ECOLOGICAL RESERVES COLLECTION
GOVERNMENT OF BRITISH COLUMBIA
VICTORIA, B.C.
V8V 1X4

Robson Bight Ecological Reserve Management Plan

PHASE I

An Assessment of the Impacts of Human Activities on the Killer Whales of Robson Bight Ecological Reserve

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Prepared for:

Ecological Reserves, Park Programs Branch
Ministry of Lands, Parks and Housing
1019 Wharf Street, Victoria, B.C.
V8W 2Y9

Prepared by:

James D. Darling

West Coast Whale Research Foundation
2020 - 1040 West Georgia Street
Vancouver, B.C.
V6E 4H1

SUMMARY

A northern Vancouver Island population of killer whales faces increasing human activities within a core summer feeding area. This area includes Robson Bight Ecological Reserve. There is concern that human disturbance will interfere with the critical natural behaviour patterns of the animals. The objective of this report is to assess the current and future impacts of human activities on the killer whale population.

Killer whales that are summer residents of the northern Johnstone Strait area typically pass through Robson Bight Ecological Reserve once to several times daily during normal activity from July to October. The two main features of the reserve are the undeveloped Tsitika estuary in Robson Bight and a series of steep pebble beaches known as the Rubbing Beaches. Whales travel to these beaches regularly to rub against the pebbles - a behaviour not seen elsewhere in B.C. The reserve is a small portion of the overall range of the killer whales, and is not in itself large enough to guarantee protection of these animals. It does, however, protect unique habitat for the whales and has a significant symbolic function in focusing concern.

Little is known about the long-term impacts of human disturbance on whale populations. A review of more extensive knowledge of the impacts of human activities on wild ungulate populations provide generalizations on this subject. It appears that wild mammal populations often can habituate to a variety of background human activities that are steady and predictable. They are far less likely to habituate to disturbance involving close approaches and pursuit, or to unusual unpredictable events. Further, ungulate studies indicate that reactions to disturbance may vary markedly with reproductive and nutritional status, habitat or the experience of the animal. Wild mammals may significantly change behaviour patterns and range in response to human disturbances, minimizing contact with human activities. Our knowledge of the impacts of human

activities on whale populations falls well within these generalizations.

Human activities in the vicinity of the reserve are divisible into two general categories: non-whale-oriented and whale-oriented. The former includes background activities such as commercial fishing and vessel traffic; the latter includes research, photography and whale watching. Activity levels in both categories can be heavy during the peak whale season - examples are two hundred plus fish boats with nets working in the core whale range, or up to eight boats (including researchers, photographers, general public and commercial whale watching vessels) closely following the whales for extended periods of time. Levels of whale-oriented and other recreational activities are expected to increase in the area for the foreseeable future. Growth of non-whale-oriented industrial activities will likely be slower, if at all (commercial fishing). Logging road construction in the vicinity of the reserve will significantly increase land access to the area in the next few years.

Available information suggests that the whales have habituated to the predictable background activities of commercial fishing and vessels transiting the area, and that these activities at current levels cause little disturbance to the animals. In contrast, whale-oriented activities, especially the close approach of boats and aircraft, or unusual events such as sonar or playback experiments, cause pronounced short-term disturbances.

Whether or not such short-term disturbances will translate into significant long-term detrimental effects on the population is not known. Although there have been no obvious changes in population status or general behaviour patterns over thirteen years of extensive research on the whales - a period when whale-oriented activities have increased significantly - some more subtle behavioral changes have occurred. Whales in the area have become easier to approach, and increasingly are initiating playful encounters with vessels, suggesting a tolerance or acceptance of human activity. However, at the same time, whales are apparently resting less in the core area today

than they were five years ago, suggesting unacceptable levels of disturbance to that activity.

Observations of whales increasing swimming speed when followed by boats (within 400 m - an almost continual occurrence in the summer), and the apparent change in resting behaviors patterns warrant concern. Subtle changes in whale behaviour patterns may be occurring in order to minimize contact with human disturbance. These might be predicted from the studies of impacts of human activities on terrestrial mammals. These may be the first signs of more significant imminent impacts on the whale population. If changes occur in feeding behaviour or range, consequences to the overall health of the population could be serious.

Future impacts of human disturbance at current or increased levels will likely include a trend to more stressed or nervous animals or partial abandonment of the area. The ability of the whales to absorb these changes and maintain optimum health is not known.

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I. PERSPECTIVE

1.1 The Concerns

Overt responses of large wild mammals to human activities vary from benign to panic while more subtle and long term responses may include elevated metabolism, lowered body weight, reduced fetus survival, and withdrawal from suitable habitat (Geist, 1971).

The northern Vancouver Island population of killer whales faces increasing human activities within a core summer feeding area. This area includes Robson Bight Ecological Reserve. Many of these activities are specifically whale-oriented, including research, commercial photography, and whale watching. Concerns have been raised as to whether these activities disturb the animals, perhaps interfering with feeding, resting, reproduction and social activities. Such interference could cause abandonment of the area, reduced survival of the population or both.

There is a lack of information on the impacts - especially long-term impacts - of human disturbance on whale populations. Studies of such impacts on land mammals are still in their early stages although they suggest that concern for the health of whale populations in areas of high human density may well be warranted.

Assessment of the impacts of human activities on the whales entails first determining if the whales are disturbed by various activities, and then

determining if this disturbance is detrimental to the overall health of the population. This is not a small problem

If it is determined or assumed that a problem exists, the management goal must be to design education programs and, if necessary, regulations to check the increasing demand for interaction with the animals. The biological requirements of the whales must be given first priority to ensure the overall health of the population.

The objectives of this report are to:

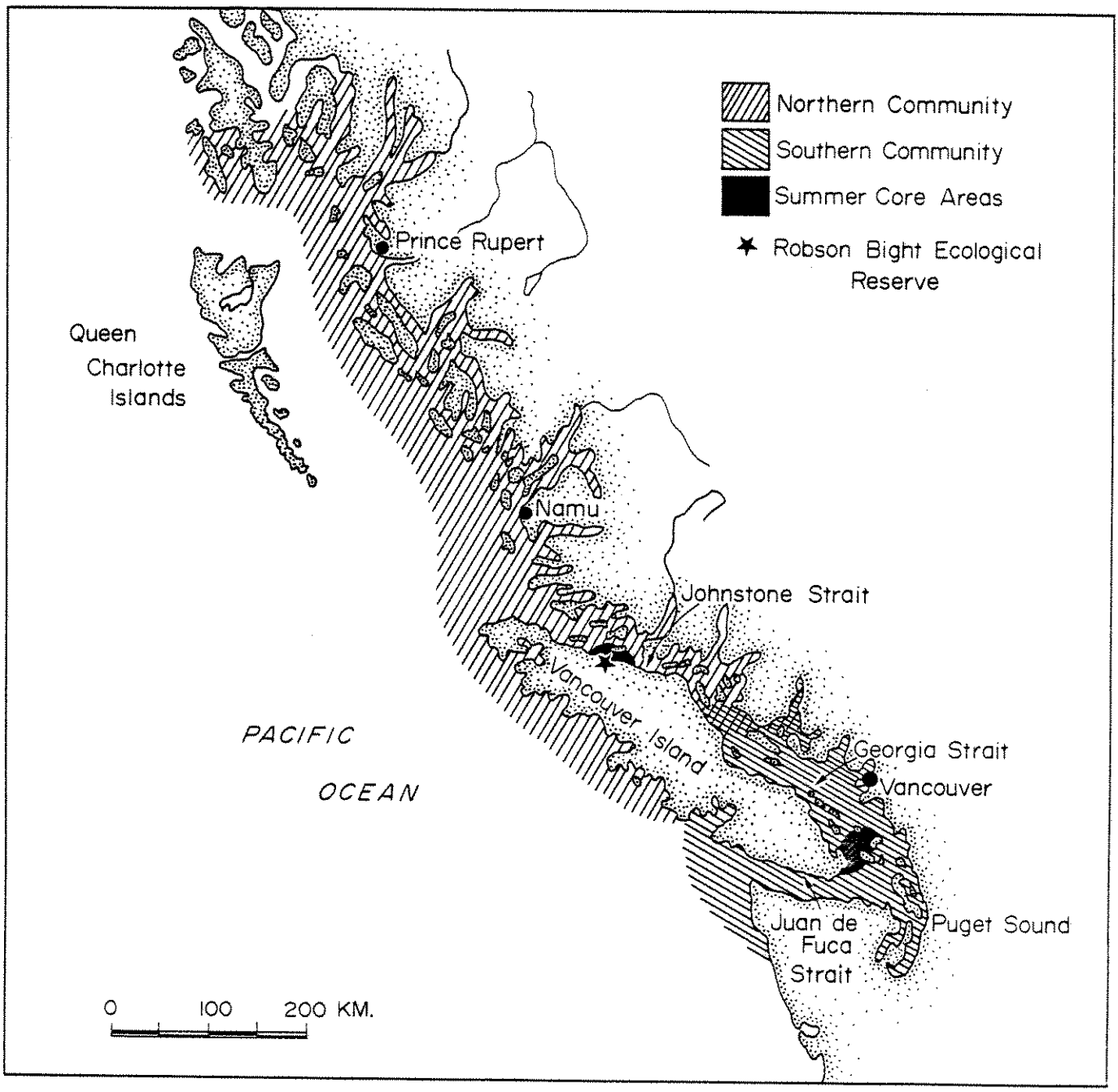
1. Determine as best as possible if killer whales are disturbed, or may potentially be disturbed, by various human activities in the area.

2. Assess as best as possible the current and future impacts of human disturbance on the health of the population.

1.2 The Killer Whale Population and the Reserve

There are approximately 300 killer whales living in B.C. waters, and this population is stable (Bigg 1982, Bigg 1986 pers comm., see Appendix 1). These animals normally live in cohesive groups known as pods.

There are two types of killer whales found in B.C. waters, the Residents that occupy specific local ranges during the summer, and Transients that pass through the entire area at irregular times apparently ranging over a much larger territory. Residents live in two communities, separated geographically (Figure 1). The southern community includes three pods with 75 whales that range through Georgia Strait, Puget Sound and Juan de Fuca Strait. The northern community

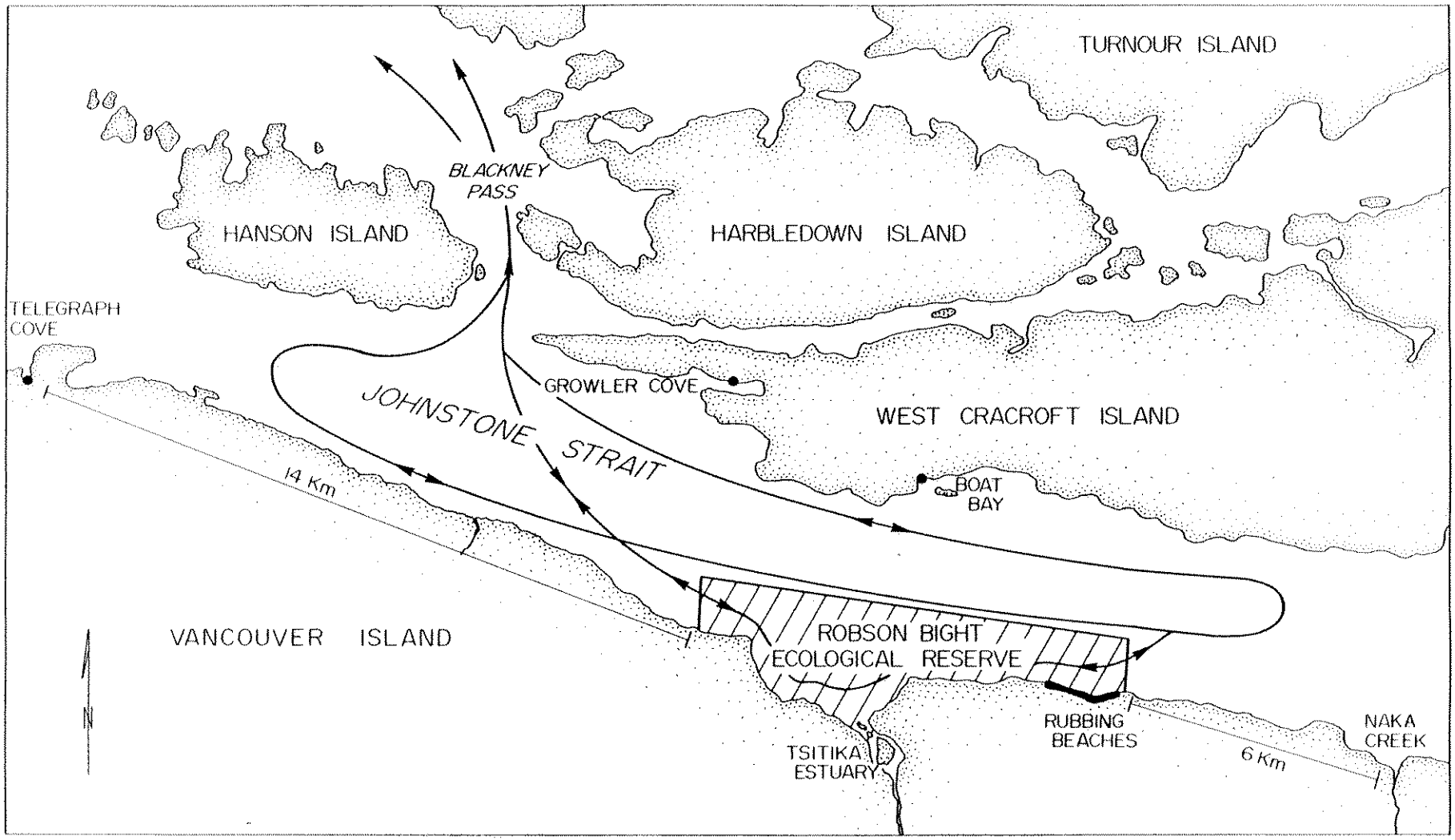

Northern Community
Southern Community
Summer Core Areas
Robson Bight Ecological Reserve
Prince Rupert
Queen Charlotte Islands
Namu
Johnstone Strait
Vancouver Island
PACIFIC OCEAN
Georgia Strait
Vancouver
Juan de Fuca Strait
Puget Sound
0 100 200 KM.

includes 13 pods with 160 whales that range from Campbell River to Prince Rupert. Twenty transient pods have been identified with 65 animals (Bigg 1982, Bigg 1986, pers. comm.). During the summer there are "core areas" in each community where killer whales can typically be seen daily. These are apparently prime feeding areas. The core area in the southern community is in San Juan Island - Haro Strait waters; the core area in the northern community is northern Johnstone Strait including Robson Bight Ecological Reserve (Figures 1 and 2).

Robson Bight Ecological Reserve is an approximately 9 sq. km section of water within an approximate 80 sq. km core area, and an overall summer range covering 1000's of sq. km (Figures 1 and 2). Following the Vancouver Island shoreline the reserve encompasses Robson Bight and the Tsitika estuary and a 4 km length of coastline to the southeast that includes the Rubbing Beaches. The reserve extends about 1000 m from shore into Johnstone Strait and is 8900 m long. A narrow land buffer zone may be added to the reserve in the near future (Wilderness Advisory Committee Report 1986).

Killer whales that are summer residents of the northern Johnstone Strait area typically pass through Robson Bight Ecological Reserve once to several times daily during normal activity from July to October (Ford 1980, Hoyt 1981). All of the northern community killer whales (13 pods) are not present in this area on a regular basis. The most sightings are of 5 pods with 50 animals (Bigg 1986, pers. comm).

Few records are available that actually document the historical use of the northern Johnstone Strait - Robson Bight area by killer whales. Fisheries literature (Stevenson, 1960) indicates that killer whales were commonly seen in the area in the 1930's and local native cultural depictions of these animals suggest a long-term, traditional presence.


TURNOUR ISLAND
BLACKNEY PASS
HANSON ISLAND
HARBLEDOWN ISLAND
TELEGRAPH COVE
GROWLER COVE
JOHNSTONE STRAIT
WEST CRACROFT ISLAND
14 Km
BOAT BAY
VANCOUVER ISLAND
ROBSON BIGHT ECOLOGICAL RESERVE
N
RUBBING BEACHES
NAKA CREEK
TSITIKA ESTUARY
6 Km

As stated above the reserve is a relatively small portion of the daily summer range of these animals. Ford (1980) gives more perspective on usage when he reports that during 150 hours of observation in 1978, the whales spent 26 hours or 17% of their time in or just adjacent to Robson Bight. Ford (1980) notes, however, that considering the constant movement of the whales and large area covered by them, this amount of time is fairly significant. To illustrate the point, one pod observed over a thirteen hour period covered 100 km and spent one and a half hours in the Robson Bight Area.

Whales may be foraging, travelling, resting, socializing or beach rubbing when inside the reserve, the full range of daily activities (Ford 1984, Appendix 1). There has been some suggestion in the popular literature that Robson Bight is primarily a resting or play area for the whales (eg. Hoyt, 1975), however its importance as such has not been established.

The reserve contains two unique features within the northern Johnstone Strait core range. These are the Tsitika estuary, the only remaining undeveloped estuary in the area, and the Rubbing Beaches, a series of steep smooth pebbled beaches that the whales rub against (Appendix 1). Similar rubbing beaches have not been reported anywhere in B.C. or Puget Sound.

The principle winter range of these killer whales, although not yet defined, does not include the reserve area (Bigg 1986, pers. comm).

The real significance of the reserve in terms of the whale population is difficult to assess. On one hand it is only used by about one sixth of the killer whales in B.C. for 17% of their time during four months of the year. It is simply too small for protective measures within its boundaries to be very significant in terms of the overall conservation of the animals. (For this reason the assessment of impacts that follows considers human activities beyond the

actual boundaries of the reserve.) On the other hand the reserve protects unique habitat for the whales, and hosts a full range of whale activities. It also has a significant symbolic function, serving as a focus for the development of education, research and management programs that will help protect the killer whale population throughout its range.

II. ASSESSMENT

2.1 Generalizations from the Ungulate and Cetacean Literature

A) Impacts of Human Activities on Ungulate Populations

Appendix 2 gives excerpts from studies conducted on the impacts of human activities on wild ungulates. The following generalizations can be made.

1) Wild mammal populations often can habituate to a variety of human background activities that are steady and predictable - ranging from highways to sonic booms. (Altmann 1958, Dorrance et al. 1975, Schultz and Bailey, 1978, MacArthur et al. 1982).

2) Wild mammals are far less likely to habituate to disturbance involving close approach or pursuit, or to unusual, unpredictable events. Animals are more likely to be alarmed if escape routes are blocked. (Schultz and Bailey 1978, Horejsi 1981, MacArthur et al. 1982, Freddy et al. 1986).

3) Responses to disturbance, including flight distance, may vary markedly depending on reproductive and nutritional status, habitat or experience of the animal (Altman 1958).

4) Wild mammals may significantly change behaviour patterns and range in response to disturbance, generally minimizing contact with human activities. These changes can potentially effect the overall health of the population (Geist 1971, Dorrance et al. 1975, Foster and Rahs 1983).

B) Impacts of Human Activities on Whale Populations

Studies of the impacts of human activities on whale populations are at a younger stage than those for land mammals. There have been a few quantitative studies conducted on the overt responses of whales to disturbance and these responses have been highly variable except under extreme conditions (Malme et al. 1984, Richardson et al. 1983, 1985). Included in Appendix 3 are descriptions of several studies as examples. Tentative generalizations from these studies follow.

1. Ship or boat traffic, aircraft overflights and other unpredictable events such as loud noise from seismic exploration or playback experiments may cause pronounced short term behavioral reactions and temporary displacement of whales (Richardson et al. 1983, Baker et al. 1983, Malme et al. 1984, Kruse 1984, Ljungblad et al. 1985, Richardson et al. 1985).

2. Whales will tolerate or habituate to human activities to some extent as is illustrated by their presence and "normal" behaviour in the vicinity of some industrial operations and vessel traffic including fishing and

whale watching (Richardson et al. 1983, Baker et al. 1983, Sorensen et al. 1984, Jones and Swartz 1984, Richardson et al. 1985).

Our knowledge of how whales react to human disturbance lies well within the broader generalizations arising from the ungulate literature.

2.2 Human Activities in the Vicinity of the Reserve: Types and Trends of Activity Levels

Human activities in the area are generally divisible into two categories: a) non-whale-oriented; and b) whale-oriented.

Non-whale-oriented activities normally include commercial vessel traffic, commercial and sports fishing activities, coastal development, and general coastal cruising. Whale-oriented activities include research operations, professional and amateur photographers and film makers, and a variety of whale watching activities.

Sports fishing and recreational cruising can fall into either category. While sports fishermen would be in the area with or without the whales, and most would rather be fishing, a significant portion of them are likely to be opportunistic whale watchers. Much recreational cruising would occur without whales but many boaters take time out to follow whales if sighted. The same is true for aircraft. Numerous kyakers, however, plan a trip to the area primarily to see whales.

A. Non-Whale-Oriented Activities

Vessel Traffic

Virtually all commercial vessel traffic using the Inside Passage between Alaska and the lower United States and between Prince Rupert and Vancouver pass through Johnstone Strait and Blackfish Sound. Some of the vessels may actually pass through the outer portion of the reserve; underwater noise from all traffic can be heard throughout the reserve.

Vessel traffic includes fishing boats in transit, military vessels, cruise-ship type ocean liners, tugboats with barges or log booms, tankers and cargo ships. Recreational traffic includes various sized motorized pleasure craft, sailboats, kayaks, and canoes.

The level of activity is best described as an almost continual stream of traffic in the summer months. Briggs (1985) presents extensive observations on all boat traffic both coincidental and whale-oriented. He scanned the area every one half hour from 0600-2100 each day from July 11 - September 1, 1984. More than 70% of scans made for all times included at least one boat, with a peak from 0800-1300 in which 100% of scans included at least one boat. It should be noted that these figures include research and other whale-oriented craft, which are virtually always present in daylight at that time of year. Commercial vessel traffic is somewhat less constant. For example, tugboats with or without tows, cargo ships and tankers combined were present in more than 20% of the scans from 0700-2100 with a peak of 45% at 2100 (Briggs, 1985). Further details are available in Briggs (1985).

Trends in vessel traffic activity are difficult to determine in more than a general way. Annual or monthly vessel traffic counts are not normally extracted

from records of the Coast Guard Vessel Traffic Centre in Vancouver that monitors the waterway. Consequently, quantitative data were not available to look at specific trends over a number of years. The statistician at the vessel traffic center felt that overall large vessel traffic through the area may have increased as much as 25% over the last 5 years, due to an increase in shipping between Prince Rupert and Vancouver, and an increase in cruise ship traffic to Alaska (M. Fisher 1986, pers. comm.). Future activity levels are difficult to predict, as the state of the economy is a major factor in determining volume of commercial traffic. For example, logging-related traffic might decrease while cruise ship traffic increases.

Commercial Fishing

Northern Johnstone Strait - Blackfish Sound has long been a prime commercial salmon fishing area for gillnetters and seiners. During openings, the number and duration varying from year to year from June - October, the area can be congested with several hundred fishing boats and nets, making it difficult for a passing vessel to navigate through the area. For example, on August 20, 1970, 403 fishing vessels (332 gillnets and 81 seine nets) were in the core killer whale area (DFO. Fisheries Statistics, Vancouver).

Activity includes seiners setting nets and drawing them into the boat, and gillnetters setting nets perpendicular to the shore, waiting for several hours and hauling the nets in. Seiners usually tie one end of the net to the shoreline. The activity is intense during openings, which have varied from approximately 15-50 days per season over the last 20 years (DFO. Fisheries Statistics, Vancouver).

The Tsitika estuary is off-bounds to fishing, however the actual boundaries shift in and out of Robson Bight to some extent. There is definitely fishing activity within the Reserve boundaries. Also, fishing boats and packers often anchor inside Robson Bight before and during openings. It is not uncommon to see a dozen or more boats inside the reserve during openings. Commercial fishing openings are unquestionably the periods of greatest overall human activity within the reserve area.

Trends in fishing activity levels are illustrated in Figure 3A. The graph shows the total amount of gear (gillnets and seine nets) in the water each season in the Johnstone Strait area for the years 1962, 1965, 1970, 1975, 1980, and 1985. The 1985 figures are not strictly comparable, as they are for the entire Area 12 that extends north of Johnstone Strait (i.e., the Johnstone Strait figure would be smaller). Commercial fishing activity in the area over the last ten years, 1975-85, is not higher than it was the previous thirteen years, 1962-75. (DFO. Fisheries Statistics, Vancouver).

Coastal Development

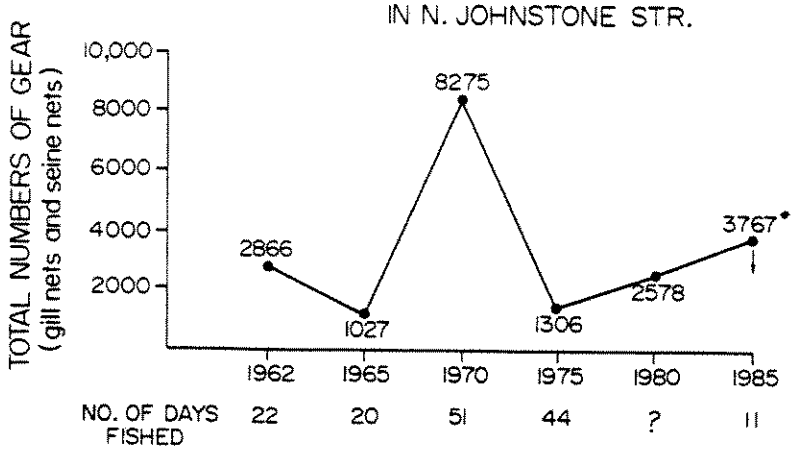
The two main areas of concern are coastal logging operations, and public or private tourist-oriented development.

Logging: Logging may have direct impacts by destruction of natural habitat, or indirect impacts through increasing accessibility to the area.

Coastal logging operations typically use estuaries or bays for log dumps, dryland sorts or booming grounds, as has occurred in Beaver Cove, the first such area to the north of the reserve, and Naka Creek, the first such area to the south. Now that Robson Bight is protected, and all other suitable locations in

A.

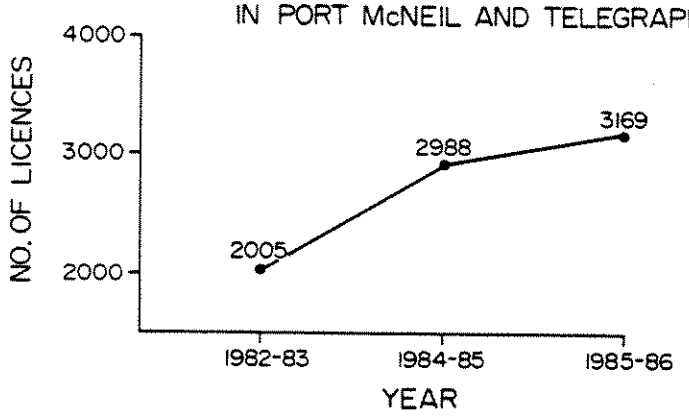
AMOUNT OF COMMERCIAL FISHING GEAR IN N. JOHNSTONE STR.



* THIS FIGURE IS FOR ALL AREA 12. STATISTICS FOR N. JOHNSTONE STR. ONLY ARE NOT AVAILABLE FOR 1985. ACTUAL NUMBERS IN N. JOHNSTONE STR. WOULD BE LESS THAN 3767.

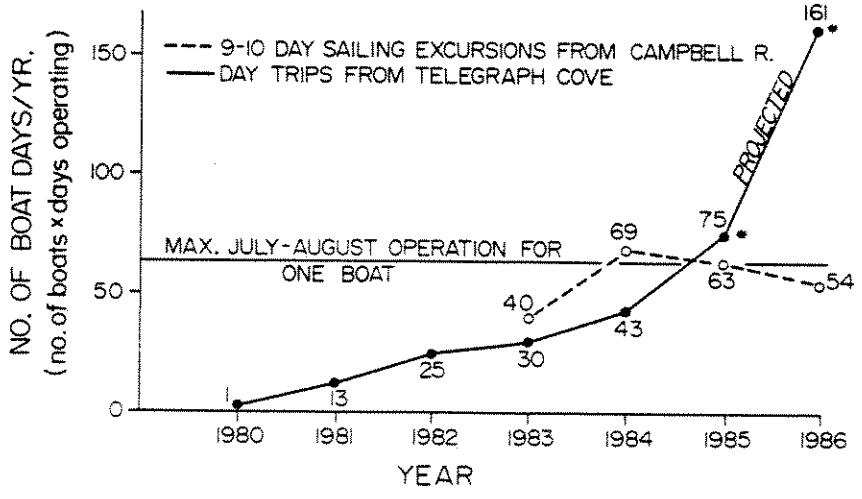
B.

NUMBER OF SPORT FISHING LICENCES SOLD IN PORT McNEIL AND TELEGRAPH COVE



C.

EXAMPLES OF COMMERCIAL WHALE WATCHING ACTIVITY IN JOHNSTONE STR.



* TWO BOATS OPERATING IN 1985 AND 1986

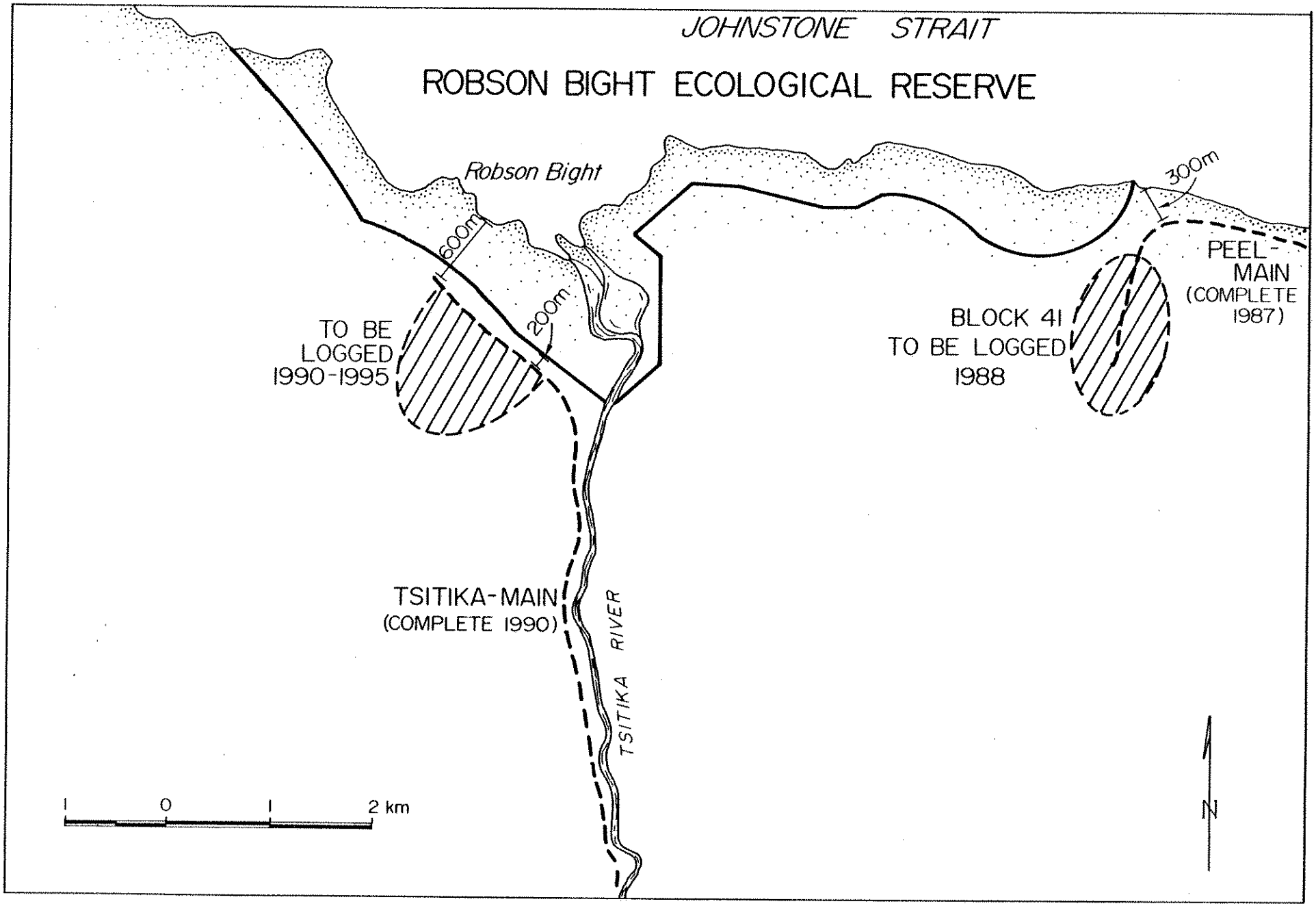
the area are already developed, this activity will not likely increase in the future.

Land access to the reserve area will be greatly eased by construction of logging roads over the next few years. Figure 4 shows the proposed near-reserve roads and the years they are expected to be completed. These roads will significantly increase hiking, camping and kyaking access to the reserve area.

An immediate concern may be the Western Forest Products road (Peel Main) just to the southeast of the reserve. This road is expected to be completed by 1987 and will run to within 300 meters of the coast at that point (Western Forest Products, 1985). This road will provide potential easy access to the Rubbing Beaches for hikers or kyakers.

A second area to be accessed and logged by 1990-1995 is to the southwest of the Tsitika Estuary, just outside the proposed upland reserve boundaries (Wilderness Review Committee, 1986). This road, the Tsitika Main, will come within an estimated 600 m of the estuary at its nearest point (MacMillan Bloedel, 1985). This road is being built by the B.C. Ministry of Forests and is expected to be of high quality.

Tourist-Oriented Coastal Development: The opening of the highway from Kelsey Bay to Port McNeil in 1979, and subsequent development of tourist facilities at Telegraph Cove (including an 80 boat marina and 110 unit campsite) that opened in 1981 has significantly increased use of the reserve area. A similar facility is planned for Alder Cove just northwest of Beaver Cove but no completion date is set.


JOHNSTONE STRAIT
ROBSON BIGHT ECOLOGICAL RESERVE
Robson Bight
600m
200m
300m
TO BE LOGGED 1990-1995
BLOCK 41 TO BE LOGGED 1988
PEEL-MAIN (COMPLETE 1987)
TSITIKA-MAIN (COMPLETE 1990)
TSITIKA RIVER
1 0 1 2 km
N

Although coastal developments in the near-reserve area are not foreseen, promotion of the north island area and increased facilities will likely attract a growing number of visitors to the region.

Sports Fishing

Eased access to the area with the new highway in 1979, new boat ramp and marina facilities at Telegraph Cove in 1981, and excellent fishing have led to a marked increase in sports fishing activity in the last few years.

Sports fishermen aggregate at several prime fishing locations throughout the day. These include Baronet Passage, Double Bay (Hansen, Is.) and Weynton Passage. These areas are at least 7 km from Robson Bight. All are within the core range of the killer whales.

All indications are that this activity will increase steadily for the foreseeable future. Figure 3B shows the number of sports fishing licenses sold in Telegraph Cove and Port McNeil from 1982-83 to 1985-86. The number of licenses sold in the area have increased by 63% in less than five years. These figures do not include fishermen who bought their licenses elsewhere. In the Campbell River area, just 130 km to the south, over 39,195 licenses were sold in 1985-86. The potential for increased sports fishing activity in the area is significant (DFO. Sports Fishing Statistics, Vancouver).

B. Whale-Oriented Activities

Researchers and Photographers

Due primarily to the predictable and regular occurrence of whales, and, in recent years, increased access, the Johnstone Strait area has become the world's

prime killer whale research and photography location. Researchers and photographers travel from across Canada, the U.S., Japan, and Europe to study, photograph, and film the whales. Research and photography generally necessitate following the whales closely for long stretches of time, over many days. In the case of research, many years. Most of the research is based on individual identification of the animals which requires a sharp photograph of the dorsal fin. This necessitates a close approach, as do behavioral observations. Recordings of whale sounds require the researcher to move in front of the whales, turn off engines and record as the whales travel past, then repeat the procedure. High quality photographs and motion pictures also depend on a close approach to the animals.

Research and photography began in the area in the early 1970s, with often 2-4 boats around the whales by 1973 (G. Ellis 1986, pers. comm.). On most days during the 1985 season between 4-8 boats typically followed the whales. These included several pleasure craft with amateur photographers, a commercial whale watching boat, researchers and photographers. Nine permits (6 researchers and 3 film makers) were given for work inside the reserve in 1985. Not all were present in the area over the entire summer. Researchers and photographers primarily enter the reserve to continue identification or recording work, and to study/photograph the beach rubbing behaviour.

This activity level has more or less doubled over the last ten years. Probably the actual amount of time that any one whale is followed has increased significantly as researchers and photographers spread themselves out physically and over daylight hours.

It is very difficult to predict what future levels of research or photography activity will be, this work depending on funding or demand respectively. There is no indication at this time that activity levels will decrease in the near future.

Whale Watching

Although organized whale watching trips existed in the area as early as 1973, recreational killer whale watching is primarily a product of the 1980's. It is the result of the immense popularity of the animals, and desire to see them in their natural habitat.

There are several different types of whale watching activities in the area.

Commercial Day Trips: There is one main operator of day trips in the area at this time, Stubbs Island Charters, based out of Telegraph Cove. Since 1980, they have taken groups to view the whales aboard the 17 m "Gicumi". In 1985 they added a second vessel to their operation, the 17 m "Clavella". They take out 20-30 people at a time, ranging from organized natural history groups from all over North America, to Fiesta Wayfarer bus tours. The day-long trip allows ample time to view killer whales, other marine mammals, and birds.

Day trips from Telegraph Cove have increased steadily since 1980. Figure 3C gives the number of day trip boat days per season and clearly shows the trend. As stated above, in 1985 two vessels were used. Stubbs Island Charters does not enter the ecological reserve when whales are present.

Cruising Expeditions: Several companies offer one week to ten day cruises into the Johnstone Strait area that emphasize the natural history of the area. The highlight (and main selling feature) is the killer whales.

Bluewater (formerly Whitewater) Adventures, based in Vancouver, has been a steady operator in the area since 1983 and is a good example of this type of trip. Up to 16 guests are accommodated aboard the 20 m motor-sailor "Island Roamer" for a nine day trip from Campbell River to northern Johnstone Strait and return. Often an expert in the natural or human history of the area accompanies the trip. Trips are often booked by American natural history groups.

The number of boat days per season since 1983 that "Island Roamer" has operated in the area are given on Figure 3C. Not all these days are spent near the whales. The number of boat days in the area have actually decreased somewhat since 1984. The owner commented that he expected to actually be doing less trips to the area in the future because his clientele generally want to go to less accessible and crowded areas.

Several other charter companies from Vancouver Island and Vancouver offer similar trips, but are in the area less frequently than the "Island Roamer".

It is not known how much time, if any, is spent actually inside the reserve during these trips.

Kayak Expeditions: Kyack expeditions to the area are very popular. A typical expedition, offered by Ecosummer of Vancouver is a eight day trip with up to six kayaks. Boats are launched at Telegraph Cove and the group camps in different locations over the eight day period. As with other trips, whale watching is a highlight of the trip.

It is difficult to estimate the current level of kayak activity. There are at least two companies operating regularly in the area over the summer months, Ecosummer and Northern Lights Expeditions of Seattle. There are other "no

name" organizations that visit the area (American companies must hire Canadian guides if they are to operate in Canada - to get around this, American groups come as "unorganized private parties"). There are estimates of "hundred and hundreds" of kayaks launched in Telegraph Cove each summer (Jim Borrowman, Bill MacKay 1986, pers. comm.).

Ecosummer has conducted "3 or 4 trips" each summer since 1981. Since that time, they have not added more trips, but the trips are more likely to fill up now. They have four 8-day trips scheduled for 1986.

Kayaks enter the reserve and, at times, camp in Robson Bight. It is not known if these are organized groups or private expeditions.

Private Boats and Airplanes: The number of private boats, including speedboats, kayaks, canoes, sailboats, or larger cruising vessels that watch whales are significant. It is not uncommon to see these vessels closely following the whales. Often aircraft will opportunistically whale watch, circling over the animals at varying altitudes. There is one recorded incident of a float plane landing amongst the whales in Robson Bight. (Ford 1986, pers. comm).

These activities are expected to increase with increased publicity and access to the area.

Beach Observation of Rubbing Behaviour: It is difficult to estimate the numbers of the general public that land on the Rubbing Beaches in small craft to watch the whales. This certainly happens, but is apparently not a common occurrence at this time. The reserve designation, volunteer wardens and researchers have discouraged this activity in recent years. The completion of a logging road to within several hundred meters of the Rubbing Beaches by 1987

could lead to a significant increase in beach activity.

Various researchers and photographers have observed and photographed whales from the beaches for a number of years. Since the reserve designation the numbers of permits issued to work on the beaches (2-3 per year) give an accurate estimate of the level of this activity.

Potential Growth of Whale Watching

The whale watching industry is likely to be the major growth activity in the area. Distance from population centers and the "small" B.C. market will not necessarily slow its growth, as eastern Canadian and U.S. markets have already shown significant interest in the activity and the area. If whale watching in Johnstone Strait follows trends in other areas it will grow significantly. In California the whale watching industry boomed in the 1970s. Now 31 operators approximately 225,000 people a year (Tilt, 1985). Hawaii had virtually no whale watching industry in 1975; now over 25 vessels carry approximately 200,000 people at season (Tilt, 1985; Anderson, 1985). In New England, whale watching began in the mid-late 1970s. In 1985, in a 120 mile arch from Gloucester to Provincetown, 19 operators with 29 vessels carried 1.5 million passengers. All these operations were centered on the 18-25 mile Stellwagen Bank. In Provincetown alone three whale watching operations carried an estimated 330,000 people during the 1985 season (Tilt, 1985).

C. Summary

Killer whales using the Robson Bight Ecological Reserve face the steady background activity of passing commercial and recreational vessel traffic, intense commercial fishing activity during openings, and increasing pockets of sports

fishermen. They also face near constant attention-pursuit by researchers, photographers, and whale watchers.

Non-whale-oriented background activities such as commercial fishing, or vessel traffic are expected to remain at current levels or slowly increase depending on economic factors.

Whale-oriented activities, such as research, photography and whale watching, potential whale-oriented activities such as sports fishing and recreational cruising, and access to the reserve area are expected to increase steadily, if not dramatically, in the foreseeable future.

Trends of activity levels in the vicinity of Robson Bight Ecological Reserve and summarized in Table 1.

TABLE 1. Trends Of Activity Levels In The Vicinity Of Robson Bight Ecological Reserve

ACTIVITY	TREND OF ACTIVITY LEVEL
NON-WHALE ORIENTED	
Commercial Vessel Traffic	Stable/Increasing
Commercial Fishing	Stable
POTENTIALLY WHALE-ORIENTED	
Coastal Development: Facilities	Stable/Increasing
Access	Increasing
Sports Fishing	Increasing
Recreational Cruising	Increasing
WHALE-ORIENTED	
Research/Photography	Increasing
Whale Watching	Increasing

Note: Camping may be associated with increased land access, recreational cruising and whale watching. It would be expected to increase with the activities

2.3 Best Assessment of Impacts

This section addresses the two questions: Are the killer whales disturbed by human activities and; can these disturbances be detrimental to the overall health of the population?

A. Are the Killer Whales disturbed by Human Activities?

Generalizations from the ungulate literature and our knowledge of how other cetecean species respond to human activities suggest that the killer whales might well habituate to predictable background activities such as vessel traffic or commercial fishing, but would likely not habituate to direct close approaches, or pursuit.

The available observations on the responses of killer whales activities in the area to appear to support these predictions.

There is no evidence that the long-term, non-whale oriented background activities of passing vessel traffic or commercial fishing significantly disturb the animals. For example, observations of apparently undisturbed foraging whales winding in, out and under 200 - 300 fish boats and nets during commercial openings are not uncommon. The facts that these activities have been ongoing at similar levels for many years, the whale population is still present with no obvious changes in abundance or behaviour over the last 13 years of scientific observation (see next section), few overt responses to these activities are noted by researchers, and many wild mammals apparently have the ability to habituate to this type of human activity, allows the tentative conclusion that this form of activity at current levels does not significantly disturb the animals.

On the other hand there is ample evidence that the whale oriented activities of research, photography and whale watching may cause pronounced

disturbance at least in the short-term. Following are examples of activities that have obviously disturbed the whales in the eyes of researchers and other whale watchers in the area:

1. A helicopter flying very low (30-50 m) above the whales, startled them, and caused them to scatter. The whales "joined-up" again shortly thereafter.

2. Small planes circling the whales at low altitudes <500 ft. caused whales to roll over to look up, then to scatter.

3. Divers jumping from boats in front of the whales caused the animals to split into groups and change course to go around the interference.

4. Small boats in pursuit of the whales, especially those that approached closely from in front of the animals, caused the whales to change course and turned them around entirely at times (see Kruse 1984, Appendix 3).

   Small boats near the whales caused other responses including tail slapping, crisscrossing of animals, termination of unified activity, and changed the behavior pattern of the animals (eg. from resting to traveling).

5. Non-motorized vessels such as kayaks also disturbed whales. In one incident, the approach of several kayaks startled resting whales, causing the animals to dive suddenly and ending the resting session.

6. Sonar from a U.S. coast guard ship upset the whales as they converged, rushed towards shore (away from the ship) and remained generally unsettled.

7. Playback experiments, where sounds ranging from music to killer whale calls were broadcast to the whales from an underwater speaker, elicited distinct reactions from the animals. On one occasion, a whale rushed a boat with apparent aggressive intentions in response to playing its own calls back.

8. In the one available quantitative study on the responses of killer whales to human activities in the Robson Bight area, Kruse (1984) reports that the speed of the whales increased significantly when vessels were within 400 meters. Killer whales showed a clear response to the presence of boats by swimming 1.4 times as fast as whales in the undisturbed category. This response did not diminish over the course of the summer, indicating that killer whales did not habituate to the presence of boats (Kruse 1985, Appendix 3).

Although most of the above observations are not quantitative, they clearly indicate that whales are disturbed by a close approach from air or sea and by unusual or unpredictable events (playback, sonar).

B. Can These Disturbances be Detrimental to the Whale Population?

The ungulate literature suggests that wild mammals may significantly change behaviour patterns and range in order to minimize contact with human disturbance. If this results in the movement of animals from their optimum range, the health of individuals and survival of the population as a whole may be effected (Giest 1971, Appendix 2).

It is necessary to determine if the short-term disturbances described above have changed behaviour patterns or other aspects of this killer whale population over the longer-term, and if so, how.

Changes in Population Composition, Summer Range and Timing

There have been no obvious changes in the distribution and abundance of killer whales in B.C. in the 13 years from 1973-1985 (Bigg 1986, pers. comm.). During this period, whale-oriented activities have increased considerably. The same pods are present, on the same range, for the same period of time each year. There have been no obvious changes in reproductive or mortality rates, although as these animals are long-lived and recruitment rates low this is difficult to gauge at this time (Bigg, 1986 pers. comm.). There seems to be no major impacts on the population from current levels of activity.

Behavioral Changes

(i) Approachability: The whales in the area are much easier to approach with small craft today then they were in 1973-75. They are much easier to approach than killer whales in northern B.C. waters which have had less contact with humans. Also, having been left alone all winter, killer whales in the area become more approachable as the summer season progresses (G. Ellis, M. Bigg 1986, pers. comm.).

(ii) Interactions with Vessels: There has been an apparent increase in the number of times that whales approach vessels. It is not uncommon for whales to approach fishboats, tugs, oceanliners, researchers, and whale watchers to ride the bow waves or surf on wakes of the vessels.

One somewhat unusual incident is related by Bill MacKay of the whale watching boat "Gicumi".

> "We were on our way home when A5 pod altered course and raced over to the boat. I put it in idle and they just stayed with us. The whales were within a few feet of the boat, and no less than a couple dozen times in a 1 1/2 hour period the folks got wet from whale blows and splashes. One of the whales rubbed against the bottom of the boat. It came up with red lead paint on it . . . ."

Whales, in general, have shown some propensity for initiating "friendly interactions" which include rubbing on boats, and positioning themselves to be patted or rubbed. The best known example are the "friendly" gray whales. This behaviour began in 1976 in San Ignacio Lagoon, Mexico and has since spread steadily through the population and its range (Jones and Swartz, 1984).

This behavioral change is certainly the result of close human activities, but a somewhat unexpected one. The potential for this type of behaviour in killer whales is not known.

(iii) Resting Behaviour

Several long-term researchers and whale watchers in the area have noticed that the whales seem to rest less in the core area than they did in the 1970s (G. Ellis, J. Ford, J. Borrowman, B. MacKay 1986, pers. comm.). The observers commented that they seldom see resting whales now. Ford's (1984) analysis of behaviour from observations made in 1978-81 indicates that whales spent 13.2% of their time (in the core area) resting in sessions that lasted from .5-7.5 hours (Appendix 1). Resting was commonly observed in the Robson Bight area. This "change" in behaviour pattern has not been quantified and is little more than a casual observation at this stage. If true, it could be a key observation in the assessment of impacts.

C. Assessment of Current Impacts

Available information suggests that:

1) Non-whale-oriented, background, industrial and recreational activity in the area does not significantly disturb the whales, and, at current levels, has minimal impacts on the population. The animals have habituated to this activity.

2) Whale-oriented activities, especially close approaches, may cause pronounced short-term disturbance responses from the whales, including course changes, splitting of groups, increases in speed, and changes in activity (from resting to travelling). It is unlikely that the whales can habituate to this disturbance.

3) To date disturbances from human activities have not caused any major changes in whale population status or behaviour, however some subtle behavioral changes are notable. These include whales becoming easier to approach, increased interactions with vessels initiated by the whales, and a possible change in behaviour patterns where the animals spend less time resting in the core area. The significance of these behavioral changes to the long-term health of the population is not known.

Comments

Some of these observations seem contradictory. On one hand the whales are obviously disturbed by close approaches or pursuit, and on the other hand they have become easier to approach and in fact have begun to approach boats.

One can only speculate as to what is actually occurring in the whale behavioral responses. Possibly there is some degree of habituation to close approaches. Possibly foraging in the area is critical to the summer, and year-round, nutrition of the whales and the animals have no alternative but to accept the close presence of boats. The observation that whales increase their speed when disturbed suggests that the habituation and/or the ability of the animals to maintain their normal behaviour pattern is not complete.

Increased interactions with vessels that are elicited by the whales are not necessarily inconsistent with observed disturbance responses. Ford (1984) indicates that interaction with vessels usually occurs when the whales are in a socializing, behavioral mode, one of five general activities (Appendix 1). Ford (1984) observed that whales spent about 11.65% of their time socializing and playing in sessions that lasted an average of 1.86 hours. Killer whales are

highly social and playful animals, and apparently vessels have become such a consistent and non-threatening part of their environment that they include them in their activities. The key point is that the whales initiate the interactions. Socializing bouts with humans are of little concern in assessment of impacts. This does not mean, however, that human interference in foraging, rubbing, and resting activities can be tolerated by the animals. This might be compared to us playing catch when we want to, and someone throwing a ball at us when we are eating or sleeping.

That whales apparently spend less time resting in the core area now compared to five years ago, is not surprising, considering the intensity of human activity and the documented response of other mammals to similar activity. Resting is probably less area-specific than foraging and rubbing, therefore, it is likely that the whales could change the location or timing of the behaviour to minimize contact with human activity. If this is the case, it is an important indicator of the degree of the impacts of human activities.

The increased average speed of disturbed versus undisturbed whales reported by Kruse (1984) has some potentially serious implications. The whales are often "disturbed" by Kruse's definition (a boat within 400 meters) continually throughout all daylight hours of the summer months. According to Kruse (1984) disturbed whales swim 1.4 times faster than undisturbed animals. Disturbed animals could, therefore, potentially spend significantly (40%) less time passing through the core area and significantly more energy doing so, than undisturbed animals covering the same route. The increased expenditure of energy alone, even if the same amount of food is obtained, may seriously affect the overall energy budget of the animal.

Available information raises the possibility that subtle but potentially significant behavioral changes are being caused by whale-oriented human activities. Patterns of foraging, resting, rubbing, and socializing may be changing. These changes may cost the animals energetically. More substantiated observations of behavioral changes are required in order to confirm the seriousness of the problem, however, the situation warrants immediate concern. Data supporting the apparent changes in whale behaviour patterns are few, however, these changes are predicted from more extensive research on the impacts of human activities on wild ungulate populations. These impacts may, ultimately, interfere with the health, growth, and reproductive fitness of the population (Geist, 1971).

Shore Activity at the Rubbing Beaches

This topic has not been included in the discussion of disturbances or current impacts on the whales as there is no evidence the quiet observation from the shore has any effect on the animals. Film crews quietly stationed in the drift logs, and their remote underwater cameras caused no obvious disruptions of the rubbing behaviour (in 1984). There are concerns that extensive movement on the beaches when the whales are present could create noise that would disturb the animals.

D. Assessment of Future Impacts.

If the preceding assessment of impacts is proven accurate, and disturbing whale-oriented activities increase as predicted, future impacts on the population could be serious.

Our understanding of the impacts of human activities on land mammals, combined with current observations from the area, suggests that the whales will change their behaviour patterns in order to minimize contact with disruptive human activities. There are hints that this process has begun. The degree of flexibility that the whales have in this regard, while maintaining optimum health is not known.

With present or increased disturbance levels, two general impacts are probable:

1) Stressed-Animals: The whales will continue to range through the area and will absorb the stress of human activities. There are indications that stress from pursuit or approach can be "additive" to mammals, and if so the whales may become more nervous, as whale-oriented activities increase (Foster and Rahs, 1983). It is unlikely that the animals will habituate to these activities. The long-term effects of stress on wild mammals are not well known, however, it is probable that the biological fitness of the population will be reduced.

2) Abandonment: If the whales have the option, they may partially or entirely abandon the area entirely during periods of high human activity. This impact has been observed in land mammals facing human disturbance (Geist 1971, Dorrance et al., 1975, Foster and Rahs 1983). The animals leave preferred ranges for alternative areas (Geist 1971, Dorrance et al., 1975, Foster and Rahs 1983). Indications are that the animals will return to the area soon after the disturbance ceases (Geist 1971, Dorrance et al., 1975, Foster and Rahs 1983). The regularity of the whales occurrence in the core area in summer indicates that this is the preferred range. It is not clear if they have an alternative during the summer season. Available observations suggest that activities that are

not core area-specific (resting) may already be minimized in that area.

Barring management of whale-oriented human activities, it is probable that some combination of the two general impacts will occur in the future.

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V. APPENDICES

APPENDIX I

Aspects of B.C. Killer Whale Biology

Extensive research over the last 15 years and has provided comprehensive information on the abundance, distribution, and behaviour of B.C. killer whales. The research has been based on individual photographic identification of all animals in the area, and intensive monitoring of the population. (Bigg et al. 1976, Bigg 1982, Ford & Fisher 1982, Ford 1984).

Population Definition

Killer whales on the southern B.C. coast are divided into two types: Residents and Transients. Residents are common in the area throughout the months of June-October. Transients pass through the area at irregular times, apparently ranging over a larger territory. The resident and transient groups do not mix, and actually avoid each other. Residents live in larger groups and eat fish, primarily salmon when available. The transients live in smaller groups with their main food being marine mammals - seals, sea lions, and other whales (Bigg 1982).

The Resident whales are divided into two communities. The southern community ranges through Puget Sound, Juan de Fuca Strait and Georgia Strait; and the northern community ranges from Campbell River northwards through Discovery Passage, Johnstone Strait and north of Vancouver Island. The two communities do not mix.

There are core areas for each community during the summer. The core area of the southern community is in San Juan Island region. The core area for the northern community is northern Johnstone Strait, including Robson Bight Ecological Reserve.

Little is known about the winter range of B.C. killer whales (Bigg 1982).

Abundance

There are a total of 300 killer whales in southern B.C., divided into cohesive groups known as pods. The southern community includes 3 pods with 75 animals. The northern community includes 13 pods with 160 animals. Twenty transient pods have been identified with 65 animals.

Within the northern community, not all pods visit the Robson Bight Ecological Reserve area on a regular basis. The most regularly sighted residents in the area are 5 pods with 50 whales (M. Bigg 1986, pers. comm.).

Population Biology

Killer whales are long-live mammals, with females reaching perhaps 70 years and males 50 years. The whales are thought to become sexually mature at 15 years. Mature females have a calf on the average of once every 10 years, with the shortest interval being 3 years. The gestation period is 17 months. The calf production of the population is 4-5% per year (Bigg 1982, 1986, pers. comm.).

Social Organization

Killer whales live in cohesive, extended family groups known as pods. These pods are made up of subgroups composed of mother and offspring. Pods appear to be matriarchies, at times consisting of three generations of animals. Males stay with their mothers pod throughout life. These pods are remarkably stable groups with no changes in any pods other than births or deaths in the 20 years of records. At times all the pods in a community come together and mix. These large groups of up to 100 animals are called superpod, and appear to be the result of food concentrations. The aggregations may form in the core areas, including Robson Bight.

Behaviour Patterns in Summer

Ford (1984) provides an analysis of 416 hours of behavioral observations made in the northern community core area including Robson Bight Ecological Reserve. As this is important baseline data in the assessment of the impacts of human activities on whale behaviour it is summarized in detail here.

Activities are the killer whales are grouped into five major categories: foraging, travelling, resting, socializing, and beach rubbing.

Foraging is the most common group activity, comprising 66% of a sample of 416 hours of observations. When foraging, pods typically separate into small subgroups (composed of cows and offspring) and may disperse widely over areas of several sq. km. Although all members of the pod travel (at 3-10 km/hr) on a similar course, subgroups dive at different times, and may independently change direction and mill for short periods. Indications of feeding include sudden lunges and changes in direction of individuals, high speed swimming just under the surface, and milling in tide ups and other good feeding areas. Prey species taken were primarily Pacific salmon, but rockfish and herring were also noted.

Travelling: A pod was considered to be travelling when all its members were moving on the same course; and at same speed, and no evidence of feeding. Travelling whales tend to be less dispersed than while foraging. Travelling was the least common activity of northern resident pods, representing only 4.19% of Ford's (1984) observed time. Bouts of travelling were typically brief, averaging .92 h. Distances of 2-6.7 km were covered at speeds averaging 10.4 km/hr, significantly faster than foraging.

Resting: Killer whales rest either in groups or individually. Group resting accounted for 13.2% of Ford's (1984) 416 hour observation period. When group resting all members of a pod join together in a tightly-knit group, usually with animals lined

up abreast. Divings and surfacings become highly regular and coordinated in the group. Long dives (mean 3.07 min) are interspersed with shorter periods at the surface (mean 1.72 min). Although the entire pod is generally underwater or at the surface together, members of maternal subgroups maintain close physical association and tend to coordinate movement. Bouts of group resting lasted from .5 to 7.5 h. Forward movement tends to be slow. Typically whales travel less than 150 m during each long dive. Overall rate of travel during resting was 2.96 km/hr. On occasion, pods break their diving pattern and remain at the surface for as long as 15 minutes slowly milling about.

Socializing: Socializing whales group together and engage in a variety of physical interactions and aerial activities. Sexual interactions are common, and erections often visible among both subadult and adult males. Aerial behaviors are frequent, and may include breaches, spyhops, bellyflops, tailslaps, flipperslaps, dorsal-finslaps, and diverse forms of acrobatic leaps. Individuals may also play with inanimate objects such as floating kelp, and surf in the wakes of passing vessels. Bouts of socializing lasted an average of 1.86 h. and accounted for about 12% of overall behaviour observations. Socializing occurs periodically in subgroups of pods engaged in foraging, travelling, or beach rubbing behaviour.

Beach Rubbing: Beach rubbing was observed regularly among pods of the northern resident community, representing 4.5% of the group activities. This behaviour is seen primarily in Johnstone Strait area where pods frequently interrupt foraging sessions with visits to a specific .5 km section of Vancouver Island shoreline known as the Rubbing Beaches (inside the Ecological Reserve). This area is comprised of two small beaches and an underwater shelf some 3-6 m deep. The beaches and the shelf are covered in small (1-5 cm) smooth pebbles, relatively uncommon in the region. Rubbing was observed occasionally at other gravel beaches, but only

sporadically. Animals rub by diving to the bottom and rolling their lateral, dorsal and ventral surfaces against pebbles shelves for approximately .25-1.5 min. before surfacing again. Large bursts of air are often released during dives, probably to reduce buoyancy. Rubbing may be accompanied by individual resting and socializing among nearby animals. Periods of rubbing varied from several minutes to as long as 1.5 h.

Beach rubbing is common among northern community resident pods, especially pods A1, A4, and A5. Resident whales in the southern community have never been observed beach rubbing.

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APPENDIX II

Examples of Studies on the Impacts of Human Activities on Ungulate Populations

Following are excerpts from studies done on the impacts of human activities on wild ungulates.

Schultz and Bailey (1978) studied the Responses of National Park Elk to Human Activity. Their observations and conclusions include:

> Elk rutting and wintering on the east side of Rocky Mountain National Park have adapted to present levels of human disturbance along normally and sometimes heavily used roads. This study produced no statistical evidence that either abundant tourist activity in autumn or planned disturbance of elk in winter and early spring affected distribution of elk, bugling activity, behaviour of rutting bulls, timing of movements, or willingness to use areas near roads.
>
> This acceptance of human activity seems to be a learned response of unhunted elk (author's note that studies of hunted elk, red deer, and white-tailed deer showed mark changes in habitat and avoidance of human areas [Post, 1975; Batchelor, 1968; Dorrance et al., 1975])
>
> Elk watching from parking areas and road did not appear to significantly affect elk movements.
>
> People leaving roads to approach elk caused animals to flee. Harems harassed by approaching people often became disorganized and harem bulls were forced to extra efforts in defending and regrouping their cows. The implications of this activity are not known.
>
> Longer flight distances for an approaching person than for an approaching vehicle suggest elk are more sensitive to the former.

Dorrance, Savage and Huff (1975) studied The Effects of Snowmobiles on White-Tailed Deer.

Study areas were St. Croix State Park where numbers of snowmobiles per day averaged 10 on weekdays and 195 on weekends, and in Mille Lacs Wildlife Management Area where snowmobiling was prohibited, except by project personnel.

The effects of snowmobile traffic on white-tailed deer were subtle in St. Croix State Park; snowmobile traffic resulted in the displacement of deer from areas immediately adjacent to snowmobile trails. We hypothesize that during severe winters, on poor ranges, the displacement of deer from even small segments of their home range is detrimental. During less severe winters, any effects of snowmobiles on white-tailed deer may be negligible at St. Croix.

The effects of snowmobile traffic on deer were more pronounced at Mille Lacs Wildlife Management. Snowmobile traffic resulted in increased home range size, increased movement, and displacement of deer from areas along trails. Some deer were particularly sensitive to intrusion by man and vehicles and changed their home range to entirely different locations. We believe that these effects could cause changes in energy budget that could be detrimental, especially during severe winters.

Results from St. Croix suggest that deer do become habituated to snowmobile traffic.

Horejsi (1981) studied The Behavioral Response of Barren Ground Caribou to a Moving Vehicle.

Behavioral responses of individual barren ground caribou to a 3/4 ton pickup truck travelling down the Dempster Highway were quantified.

Forty-eight percent of the individual caribou reacted to the vehicle by running away, while 38% trotted away. The mean flight duration of females was 73$\pm$ 11 sec, that of males 38$\pm$ 6 seconds. Caribou encountering a moving vehicle exhibited signs of excitement and fright, including the excitation jump and tail-up response. Reversal of direction and/or splitting of the group involved 29% of the individual caribou.

The flight of caribou in response to a pursuing objects such as a snow machine or slow-moving aircraft can be expected to be more prolonged since the threatening object can keep itself within a certain distance of the animal.

In general, caribou exhibit signs of anxiety and fear when encountering a fast moving vehicle, and they exert themselves strenuously for a short period when withdrawing from a vehicle.

One of the tenets of behaviour in response to harassment is that animals avoid the area(s) in which they experience disturbance (Geist, 1971). Reindeer did exactly that in Finland when herders began using snow- machines (Ito, 1973). Cameron et al. (1979) also present data to report an avoidance response by female caribou and their calves in relation to Trans-Alaska Pipeline.

Freddy, Bronaugh and Fowler (1986) studied the Responses of mule deer to disturbances by persons afoot and snowmobiles.

. . . Objectives were to compare overt behavioral responses of adult female mule deer reacting to persons afoot or snowmobiles during controlled disturbance trials and to monitor survival and fecundity of these deer.

Mule deer were disturbed more by persons afoot than by snowmobiles. Responses to deer to persons were longer in duration, involved running more frequently, and were greater in estimated energy expenditure. Our observations supported previous conclusions that persons afoot elicit more intense reactions by ungulates than do vehicles (Ward et al., 1976; Richens and Lavigne, 1978; Schultz and Bailey, 1978; Eckstein et al., 1979; MacArthur et al., 1982).

Intensity of responses by deer were dependent upon distance between animals and disturbances . . . . Minimizing all levels of response by deer would require persons afoot and snowmobiles to remain >334 m and >470 m from deer respectively . . . If human activities were further restricted to trails, deer might perceive these activities as predictable and more acceptable (MacArthur et al., 1982).

Flight distances for mule deer of 191 m and 131 m from persons afoot and snowmobiles, respectively, were similar to values documented for other ungulates. Ward et al. (1980), Schultz and Bailey (1978), and MacArthur et al. (1982) reported that persons afoot during winter elicited locomotor behaviour by mule deer at distances of 200 m, by elk (Cervus elaphus) at 86 m and by mountain sheep (Ovis canadensis) at 50 m, respectively. White-tailed deer moved away from snowmobiles at distances of 61 m (Eckstein et al., 1979) while elk and caribou fled from highway vehicles at 77 and 144 m, respectively (Schultz and Bailey, 1978; Horejsi, 1981). Factors that could influence flight distances are species, intensity of sport hunting (Geist, 1971; Dorrence et al., 1975) potential for habituation, (Richens and Lavigne, 1978; Jacobsen, 1979) type of vegetation, and season, (Altmann, 1958).

The tendency for flight distances to increase when deer exhibited multiple flight responses to persons afoot suggested that deer did not readily habituate to disturbance. A lack of immediate habituation to persons afoot was also observed for mountain sheep (MacArthur et al., 1982), whereas white-tailed fawns did not

habituate to snowmobiles (Moen et al., 1982).

Our disturbance did not markedly affect mortality and fecundity of adult female deer. Deer may not have been disturbed often enough or they may have compensated for the energetic costs of disturbance by altering their activity patterns. However, the potential for deer to compensate could be limited because consumption of forage may be restricted by availability or passage rates (Altmann et al., 1973). Furthermore, undisturbed activity patterns may be optimised for survival (McFarland, 1977).

MacArthur, Geist and Johnstone (1982) studied the Cardiac and Behavioral Responses of Mountain Sheep to Human Disturbance.

Telemetered heart rates and behavioral responses at mountain sheep (Ovis canadensis) reacting to human disturbance in the Sheep Rive Wildlife Sanctuary, southwestern Alberta, were recorded.

The low reactivity of Sheep River mountain sheep to human disturbance confirms expectations for a population existing in a known, and largely predictable environment (Geist, 1979:24). As the road was the focal point of human activity in the sanctuary, it is not surprising that few responses were observed to traffic or approach by humans walking directly from parked vehicles. Predictably, strongest reactions to an approaching human occurred when the person was accompanied by a leashed dog . . . canines are traditional predators of mountain sheep.

The greater sensitivity of mountain sheep to human approach from over a ridge (Type II) rather than directly from the road (Type I) was expected. Most encounters with humans (often amateur photographers) in the sanctuary occur proximal to the road, hence the Type II approach was a departure from the usual experience of these sheep. The increased sensitivity of sheep to approach from above may also relate to the tendency for mountain sheep to run uphill into cliff terrain when alarmed (Hicks and Elder, 1979).

In no case did we observe a reduction in HR response with repeated harassment trials.

Reactions to road traffic were minimal as only 8.8% of vehicle passes elicited HR responses. No reaction to helicopter or fixed wing aircraft were observed at distances exceeding 400 m from sheep.

The ability for mountain sheep to coexist with humans in areas protected from hunting is well known (Geist, 1971, 1978; Hicks and Elder, 1979), and the present study reveals the extent to which this species is capable of habituating to common human-related stimuli. Our data also suggest that on sheep range used heavily from recreation, disturbance to sheep may be minimized by restricting human activities to roads and established trail systems.

Foster and Rahs (1983) studied Mountain Goat Response to Hydroelectric Exploration in Northwestern B.C.

> The behavioral responses of more than 800 mountain goats, comprised of 195 social groups , were recorded during hydroelectric exploration activities (primarily aircraft) in northwestern British Columbia. Four categories of overt response were recorded during case tests ranging from maintenance activity to severe flight. More than 80% of the observed goats elicited some form of behavioral stress response, with 33% displaying severe flight response to local rock or plant cover. . . .
>
> Repeated aerial and ground follow-up surveys documented temporary range abandonment, and changing observability indices (habitat use and activity patterns) associated with areas of intense exploration activity.
>
> Individual goats were noted to respond differently to varying intensities of disturbance, possibly due to the degree of previous stress encounter.
>
> . . . To completely avoid harassment, it appears that the goats observed in the study require a buffer area with a minimum radius of two kilometers, particularly in regions of elevated human activity. This conclusion is supported by the results of Barry and Spencer (1976) who discuss low-flying helicopters as apparently the most disturbing factor on wildlife in the Mackenzie River delta, which directly affects an area of at least a 2.5 kilometre radius.
>
> Noise from aircraft and other machinery (generators, drilling rigs etc.) was observed to cause goats to relocate onto adjacent ranges, as supported by the statistical significance found between intensity of response and geographic region. During the period of drilling activity in the summer of 1979, goats previously observed inhabiting slopes about the sub-unit one proposed dam location (from February to April) moved away in June, coinciding with the installation of a drilling camp, some 100 metres distant. This area was classified as traditional summer goat range due to the presence of small kid pellet groups. Up to 25 goats were observed to have vacated these slopes and cliffs for the remainder of the summer, inhabiting south-facing hillsides in an area 1-3 km upstream. The drilling camp was shut down at the end of September and within two weeks goats reoccupied the summer-vacated areas and remained there throughout the fall and winter periods. Other researchers (for example, Miller and Grunn, 1980) stated that observed helicopter harassment did not cause range abandonment in their study; however Klein (1971) documented automobile and railway traffic as causal factors of range abandonment by caribou in Norway.
>
> It was initially hypothesized that the type of disturbance would induce different responses from the goats, as reported by Thomson (1972), McCourt and others (1974), and Barry and Spencer (1976) for other vertebrates. In contrast, the goats we observed appeared to be equally nervous and as highly excitable in response to helicopter, airplane, and human activity ($r^2 = 0.0030$). Some goats even responded to thunder resounding through the study area; whereas Fishmark (1972) documented habituation by reindeer to sonic booms. The intensity of goat response to observed stimuli suggests that past disturbance levels were of such magnitude not only to negate passive habituation, noted by Peterson (1977) and

Miller and Gunn (1980) for other species, but also to sensitize the goats to other milder forms of disturbance (that is, additive effects). During 1979, many goats were forced to alter their normal diurnal feeding patterns (Rideout, 1974) near the active Sub-unit One drilling camp .... early morning human-induced disturbances (primarily the first helicopter flight of the morning, associated with the camp arousal and commencement of the work day) cut short early morning foraging patterns. These goats were therefore affected through their compensation efforts by one or more of the following: selection of less preferred forage species in rocky habitats; exertion of more energy to obtain sparse vegetation in rocky areas; and increased nocturnal foraging patterns in more gently sloping areas. All of these could result in greater chance of accident, predation and maternal-offspring separation.

. . . Gassow and Hjeljord (1978) stated that mountain goats, as well as chamois, readily altered their preference of rocky habitat during times of stress.

Our results, and those of others cited in this paper, imply that disturbance response patterns are species-specific, the intensity of which appears to relate to animal sensitivity created from levels of previous disturbance. Although some species reportedly habituate to many forms of noise and disturbance, the mountain goats under study did not. Disturbance functions are believed to be additive for mountain goats, particularly those with close encounters of severe degree. The goats we observed were so sensitized from hydroelectric explorational activity that severe flight responses were observed even following thunder.

Margaret Altmann (1958) studied the Flight Distance in Free-Ranging Big Game:

Flight distance . . . [is] the distance to which a person can approach a wild animal without causing it to flee.

. . . It has become apparent that a number of factors can change the flight distance of a species completely . . . including a seasonally changing threshold of sensitivity due to reproductive and nutritional status; variations due to type of habitat; and variations due to the specific experience of the individual or group.

For example: A moose cow with newborn calf keeps quietly in a restricted space, well selected for cover. She will not move unless an intruder comes close. She will dodge rather than take off because of the poor locomotion of the calf.

One week or several weeks later, during July or August, the reaction will be quite different. The cow will defend her calf territory against other moose and other animal species, but will react to human intruders with a very long flight distance, the heeling calf close by her side.

The moose bulls in velvet are, on the whole, a wary lot. They do not expose themselves, but stay much in cover and have a long flight distance. The prerut begins in late August. The bulls rub the velvet, get bolder, and their flight distance shortens. As the rutting season gets underway, the moose bulls

lose almost all caution; the flight distance dwindles to almost zero.

The females, too, have much less inhibition; they often approach humans or other intruding species.

The beginning of hunting season cuts into the rutting seasons like a catastrophic storm. The flight distance is suddenly stepped up. I have evidence showing that individual experience and clues of general excitement contribute to this change. The flight distance becomes very long.

I found that water-feeding moose have a definitely shorter flight distance than moose feeding on land.

In the winter grouping, as a loose aggregation, the moose is not flighty at all, so that it is possible to come very close. This behaviour is due, in my opinion, to a general lowering of vigour. . . .

Under special experience, however, the moose can give a completely reversed reaction to disturbances. For example, on a tourist-frequented meadow in Yellowstone National Park, I found that moose were highly suspicious of my silent approach under cover. They actually took flight at a long distance, while later, droves of noisy tourists with car doors slamming, could approach closely.

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APPENDIX III

Examples of Studies of the Impacts of Human Activities

on Whale Populations

Richardson et al. (1983) summarized our understanding of the Reactions of Marine Mammals to Industrial Noise.

> In summary , noise from certain offshore operations of the oil industry e.g., ship traffic and aircraft overflights, as well as other human activities, sometimes cause pronounced short-term behavioral reactions and temporary local displacement of certain marine mammals (whales and hauled out pinnipeds). Sometimes the effects are more subtle, and at other times no effects are detectable even within the presence of strong industrial noise. Some masking of natural sounds is also an inevitable consequence of elevated noise levels. The biological significance of most observed effects is unknown . . . . Conclusive studies of long-term effects are difficult to design and implement, and have not been conducted. However, the continued presence of various marine mammals in certain areas, despite intense ship traffic, fishing, hunting, sealing, etc., for many decades suggests that many marine mammals are tolerant of much human activity.

Malme, Miles, Clark, Tyack and Bird (1984) studied the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behaviour.

> The objective was to determine the degree of behavioral response of migrating gray whales to acoustic stimuli associated with oil and gas exploration and development activities.
>
> The playback sounds consisted of tape recordings of underwater acoustic signatures of a drilling platform; drillship, production platform, semisubmersible drilling and a helicopter overflight. Responses of the whales to the operation of a single airgun were measured.
>
> Migrating whales were found to respond to the presence of a noise source by small course changes at some distance from the noise. This "detection" reaction often occurred at ranges where the estimated level of noise source was equal to local ambient noise level. In the best area this corresponded to ranges of 2 to 3 km. The result of these small course changes as the whales

approached the sound source, was an increase in the distance between the whales and the source at the closes point of approach. This "avoidance" behaviour resulted in a lower sound level exposure than would have occurred had the whale maintained the original course.

Avoidance behaviour began at sound exposure levels of around 100 dB for the playback signals and was greater than 80% for regions with signal levels higher than 130 dB. For the 100 cu. in. air gun the threshold of avoidance behaviour was 164 dB. Level of 180 dB were observed to produce nearly complete avoidance of the area.

Jones and Swartz (1984) studied the Demography and Phenology of Gray Whales and Evaluated Whale watching Activities in Laguna San Ignacio, Baja California Sur, Mexico.

From 1978-82 whale watching in San Ignacio Lagoon consisted of an average of 32 trips, 60 vessel days and 514 skiff operating hours per season. Only two commercial whale watching vessels were allowed inside the lagoon at any one time. During a vessel's stay in the lagoon, the vessel would typically shift its anchorage in the main channel 1-3 times a day. Skiffs were deployed throughout daylight hours running the ship's 25-30 passengers in shifts of 4-5 per skiff throughout the lower reaches of the lagoon in search of whales.

The gray whales did not shift their distribution in response to the presence of whale watchers, and an increase in abundance of whales occupying the lagoon was noted, exceeding the estimated growth rate. The authors concluded that the gray whales posed sufficient resiliency to tolerate the physical presence and activities of whale watching vessels and skiffs and the noise produced by this level of activity without major disruption.

The designation of the lagoon as a gray refuge and management of the whale watching fleet is found to be a significant factor in this coexistence. Another important variable was the (experienced) handling of the whale watching skiffs.

Baker, Herman, Bays and Bauer (1983) studied the Impact of Vessel Traffic on the Behaviour of Humpback Whales in Glacier Bay, Southeast Alaska. (From Tilt 1985, original not seen).

. . . a clear and graded change in behaviour of whales in response to vessel traffic. Observed responses included changes in respiratory intervals, strenuous episodes of aerial behaviour, movement away from the path of vessels, and the temporary displacement of individuals from preferred feeding areas. Changes in the behaviour of whales were correlated with vessel distances, vessel speed,

vessel size, and the occurrence of sudden changes in speed or direction of the vessels.

However, these researchers did not find consistent avoidance behaviour exhibited by all individual humpbacks. For example, humpback whales were often found feeding in relatively close association with slow moving salmon trollers. In 1982, four whales were present in Bartlett Cove which has the heaviest volume of vessel traffic in Glacier Bay. Although some behaviors were observed that were attributable to vessels; the whales continued to feed in the area regardless of the heavy vessel traffic. On another occasion, however, a single whale moved 10 km off-site after two higher speed motor boats made a close approach to the whale. The whale did not return to the feeding site until the next day (Baker in NMFS, 1984, from Tilt, 1985).

Sorensen et al. (1984) studied the Distribution and Abundance of Cetaceans in the Vicinity of Human Activities Along the Continental Shelf of the Northwestern Atlantic.

The distribution and abundance of cetaceans were investigated in the vicinity of oil rigs, surface oil and boat traffic along the continental shelf of the northwestern Atlantic. Sightings per unit effort and individuals per unit effort for areas surrounding active oil rigs were not significantly different from those found in the same areas when no oil rigs were present. Surface oil was sighted ninety-four times. Cetacean sightings were made in the vicinity of oil on eleven different occasions and in oil twice. None of these animals was noted as displaying unusual behaviour and no feeding was observed. The presence of boat traffic was found to decrease the probability of sighting squid-eating cetaceans but had no apparent effect on the probability of sighting fish-eating cetaceans.

Ljungblad et al. (1985) studied the Behaviour of Bowhead Whales (Balaena mysticetus) in the Presence of Operating Seismic Exploration Vessels in the Alaskan Beaufort Sea.

The exposure of bowhead whales to seismic exploration signals resulted in some significant short-term changes in their surfacing, respiration and dive characteristics, particularly during close approaches by active geophysical vessels. The four experiments presented in this report do provide strong evidence that there exists a predictable "zone of influence" for seismic sounds and vessel noise surrounding an approaching active geophysical vessel that can affect bowhead whale behaviour at close ranges.

No discernable behavioral changes occurred during exposure to seismic sound at ranges of greater than 10 km (5.4 nm), with pronounced changes occurring once an active vessel approached to within 5 km (2.7 nm) of the whales.

Avoidance responses to full-scale seismic operations, including orientation away from the approaching vessel and "flight", occurred at ranges of 3.5 - 5 km (1.9 - 2.7 nm) with received sound levels ranging from 160 to 170 dB.

The conclusion that influence of seismic sounds on bowhead whale behaviour is short-term is supported by the "post disturbance" reversal of the changes in the whales surface, respiration and dive characteristics that occurred after the sound disturbance ceased. The trend for these parameters to return to values approaching those prior to the onset of close seismic sound suggests that a period of between 30 - 60 minutes is required before the whales "recover" for the effects of the close disturbance.

Richardson et al. 1985. studied the Behaviour of Bowhead Whales (Balaena mysticetus) Summering in the Beaufort sea: Reactions to Industrial Activities.

Behaviour near actual and simulated activities associated with off-shore oil exploration was compared with presumably undisturbed behaviour. Underwater noise was monitored. Reactions to an approaching fixed-wing aircraft were frequent if it was at <305 m above sea level, infrequent at 457 m, and not detected at 610 m. When boats closed to within 1-4 km, surface/dive cycles became shorter and the whales swam rapidly away. Fleeing ceased when the vessel was a few kilometers beyond the whales, but scattering persisted longer. Bowheads did not move away from seismic vessels > 6 km away, but subtle effects on behaviour sometimes were suspected. We found bowheads as close as 4 km from drillships and 1 km from driedge, but drilling noise playback experiments provided evidence of an avoidance reaction. In general, bowheads showed considerable tolerance of ongoing noise from seismic exploration, dredging or drilling, but tended to react more strongly to rapidly changing situation such as an approaching boat or aircraft or a brief playback experiment.

Kruse (1984) conducted a study on the Interactions Between Killer Whales and Boats in Johnstone Strait, B.C.

Killer whales and boats were tracked from a land-based station overlooking Johnstone Strait, using a theodolite.

Killer whales showed a clear response to the presence of boats by swimming 1.4 times as fast as whales in the undisturbed category ($x = 6.37$ km/hr., $s = 3.48$, $n = 84$). This response did not diminish over the course of the summer,

indicating that killer whales do not habituate to the presence of boats. Increased swimming speed is a common cetacean response to boat disturbance. Richardson et al. (1985) note strong and consistent increases in swimming speeds at bowhead whales in response to approaching boats. Humpback whales in Alaskan waters swim faster when boats draw near (Baker et al., 1983). Au and Perryman (1982) report that schools of Stenella sp. fled at high speed from approaching boats.

Swimming speed was positively correlated with the number of boats operating within 400 m of killer whales ($r = 0.442$, $p < 0.001$, $df = 3$). Disturbed whales had from 1 to 4 boats operating within 400 meters off them.

Boats which approached whales closer than 400 meters were divided into two size classes, smaller than 7 meters and larger than 7 meters. Swimming speeds of whales were compared with respect to the boats size classes. Killer whales did not respond differently to varied boat sizes, nor did the whales respond differently to outboard motors or inboard engines.

Killer whales commonly responded to boats by increasing their swimming speeds rather than changing their courses. Indeed, I did not observe many obvious avoidance responses by whales. However, there was a group of four animals which radically changed its course when approached by boats. This response occurred in a situation where several boats converged on the whales at once.

Hourly boat counts were made in the study area on 26 days between August 3 and September 1. During a total of 271 census hours, the average boat density was 17.86 boats per hour, and ranged between 0 and 107 boats per hour. Traffic was greatest during the commercial salmon fishing openings which corresponded to a sharp increase in boat activity within the Robson Bight Reserve. Boats were present during all but 12 of the 155 killer whale tracking sequences. Neither disturbed nor undisturbed whales responded to varying levels of boat density by increasing their swimming speeds. Thus, whales appear to respond specifically to close approaches of boats rather than their mere presence.

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APPENDIX IV

List of Literature Submitted With This Report

A. Sample Whale Watching Guidelines

1. Watching Whales. Communications Directorate, Department of Fisheries and Oceans. Ottawa. K1A 0E6. 1983.

2. The Gray Whale. American Cetacean Society. P.O. Box 2639. San Pedro, CA. 90731.

3. The Humpback Whale. The Lahaina Restoration Foundation. P.O. Box 338, Lahaina, Maui. HI. 96761. 1978.

4. The California Gray Whale. The National Marine Fisheries Service. S.W. Region. 300 S. Ferry Street., Terminal Island, CA. 90731. 1980.

5. Whales of the Gulf of Maine. National Marine Fisheries Service. N.E. Region. 14 Elm Street, Glouchester, MA. 01930. 1985.

6. Watching Whales Without Harassment. Resource Allocation Branch Fisheries and Oceans Quebec Region. 901, Cap Diament, Quebec City, P.Q. G1K 7Y7.

7. Observez Les Baleines Sans Les Harceler. Division de la Reparitition de la resource, Peches et Oceans, Region du Quebec 901, Cap Diamant, Quebec. G1K 7Y7.

8. Peak Season For Whale Watching. National Marine Fisheries Service, S.W. Region. 300 S. Ferry Street, Terminal Island, CA. 90731. 1984.

9. Whale Watching Regulations. The Whale Museum. P.O. Box 945, Friday Harbour, WA. 98250.

10. Northwest Region Whale Watching Guidelines. National Marine Fisheries Service. Northwest Region. 7600 Sand Point Way. N.E. Seattle, WA. 98115. 1985.

B. Sample Scientific Research Regulations, Applications and Permits

1. National Marine Fisheries Service Application Instructions for Marine Mammal Protection Act, Endangered Species Act, Fur Seal Act Permits. Assistant Administrator for Fisheries, National Marine Fisheries Service. Washington, D.C. 20235 (1981)

2. Scientific Collecting Permit Application. Department of Land and Natural Resources, Division of Aquatic Resources 1151 Punchbowl St., Room 330. Honolulu, Hawaii. 96813 (1981)

3. Application For Permit For Scientific Research Under the Marine Mammal Protection Act, and Scientific Purposes under the Endagered Species Act. Measuring and Recording Photographically Identified Humpback Whales

(Megaptea novalangliue): An Hypothesis Test on The Mating System and Song Function of the Hawaiian Humpback Whale. WCWRF. 1040 West Georgia Street. Vancouver, B.C. V6E 4H1 (1984)

C. Sample Management Plans.

1. Humpback Whale Management Plan for Hawaiian Waters. Western Pacific Program Office. Southwest Region. National Marine Fisheries Service, Noaa Honolulu, HI. 96812.

2. Etude socio-economique sur l'industrie d'observation des Baleines au Quebec (Resume). Par Celine Payer. Avec La Collaboration de Mimi Breton. Quebec. November 1984. Recherche Effectivee pour la Gestion des Peches Direction Generale du Quebec. Ministere des Peches et des Oceans. Government du Canada.

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D. Additional Literature Submitted with Report

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2. Department of Fisheries and Oceans. 1960. Notes of Meeting Re: Blackfish control in the Discovery Passage. Dept of Fisheries and Oceans. Nanaimo, B.C.

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