provided an opportunity for the diversification and expansion of the local economy. In Northeastern Iceland, among other places, whale watching has revealed many of its benefits. Situated on the shores of Skjálfandi Bay, whale watching companies in Húsavík are taking advantage of the cetacean species present in nearby waters throughout the summer months. Here, guidelines attempting to manage whale watching activities are limited and have not been monitored for compliance. Knowledge regarding the utility of these guidelines is important, as the implementation of effective management is likely necessary to promote sustainable development within the industry.

The present study provides insight into the sustainability of whale watching on Skjálfandi Bay, using suggestions and recommendations from various guidelines and regulations as an indication of what sustainable whale watching might entail. Upon review of whale watching guidelines and management initiatives in existence throughout the world, the results of this study reveal that certain aspects of the whale watching activities are inconsistent with what appear to be the whale watching standards. It was determined that future management initiatives, targeting the whale watching activities on the Bay, should consider the development and strengthening of guidelines attempting to reduce the potential disturbance caused by approaching boats. Such guidelines can manage or limit the number of viewing boats, the distances within which the boats approach the animals, and the speeds at which the approaches are made. It should be kept in mind, however, that different guidelines may be more or less effective for the various species encountered on Skjálfandi Bay. For example, as blue whales have recently been spending more time feeding in the Bay, species specific guidelines should perhaps be considered as well. Such species-specific management strategies have been implemented in other places, e.g., along the East Coast of the United States for right whales, in the Pacific Northwest for orcas, and in Chile for blue whales, and seem to be effectively managing the whale watching activities occurring in these areas. These management efforts may be helpful in promoting more sustainable whale watching activities on Skjálfandi Bay.

In addition to benefiting the cetaceans in Skjálfandi Bay, the companies participating in the whale watching activities will gain from the implementation of guidelines and/or management as well. Not only are the animals more likely to be present for longer periods of time, if the whale watching activities are carried out in a potentially less disturbing manner, but the companies may also experience the advantages associated with being perceived by whale watching tourists as having a more environmentally friendly image. As a result of diverse environmental issues receiving greater attention, many people are becoming more environmentally conscious. Whale watching passengers are no exception, as awareness and concern appears to be increasing amongst this clientele as well. If the companies conduct their whale watching operations with guidance from various management efforts, their reputation may reap the benefits. Such an incentive, along with proper education and monitoring, may contribute to more effective whale watching management initiatives in the future.

Cooperation amongst the various stakeholders can help to achieve the overall goal of enabling Húsavík, and Iceland in general, to continue to benefit from the thriving whale watching industry, while at the same time reducing the potentially adverse impacts on the environment.

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Appendix A

DAY: BOAT: CAPTAIN:

Start time: Horizon:

Track#	Speed (km/hr)	WP#	Orientation	Photo #	# of Boats	Comment

RECORDER:

PHOTOGRAHPER: CAMERA: