Behavior of Belugas in the Presence of Whale-Watching Vessels in Churchill, Manitoba and Recommendations for Local Beluga-Watching Activities

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Introduction

On a global scale, the growth of marine mammal viewing activities (most often whale watching) has often exceeded the ability of governments to develop appropriate regulatory measures. In many locations, regulations applicable to nominally nonconsumptive activities such as whale watching are vague, exist in a "complex array" of regulatory structure, or do not exist at all (Garrod & Fennell, 2004; Gjerdalen & Williams, 2000). Existing regulations vary considerably and have largely been established as presumed precautionary measures; few are based on scientific understanding (Garrod & Fennell, 2004).

It can be difficult to link cetacean behavioral cues to indicators of biologically significant short-term, and particularly long-term, impacts of marine mammal viewing (Duffus, 1988; Duffus & Baird, 1995; Higham & Lusseau, 2004), and consequently it can be difficult to establish prescriptive management measures. A common solution to the regulatory management gap has been self–regulation by whale watch industry operators. In many areas, whale watch industry operators, environmental nongovernment organizations, and local government agencies have cooperated to develop local codes of ethics (Garrod & Fennell, 2004). These codes of ethics can be quite detailed to species and location (e.g., in British Columbia) (Malcolm, 2003).

There are drawbacks to both the legislated and voluntary self-regulatory control of whale-watching activities. Legislated regulations, in an attempt to address macroscale issues, can be general in nature. Enforcement is also a difficulty, given the cost of policing activities over vast areas (Wilson, 2003). Industry self-regulation, while providing regional bases for commercial marine mammal viewing activities, carries little punitive powers within the industry beyond peer pressure tactics (Malcolm, 2003) and does not necessarily influence the activities of noncommercial watchers (Garrod & Fennell, 2004; Gjerdalen & Williams, 2000). The most effective method of managing whale watching should be a set of fundamental regulations, under which regionally specific guidelines that are consistent with these regulations can be developed.

Successful management of wildlife ecotourism, including whale watching, requires integration of both socioeconomic and natural scientific understanding of the resource (Duffus & Dearden, 1990; Higham & Lusseau, 2004; Reynolds & Braithwaite, 2001). Management prescriptions should therefore integrate regionally appropriate understanding of the critical behaviors and spatial ecologies of focal wildlife's habitat (Lusseau 2003a; Lusseau & Higham, 2004), along with issues and concerns of those stakeholders with an interest in the resource, such as wildlife tour operators (Malcolm & Lochbaum, 1999). Development of an integrated set of federal/provincial/state regulations and regional guidelines for marine mammal viewing should follow this model.

In Canada, marine mammals are protected under the Marine Mammal Regulations (1993) (MMR, SOR/93-56) made under the federal Fisheries Act (R.S., 1985, c. F-14). The MMR were designed to regulate consumptive activities such as harvesting; they do not specifically address nonconsumptive activities such as marine mammal viewing. The MMR do prohibit disturbance to marine mammals, but the prohibition is difficult to apply given the complexity of interpreting when disturbance of a marine mammal has occurred.

In 2000, Fisheries and Oceans Canada (DFO) commissioned an assessment of the effects of whale-watching activities on marine mammals in Canada. In his assessment, Lien (2001) concluded that there is evidence that the presence of whale watching vessels changes the behavior of targeted animals, and recommended that the industry be regulated to restrict "frequent and repetitive disturbances" to marine mammal "life processes" (p. 3) (e.g., resting, foraging, feeding, socializing, etc.). A gradually increasing set of peer-reviewed studies of cetacean/whale-watching vessel interactions in southern Canadian latitudes (e.g., Blane & Jaakson, 1994; Jelinski, Krueger, & Duffus, 2002; Lesage, Barrette, Kingsley, & Sjare, 1999; Williams, Bain, Ford, & Trites, 2002; Williams, Trites, & Bain, 2002), along with a socioeconomic understanding of the industry and its stakeholders (e.g., Fisheries and Oceans Canada, 2005; Fisheries and Oceans Canada & BC Parks 1992; Malcolm & Lochbaum, 1999), has become available to inform this type of management in Canada. Marine mammal viewing in northern Canada has received virtually no research attention, given the small size and relatively recent establishment of the industry, compared to those on the Pacific and Atlantic coasts.

A proposal to amend the current MMR to include marine mammal viewing is in progress (Fisheries and Oceans Canada, 2005). On a national scale, the proposal suggests broad regulations designed to guide marine mammal viewing activities common to all regions. The proposed amendments are intended to apply to all activities that may disturb marine mammals and suggest a minimum approach distance of 100 m, prohibitions on direct contact, and a proposal to license commercial operators (Fisheries and Oceans Canada, 2005). On a regional scale, the proposal provides a provision for areas and species that deserve special consideration.

The town of Churchill, Manitoba, located at the mouth of the Churchill River (Figure 4.1), has maintained an active ecotourism industry for several decades. From late May to the end of September visitors are able to view a component of the Western Hudson Bay beluga (*Delphinapterus leucas*) population that summers along the Manitoba coast of Hudson Bay, chiefly in the Churchill, Seal, and Nelson River estuaries (Richard, 1993; Richard, Orr, & Barber, 1990). Of these three estuarine concentrations, only the Churchill River is easily accessible to tourists

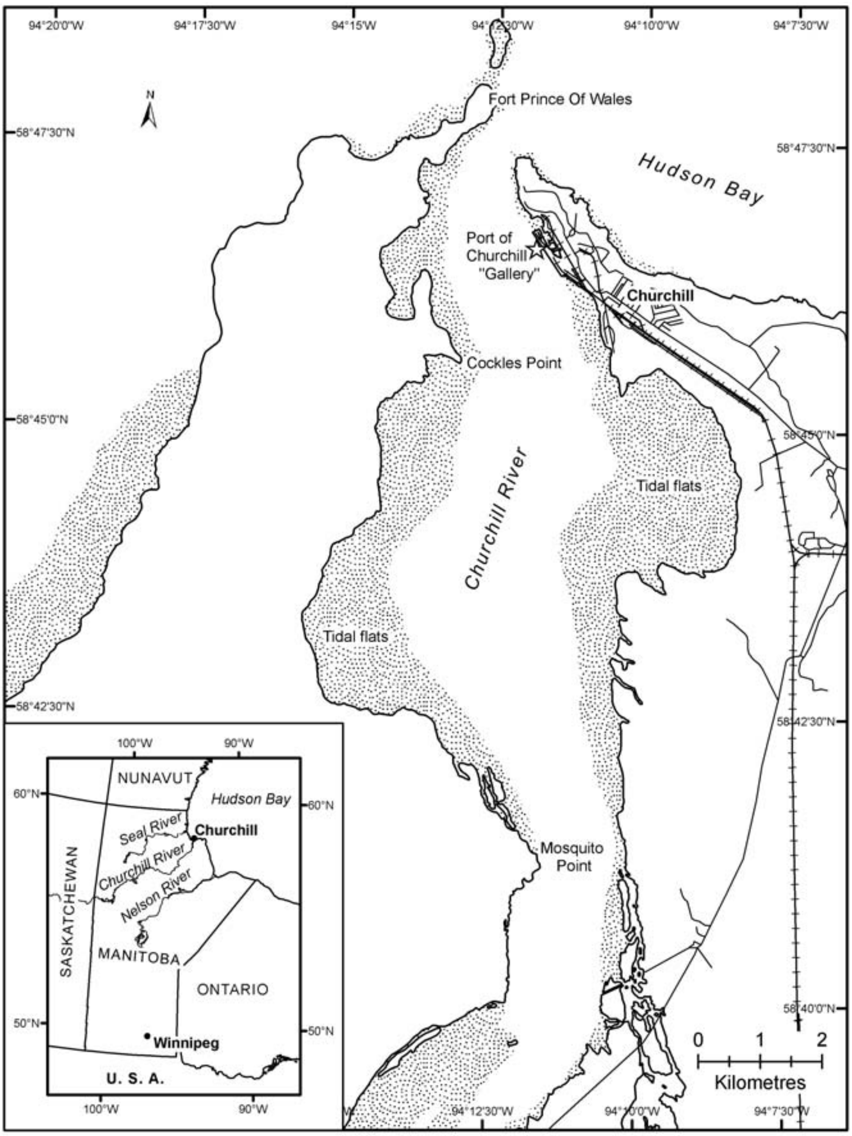

Figure 4.1. Lower Churchill River, where whale watching takes place, and the town of Churchill.

at the present time. Tourists are typically able to view hundreds of belugas in a restricted area near the river mouth on a daily basis (Figure 4.2). There is currently no formal, voluntary code of ethics for commercial, vessel-based whale watching in Churchill. The industry is very small, with only two commercial companies that operate two motorized vessels, three six-person zodiacs, and several kayaks between them. However, as northern travel becomes increasingly accessible to the general public, it is reasonable to assume a growth in interest for commercial whale watching in Churchill, as well as other northern estuaries where belugas consistently congregate in summer.

Given the unique nature of whale watching in Churchill (e.g., high numbers of animals concentrated in a restricted area and the geography of the river environment), the goal of this study was to determine appropriate vessel operation protocols that afford belugas protection from disturbance to critical life processes. Mindful of the variability observed in beluga reactions to motorized vessels, the research design incorporates both ecological and social aspects of whale watching in Churchill. Interviews with experienced local whale watch operators, beluga behavior in the presence of whale watching vessels, and mapping of areas of whale-watching vessel activity were included to inform both the proposed regulatory amendment and the development of regional guidelines for whale-watching management in Churchill.

Figure 4.2. Kayaker and belugas in the Churchill River, Churchill, Manitoba. Photo by C. Malcolm.

Research on Beluga–Vessel Interaction

Beluga reactions to marine vessels are variable:

> depending on habitat, demography, prior experience, activity, resource availability, sound transmission characteristics, behavioral state, and ever-present individual variability, the response of beluga whales can range from most sensitive reported for any species to ignoring of intentional harassment. (National Academy of Science, 2003, p. 95)

Belugas have been documented to exhibit behavioral changes in the presence of ice-breaker and industrial vessels at distances up to 50 kilometers. Alterations in behavior have included changes in surfacing, breathing, and diving patterns, group composition, and vocalizations; however, belugas were also observed to habituate to ice-breaking activities within the season (Cosens & Dueck, 1988; Finley, Miller, Davis, & Greene, 1990; LGL & Greenridge, 1986). Erbe and Farmer (2000) analyzed beluga vocalizations in the presence of ice-breaking ships and found that alterations occurred at distances up to 40 kilometers and interference in beluga communication began as far away as 10 kilometers.

In Alaska, belugas were observed to stop feeding and move downstream in the presence of outboard motorboats; however, the same animals were less responsive to local fishing boats, to which they may have become habituated (Stewart, Evans, & Aubry, 1982). In another study, however, belugas continued to feed in the presence of vessels, even when purposefully harassed (Fish & Vania, 1971). The only previous studies of beluga reactions to the presence of whale-watching boats have been made on St. Lawrence River belugas near Tadoussac, Quebec. Blane and Jaakson (1994) found belugas at this location were more tolerant of large vessels moving in straight lines at constant speeds than of smaller, faster boats that changed directions more often. Older individuals were more likely to be disturbed; feeding and traveling animals were less likely to exhibit changes in behavior, but when they did exhibit changes they reacted more strongly. Lesage et al. (1999) studied beluga vocalizations in the presence of ferries and small boats (including whale-watching vessels) and reported reduced calling rates, increased call repetition, and altered call frequency; however, reactions were variable depending on the type of vessel.

Methods

Research took place during July and August in 2005 and 2006. The study was composed of three elements. First, interviews were conducted with the three commercial whale-watching operators in 2005 (there are currently only two companies, as one of the companies bought out the kayaking company in 2006) to record their views and concerns about the management of whale watching in Churchill, including the concepts described in the proposed regulatory amendment. Second, behavioral observations of beluga whales in proximity to commercial whale-watching vessels were conducted using a laser range finder to link distances to observed behaviors. Observations were made with respect to the main passenger vessel in

2005 and 2006. Lastly, areas of whale-watching intensity were documented using a global positioning system (GPS).

Passenger Vessel

Beluga behaviors were recorded under experimental (vessel present) and control (vessel absent) treatments. Under the experimental treatment belugas were observed from the bridge of a commercial whale-watching vessel; from this platform, 5 meters above the water, precise distance and behavior observations of belugas could be made in relation to the vessel. In Churchill, belugas tend to approach and remain in close proximity to vessels; consequently their proximate, often subsurface, behaviors could only be documented from the vessel itself.

First, a focal group of belugas was randomly selected and then classified as either "calf," "juvenile," "adult," or "mixed" (Table 4.1). An initial behavior state and distance from the vessel were recorded. Each focal group was then followed for a 3-minute interval. For any observed changes in behavior the time, new behavior type, and distance from the vessel were recorded. Prior to the study we determined that 3 minutes was the maximum time we could follow a group. Given the density of belugas at certain times and the desire to have the whale-watching vessel pilot conduct a typical tour, it is easy to lose track of the focal group, particularly at distance from the vessel. If a focal group did not remain confidently identifiable for the entire 3-minute time period, the follow was abandoned and the data discarded.

Established definitions of small cetacean behavior were used to categorize the observations (e.g., Bearzi, Notobartolo-di-Sciara, & Politi, 1997; Lusseau, 2003b; Shane, 1990) (Table 4.2). This approach is consistent with that used by Lien (2001) to define cetacean life processes. The classification "interaction" was added to identify behavior exhibited by belugas towards vessels in this study. This behavior is significantly different from "traveling," as belugas will often change direction to "interact" with the vessel. The established classification "dive" was not used, as the higher body arching associated with the start of a deep dive was only associated with "feeding" in the shallow water environment of this study.

Table 4.1. Classification of Beluga Group Types Observed in the Churchill River, 2005 and 2006

Group Type	Definition
Calf	Any group containing a calf of the year
Juvenile	A group composed solely of juvenile animals; identified as gray in color
Adult	A group composed solely of adult animals; identified as white in color
Mixed	A group composed of juvenile and adult animals; no calves present
Adult mixed[a]	A group composed of solely adults or some combination of adults and juveniles; no calves present

[a]See Results section.

Table 4.2. Classification of Beluga Behavior Types

Behavior Type	Definition
Interaction	In close proximity to and moving in same direction as vessel; gliding underneath, beside, or directly behind vessel in various body orientations (sometimes rubbing against each other), placing head in jet wash, investigating/mouthing hydrophone, bubble blowing
Traveling	Group moves in a consistent direction without frequent changes
Socializing	Various interactive behaviors including rubbing against each other, splashing, pectoral fins, and/or tail flukes raised above the surface, rolling, bubble blowing; no consistent directional movement
Milling	Individuals surface in different orientations; no discernable directional movement
Resting	Group moves extremely slowly in a consistent direction; submergence and surfacing relatively synchronous between individuals; individuals grouped tightly together
Feeding	Individuals moving rapidly at surface, surfacing in different directions, often in large aggregations; often accompanied by foraging birds; may exhibit greater body arching as animal dives; also includes calves nursing

In the control treatment (vessels absent) beluga behavior was observed from the Port of Churchill. The "Gallery" is a grain elevator/container ship loading structure, which is 27 meters above the water, safe from polar bears, and allows an unobstructed view of approximately 85% of the area in which commercial whale watching typically occurs (i.e., from Mosquito Point upstream to Fort Prince of Wales) (Figure 4.1). The data collection method used for the experimental treatment was also used in the control, minus the distance variable. If a vessel approached within 300 meters of the focal group we terminated the follow.

To analyze the experimental data distances we first corrected for the angle resulting from the 5-meter height at which measurements were taken. The area within a 150-meter radius of the vessel was then divided into six concentric zones of 25 meters each. Behaviors observed beyond 150 meters were classified into a single zone because distance measurements could not be consistently obtained with the laser range finder beyond this distance due to the diminished target size of distant belugas. Paired distance–behavior observations were then classified into the appropriate distance zone.

Chi-square analysis was used to test for significant differences in observed counts within and between treatments. "Interaction" observations were removed from the 0–25-meter zone, in order to avoid violation of the no "0" cell count assumption for chi-square analysis, as "interaction" could not occur in zones beyond 0–25 m. In other cases where zero counts were present [e.g., no calf "feeding" (nursing) able to be documented beyond 25 meters] these cases were not included in the analysis.

Spearman's rho (ρ) correlation test was then used to compare the numbers of group types observed across distance zones within the experimental treatment.

Finally, the total percentages of group types within the experimental and control treatments were compared.

Kayak

To study beluga interaction with kayaks, a focal group within 100 meters of our kayak was randomly selected and the group type classified. The "Gallery" is not a suitable location to conduct this research because we could not assess behavior in proximity to kayaks at distances beyond 100 meters and very little kayaking activity takes place in proximity to this observation point.

Due to the extremely low position for observation from a kayak, we did not attempt the detailed observations undertaken for the passenger vessel study. Instead, we counted the number of "pass" and "interaction" events during the time period that the focal group remained within 100 meters of our kayak, to assess the level of attention paid to the kayak by the belugas. A "pass" occurred when the focal group swam within 2 meters of the kayak but did not stop. An "interaction" occurred when the focal group approached the kayak and exhibited behaviors such as gliding underneath, beside, or directly behind the kayak, looking up at the kayak or us, bubble blowing underneath the kayak, investigating the rudder (including mouthing), or rubbing against the kayak. When the focal group was >100 meters away we recorded the time and selected a new group. We used a Kruskal-Wallace statistical procedure to test for differences between group types.

Zodiac/Snorkeling

We collected data with a snorkeler in the water in the same manner as for the kayaks. In addition, the snorkeler indicated by raising a hand if a beluga approached within the snorkeler's reach.

Results

Interviews

The interviews with commercial whale-watching operators identified several issues regarding whale-watching management in Churchill. Operators unanimously felt that a 100-meter approach distance was inappropriately high for Churchill, but had divided views about licensing and its financial implications to commercial operators. There was general agreement that the limited tourism base in Churchill could not support a growth in motorized passenger vessel numbers at the present time, and that passenger vessel whale watching should only be done from Transport Canada-certified vessels. Commercial operators we interviewed have observed pleasure boats speeding through herds of belugas, and they are concerned for both passengers and belugas when inexperienced boaters travel to beluga congregation areas (often areas of shallow water strewn with submerged glacial erratics). Commercial operators anticipated that they would be required to assist should a rescue operation be needed, and noted that an accident involving a noncommercial vessel (i.e., a local resident taking passengers to see whales) would likely reflect negatively on the commercial whale-watching business as well. Also with respect to safety, it was suggested that a motorized vessel such as a small zodiac should always accompany kayaking trips. There is a concern that novice kayakers may get caught on flow or ebb tides that could carry them upriver or out into Hudson Bay.

Commercial operators indicated that beluga hunting, which occurs infrequently in the vicinity of the Churchill River mouth, negatively affects whale-watching tourism. Belugas were reported by the operators as becoming scarce for one to several days following a hunt in the Churchill area.

Operators also stated that habitat use by belugas in 2005 was atypical, in that belugas spent most of their time in proximity to the river mouth. In previous years, belugas regularly traveled upriver to Mosquito Point (Figure 4.1), an area where a large proportion of whale-watching tours was conducted.

Passenger Vessel

The combined sample for 2005 and 2006 contains a similar number of completed focal follows of beluga groups made under experimental (n=102) and control (n=99) treatments. Table 4.3 presents the number of focal follows attempted and those completed in each year, and details the number of follows abandoned for reasons of beluga behavior or adverse observation conditions. In both the experimental and control treatments, there were insufficient observations of "adult" groups for analysis, so observations of "adult" and "mixed" focal groups were merged into a new "adult mixed" group. The adult mixed group contained either solely adults or some combination of adults and juveniles, but not calves (Table 4.1).

Information from each focal follow was then reduced to a series of paired distance–behavior observations, for each group type, made under experimental (n=666) and control (n=615) treatments (Table 4.4).

The percentages of each of the six behavior types observed for each group type, under experimental and control treatments, are presented in Table 4.5. Within 25

Table 4.3. Focal Follows of Beluga Whales Attempted and Completed for the Passenger Vessel, as Well as Reasons for Discontinued Follows, in the Churchill River, 2005 and 2006

	2005		2006		Total	
	Experiment	Control	Experiment	Control	Experiment	Control
Attempted follows	86	72	59	61	145	133
Completed follows	65	49	37	50	102	99
Discontinued: lost visual contact with group >30 s	17	11	17	8	34	19
Discontinued: lost group within large numbers of whales	4	7	5	1	9	8
Discontinued: vessel within 300 m	n/a	4	n/a	2	n/a	6
Discontinued: lost group in fog		1				1

Table 4.4. Number of Paired Distance/Behavior Observations of Beluga Whales Recorded Under Experimental and Control Treatments in the Churchill River, Manitoba During 2005 and 2006

Experiment (Distance Zone)	Entire Sample	Calf	Juvenile	Adult Mixed
0–25 m	141	36	71	34
26–50 m	163	32	99	32
51–75 m	82	32	23	27
76–100 m	75	20	22	33
101–125 m	48	18	10	20
126–150 m	69	12	13	44
>150 m	78	25	23	30
Experiment total	666	175	261	220
Control total	615	201	52	306
Total observations	1,271	376	313	526

meters of the vessel, "interaction" was the most commonly observed behavior for each group type. The most commonly observed behavior across all group types, throughout both the experimental and control treatments, was "traveling," followed by "socializing," "feeding," "milling," and finally "resting." Feeding was observed throughout all of the distance zones, including adjacent to the vessel, but was most often observed in the zone furthest from the vessel (>150 meters).

"Resting" was observed in all zones, in the greatest proportions by calf groups. Interruption of resting within 50 meters of the vessel was not documented for any focal group. Two cases of calf groups switching to resting, following interaction, while slowly moving away from the vessel were observed. Two calf groups and one adult mixed group were observed resting within 50 meters of the vessel for the entire 3-minute focal follow.

There was, however, variability in observed behavior when analyzed by group type. While interaction was the highest behavior type in the 0–25-meter zone for each group type, and traveling was the highest percentage of behavior type throughout the remaining zones in general, the group types, particularly juvenile and adult mixed, exhibited different proportions of the other behaviors. Juvenile groups exhibited higher proportions of socializing throughout the zones and very little feeding in the closest three zones to the vessel. Traveling and feeding dominated the behavior exhibited by adult mixed groups. Higher proportions of resting, including a high proportion within 50 meters of the vessel, and lower proportions of socializing in the closest two distance zones were documented for calf groups. While two instances of nursing right next to the vessel were observed, this behavior could not be confidently identified farther away; nursing is likely classified as socializing in farther distances from the vessel. No calf groups were observed in feeding aggregations.

Table 4.6 presents the results of the chi-square analyses of behaviors observed within and between experimental and control treatments for each group type (minus interaction). Statistically significant differences in behavior types between distance zones is the norm; 78.5% of the comparisons for calf groups, 50.0% for juve-

Table 4.5. Percentages of Beluga Behaviors Observed in Churchill, Manitoba During 2005 and 2006 Under Experimental (Passenger Vessel) and Control Treatments

Experiment (Distance Zone)	Behavior Type					
	Interaction	Traveling	Socializing	Milling	Feeding	Resting
0–25 m						
Calf	52.3	15.3 (32.7)	7.2 (15.6)	19.8 (41.4)	1.0 (2.1)	4.5 (9.2)
Juvenile	53.3	22.0 (46.8)	17.5 (37.5)	2.2 (4.7)	2.8 (6.3)	2.2 (4.7)
Adult mixed	38.3	34.0 (55.6)	2.1 (3.1)	20.0 (32.6)	2.1 (3.1)	
26–50 m						
Calf	n/a	49.0	7.9	3.9	0	39.2
Juvenile	n/a	50.0	38.1	7.1	3.2	1.6
Adult mixed	n/a	69.7	8.0	3.4	13.5	5.4
51–75 m						
Calf	n/a	59.2	20.0	10.2	0	10.6
Juvenile	n/a	44.7	44.1	3.1	5.2	2.9
Adult mixed	n/a	55.0	2.1	12.9	26.3	3.8
76–100 m						
Calf	n/a	66.7	16.7	5.5	0	11.1
Juvenile	n/a	56.4	28.6	1.8	12.3	2.7
Adult mixed	n/a	53.3	9.8	6.7	19.7	11.3
101–125 m						
Calf	n/a	44.2	38.2	2.9	0	14.7
Juvenile	n/a	40.0	33.3	3.1	22.7	1.1
Adult mixed	n/a	69.4	2.1	14.6	2.8	11.1
126–150 m						
Calf	n/a	70.3	24.1	2.5	0	3.1
Juvenile	n/a	36.8	42.1	2.6	10.5	8.2
Adult mixed	n/a	64.9	3.9	2.6	13.8	16.8
>150 m						
Calf	n/a	66.5	21.1	4.6	0	7.8
Juvenile	n/a	40.2	42.5	2.2	13.2	1.9
Adult mixed	n/a	30.4	5.1	3.9	55.6	5.0
Control						
Calf	n/a	65.8	25.8	4.2	0	4.2
Juvenile	n/a	46.8	29.5	3.1	15.5	5.1
Adult mixed	n/a	55.7	7.2	8.8	17.8	10.4

Values in parentheses represent percentages of behavior within each distance zone with "interaction" removed.

nile groups, and 92.9% for adult-mixed groups are significantly different; however, there is no pattern to indicate behavior is different in proximity to the vessel.

Table 4.7 summarizes the percentage of group types observed across the distance zones in the experimental treatment. No correlation between distance zone and the percentage of calf groups present was found ($\rho = 0.071$, $p = 0.879$). However, a negative correlation between distance zone and the percentage of juvenile groups ($\rho = -0.893$, $p = 0.007$) and a positive correlation between distance zone and the per-

Table 4.6. Chi-Square Values for Comparison of Beluga Behavior Types Observed Under Experimental (Passenger Vessel) and Control Conditions in Churchill, Manitoba in 2005 and 2006

	0–25 m	26–50 m	51–75 m	76–100 m	101–125 m	126–150 m	>150 m	Control
Calf groups								
0–25 m								
26–50 m	57.61**							
51–75 m	29.25**	25.45**						
76–100 m	41.42**	21.83**	2.16					
101–125 m	48.03**	31.45**	16.60*	14.29*				
126–150 m	55.14**	57.89**	23.23**	19.03**	27.35**			
>150 m	43.99**	29.70**	3.00	1.17	11.93*	13.32*		
Control	47.95**	40.20**	5.35	5.24	12.72*	8.87*	1.57	
Juvenile groups								
0–25 m								
26–50 m	3.14							
51–75 m	1.44	5.88						
76–100 m	5.54	23.14**	20.67**					
101–125 m	12.62*	27.96**	26.51**	5.16				
126–150 m	4.07	20.92**	20.74**	15.88**	14.18*			
>150 m	5.03	18.90**	16.39**	7.62*	5.10	4.42		
Control	5.01	21.95**	25.38**	5.51	4.36	5.14	4.65	
Adult mixed groups								
0–25 m								
26–50 m	29.64**							
51–75 m	5.05	21.86**						
76–100 m	112.00**	35.64**	80.33**					
101–125 m	144.74**	49.14**	95.34**	22.72**				
126–150 m	212.80**	79.81**	163.51**	15.50*	26.22**			
>150 m	27.12**	42.13**	28.07**	67.50**	118.43**	143.55**		
Control	97.79**	29.17**	65.91**	1.14	16.90**	18.27**	63.50**	

*Significant at 0.05; **significant at 0.01.

centage of adult mixed groups ($\rho = 0.857$, $p = 0.014$) existed. Although the percentage of calf groups observed remained relatively constant across all distance zones, with decreasing distance to the vessel there was an increased percentage of juvenile groups and a decreased percentage of adult mixed groups recorded.

Finally, within the control treatment there was a much smaller percentage of juvenile groups observed compared to calf or adult mixed groups; there were also significantly fewer observations of juvenile groups in the control than in the experimental treatment.

Kayak

We attempted 105 focal follows from the kayak and completed 103, on five separate kayak trips. We spent 6 hours and 26 minutes within 500 meters of whales and

Table 4.7. Percentage of Beluga Whale Group Types Observed Under Experimental (Distance Zone From the Passenger Vessel) and Control Conditions in Churchill, Manitoba in 2005 and 2006

Experiment (Distance Zone)	Calf	Juvenile	Adult Mixed
0–25 m	32.4%	54.0%	13.7%
26–50 m	36.4%	45.7%	17.9%
51–75 m	44.6%	40.6%	14.9%
76–100 m	44.4%	18.5%	37.0%
101–125 m	40.0%	17.6%	42.4%
125–150 m	20.5%	16.1%	63.4%
>150 m	40.2%	18.0%	41.8%
Control	40.8%	9.1%	50.2%

recorded a total of 2 hours, 34 minutes, and 5 seconds of focal groups within 100 meters. Table 4.8 shows the number of focal groups, total time spent, and the number of passes and interactions per minute for each group type. There was no statistically significant difference in the average time focal groups spent within 100 meters, by group type [$F(2)=0.935$, $p=0.396$). However, there was a statistically significant difference between group types for passes [$F(2)=4.19$, $p=0.018$] and interactions [$F(2)4.951$, $p=0.019$] per minute. Table 4.9 shows the results of Tukey's post hoc tests in which, for passes per minute, juvenile was significantly different than adult mixed, and for interactions per minute juvenile was significantly different than calf and adult mixed. Adult mixed groups showed less propensity to pass or interact with kayaks than the other two group types, while juveniles showed a significantly greater tendency to interact. There were no occasions in which a focal group did not exhibit at least one pass or interaction behavior during the sampling period.

Snorkeling

We attempted 75 focal follows with a snorkeler in the water alongside a zodiac and completed 72, on six separate snorkeling trips. We spent 7 hours and 15 minutes within 500 meters of whales and recorded a total of 3 hours, 7 minutes, and

Table 4.8. Number of Samples, Time Spent, and Number of Passes and Interactions by Group Type in Proximity to Kayaks

	Calf	Juvenile	Adult Mixed
Number of focal groups	9	64	30
Total time spent with group type	11:23	31:52	50:50
Average time per focal group	1:16	1:26	1:42
Total number of passes	52	148	166
Mean passes per minute	4.57	4.64	3.27
Total number of interactions	51	196	137
Mean interactions per minute	4.48	6.15	2.70

Table 4.9. Tukey's Post Hoc Significance Results (*p*-Value) Between Group Types for Passes and Interactions per Minute Within 100 Meters of Kayaks

	Passes per Minute		Interactions per Minute	
Group Type	Calf	Juvenile	Calf	Juvenile
Calf				
Juvenile	0.216		0.038	
Adult mixed	1.000	0.026	0.627	0.050

8 seconds of focal groups within 100 meters. There was no statistically significant difference in the average time focal groups spent within 100 meters, by group type [$F(2)=2.161$, $p=0.123$]. There was no statistically significant difference between group types for passes per minute [$F(2)=1.689$, $p=0.192$] (see Table 4.10). However, there was a statistically significant different difference for interactions per minute [$F(2)=3.258$, $p=0.044$]. Table 4.11 shows the results of Tukey's post hoc tests in which, for interactions per minute, juvenile was significantly different than calf. Juvenile groups showed a greater propensity to interact with the snorkeling vessel and associated snorkeler than the other two groups. There were no occasions in which a focal group did not exhibit at least one pass or interaction behavior during the sampling period.

There were only three occasions in which belugas approached within reaching distance of the snorkeler. These occurred among three different focal groups, twice with a single individual in a juvenile group and once with a juvenile animal in an adult mixed group.

Vessel Tracking

Figure 4.3 presents the GPS tracks ($n=15$) recorded during whale-watching trips conducted in 2005 and 2006. Figures 4.4 and 4.5 present the GPS tracks recorded during kayaking ($n=5$) and snorkeling ($n=6$) trips in 2006, respectively. The majority of the whale-watching activity in 2005 and 2006 occurred near the mouth of the river, between Fort Prince of Wales and Cockles Point.

Table 4.10. Number of Samples, Time Spent, and Number of Passes and Interactions by Group Type in Proximity to Snorkelers

	Calf	Juvenile	Adult Mixed
Number of focal groups	11	35	29
Total time spent with group type	0:27:37	1:07:11	1:52:20
Average time per focal group	0:02:31	0:01:55	0:03:11
Total number of passes	23	116	97
Mean passes per minute	0.83	1.73	0.86
Total number of interactions	5	169	84
Mean interactions per minute	0.18	2.52	0.75

Table 4.11. Tukey's Post Hoc Significance Results (*p*-Value) Between Group Types for Passes and Interactions per Minute Within 100 Meters of Snorkelers

	Passes per Minute		Interactions per Minute	
Group Type	Calf	Juvenile	Calf	Juvenile
Calf				
Juvenile	0.948		0.040	
Adult mixed	0.584	0.174	0.669	0.148

Discussion

Interviews with the whale watch operators in Churchill yielded several important issues for consideration in the development of regional management recommendations for whale watching in Churchill. First, local concerns about compliance with the suggested minimum approach distance (100 meters) seem well founded, given the consistent density of belugas occupying the Churchill River and the tendency of local belugas to be attracted to vessels. We recorded belugas, especially juvenile and calf groups, spending up to 50% of their time interacting with the passenger vessel when within 25 meters.

Second, commercial operators were not opposed to the idea of establishing a commercial licensing scheme. Rather, they were concerned that the financial implications of licensing that might restrict their ability to maintain or increase the number and/or size of vessels in their fleets. A commercial licensing program could alleviate their concern regarding industry growth, because a license would require compliance with specific operating requirements addressing issues of public safety and potential disturbance to belugas.

Third, it would be beneficial to initiate dialogue among regional stakeholders in order to harmonize the needs of those with consumptive and nonconsumptive interests in marine mammals. Subsistence hunting of beluga is an Inuit aboriginal right. With respect to belugas in the Churchill area, the Nunavut Land Claims Agreement Act (1993) stipulates that the Nunavut Settlement Area (NSA) includes the marine waters north and west of Churchill. Although subsistence hunting for belugas occurs infrequently in the Churchill River estuary, this activity does have a socioeconomic effect on the tourism industry because it appears to result in a temporary avoidance by belugas of areas habitually used by commercial tour operators. Avoidance of the vicinity following beluga hunts in Eastern Hudson Bay was also reported by Caron and Smith (1990).

Fourth, the change in beluga habitat use noted by commercial operators in 2005 (which also occurred in 2006) emphasizes the importance of adaptive management; local guidelines may need to be changed as new information becomes available, such as future changes in habitat use. Therefore, the habitat around Mosquito Point should still be considered an important whale-watching area, as it is premature to conclude a trend towards habitat abandonment from 2 years of observation.

The behavior analysis in this study also points to some important recommenda-

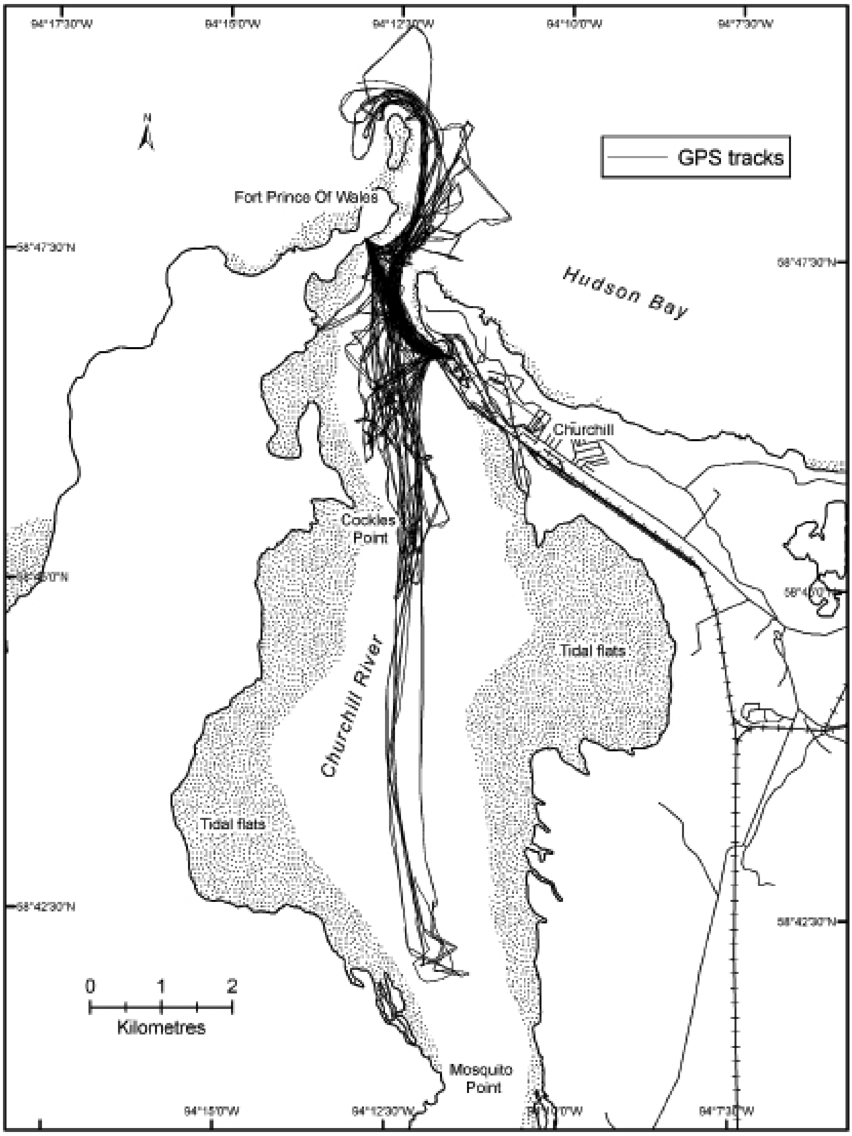

Figure 4.3. Passenger vessel tracks ($n=15$) from 2006 and 2007.

tions for consideration in future management of whale watching in Churchill. First, belugas in the Churchill estuary appear to be attracted to boats, regardless of type. With respect to the passenger vessel, while interaction could not be included in chi-square tests for statistical difference, the high percentages of interaction for all group types in the 0–25-meter zone reveal a significant and important difference in behavior close to the vessel. This attraction and associated interaction behavior in Churchill will require consideration of cautious vessel operation, such as no-wake speed, during whale-watching protocol design.

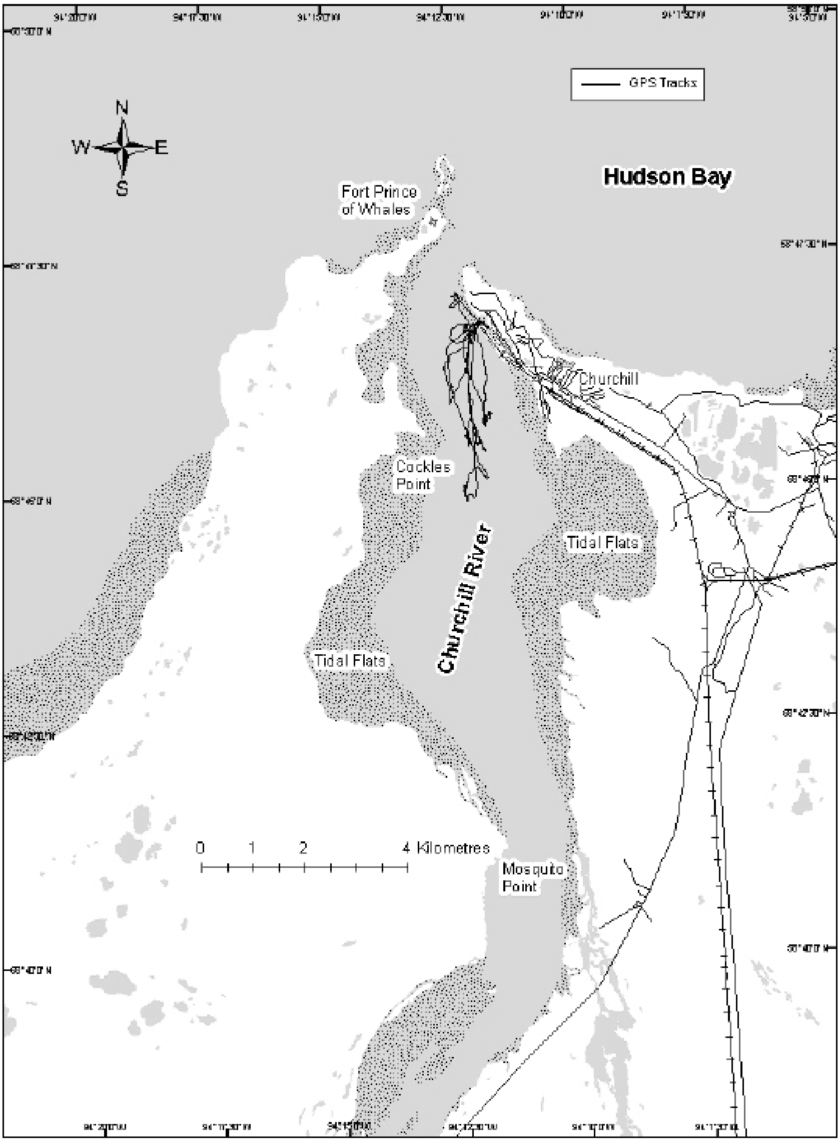

Figure 4.4. Kayak tracks ($n=5$) in 2006.

Second, the entire sample demonstrated a statistically significant increase in feeding behavior in the >150-meter zone versus the closer zones (see Tables 4.5 and 4.6). This greater prevalence of feeding at the farther distances from the vessel may not indicate a disturbance of feeding in closer zones, however, as nursing calves as well as adults and juveniles feeding on capelin were documented near the vessel. In this case, the observation of increased feeding at the farthest distance zone was most likely documented as the operator of the vessel upon which research was conducted intentionally maintained distance between the vessel and

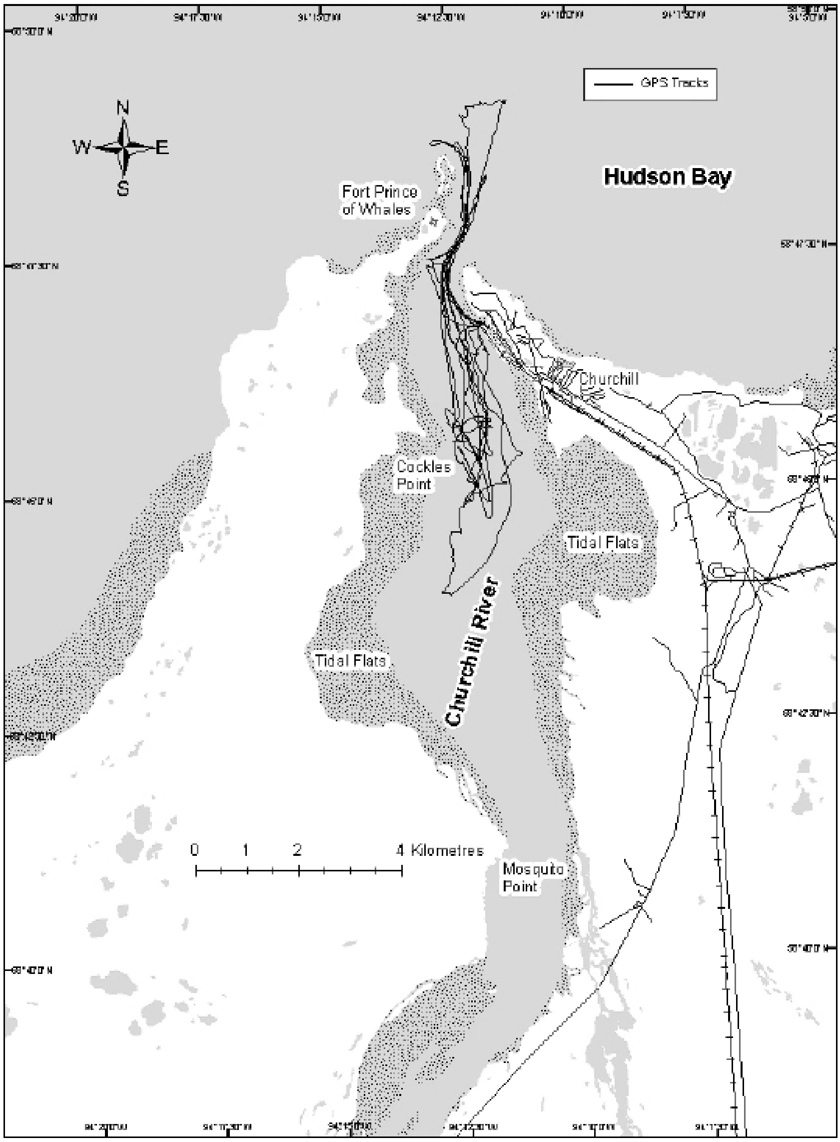

Figure 4.5. Snorkeling trip tracks (n=6) in 2006.

feeding aggregations. Although other researchers have also demonstrated continued feeding by belugas in close proximity to local vessels (Fish & Vania 1971; Stewart et al., 1982), others (Gerlatto & Fréon, 1992) have reported that vessels passing over schooling fish can cause the prey to dive or disperse. For this reason, a recommendation that beluga feeding aggregations be avoided is appropriate. In addition, prey dispersal would not only affect belugas but also piscivorous birds and predatory fish that also benefit from feeding aggregations in the Churchill River estuary.

Third, the statistical differences in behaviors within group types across distance zones did not reveal a consistent pattern. The statistical differences were either variable with decreasing distance to the vessel or were consistently present between all distance zones. As a result, there was no indication of significant behavioral differences between zones close to the vessel and those farther away that could be interpreted as behavior alteration due to the proximity of the whale-watching vessel. In other words, while some statistically significant differences exist in the dataset, there is no indication of biological significance. Similar conclusions, based on variability of cetacean surface behavior in other whale-watching studies, were reached by Bass (2000), Duffus and Baird (1995), Duffus and Dearden (1993), and Trites and Bain (2000).

Fourth, there was important variability in the proportions of the time different group types spent in proximity to the vessel (see Table 4.7). All group types spent large proportions of their time interacting when within 25 meters of the vessel. However, calf groups did not appear to avoid the vessel, showing no statistically significant variability in their presence with decreasing distance to the vessel. Juvenile groups were particularly attracted to the vessel, showing a statistically significant increase in presence with decreasing distance to the vessel. Adult mixed groups exhibited a negative correlation between presence and decreasing distance to the vessel.

The negative correlation between adult mixed group presence and distance from the vessel is not necessarily an indicator of disturbance. In general, across all distance zones, calf, and particularly juvenile, groups exhibited higher proportions of socializing behavior than did adult mixed groups, which primarily exhibited traveling and feeding behaviors. Interaction is hypothesized to be closely related to socializing, perhaps representing a form of "play." Some of the actions within both behaviors are similar: rolling, rubbing (each other, the vessel), changes in orientation, blowing bubbles. This hypothesis follows from animal behavior theory, which suggests that older mammals are less likely to engage in play behavior, that the movements of play are generally borrowed from other behaviors (e.g., socializing), and that play can also involve other species or inanimate objects (e.g., vessels) (Fagen, 1981; Grier & Burk, 1992; Loizos, 1966). If this is the case, and there is a socializing/play component to interaction, adult mixed groups may have chosen not to engage in interaction as often, similar to their lower percentage of socializing (see Table 4.5); therefore, adult belugas may have more often refrained from approaching the vessel due to disinterest rather than avoidance. When in close proximity to the vessel, adult mixed groups spent over one third of their time interacting.

This "play" hypothesis may also explain the relative lack of juvenile groups in the control treatment of the study. Juveniles spent the highest proportion of time socializing and the vessel may provide a stimulus for an alternative or play mode of this behavior. In the control data there may be few juvenile groups because there are no vessels present. When vessels are present, they may serve as an attractant to juveniles, who break off from adults that are not as interested in socializing or play.

Fifth, although the behavior results in this study differ from those of Blane and Jaakson (1994), who documented reactions by St. Lawrence belugas to close vessel approaches, this may be attributed to differences in research design and independent environmental variables. In Churchill, there are many fewer vessels, reduced temporal access to view belugas, higher population size and densities, and the belugas are in comparatively better health (e.g., Martineau et al., 2002; Metcalfe, Metcalfe, Ray, Paterson, & Koenig, 1999; Muir et al., 1996). The amount of time Churchill belugas observed in this study spent in proximity to the vessels may be indicative of habituation, making our results more comparable to studies of other Arctic belugas in response to fishing boats or purposeful harassment (Fish & Vania, 1971; Stewart et al., 1982).

The high incidence of interaction in our study may also indicate habituation, or socializing/play, which is most likely to be observed under relaxed or familiar conditions (Grier & Burke, 1992). The observations in this study of undisturbed resting within 50 meters of the vessel, as well as nursing right next to the vessel, may also indicate habituation.

With respect to kayak and zodiac snorkeling activities we were not able to undertake the detailed studies we could from the passenger vessel. However, we were able to collect data in both cases that show similar trends to behavior in the presence of the passenger vessel. In both cases, group types, when within 100 meters of either type of vessel, remained within this distance for similar periods of time. However, juvenile groups again demonstrated statistically greater attraction to the vessels, exhibiting higher rates of passes and interaction, while adult mixed groups again showed less inclination to engage in these activities. These trends were stronger for kayaks than the snorkeling zodiacs, perhaps because all groups showed more tendencies to be attracted to kayaks than the snorkeling zodiacs.

The most important aspect to understand with respect to group types is therefore the difference in their most prevalent behaviors. Juvenile groups exhibited a high proportion of socializing in most distances zones and the greatest attraction to interact with the vessels; adult mixed groups exhibited traveling and feeding almost to the exclusion of all other behaviors, and were least attracted to the vessels to interact; calf groups did not display strong tendencies, exhibiting interaction in similar proportions to the other groups, resting in proximity to the passenger vessel, and maintaining a similar presence percentage across all distance zones from the passenger vessel (see Table 4.5).

Management Considerations for Churchill

By integrating the social and natural scientific data collected, the following considerations are presented for further discussion regarding the future management of whale watching in Churchill. Unless otherwise noted, recommendations for vessel operation with respect to minimum distances and in regards to beluga group types apply to all vessel types studied in this report. These considerations are grouped into operational, industry and research initiatives.

Operational Considerations

1. Although a 100-meter precautionary approach distance (either as a guideline or legislated restriction) is used in several other jurisdictions domestically and internationally (e.g., British Columbia, Newfoundland, various states in the US,

New Zealand, Australia, Argentina) it appears, from observations collected during this study, that 25 meters would be an appropriate minimum approach distance for the Churchill River, given the geography of the river, the density of belugas, their apparent habituation to vessels, and propensity to approach and interact with them. Maintenance of 25 meters will allow belugas to initiate and control approach and interaction.

2. Establish two "Caution Zones": one near the mouth of the Churchill River and one upstream near Mosquito Point (see Figure 4.6). These areas were most often used for commercial whale watching, based on GPS tracks collected in 2005 and 2006 and the information provided by commercial operators regarding beluga habitat use before 2005.
3. Establish a "Travel Corridor" over the deep central channel connecting the two proposed Caution Zones (see Figure 4.6).
4. If the suggested 25 m minimum approach distance is accepted for Churchill, the following vessel speeds would be appropriate:
   i. Within each Caution Zone speed should not exceed 15 knots when belugas are within 26–100 meters, and 6 knots (no wake) when belugas are within 25 meters of the vessel (given their propensity to approach and interact with the vessel).
   ii. Within the Travel Corridor speed should not exceed 30 knots and vessel operators should maintain a straight-line direction of travel to enable subsurface or undetected whales to judge vessel speed and direction and minimize their reactions to it (*sensu* Blane & Jaakson, 1994). If whale watching is undertaken within or adjacent to the Travel Corridor then Caution Zone protocols should apply.
5. If the suggested 25 meter minimum approach distance is accepted for Churchill, vessels should not actively approach closer than 50 meters to beluga feeding aggregations, to avoid the possible dispersal of schooling fish (*sensu* Gerlatto & Fréon, 1992). Feeding belugas may voluntarily approach more closely, as belugas were observed feeding close to the vessels in this study. This protocol will require that vessel operators (including kayakers) are able to recognize feeding aggregations. This may require education by the guide for kayakers during the trip.
6. A motorized "safety" vessel, such as a small zodiac, should be required to accompany all kayak trips.
7. Commercial operators should consider the variability in approach and interaction behaviors exhibited by beluga group types by reducing the time spent paralleling adult and/or adult mixed groups, which exhibited fewer tendencies to approach vessels. Following this protocol will make disturbance to beluga life processes less likely. This may require education from the guide on kayak trips.
8. Consideration should be given to licensing commercial marine tour operators. This would establish enforceable operating standards to ensure that beluga life processes are not adversely affected by any future expansion of local commercial whale-watching activities.
9. In Churchill, as in other northern areas, it will be beneficial to initiate dialogue

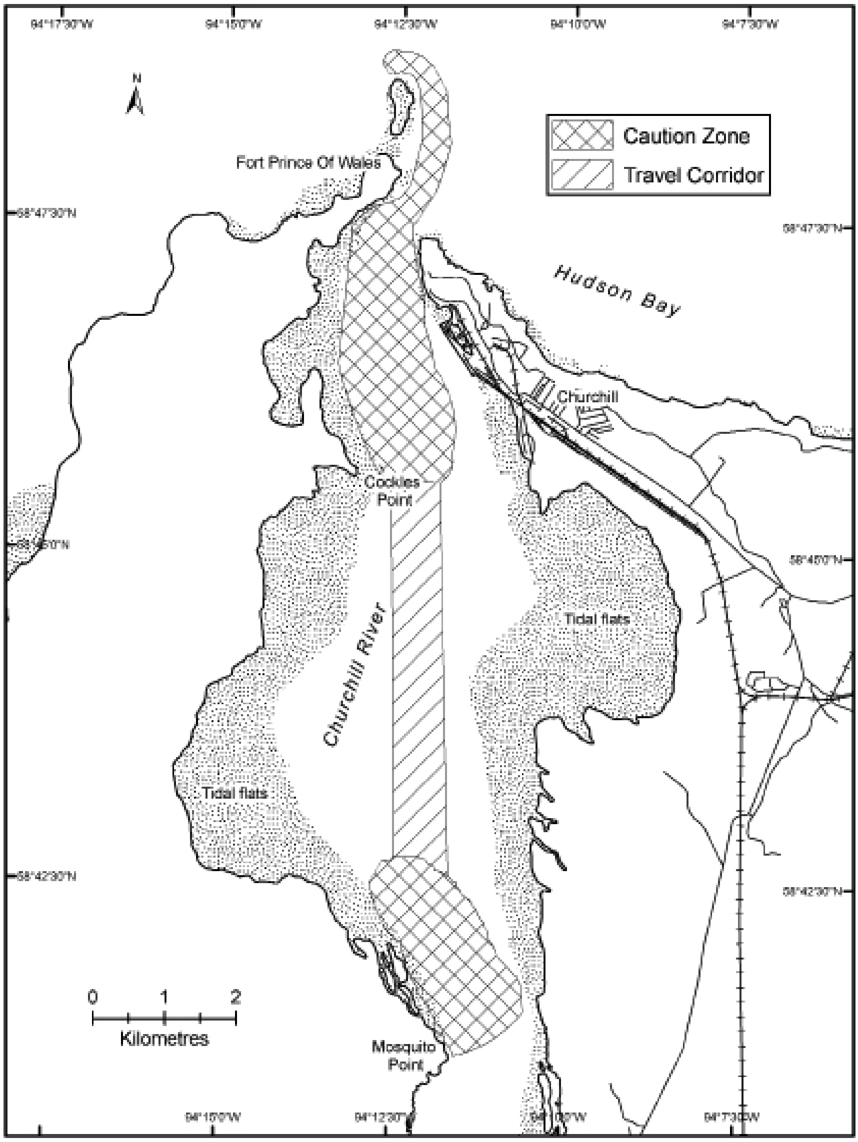

Figure 4.6. Recommended Caution Zones andTravel Corridor for whale-watching activities in the mouth of the Lower and Mouth of the Churchill River.

among stakeholders in order to harmonize the needs of consumptive versus nonconsumptive users of marine mammals.

Industry Considerations

10. The local tourism industry association should be engaged to provide a community voice in discussions regarding the management of whale watching in

Churchill. This engagement could provide advice on minimum operating standards required for future expansion of the industry, and participation in the development of a local code of ethics that would minimize the level of disturbance to which belugas are exposed.

Research Considerations

11. Researchers should continue to examine the spatial habitat use of the Churchill River estuary by belugas, to identify areas that may be used preferentially by different life stage groups for critical life processes such as feeding or resting. Churchill is currently one of the few established Canadian whale-watching locations where whale behaviors can still be observed for extended periods of time each day in the core whale-watching area without vessel disturbance. This situation provides an opportunity to gather baseline behavior and habitat use data for the adaptive management of the local whale-watching industry.
12. The question of habituation should be explored further to determine what behaviors belugas may exhibit towards novel vessels added to their environment. This knowledge will inform future discussions regarding expansion and management of the industry. Understanding gained through Recommendation 11 will be beneficial in this research.
13. The socioeconomics of whale watching in Churchill should be researched to gain an understanding of: the cost of operating a whale watching company in Churchill; numbers, types, capacities, and typical activities of vessels currently in operation; the number of tourists participating in the activity; and the financial benefit to the operators and the Town of Churchill. This knowledge will help guide any future development of the industry; participation of the local tourism association would be invaluable in this endeavor.

Conclusion

This research illustrates the value of integrating social and natural science within a single project. We were able to better understand issues important to whale watch operators and incorporate local knowledge of beluga behavior and habitat use, as well as study beluga–vessel interactions, to develop recommendations for consideration regarding the future management of whale watching in Churchill. We were also able to identify further research required to address both ecological and socioeconomic issues related to whale watching. Churchill currently provides the unique whale-watching experience in Canada of few vessels and hundreds of whales, many in close proximity, interacting with whale-watching vessels of various types. Careful management consideration should be given to maintaining this experience during future development of guidelines and regulations.

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