Summary of killer whale and human activities in the Robson Bight Ecological Reserve and adjacent waters during the summer of 1990

Prepared for:

The Ecological Reserves Program
Ministry of Parks
Victoria
2nd Floor, 800 Johnson Street
Victoria, BC
V8V 1X4

Prepared by:

David A. Briggs
131 Bethany Curve
Santa Cruz, CA
95062

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Executive Summary

Killer whales regularly visit Johnstone Strait. These orcas, members of the northern resident population, spend much of their time in the Robson Bight area. Most of this time is spent at the rubbing beaches. The rubbing beaches are well known as important orca habitat. Public interest has increased since the Robson Bight Ecological Reserve was created in 1982. People are concerned that human activity in the reserve and adjacent waters and lands may threaten the whales' use of the area. Results from a previous study indicate that the whales' use of the rubbing beaches, and possibly of the entire reserve, are decreasing.

This study was commissioned by BC Parks to examine the usage of the entire reserve by orcas and the impact of human activity on the behaviour of the whales in the reserve and adjacent waters. An assessment of the BC Parks information officer program was included to determine this program's effectiveness in preventing boaters from entering the reserve to view whales. It was conducted during July and August 1990 at a site directly across from the reserve. The study team made observations from a cliff site across from the reserve to enable observations of the reserve and adjacent waters. Observations from studies at the rubbing beaches in 1987 and 1989 are also considered in the analysis.

Whale Use of Johnstone Strait and the Reserve

A total of 193 whales were counted in the northern resident population of killer whales in 1990. Of these, a total of 13 pods with 115 whales frequented Johnstone Strait during the study period. More than 89 percent of the whales seen in Johnstone Strait were observed in the reserve and at the rubbing beaches during the 1987, 1989 and 1990 study periods. Whales visited the reserve on most days that they entered the strait. The number of whales visiting the reserve at any one time ranged from several individuals to more than 90. Beach rubbing at the rubbing beaches was the predominant activity, after travelling, in the reserve. The bight was used mostly for resting and foraging and the areas east and west of the bight were used mostly for travelling. Much foraging and socializing occurred as the whales travelled. The whales spent most of their time at the rubbing beaches (37 percent) and in the bight (34 percent).

The length of time that whales spent in the reserve during 1990 ranged from several minutes to just over five hours. Whales spent 21 percent of their time in Johnstone Strait in the reserve. This is only slightly less than the figure of 24 percent that Ford recorded during 1978-1980. However, the whales use of the rubbing beaches declined for the third consecutive year of study, from 9 percent to 8 percent. Although the average length of a visit by whales to the rubbing beaches increased during 1990, it appears that the whales use of the beaches is decreasing. Proportionately, the decline in time spent by whales at the beaches is greater than that in the strait and the proportion of whales in the strait which also visited the beaches decreased.

Whale/Human Interaction on Water

Vessels accounted for most (98%) of the human activity in the ecological reserve during 1990 and at the rubbing beaches during 1987, 1989 and 1990. Commercial fishing boats, which are exempt from reserve restrictions, accounted for 85 per cent of the marine traffic in the reserve during 1990. During part of July and all of August, commercial fishing boats were present for 24 hours each day, 4-7 days a week. They moored and fished throughout the reserve, but the bight received the most use. At the rubbing beaches and in the bight, fishermen watched whales and landed on shore.

Whale oriented boats (such as recreational boaters, kayakers, commercial whale watching, research, photography and film crews) and general marine traffic made up the remaining 15 per cent of vessels in the reserve. Most of this activity was in the bight and west of the bight. BC Parks Visitor Information Officers contacted whale oriented boats which travelled towards the reserve, diverted them out of the reserve and provided them with information on the reserve and the whales with the aid of a pamphlet outlining whale-watching guidelines.

Whales reacted to 23 percent of the vessel interactions in the reserve with a negative reaction, although in 27 percent of the cases the response by the whales was unobserved. Commercial fishing vessels had the highest number of interactions and the highest reaction rate. Recreational boats, other whale oriented traffic and the information officers accounted for most of the remaining reactions. The reaction rates were highest at the rubbing beaches and in the bight. The reaction rates at the beaches during 1990 are lower than recorded during 1987 and 1989 because 59 percent of the responses at the beaches during 1990 were unobserved due to a bad angle of visibility from the study site. This may also give a false low rate for the reserve as a whole.

In the waters immediately adjacent to the ecological reserve, whales interacted with boats during 77 percent of the approaches to the reserve. Commercial and recreational whale-watching boats were present during most (96 percent) of these and accounted for the majority of interactions. Commercial fishing vessels were usually present as well. Whales were more likely to not enter the reserve during commercial fishing activity than at other times. When boats were present, whales usually did not alter their use of the reserve, although they were more likely to not enter the reserve. The whales did change their behaviour if followed to the rubbing beaches by boats. This would usually result in the whales spending less time there.

Interactions on the water resulted in a reaction by the whales 20 per cent of the time, with the whales changing direction away from the reserve (most common), changing their activity state or passing by or rubbing for shorter periods of time at the rubbing beaches.

Whale/Human Interaction on Land

Very few interactions resulted from the presence of people on land as access by land is limited in that area. During 1990, all were from boat landings west of the bight, although one rubbing beach shore was out of view from the study site. No reactions by the whales were observed west of the bight, although there may have been unobserved landings and reactions at one rubbing beach.

Records of human activity on the land adjacent to the reserve indicate that logging was the predominant activity. This was particularly evident to the east of Robson Bight, along Johnstone Strait, where a new logging road has been built. Large dust clouds from trucks on these roads were clearly visible. Blasting was heard east and west of the reserve and in the Tsitika valley.

Visitor Information Officer Program

The visitor information officers were observed contacting about half of the boats (other than commercial fishing boats) which entered the ecological reserve. The other half were not contacted either because the information officers were at camp, commercial fishing was taking place or because the boat was too fast to contact. Most of the boats which were contacted were contacted in the reserve. Most of the contacted boats left the reserve.

Analysis

The study indicates that the whales spend the majority of their time in the reserve at the rubbing beaches and in the bight. Interactions between vessels and whales both in the reserve and in the waters immediately adjacent to the reserve affect the whales use of the reserve in the short term, especially at the rubbing beaches and in the bight.

The information officers contacted a large number of whale oriented boats and diverted them out of the reserve, although an equal number of these boats entered the reserve without being contacted.

Although the study may not be long enough to detect meaningful long-term impacts, the whales' use of the reserve has declined slightly from that observed ten years ago and the use of the rubbing beaches has declined each of the last 3 study periods. Furthermore, the decline in whale usage observed at the rubbing beaches may be proportionately greater than that observed in the strait in general.

Conclusion

At this time, we cannot be sure whether the decline in Johnstone Strait and at the rubbing beaches has resulted from an accumulation of human disturbances in the region or whether it has resulted from other environmental changes, such as food supply. The number of whales observed in the Strait and in the reserve has decreased from previous years. The reason for this is unknown. However, the larger decrease in the time spent by whales at the beaches suggests it may be independent from the decrease observed in the Strait and that human disturbance may be a factor in that decline. The bight is also heavily used by whales and boats and may be an area of concern in the future.

Table of Contents

List of Tables

List of Figures

List of Appendix Tables

Introduction

The waters within the Robson Bight Ecological Reserve in northern Johnstone Strait, British Columbia, are well known as an important killer whale habitat (Ford, 1981; Bigg, 1982; Rennie, 1982; Darling, 1986; Blood et al., 1988). This provincial ecological reserve was established in 1982 "...to protect key habitats for killer whales, prevent their harassment while using those habitats and maintain unique opportunities to research and observe killer whales; (and) to protect a pristine estuary and forested shorelines." (Ministry of Parks, 1987). The reserve is utilized by northern resident killer whales, a population which consists of 16 family groups or pods. This population increased in size by 2% from 189 to 193 between 1989 and 1990 (Appendix Tables 1 and 2).

Studies by Kruse (1984), Briggs (1985), Darling (1986), Duffus and Dearden (1987) and Taylor (1988a,b) have examined some aspects of human impacts on killer whales in Johnstone Strait. But no detailed study on the whales' use of the reserve was carried out until Briggs (1988, 1991) examined the whales' use of the rubbing beaches, the key habitat which attracts the whales to the reserve during 1987 and 1989. Briggs noted a decrease in the whales' use of the rubbing beaches from 1987 to 1989 and comparisons with a previous study indicate that the whales use of the reserve may have been twice as frequent during the summers of 1978 to 1980. Concerns were raised that human activities such as whale watching, commercial fishing and logging in the reserve and adjacent waters and lands might threaten killer whale use of this key habitat. This is why in 1990, the author was commissioned by the B.C. Ministry of Parks to examine the use of the entire ecological reserve by killer whales and the impact of human activities on the whales throughout the reserve and in waters adjacent to the reserve. An assessment of the visitor information program was also done to determine how well this program prevented boats from entering the reserve. B.C. Parks also expanded its information officer program to inform more visitors of boater restrictions in the reserve in 1990.

The 1990 study investigates the use of the reserve by the northern resident community of killer whales, identifies key areas of use and behaviours by the whales in the reserve and, where possible, assesses impacts from human activities both in and out of the reserve.

A field study was conducted from a site across the strait from the reserve during July-August 1990. Although two types of killer whale, called residents and transients, use the Johnstone Strait area, only the residents are considered here because transients do not typically use the reserve.

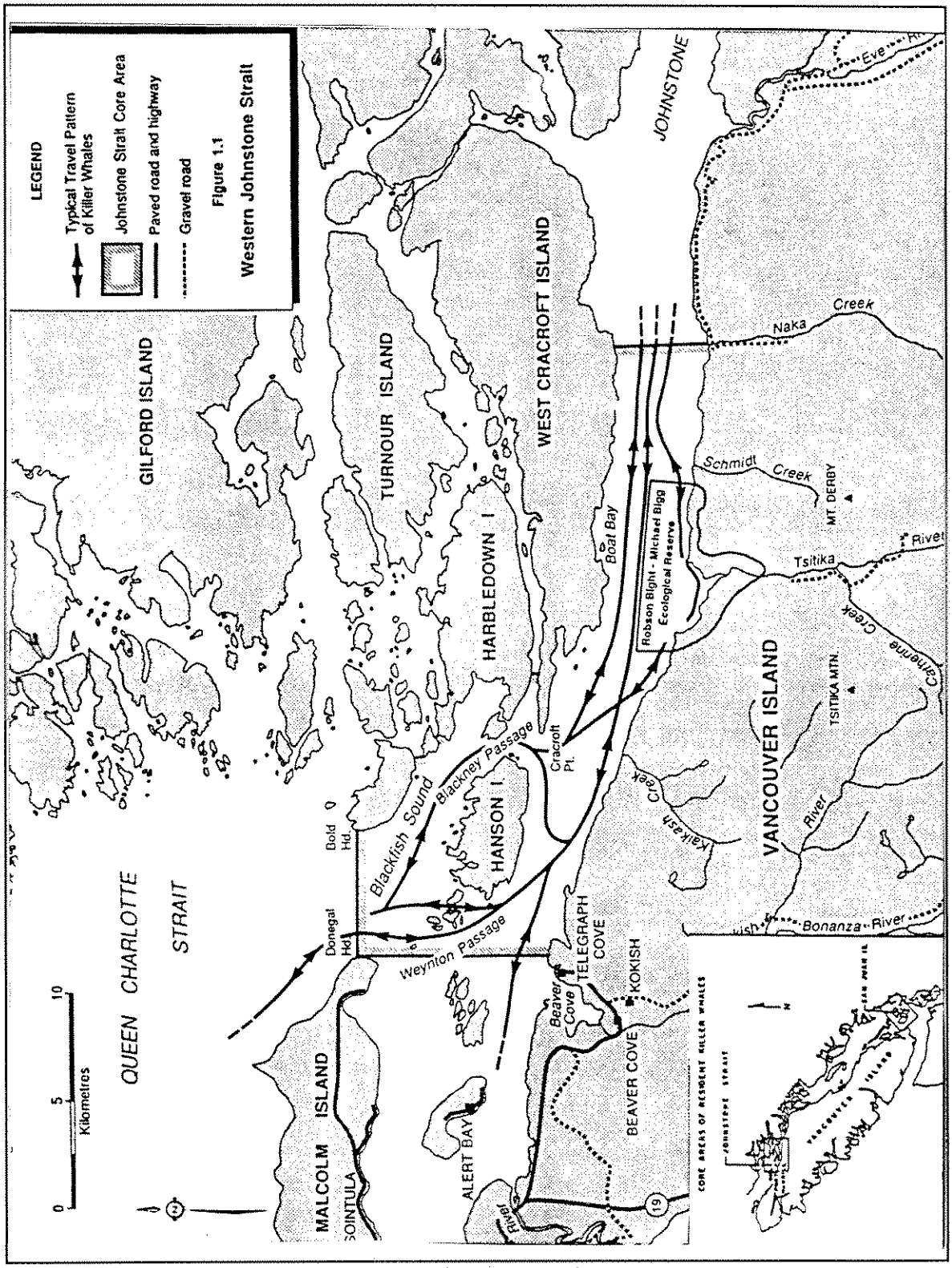

Figure 1: Robson Bight Study Area

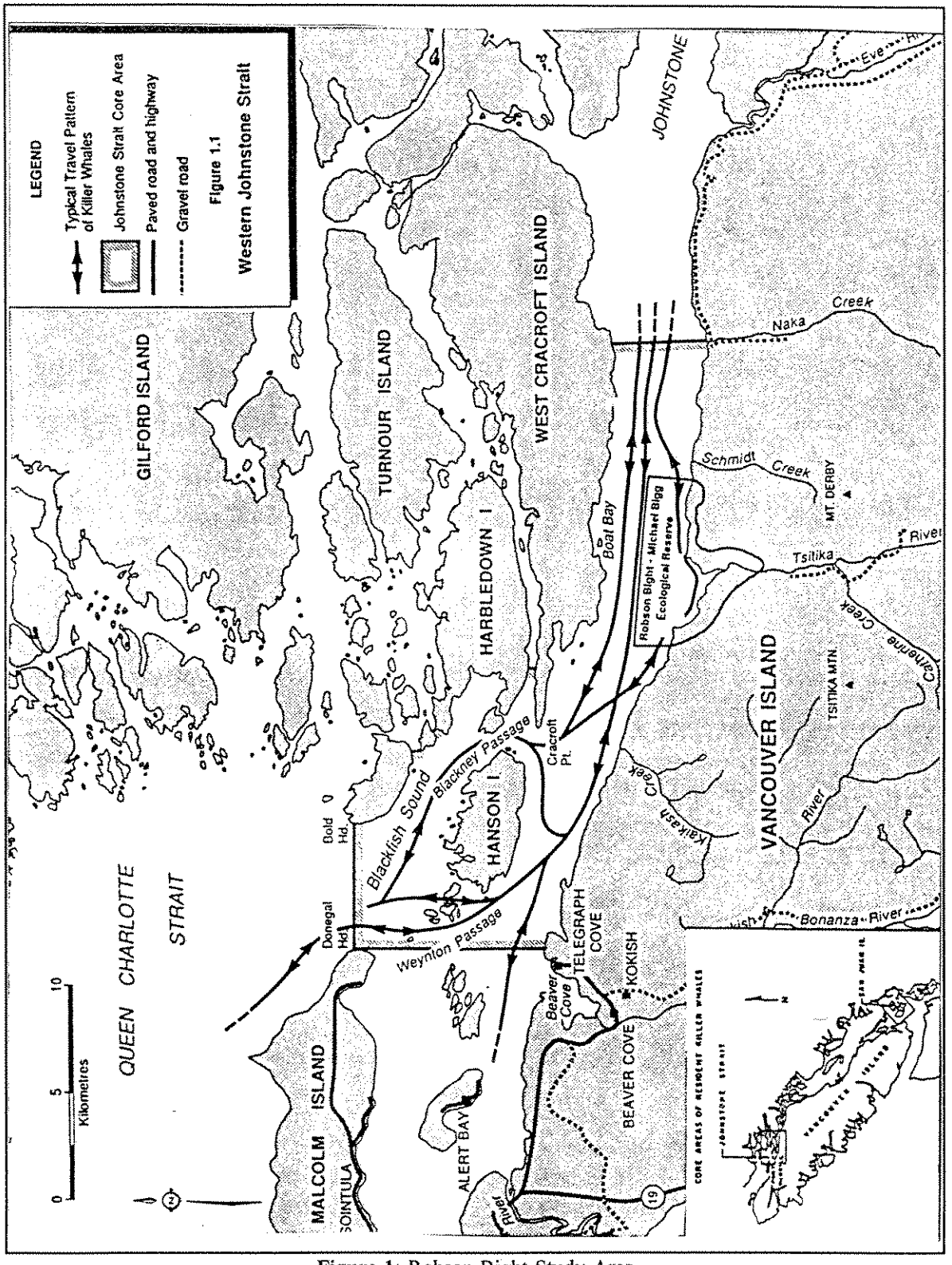

Figure 1: Robson Bight Study Area

Methods

Robson Bight Study Area

The study area (Fig. 1) includes six zones. The first zone for recording data is Johnstone Strait and for the purpose of this study includes the waters of Johnstone Strait from the west end of Hanson Island to the east end of the ecological reserve, and not north of Blackney Pass. The second zone for recording data is the water adjacent to the reserve and includes the waters of Johnstone Strait from approximately 2 km west of the western boundary of the Robson Bight reserve to approximately 1 km east of the eastern boundary and extends to West Cracroft Island across the strait. The next four zones are for recording data in the reserve and include the area from the shore out to the boundary offshore. The western most zone in the reserve is the area from west of the bight to the western boundary of the reserve. To the east of this zone is the bight itself. The area from east of the bight to the rubbing beaches is the next zone. The area from the rubbing beaches to the eastern boundary of the reserve is the last zone in the reserve.

The campsite at Boat Bay was used during the 1990 study. Observations were made from a cliff site approximately 1 km west of Boat Bay, except during bad weather and late in the day when observations were made at Boat Bay. Travel by boat to and from these sites occurred once a day and was postponed if conditions were bad. The entire reserve, except for the shore area at the eastern rubbing beach, was visible from the cliff site. We could determine when whales were present at the eastern rubbing beach, but it was not always possible to determine whale responses to interactions with human activity that occurred there.

Data Collecting Procedures

Research was conducted at Boat Bay and the cliff site from July 1 to August 31, 1990 (62 days). A minimum of four observers operated at each site, although only one site was occupied at one time. Observations of whale activity in Johnstone Strait were made 24 hours a day; human activity was primarily recorded from 8am-8pm. Observations of whale and human activity in the ecological reserve were recorded from 8am-8pm. Calculations for whale visits and whale hours in the reserve were derived by doubling the recorded observations of the 12 hour day to compare with earlier studies (Briggs, 1988; 1991) which recorded whale activity over 24 hours. Data used for whale responses to human activity are from the 12 hour day. During the day, individual whales were recognized visually by their unique natural markings (Bigg et al., 1987). At night, pods were recognized acoustically using a hydrophone to identify their dialects (Ford and Fisher, 1982).

Data collected on whale activity included: the time of day; the identity of individual whales; their location; direction of travel and activity state. Normal whale activities include foraging, travelling, resting, rubbing and socializing (for descriptions see Ford, 1984). For this study, socializing was recorded under the other activities. Foraging and socializing probably occurred often as the whales travelled. Whales were noted as to whether they were approaching the reserve and whether they entered or not. Whales were recorded as being in Johnstone Strait once they entered the first zone. Whale approaches to the reserve and human activities in the waters adjacent to the reserve occurred in the second zone. Whale and human activities in the reserve occurred in zones three-six (see Study Area, above).

A killer whale family group or "pod"* was recorded as being present if any of its members were observed within the study area. The specific "subpods"** and the precise number of individuals present were also noted whenever possible. The presence of a "subpod" was defined as including all or some of the members of that subpod. For the purposes of analysis, whale activities are broadly defined as follows:

- **one whale visit:** one arrival and continuous activity period into any of the six zones by one or more whales. A visit to one zone ended when entry into a new zone began.
- **one whale-day**: one individual whale present on a given day. Total whale-days were calculated by adding the total number of days during which each individual whale was present. For example, if whale A was present on 5 days and whale B was present on 12 days, this would account for a total of 17 whale days.
- **one whale-hour:** one individual whale present for one hour. Total whale-hours were calculated by adding the total number of hours during which each individual whale was present.

The levels of commercial fishing traffic, commercial and recreational whale-watching, and general marine traffic, both in and out of the reserve, were recorded. Human activities on land which were recorded included walking on shore, picnicking, sport fishing in the Tsitika River, making fires, camping and logging.

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*A "pod" is one or more "subpods" that tend to travel together (Bigg et.al. 1987)

**A "subpod" is one or more maternal groups (mother and her offspring) that tend to travel together (Bigg et.al. 1987).

Data recorded to document vessel activity included: vessel type; direction of travel; direction and distance from whales; and type of activity for commercial fishing boats. Types of fishing vessels were categorized as: commercial fishing boat travelling (cbt); commercial fishing boat fishing (cbf); and commercial fishing boat skiff (cbs). General marine traffic (gm) included tugs with barges (tb), tugs with log booms (tl), tankers (tc), military boats (mb), coast guard (cg) and fishery patrol boats (fo). Recreational boats (rb) included mainly small and large motorized pleasure craft and sailboats. Kayaks (kc), research (re), photography (ph) and TV/film crew (tv) boats were also observed. All pleasure craft were assumed to be recreational traffic although some were observed running supplies and people to the fishing boats moored in the area, and the purpose of their visit may have been related to commercial fishing. When these boats were observed interacting with commercial fishing vessels, they were classified as commercial fishing boat skiffs. A "**boat visit**" was defined as one arrival into one of the six study zones by one boat. One boat could make several visits in one day.

For boats, a "**whale-boat interaction**" (which may or may not have elicited a **whale reaction**) was considered to have taken place when the boat was within 300m of a killer whale. One whale-vessel interaction could involve one or more boats; conversely, one boat could be involved in several interactions. Similarly, a **shore-based interaction** between people and whales was considered to have taken place when people were on shore while whales were within 300m of them. Whale responses to each interaction in the reserve were noted. In waters adjacent to the reserve, the type and number of boats involved in the interaction were recorded and then one response per whale approach to the reserve was noted. The following terms were used to describe whale responses to an interaction:

In and out of the ecological reserve

1. No Reaction: No visible change in behaviour of the whale was observed.
2. Reaction: Evidence of some change in typical behaviour of the whale was observed. Evidence of reaction was classified as follows:
   a. Change Activity: The whales changed their activity state within one minute from the time that the interaction began.
   b. Change Direction: The whales stopped travelling in (or towards) the reserve, changed their direction of travel and continued to a different area in the reserve (or away from the reserve).

Rubbing beaches

   c. Leave the Area: The whales left the beaches within one minute from the time that the interaction began and did not return.
   d. Passed By: The whales were inside the rubbing beach zone but did not stop to rub.
   e. Leave and Return: The whales moved further away from the beaches within one minute from the beginning of the interaction, but then returned within five minutes following the interaction.
   f. Short Rub: The whales remained at the beaches for less than 10 minutes, which is an abbreviated rub.

The whale data obtained at the rubbing beaches has been supplemented by data on whale presence in Johnstone Strait wherever possible to aid in determining the usage of the strait by whales. Other researchers responsible for the collection of these data are Dr. Paul Spong and Ms. Helena Symonds (OrcaLab) and Ms. Naomi Rose (University of California, Santa Cruz). Sighting information was also collected by several local charter boats in the area, including Stubbs Island, Sea-Smoke and Robson Bight Charters.

Results

Killer Whale Distribution

More than 370 killer whales frequent the coastal waters of British Columbia. At least 280 of these are "resident" whales which are culturally specialized as fish eaters. The remainder are transients, a distinct population of whales that prey primarily on marine mammals. The resident population is separated into two communities: northern and southern. This report is concerned strictly with the former community.

The northern resident community of killer whales consists of 16 pods or family groups, with a total population of 193 in 1990. The known range of the northern residents extends from mid-way down Vancouver Island to northern British Columbia, excluding most of the west coast of Vancouver Island and the Queen Charlotte Islands (Bigg et.al., 1987). Although they have been seen anywhere in this range over the past 20 years, most pods are usually found in northern Johnstone Strait at some time between June and November each year. Such a predictable presence of killer whales appears to be unique, and for this reason, northern Johnstone Strait has been labelled "core" habitat for the northern resident community of killer whales (JSKWC, 1991).

Table 1. Number of Individual Killer Whales Sighted in Johnstone Strait during July-August, 1987-1990.

	1987	1988	1989	1990	1987-90
N. resident population	180	185	189	193	+7%
# in Johnstone Strait[2]	157	112	133	115	-27%
By Individual					
Total whale-days[2,3]	1,726	1,084	937	1,325	-23%
Total whale-hours	16,294	-	8,714	13,750	-16%
Mean # hours/whale/day	1.8	-	1.1	1.9	+6%
By Pod					
Mean # days/pod[2]	9.9	6.6	4.6	6.7	-32%
Total # visits	155	-	115	133	-14%
Mean # visits/day	2.67	-	1.92	2.15	-19%

1. See Appendix Table 1 and Appendix Table 2 for further details.
2. See Appendix Table 4 and Appendix Table 5 for further details.
3. Whale Days = Number of Subgroup Members x Number of Days Observed.

1. Presence in Johnstone Strait

The number of whales observed in Johnstone Strait during July and August of 1990 decreased by 14% from 1989 (Table 1). Although the number of whales seen in the Strait decreased between 1989 and 1990, the time they spent there increased by at least 41% during that same period, as indicated by the numbers of days and hours whales were seen (whale-days and whale-hours respectively). While still sighted on fewer days than during 1987, most whales showed an increase from 1989 to 1990. On average, the length of each whale visit to Johnstone Strait increased from 1.1 hours per day to 1.9 hours per day, which is greater than during 1987 (Table 1).

Pod diversity was low, but the whales which did enter the strait spent more time there. The decrease in pod diversity during 1990, however, caused the total whale-days and whale-hours to still be lower than recorded during 1987. All 16 resident pods visited Johnstone Strait during July and August 1987, but during 1988-1990 2-3 pods each year have not been sighted (Appendix Table 4).

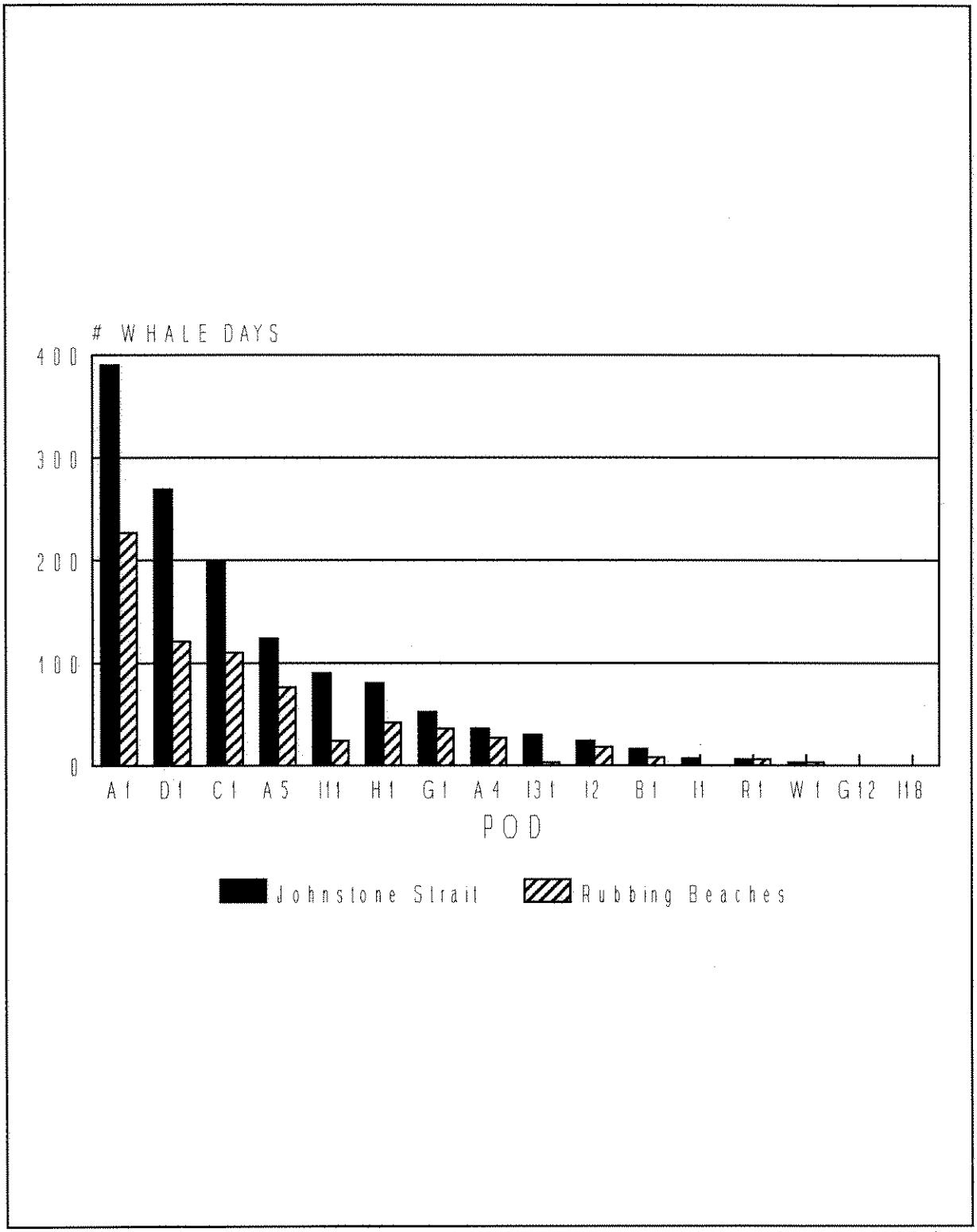

Figure 2. Killer Whale Use of Johnstone Strait and the Rubbing Beaches during July-August 1990.

Figure 2 shows the usage of Johnstone Strait by each pod, based on the index of whale-days. Pods A1, D1, C1 and A5 used the strait most often. Most (68%) subpods showed an increase or no change in the number of days sighted during 1990 and D pod, not seen at all during 1988 and 1989, was the second most frequently sighted pod during 1990.

Table 2. Occurrence of Killer Whales by Individual and by Pod in the Ecological Reserve during July-August, 1990.

		% of Johnstone Strait
Number in reserve1	108	94%
By individual whale		
Total whale-days	865	65%
Total whale-hours	2,867	21%
Mean number hours/whale	26.5	22%
By Pod		
Mean number days/pod	4.5	67%
Total number visits	204	153%
Mean number visits/day	3.29	153%

1. See Appendix Table 3 for a listing by subpod.

2. Presence in the Ecological Reserve

Most (94%) whales which were sighted in Johnstone Strait during 1990 entered the ecological reserve (Table 2). Whales entered the reserve on the majority of days that they entered the strait, as indicated by the number of whale-days and mean number of days per pod. The reserve received several visits by whales per day. The whales averaged 1.53 visits to the reserve per visit to the strait. The percentage of hours spent in the reserve of total time in Johnstone Strait was 21%. This is slightly less than the figure of 24% that Ford (1981) recorded during 1978-1980.

Table 3. Occurrence of Killer Whales by Individual and by Pod in the Four Areas of the Ecological Reserve during July-August, 1990.

	W of Bight	Bight	E of Bight	Beaches
Number in area[1]	105	105	103	103
By Individual Whale				
Total whale-days	651	696	626	701
Total whale hours	427	961	421	1,058
Mean number hours/whale	4.1	9.2	4.1	10.3
By Pod				
Mean number days/pod	3.5	3.7	3.4	3.8
Total number visits	144	154	154	126
Mean number visits/day	2.32	2.48	2.48	2.03

1. See Appendix Table 3 for a listing by subpod.

The whales spent most of their time in the ecological reserve during 1990 at the rubbing beaches (37%), but the bight was used nearly as much (34%), as indicated by the number of whale-hours (Table 3). This was true of most pods. Consistent daily visits to the bight and rubbing beaches is indicated by the high number of whale-days for these areas. A low number of total visits to the rubbing beaches (compared to the other zones of the reserve) is reflective of the whales often travelling through the other zones to and from the beaches. Visits to the bight and rubbing beaches were longer than visits to west and east of the bight, as indicated by the higher number of whale hours and similar (or lower) number of visits.

Table 4. Activities by Killer Whales in the Four Areas of the Ecological Reserve during July-August, 1990 as Indicated by the Number of Whale-Hours.

Behaviour	W of Bight	Bight	E of Bight	Beaches	Total
Travel	305	375	287	111	1,078
Rest	101	401	118	46	666
Forage	21	185	16	6	228
Beach rub	-	-	-	895	895
Total	427	961	421	1,058	2,867

The activities of the whales varied, depending on what area of the reserve they used (Table 4). Beach rubbing was the primary activity at the rubbing beaches, although much resting was included with rubbing. Resting and foraging occurred mostly at the bight. The areas east and west of the bight were used mostly for travelling to and from the bight and the rubbing beaches. Travelling was the primary activity observed in the reserve, although as mentioned in the methods, foraging and socializing often occurred as the whales travelled. Beach rubbing and resting were the following two most observed activities in the reserve.

3. Presence at the Rubbing Beaches

Rubbing beach use shows a similar pattern of use to that observed in Johnstone Strait as a whole (Figure 2). All pods visited the beaches on most of the days that they visited the Strait. As in Johnstone Strait, pods A1, D1, C1 and A5 used the rubbing beaches most often. See Appendix Tables 4 and 5 for a listing by year.

Table 5. Occurrence of Killer Whales by Individual and by Pod at the Rubbing Beaches during July-August, 1987, 1989 and 1990.

	1987	**1989**	**1990**	**% Change 1987/90**
# at beaches[1]	142	123	103	-27%
By individual whale				
Total whale-days	1,288	645	701	-46%
Total whale-hours	1,673	789	1,058	-37%
Mean # hours/whale	11.8	6.4	10.3	-13%
By Pod				
Mean # days/pod	7.5	3.2	3.8	-49%
Total # visits	179	97	126	-30%
Mean # visits/day	3.08	1.62	2.03	-34%
Mean # minutes/visit	45	39	53	+18%

1. See Appendix Tables 4 and 5 for details.

The number of whales to visit the rubbing beaches decreased during the period from 1989 to 1990 (Table 5), although the amount of time they spent there increased during the same period, as indicated by the number of whale-days and whale-hours. The number of visits to the beaches also increased during 1990, but all these measures of usage were lower than those recorded during 1987. The average length of a visit to the rubbing beaches during 1990 was higher than during 1987, however.

Table 6. Comparison of Killer Whale Occurrence in Johnstone Strait and at the Rubbing Beaches during July-August, 1987, 1989 and 1990.

By Individual	**1987**	**1989**	**1990**
# in Johnstone Strait	157	133	115
# at rubbing beaches	142	123	103
% of whales in Johnstone Strait at rubbing beaches	90.4%	92.5%	89.6%
% of whale-hours in Johnstone Strait at rubbing beaches	10%	9%	8%

The decrease in the number of whales to visit the rubbing beaches was slightly larger than the decrease observed in the strait (16% and 14%, respectively; Table 6). This is evident by the observed decrease in the amount of whales in the strait which visited the rubbing beaches. As in the strait, the amount of time whales spent at the beaches increased during the same period, but at rates less than those recorded for the strait (from Table 1 and Table 5). As a result, the percentage of hours spent at the beaches of total time in Johnstone Strait decreased from 9% to 8% (Table 6).

On a daily basis, the average time spent at the beaches per whale increased between 1989 and 1990 from 0.1 hours to 0.16 hours per whale (Table 5).

Human Activity

1. Presence in Johnstone Strait

A. Vessel Activity

Although not quantified, vessel activity was virtually constant in Johnstone Strait during the study period. Only 17 (1%) of 1336 vessel counts during 1990 had no boats recorded. Boats sighted in the strait included commercial fishing, whale oriented (such as commercial and recreational whale watching, kayaks, photographers, film crews and research boats) and general marine traffic. Commercial fishing vessels were most numerous, although commercial and recreational whale watching boats and general marine traffic were also usually in the area.

Commercial fishing boats were observed travelling, fishing and mooring throughout the study area. They rarely followed whales and usually stayed at least 30m back, but were observed passing through groups of whales, within 5m, on several occasions. Approximately 75-100 commercial fishing boats were recorded from the eastern boundary of the ecological reserve to Blackney Pass during fishing openings. The whales travelled around and under nets without mishap, except for one calf which became temporarily entangled in a gill-net before freeing itself.

Most commercial whale watching boats stayed at least 100m from the whales forming a line parallel to the whales. Many other boaters used this line as the distance to stay back from the whales, but others did not and approached to within 100m. The three regular charter boats in the area are self-policing and set a good example for other boaters to follow while whale watching, but not everyone acts accordingly.

Recreational boats and kayaks were usually the most numerous boats with whales in the strait. From 1-5 boats and 1-20 kayaks would be with a group of whales. The kayaks were often closer than 100m to the whales. The recreational boats usually followed the whales for a longer period of time than the kayakers, but shorter than the commercial whale watching vessels, and were often closer than 100m, as well.

Several film crews were observed with whales frequently during 1990. They often were closer than 30m to the whales and on several occasions, the information officers asked them to move away from the whales.

Only one researcher working in a boat was present during the study period on a daily basis. She remained 100m from the whales. Two other researchers were present for short periods of time during the study.

B. Shore Activity

Although not recorded for this study, shore activity adjacent to the ecological reserve included commercial fishing tie-ups, kayak and recreational boat landings and logging. Commercial fishing boats moored and fished along the entire Vancouver Island shoreline in the study area. Several different kayak groups operate in the area and have campsites which are in constant use during the summer. Recreational boats landed on occasion. Blasting from logging activities was heard east and west of the reserve and in the Tsitika valley. Logging trucks on roads near the eastern boundary of the reserve created large dust clouds that drifted into the reserve, visible from our study site opposite the reserve and 4-5 km to the west.

Table 7. Killer Whale Presence during Water-Based Activities in the Ecological Reserve during July-August, 1990.

Total vessel visits[1]	4,836	
# when whales present[1]	752	
	# Visits	**% When Whales Present**
Commercial fishing	4,120	15%
Recreational boats	368	16%
Kayaks	220	13%
General marine	70	11%
Commercial whale watching	41	71%
Research	11	100%
Photography/film crews	6	83%
Total non-commercial fishing	716	20%
Sea planes	8	13%

1. See Appendix Table 7 for details.

2. Presence in the Ecological Reserve

A. Vessel Activity

Vessels made 4836 visits into the 4 zones of the ecological reserve during 1990 (Table 7). Commercial fishing vessels were the predominant users of the area, making 4120 visits. Seiners, gill-netters and trollers were present 24 hours a day for 4-7 days a week, beginning July 28, just before the first fishing opening. Commercial boats commonly fished close to the shore throughout the reserve. The trollers would often fish in the reserve in between gill-net and seine openings.

Gunshots, from commercial fishing boats moored in and out of the ecological reserve were heard during 1990, but were not quantified. Most shooting was directed at shore, but on one occasion we received a report of harbour seals and gulls in the bight being shot. Garbage was often disposed of by commercial fishermen and other users, both in the water and on shore in the reserve.

All other boat types combined totalled 716 visits to the reserve in 1990. Other users consisted mainly of recreational boaters, kayakers and general marine traffic.

Recreational boats were the second most numerous boat type in the reserve. They followed whales into the reserve, looked for whales and fished. The information officers contacted about half of these boats.

Kayaks made many visits into the reserve during 1990. The majority of kayaks entered the reserve from the west and were organized groups. Some kayakers were observed entering the reserve from the east, presumably from Naka Creek and possibly from logging roads between Naka Creek and the reserve.

General marine traffic in the reserve consisted mainly of fishery patrol boats and tugs with log booms.

Commercial whale watching vessels usually stayed out of the reserve, except for some small sport charter boats which would travel fast into the reserve, spend a short time there and travel fast away. These boats were difficult for the information officers to contact because they were so fast.

Researchers rarely entered the reserve. Researchers entered mostly to quickly identify the whales and then left the reserve.

Film crews did not commonly enter the reserve, although they sometimes remained in the reserve even after being contacted by the information officers.

Sea planes frequently landed in the reserve to supply commercial fishing boats and occasionally to whale watch. Helicopters were also observed hovering over the whales, both in and out of the reserve.

The information officers were often in the reserve watching for boats and whales and contacting boats.

Table 8. Vessel Visits in the Four Areas of the Ecological Reserve during July-August, 1990.

	W of Bight	Bight	E of Bight	Beaches	Total
Commercial fishing	917	1,414	871	918	4,120
Recreational boats	117	129	72	50	368
Kayaks	173	24	14	9	220
General marine	24	25	11	10	70
Comm. whale watching	12	12	12	5	41
Research	3	3	2	3	11
Photography/film	0	2	1	3	6
Total	1,246	1,609	983	998	4,836
Information officer	129	103	97	23	352
Sea plane	0	5	1	2	8

Most vessels were observed in the bight and west of the bight (Table 8). Commercial fishing vessels moored and fished throughout the reserve, but the bight received the most use (34%). Fishing boats moored mostly in the bight, in coves immediately adjacent to the rubbing beaches and just inside of the western reserve boundary. The remaining visits were divided approximately evenly among the other three areas of the reserve. Commercial packer boats frequently moored in the bight prior to and during openings.

Recreational boats were sighted mostly in the bight and west of the bight. The majority entered from the west and headed directly for the bight, both to whale watch and to sport fish. Many fished in the bight while others landed and fished in the Tsitika River. Many boats passed through the reserve during travels through the area. These boats usually appeared to be sight-seeing, fishing and looking for whales.

Kayaks were sighted mostly west of the bight, but sightings occurred in all areas of the reserve. The information officers allowed the kayakers to travel just inside of the western boundary of the reserve to view the bight, if whales were not present. They usually did not travel beyond this cove, although some kayakers did continue on further into the reserve. The information officers asked them to leave.

The fishery patrol boats were sighted mostly in the bight and west of the bight. They often moored in the bight prior to, and during, fishing openings. Tugs with log booms, which travel very close to shore, would pass through the entire reserve, usually taking 6-8 hours or more.

Charter boat sightings occurred approximately evenly in the areas west of the rubbing beaches, although they were sighted at the beaches as well. Charters sometimes entered the reserve west of the bight to get out of bad weather.

Research vessels were sighted approximately evenly among the four areas of the reserve.

Photography and film crews were sighted mostly at the rubbing beaches, although sightings occurred in all areas except west of the bight.

Information officers were mostly west of the rubbing beaches, where they watched for boats.

Most landings by sea-planes were in the bight and at the rubbing beaches.

Table 9. Killer Whale Presence during Vessel Landings and Shore-Based Activities in the Ecological Reserve during July-August, 1990.

Landings	**# Landings**	**# When Whales Present**
Kayaks	60	3
Recreational boats	18	2
Commercial fishing	4	0
Total	82	5
Camping		
Kayaks	5	0
Recreational boats	1	0

B. Shore Activity

The majority (73%) of landings and shore activity in the reserve were by kayakers (Table 9), although the number of landings by commercial fishermen during fishing activities were not recorded. Recreational boats accounted for 22% of the landings.
Most of the kayaks landed at a cove near the west boundary of the ecological reserve, with permission from the information officers. Others came with plans of camping in the reserve, which was prohibited.

Table 10. Shore Activity in the Four Areas of the Ecological Reserve during July-August, 1990.

Landings	**W of Bight**	**Bight**	**E of Bight**	**Beaches**	**Total**
Kayaks	55	4	0	1	60
Recreational boats	6	11	0	1	18
Commercial fishing	1	1	0	2	4
Total	62	16	0	4	82
Camping					
Kayaks	0	4	0	1	5
Recreational boats	0	1	0	0	1

Most landings were west of the bight and in the bight (Table 10). Kayakers were also observed landing at the rubbing beaches and in the bight, mostly to camp. Kayakers camped four times in the bight and once at the rubbing beaches. It is possible that more landings occurred at the rubbing beaches than we were aware, but the majority of kayakers entered the reserve from the west. They usually left to the west.
Recreational boaters, commercial fishing and commercial whale watching vessels accounted for the remainder of landings in the reserve. Recreational boats landed mostly in the bight, once to camp, but usually to fish in the Tsitika River. They also landed west of the bight, usually to wait out bad weather, and at the rubbing beaches to camp and wait for whales.

Commercial fishermen landed at the bight to make a fire and to dispose of bags of garbage. Skiffs were often observed travelling up the Tsitika River. They landed at the rubbing beaches to walk on shore. At the rubbing beaches, five 5-gallon pails full of used motor oil were found in the bush above one of the beaches. We do not know who put them there.

Table 11. Summary of Human Activity in the Ecological Reserveduring July-August, 1990.

	Number	Percent
Vessel visits	4,836	98.3%
Shore-based activity	82	1.7%
Total	4,918	100%

Vessel activity accounted for more than 98% of the human activity in the ecological reserve during the study period (Table 11). Shore activity was a relatively minor component of the total activity in the reserve and all of this observed shore activity was a result of boats making landings.

Responses of Killer Whales to Human Activity

Whales responded with a negative reaction to interactions with human activities during 16% of the approaches and 41% of the visits to the ecological reserve (Table 12). Table 12 shows the frequency of interactions recorded with killer whales for various human activities. Most (77%) approaches by whales to the reserve and most (68%) of the visits into the reserve involved a vessel interaction. Interactions with whale oriented boats (including commercial and recreational whale watching, kayaks, research and photo/film crews) during approaches and visits into the reserve were more common than commercial fish boat interactions, although commercial fishing boats were also present in the majority of approaches and reserve visits. Interactions with whale oriented boats were more common than interactions with fishing boats possibly because whale oriented boats seek out whales while fishing boats generally do not. Additionally, commercial fishing in the study area did not begin until the last week of July during 1990, so whale oriented boats were present during more days than were the commercial fishing boats.

Table 12. Incidence of Killer Whale Interactions with Vessels in and Adjacent to the Ecological Reserve during July-August, 1990.

Johnstone Strait whale approaches to reserve	110
# observed approaches	102 (93% of total)
# approaches with vessel interactions	79 (77% of observed)
# with whale oriented vessels	74 (94% of approaches w/ inter.)
# with commercial fish boats	43 (54% of approaches w/ inter.)
# with commercial fishing activities	34 (43% of approaches w/ inter.)
# with whale reactions to interactions	16 (20% of approaches w/ inter.)
Reserve visits	102
# observed visits	95 (93% of total)
# visits with vessel interactions	65 (68% of observed)
# with whale watching vessels	38 (58% of visits w/ inter.)
# with commercial fishing boats	37 (57% of visits w/ inter.)
# with commercial fishing activities	13 (20% of visits w/ inter.)
# with whale reactions to interactions	39 (60% of visits w/ inter.)

1. Responses in Johnstone Strait Adjacent to the Ecological Reserve

Table 13 shows the number and types of vessels that interacted with the whales during approaches to the ecological reserve. The whales interacted with 419 vessels during the 79 approaches involving vessel interactions. Interactions with commercial whale watching boats were most common, but commercial fishing boats, recreational boats and kayaks interacted with whales nearly as much.

Table 13. Number of Each Vessel Type Interacting with Killer Whales during Approaches to the Ecological Reserve during July-August, 1990.[1]

Commercial whale watch	102
Commercial fish boats	97
Recreational	96
Kayaks	82
Photography/film	19
Research	15
General marine	5
Information officers	3
Total	419

1. See Appendix Table 6 for details.

Table 14. Number of Killer Whale Responses to Vessel Interactions during Approaches to the Ecological Reserve during July-August, 1990.

	Total	Mostly commercial fishing	Mostly whale watching
No Reaction	63	24	39
Reaction (Total)	16	10	6
1. Pass By[1] (PB)	11	9	2
2. Change Direction(CD)	4	1	3
3. PB and CD	1	0	1
Total Whale Responses	79	34	45

1. Whales passed by the ecological reserve 3 times without vessel interactions.

In 16 out of the 79 approaches with a vessel interaction (20%), the whales did not enter the reserve (Table 14). Whales did not enter the ecological reserve during 3 of the 20 cases (15%) that no boats were present. Whales reacted to vessel interactions by passing by the reserve, and changing direction away from the reserve. Whales passed by the reserve mostly during commercial fishing activities. Changes of direction away from the reserve occurred mostly when whale watching boats near the reserve were between the whales and the reserve.

2. Responses in the Ecological Reserve

A. Vessel Activity

Vessel activity accounted for 579 of a total of 584 interactions with whales in the ecological reserve during 1990 (Table 15). The remainder were from vessel landings. The majority (67%) of vessel interactions were with commercial fishing boats. Commercial fishing boats also accounted for the majority (66%) of reactions and the majority (94%) of unobserved responses to vessel interactions (Appendix Table 8).

Table 15. Incidence of Killer Whale Interactions with Vessels and Vessel Landings in the Ecological Reserve during July-August, 1990.

Vessel Interactions[1]	**Number of Interactions**	**# with Reactions**
commercial fishboats	389	88 (66% of reactions)
recreational boats	69	19 (14% of reactions)
information officers	43	9 (7% of reactions)
commercial whale watch	32	8 (6% of reactions)
kayaks	17	4 (3% of reactions)
research	13	1 (<1% of reactions)
general marine	9	1 (<1% of reactions)
photography/film	7	4 (3% of reactions)
Total	579	134 (23% of interactions)
# with No Reaction[1]	290 (50%)	
# unobserved[1,2]	155 (27%)	
Vessel Landing Interactions	5	
# Reactions	0	

1. See Appendix Tables 8 and 9 for details.
2. 145 of 155 unobserved responses to interactions were with commercial fish boats.

The majority (37%) of vessel interactions in the ecological reserve occurred at the rubbing beaches, although a high number were also observed in the bight (Table 16). Approximately equal numbers of interactions were observed in the areas east and west of the bight. The majority (46%) of reactions to interactions and the majority (82%) of unobserved responses to interactions also occurred at the rubbing beaches. The high number of unobserved responses at the rubbing beaches was due to the whales being partially out of view while at the eastern rubbing beach.

Commercial fishing vessels accounted for the majority of vessel interactions in all areas of the reserve, due to the fact that they were the most common vessel in the reserve. Commercial fishing vessel interactions with whales occurred as fishing boats passed through the reserve, fished and whale watched.

Table 16. Incidence of Killer Whale Reactions to Interactions with Human Activity in the Four Areas of the Ecological Reserve during July-August, 1990.

Interactions[1]	**W of Bight**	**Bight**	**E of Bight**	**Beaches**	**Total**
1. Vessels	113	139	110	217	579
# Reactions[1]	23	34	16	61	134
Comm. fishboat	13	19	10	46	88
Recreational	5	4	1	9	19
Information officers	2	3	2	2	9
Comm. whale watch	1	3	3	1	8
Kayaks	2	1	0	1	4
Research	0	1	0	0	1
General marine	0	0	0	1	1
Photo/film	0	3	0	1	4
No Reaction	85	87	89	29	290
Unobserved	5	18	5	127	155
Total	113	139	110	217	579
2. Landings	5	0	0	0	5
# Reactions	0	0	0	0	0
Total	5	0	0	0	5

1. See Appendix Tables 8 and 9 for details.

Most (78%) of the remainder of interactions in the ecological reserve were with various whale oriented boats (commercial and recreational whale watching, kayaks, photo and film crews and researchers) and occurred in all areas of the reserve.

Interactions with commercial whale-watching boats occurred mostly in the bight and east of the bight. Most of these interactions were with small fast boats that avoided the attempted contacts by the wardens.

Recreational boat interactions occurred mostly at the rubbing beaches during whale watching, but also as boats followed whales into the reserve and encountered whales while travelling through the reserve.

Interactions with kayakers occurred west of the bight as they followed whales into the reserve and in the bight and rubbing beaches during whale watching. Kayakers that were allowed into the reserve to briefly view the bight (from just east of the west boundary) would sometimes paddle further into the reserve and then would not be able to leave before whales passed them, resulting in an interaction.

Photo and film crews interacted with whales in the bight and at the rubbing beaches. The film crew and photographers knew of the reserve guidelines, but often approached whales anyway.

Researchers interacted with whales once in the bight during an attempt at identifying whales.

Interactions with visitor information officers occurred as they were in the reserve watching for approaching boats, patrolling the reserve, approaching boats and whale watching.

General marine traffic interacted with whales at the rubbing beaches while passing through the reserve.

Although observed from a different site, whale interactions with commercial fishing vessels at the rubbing beaches did not appear to increase significantly from 1989 (Briggs, 1991) and the number of observed interactions with recreational and general marine boats were lower at the beaches during 1990. The number of interactions with commercial whale watching boats increased slightly, from 4 to 5, during 1990.

Table 17. Killer Whale Responses to Vessel Interactions in the Ecological Reserve during July-August, 1990.

	Commercial Fishing	Whale Oriented[1]	Information Officers	General Marine	Total of All Interactions
# Interactions[2]	389	138	43	9	579
Responses (%)[3]					
Reaction	23%	26%	21%	11%	23%
Change Direction (CD)	(6%)	(12%)	(7%)	(0%)	(7%)
Change Activity	(5%)	(4%)	(7%)	(0%)	(5%)
CD and CA	(2%)	(>1%)	(2%)	(0%)	(2%)
Pass By/Short Rub	(5%)	(6%)	(5%)	(11%)	(5%)
Leave the Area	(3%)	(>1%)	(0%)	(0%)	(3%)
Leave and Return	(>1%)	(1%)	(0%)	(0%)	(1%)
No Reaction	40%	69%	72%	89%	50%
Unobserved	37%	5%	7%	0%	27%
Total	100%	100%	100%	100%	100%

1. Whale oriented includes commercial and recreational, kayaks, research and photography/film boats.
2. See Appendix Table 7 for details.
3. See Appendix Tables 8 and 9 for details.

Table 17 lists the responses by whales to vessels in the ecological reserve. Negative reactions (changes in behaviour) by whales were recorded in 23% of the observed interactions. The most common changes in behaviour were changes in direction of travel, changes in activity state and passing by or short rubbing at the rubbing beaches. In half of the vessel interactions in the reserve, no noticeable change in the activity state of the whales was observed. Responses by whales to vessel interactions in the reserve were unobserved in 27% of the cases. Interactions with commercial fishing boats were most common, although the percentage with reactions was highest among the various whale-watching boats. Commercial fish boats also had the highest percentage of unobserved responses to interactions, however.

Response types were divided almost evenly among the different reaction types observed from commercial fishing boats, probably because of the high number of interactions with these boats. Changes in direction were twice as frequent than other reactions observed from the various whale watching boats, perhaps from their behaviour of following whales. Negative reactions from general marine traffic were only observed at the rubbing beaches, as they passed through the reserve.

Table 18. Killer Whale Responses to Vessel Interactions in the Four Areas of the Ecological Reserve during July-August, 1990

	W of Bight	Bight	E of Bight	Beaches	Total - All Reserve
# vessel interactions	113	139	110	217	579
Whale response (%)					
Reaction[1]	21%	24%	14%	28%	23%
Change Direction (CD)	9%	14%	6%	3%	7%
Change Activity (CA)	8%	6%	8%	<1%	5%
CD and CA	4%	4%	0%	1%	2%
Pass By / Short Rub	0%	0%	0%	14%	5%
Leave the Area	0%	0%	0%	7%	3%
Leave and Return	0%	0%	0%	3%	1%
No Reaction	75%	63%	81%	13%	50%
Unobserved	4%	13%	5%	59%	27%
Total	100%	100%	100%	100%	100%

1. See Appendix Tables 8 and 9 for details.

Negative reactions to vessel interactions were most common at the rubbing beaches and in the bight. The highest percentage of negative reactions in the reserve was recorded at the rubbing beaches. This figure may have been higher due to the fact that the response during 67% of the interactions at the beaches was unobserved. This was due to not being able to see the entire beach area. The whales most commonly responded by passing by or short rubbing. Whales also left the beaches as boats approached whales to whale-watch. This was the case for all boats. Whales reacted most often in the bight by changing direction.

Whales were more likely to react as:

- boats approached the whales
- boats were in front of the whales
- the number of successive passes by boats increased.

B. Shore Activity

All observed shore interactions occurred west of the bight. Three were by kayaks and two were by recreational boats. No responses by the whales were observed.

Visitor Information Officer Activity

The information officers contacted boaters on the water (primarily commercial and recreational whale-watching boats and kayaks) to inform them of the ecological reserve and whale watching guidelines and to ask them to remain outside of the reserve.

1. Vessel Contacts

The information officers contacted boats which approached the ecological reserve. Table 19 shows the activity of the information officers as boats approached the reserve and the response of the boat after the information officers contacted (or attempted to contact) them.

Table 19. Information Officer Interactions with Vessels Which Entered theEcological Reserve and Vessel Responses to Information Officer Contacts During July-August 1990 .

Information Officer and Vessel Activity	Recreation	Kayak	Comm. Whale Watch	Research	Photo/ film	TL
Contact In; Boat Leaves	75	34	3	0	0	112
Contact In; Boat Stays	46	13	3	1	1	64
Contact Out; Boat Enters	9	104	0	0	0	113
Previous Contact; Enters	5	0	4	0	0	9
Approach, No Contact; Enters	23	0	0	0	0	23
No Approach; Enters	93	23	7	6	1	130
Info. Off. At Camp; Enters	100	21	15	3	2	141
Info. Off. Unobserved; Enters	17	25	9	1	2	54
Total in Reserve	368	220	41	11	6	646
Contact Out; Boat Stays	13	20	0	0	0	33
Total Observed Contacts	381	240	41	11	6	679

The activity of the information officers and the whale oriented boats (commercial and recreational whale watching boats, kayaks, research and photo/film crews) was observed for 592 of the 646 (92%) instances in which these boats which entered the ecological reserve during 1990. The activity of the information officers was not observed for 54 vessels (8%) which entered the reserve.

The information officers contacted 298 (50%) of the boats which were observed entering the ecological reserve. Of the 298, 176 (59%) were contacted in the reserve. This was because the information officers either waited for approaching boats in the reserve or had to follow boats into the reserve to make the contact. The majority of these were recreational boats (69%) and kayaks (27%). Of the 176 boats which were contacted in the reserve, the majority (112, 64%) left the reserve after being contacted. The remaining 64 boats did not comply with the information officers and remained in the reserve.

Of the 122 boats which entered the reserve after being contacted by the information officers (41% of contacts which entered the reserve), the majority (92%) were kayakers who were allowed by the information officers to view the bight from just inside of the western boundary, if whales were not in the area. The remainder (8%) of these boats were recreational boats which did not comply with the information officers. The information officers contacted 33 boats outside of the reserve which remained outside.

Of the 592 boats which were observed entering the reserve, 294 (50%) were not contacted by the information officers. The majority (48%) of these boats entered the reserve while the information officers were at camp, either before or after the hours they patrolled the reserve, or during fog or bad weather. The information officers did not approach 131 (44%) of the boats which were not contacted. This often occurred when commercial fishing boats were in the area. The information officers may have thought that the approaching boat would not comply with the no entry guidelines while the reserve was busy with other boats. Boats travelling at high speeds were sometimes not approached. The information officers attempted to contact 23 (8%) of the boats which were not contacted, but these boats did not stop and were too fast for the information officers to contact.

Discussion

Killer Whale Activity

The population of the northern resident community increased by 2% (from 189 to 193) from 1989. The whales spent more time in Johnstone Strait and in the ecological reserve during 1990 than during 1989, although fewer whales entered the strait and reserve. The number of whales in the strait would have been higher than recorded for 1990 (by approximately 17 whales), had a group of whales in Blackney Pass entered Johnstone Strait rather than a nearby inlet. Conversely, the number would have been lower than recorded (by 7 whales) had a subpod which was in the strait for only half an hour not been included. The decrease appears accurate given the area described as Johnstone Strait for this study.

Usage of the reserve and the rubbing beaches parallels that of the strait. Of the whales observed in the strait, only the subpod of 7 whales mentioned above did not enter the reserve and only 5 others, in addition, did not visit the beaches. The percentage of whales in the strait to visit the beaches was slightly less than during 1987 or 1989. The percent of time in the strait spent in the reserve during 1990 (21%) was similar, although slightly less, to the figure (24%) Ford recorded during 1978-80. However, the percent of time spent at the beaches decreased for the third consecutive year of study, from 9% to 8%, even though the average length of a visit to the beaches increased and was higher than during 1987 or 1989. The whales spent the majority of their time at the rubbing beaches, although nearly as much time was spent in the bight, where most of the resting by the whales was observed. The bight may be as important as the rubbing beaches in consideration of access to the shore in this area from nearby logging roads.

Vessel Activity

Vessel activity in the strait did not appear to greatly alter the whales' use of the ecological reserve in the short term. The whales usually travelled on to the reserve, although the frequency of the whales not entering the reserve was higher when they were accompanied by boats and was highest when commercial fishing was taking place. The whales' use of the rubbing beaches was altered if boats followed the whales to the beaches. The whales interacted with mostly commercial and recreational whale watching boats and commercial fishing vessels during approaches to the reserve.

Vessel activity in the reserve, especially at the rubbing beaches, did appear to alter the whales' use of the area. Commercial fishing boats accounted for the majority of vessel traffic and interactions with whales in the reserve during each of the 3 years of study. During 1990, the rubbing beaches and the bight had the highest number of interactions. This was due to high numbers of boats in these areas and a high amount of time spent there by the whales. The frequency of negative reactions by the whales was also highest in these areas, as well. The whales are known to be sensitive to disturbance at the beaches and they may also be sensitive to human activity in the bight.

Much shore activity occurred in the bight. Kayakers landed to camp, sport fishermen fished in the Tsitika River and commercial fishermen, presumably, disposed of large amounts of trash on shore in the bight as well as at the rubbing beaches. Gunfire by commercial fishermen, although commonly heard during the study period, was mostly directed at objects on shore. On one occasion, apparently, seals and gulls in the bight were shot. Gunfire was not commonly heard in the presence of whales and we did not believe it was ever directed at the whales. Shore activity at one rubbing beach was difficult to observe from the study site during 1990.

Visitor Information Officer Activity

The information officers contacted approximately half of the observed boats which entered the ecological reserve. Most of these were contacted in the reserve, because the information officers usually stationed themselves in the reserve or had to follow boats into the reserve to contact them. Most of these boats left the reserve. Most of the boats contacted out of the reserve were kayaks which were allowed into the western end of the reserve if whales were not present. Many others entered while the information officers were at camp, either before or after their shift on the water or during bad weather. A large number of boats were not approached as they entered the reserve, either due to the speed of the boat or because commercial fishing was occurring.

Overview

Most of the whales entering Johnstone Strait use the ecological reserve. Whales interacted with boats during most approaches to the reserve, although this did not appear to greatly affect their use of the reserve. The whales were more likely to not enter the reserve when accompanied by boats. They passed by or changed direction away from the reserve most often when commercial fishing was taking place. Boats in waters adjacent to the reserve appeared to alter the whales' use of the rubbing beaches. The rubbing beaches and the bight were the key areas of use by the whales in the reserve. These areas are also where most of the interactions with boats in the reserve occurred. The whales react at the rubbing beaches mostly by changing their activity from rubbing to travelling. In the bight, changes in activity from resting to travelling were common.

The number of whales sighted in the strait and the reserve decreased, although the time spent in the area by the whales increased. The percentage of time in the strait spent at the rubbing beaches decreased again in 1990, although the percentage of time in the strait spent in the reserve as a whole during 1990 was only slightly less than Ford's figure from 1978-80.

This study shows that vessel activity in the reserve and adjacent waters does affect the short-term use of the reserve by the whales. The whales' use of the rubbing beaches is decreasing but the overall use of the reserve may be relatively unchanged from 10 years ago.

The population increased during 1990 so the reduced number of whales in the strait has resulted from changes in whale distribution. Observations from September through November during 1989 and 1990 indicate that many whales are sighted on a daily basis in Blackney Pass and Johnstone Strait during this time of year, including many of the whales not seen during the summer. More observations are needed to determine the whales' use of the area.

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Appendix Table 1. Number of Individuals Within Each Pod of the Northern Resident Community of Killer Whales during July-August, 1987-1990.

Pod	1987	1988	1989	1990
A1	15	14	15	16
A4	8	8	8	9
A5	13	13	13	13
B1	8	8	8	8
C1	8	8	10	10
D1	12	12	12	13
G1	24	25	23	24
G12	11	11	12	11
H1	7	8	8	8
I1	7	7	8	7
I2	8	8	8	8
I11	14	14	14	15
I18	14	15	17	17
I31	7	9	9	8
R1	21	22	21	23
W1	3	3	3	3
Total	**180**	**185**	**189**	**193**

Appendix Table 2. Number of Individuals Within Each Pod and Each Subpod of the Northern Resident Community of Killer Whales during July-August, 1987-1990.

Pod	Subpod	1987	1988	1989	1990
A1	A30	6	5	6	6
	A36	4	4	4	4
	A12	4	4	4	5
	A20	1	1	1	1
A4	A11	5	5	5	6
	A24	3	3	3	3
A5	A8	3	3	3	3
	A9	3	3	3	3
	A14	4	4	4	4
	A23	3	3	3	3
B1	B1	8	8	8	8
C1	C5	3	3	4	4
	C6	5	5	6	6
D1	D3	4	4	4	5
	D7	8	8	8	8
G1	G3	6	6	6	8
	G4	3	3	3	3
	G17	6	6	5	5
	G18	5	5	5	4
	G30	4	5	4	5
G12	G2	4	4	5	5
	G12	7	7	7	5
H1	H3	4	4	4	4
	H6	3	4	4	4
I1	I1	7	7	8	7
I2	I2	8	8	8	8
I11	I11	6	6	6	6
	I15	8	8	8	9
I18	I17	5	5	6	6
	I18	9	10	11	11
I31	I31	5	6	6	5
	I33	2	3	3	3
R1	R2	4	4	3	3
	R4	2	3	3	3
	R5	7	7	7	7
	R7	2	2	2	3
	R9	2	2	2	2
	R14,15	2	2	2	2
W1	W1	3	3	3	3
Total		**180**	**185**	**189**	**193**

Appendix Table 3. Number of Days Killer Whales Were Sighted in the Ecological Reserve during July-August, 1990.

Pod	Subpod	W of Bight	Bight	E of Bight	Beaches	Reserve
A1	A30	24	28	23	29	36
	A36	2	2	3	3	3
	A12	9	10	9	8	13
	A20	1	1	1	1	1
A4	A11	2	2	2	3	3
	A24	2	2	2	3	3
A5	A8	9	8	8	8	9
	A9	9	8	8	8	9
	A14	4	4	3	4	5
	A23	4	4	3	4	5
B1	B1	1	1	1	1	1
C1	C5	15	17	17	17	19
	C6	5	5	8	7	9
D1	D3	11	11	11	13	13
	D7	11	11	11	13	13
G1	G3	6	6	5	6	7
	G4	2	3	2	2	3
	G17	0	0	0	0	0
	G18	6	6	5	6	7
	G30	0	0	0	0	0
G12	G2	0	0	0	0	0
	G12	0	0	0	0	0
H1	H3	5	5	5	5	6
	H6	5	6	6	6	6
I1	I1	0	0	0	0	0
I2	I2	0	0	0	0	0
I11	I11	2	2	1	1	2
	I15	4	5	2	2	5
I18	I17	0	0	0	0	0
	I18	0	0	0	0	0
I31	I31	2	2	0	0	2
	I33	2	2	1	1	2
	I35	1	1	0	0	1
R1	R2	1	1	2	2	2
	R4	0	0	0	0	0
	R5	0	0	0	0	0
	R7	0	0	0	0	0
	R9	0	0	0	0	0
	R14,15	0	0	0	0	0
	R17	0	0	0	0	0
W1	W1	0	0	1	1	1
Total		**145**	**153**	**140**	**154**	**186**

Appendix Table 4. The Usage of Johnstone Strait and the Rubbing Beaches by Killer Whales during July-August, 1987-1990 as Indicated by the Number of Whale-days.

	Johnstone Strait					Rubbing Beaches			
Pod	**1987**	**1988**	**1989**	**1990**	**% change**	**1987**	**1989**	**1990**	**% change**
A1	407	418	372	390	-4%	312	259	227	-27%
A4	167	85	32	36	-78%	135	16	27	-80%
A5	339	209	60	124	-63%	264	23	76	-71%
B1	48	64	72	16	-67%	32	56	8	-75%
C1	144	102	196	198	+38%	96	168	110	+15%
D1	276	0	0	269	-3%	168	0	121	-28%
G1	57	0	0	52	-9%	39	0	36	-8%
G12	12	0	7	0	-100%	12	0	0	100%
H1	91	48	32	80	-12%	77	24	42	-45%
I1	7	7	16	7	0%	7	8	0	100%
I2	16	32	16	24	+50%	16	8	18	+13%
I11	64	32	34	90	+41%	50	28	24	-52%
I18	9	15	34	0	-100%	9	17	0	100%
I31	40	54	39	30	-25%	30	24	3	-90%
R1	34	12	24	6	-82%	26	14	6	-77%
W1	15	6	3	3	-80%	15	0	3	-80%
Total	**1726**	**1084**	**937**	**1325**	**-23%**	**1288**	**645**	**701**	**-46%**

Appendix Table 5. Number of Days Killer Whales Were Sighted in Johnstone Strait and at the Rubbing Beaches during July-August, 1987-1990.

		1987		1988	1989		1990	
Pod	**Subpod**	**J.St**	**Beach**	**J.St**	**J.St**	**Beach**	**J.St**	**Beach**
A1	A30	47	37	40	52	38	47	29
	A36	17	10	18	9	6	4	3
	A12	11	10	31	5	1	18	8
	A20	13	10	22	4	3	2	1
A4	A11	22	18	8	4	2	4	3
	A24	19	15	15	4	2	4	3
A5	A8	26	22	15	3	1	13	8
	A9	28	22	15	3	1	12	8
	A14	30	24	17	6	2	7	4
	A23	19	12	17	6	3	7	4
B1	B1	6	4	8	9	7	2	1
C1	C5	18	12	19	40	36	24	17
	C6	18	12	9	6	4	17	7
D1	D3	24	13	0	0	0	25	13
	D7	24	13	0	0	0	25	13
G1	G3	1	0	0	0	0	0	0
	G4	4	3	0	0	0	4	2
	G17	5	5	0	0	0	0	0
	G18	1	0	0	0	0	8	6
	G30	1	0	0	0	0	0	0
G12	G2	3	3	0	0	0	0	0
	G12	0	0	0	1	0	0	0
H1	H3	13	11	6	4	3	10	5
	H6	13	11	6	4	3	10	6
I1	I1	1	1	1	2	1	1	0
I2	I2	2	2	4	2	1	0	0
I11	I11	4	3	0	3	2	3	1
	I15	5	4	4	2	2	8	2
I18	I17	0	0	1	2	1	0	0
	I18	1	1	1	2	1	0	0
I31	I31	6	4	6	5	3	4	0
	I33	5	5	6	3	2	4	1
R1	R2	2	2	4	4	2	2	2
	R4	0	0	0	0	0	0	0
	R5	0	0	0	0	0	0	0
	R7	3	3	0	0	0	0	0
	R9	6	4	0	6	4	0	0
	R14,15	6	4	0	0	0	0	0
	R17	0	0	0	0	0	0	0
W1	W1	5	5	2	1	0	1	1
Total		**407**	**307**	**275**	**188**	**131**	**266**	**148**

Appendix Table 6. Frequency of Vessel Interactions during Killer Whale Approaches to the Ecological Reserve by Distance from the Whales during July-August, 1990.

	Vessel Distance from the Whale			
Vessel Type	**1-30m**	**31-100m**	**101-300m**	**Total**
Commercial whale watch	20	59	23	102
Commercial fish boat	18	22	57	97
Recreational	23	50	23	96
Kayak	24	22	36	82
Research	0	13	2	15
Photography / TV crew	8	6	5	19
General marine	1	1	3	5
Information officer	1	1	1	3
Total	**95**	**174**	**150**	**419**

Appendix Table 7. Vessel Activity in the Four Areas of the Ecological Reserve during July-August, 1990.

Vessel Type*	No Whales Present					Whales Present					Total
	WOB	**BT**	**EOB**	**BCH**	**Total**	**WOB**	**BT**	**EOB**	**BCH**	**Total**	
cbt	304	362	283	268	1217	21	61	47	49	178	1395
cbf	273	381	270	252	1176	27	64	28	68	187	1363
cbm	244	357	201	178	980	16	124	18	74	232	1212
cbs	29	63	24	21	137	3	2	0	8	13	150
Total CF	**850**	**1163**	**778**	**719**	**3510**	**67**	**251**	**93**	**199**	**610**	**4120**
ch	5	3	4	0	12	6	10	8	5	29	41
kc	155	23	8	5	191	18	1	6	4	29	220
rb	104	106	64	34	308	13	23	8	16	60	368
Total REC	**264**	**132**	**76**	**39**	**511**	**38**	**34**	**22**	**25**	**118**	**629**
re	0	0	0	0	0	3	3	2	3	11	11
ph	0	0	0	0	0	0	0	0	1	1	1
tv	0	0	1	0	1	0	2	0	2	4	5
Total WW	**264**	**132**	**77**	**39**	**512**	**41**	**39**	**24**	**31**	**134**	**646**
fo	15	16	2	1	34	1	0	0	0	1	35
cg	0	1	0	1	2	0	0	0	0	0	2
tl	6	5	6	6	23	2	1	2	2	7	30
mb	0	1	0	0	1	0	0	0	0	0	1
tb/tc	0	1	1	0	2	0	0	0	0	0	2
Total gm	**21**	**24**	**9**	**8**	**62**	**3**	**1**	**2**	**2**	**8**	**70**
TOTAL	**1135**	**1319**	**864**	**766**	**4084**	**111**	**291**	**119**	**232**	**752**	**4836**
vo	117	91	88	17	313	12	12	9	6	39	352
Total with vo	**1252**	**1410**	**952**	**783**	**4397**	**123**	**303**	**128**	**238**	**791**	**5188**

* Vessel type:

cbt - commercial fishing boat travelling
cbf - commercial fishing boat fishing
cbm - commercial fishing boat moored
cf - commercial fishing (Total)
cbs - commercial fishing boat skiff
ch - commercial whale watching
cg - coast guard
fo - DFO patrol vessel
gm - general marine
kc - kayaks and canoes
mb - military boat
ph - photographer
rb - recreational boat
re - research
rec - recreational (Total)
tb/tc - tug / tanker
tl - tug with log boom
tv - tv / film crew
vo - information officer
ww - whale watching (Total rec, re, ph, tv)

Appendix Table 8. Frequency of Responses by Killer Whales to Interactions with Vessels in the Ecological Reserve during July-August, 1990.

CF	W of Bight	Bight	E of Bight	Rubbing Beaches	Total
No Reaction	34	45	58	19	156
Reaction	13	19	10	46	88
CD	2	9	7	5	23
CA	8	7	3	1	19
CD/CA	3	3	0	3	9
PB/SR	0	0	0	19	19
LA	0	0	0	13	13
LR	0	0	0	5	5
Unobserved	5	14	5	121	145
Total	**52**	**78**	**73**	**186**	**389**
WW					
No Reaction	36	29	22	8	95
Reaction	8	12	4	12	36
CD	7	9	0	1	17
CA	1	1	4	0	6
CD & CA	0	2	0	0	2
PB/SR	0	0	0	8	8
LA	0	0	0	2	2
LR	0	0	0	1	1
Unobserved	0	2	0	5	7
Total	**44**	**43**	**26**	**25**	**138**
GM					
No Reaction	2	3	2	1	8
Reaction	0	0	0	1	1
PB/SR	0	0	0	1	1
Unobserved	0	0	0	0	0
Total	**2**	**3**	**2**	**2**	**9**
VO					
No Reaction	13	10	7	1	31
Reaction	2	3	2	2	9
CD	1	2	0	0	3
CA	0	1	2	0	3
CD & CA	1	0	0	0	1
PB/SR	0	0	0	2	2
Unobserved	0	2	0	1	3
Total	**15**	**15**	**9**	**4**	**43**

Appendix Table 9. Frequency of Killer Whale Responses to Vessel Interactions in the Ecological Reserve by Distance of the Vessel to the Whale during July-August 1990.

	Vessel Distance from the Whale			
	1-30m	**31-100m**	**101-300m**	**Total**
No Reaction	82	84	124	290
Reaction	30	70	34	134
Change Direction	13	18	12	43
Change Activity	6	15	7	28
Change Dir. & Activ.	3	6	3	12
Pass By / Short Rub	5	17	8	30
Leave the Area	3	8	4	15
Leave and Return	0	6	0	6
Unobserved	15	24	116	155
Total	127	178	274	579