ROBSON BIGHT ECOLOGICAL RESERVE

-Background Report-

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by

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SUMMARY

Background

The purpose of this report is to consolidate available information on Robson Bight Ecological Reserve resources, on public use of the reserve, on surrounding land uses, and on management actions taken to date to promote reserve objectives. The report provides background information needed to prepare a management plan.

Robson Right Ecological Reserve, located near Port McNeill, Vancouver Island, contains a marine component of 1248 ha and an adjacent forestland buffer of about 500 ha.

Reserve resources and objectives

Reserve waters and rubbing beaches are intensively used by about 170 killer whales from July to October. The reserve is important as a resting and socializing area for B.C.'s northern resident community of orcas. The abundance and daily occurrence of killer wales here in summer and their regular use of rubbing beaches are of international significance.

Other significant resources include salmon and trout spawning/rearing habitat in the lower Tsitika River, estuary plant communities, and floodplain Sitka spruce and Douglas fir stands.

The major purpose of the reserve is to protect killer whales from human disturbance while using the rubbing beaches and adjacent waters, and to provide unique opportunities for killer whale research and education.

Use of the reserve

The demand for research on killer whales has grown rapidly in recent years. Although the number of individuals and boats involved in research is small, 30% of contacts between boats and whales and 35% of all encounter-minutes are attributable to researchers. Researchers are increasingly concentrating their activity outside the reserve.

Educational users include professional photographers who, although few in number, have stimulated a world-wide demand to view killer whales in this area.

Over 1500 recreational whale-watchers have visited the reserve and vicinity in recent summers, about half with charters and half independently. While accounting for only 6 to 18% of boats in the area, recreationists are responsible for about 60% of boat time in close contact with whales. This use is predicted to increase greatly in future.

Commercial fishing accounts for 75 to 90% of total boats counted in the area in July and August. This activity is primarily of concern at the rubbing beaches where about 75% of whale reactions to boats are a result of inadvertent disturbance by fishermen.

Management Issues

1. CONTROL OF DISTURBANCE BY RECREATIONAL BOATERS, RESEARCHERS/PHOTOGRAPHERS, AND FISHERMEN.

Disruption of the predictable seasonal and daily occurrence of killer whales at Robson Bight would severely impact the most reliable site in the World for killer whale research and photography, and could adversely affect North-Island tourism. Disturbance by researchers/professional photographers should be controllable through the present permit system. Recreational whale-watching is expected to increase steadily, perhaps even dramatically, in the near future. Control of recreational disturbance will require an information/education program at the reserve (primarily directed at non-charter recreationists), and a regional strategy to direct recreational use into adjacent areas where equally good viewing opportunities occur.

Disturbance by commercial fishermen, largely a problem at the rubbing beaches, is of considerable concern but should not worsen over the long term. Cooperative management by federal provincial agencies is desirable to control this impact.

2. CONTROL OF LAND ACCESS

Public access facilitated by logging roads could result in disturbance of whales at the rubbing beaches, trampling of estuary vegetation, and illegal camping, fishing or hunting. Cooperative management with the Ministry of Forests and logging companies could lessen this impact. Public access into the land portion of the reserve could be prohibited by law, but would be difficult to enforce.

3. CONTROL OVER THOSE EXTERNAL LAND USES WHICH MAY ADVERSELY AFFECT RESERVE RESOURCES.

Logging is the only surrounding land use of significant concern. Logging could result in more variable flows in the Tsitika River; in erosion, sedimentation or debris accumulation in salmonid spawning habitats, the Tsitika estuary, or at the rubbing beaches; in blowdown of timber around the reserve boundary; and in noise and disturbance associated with active logging. Mitigation of such impacts will require active participation on the Tsitika Follow-up Committee and direct consultation with the Ministry of Forests, MacMillan Bloedel, and Western Forest Products with respect to lands outside the Tsitika watershed.

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I INTRODUCTION

The major objective of the Ecological Reserves Program is to preserve representative and special ecosystems and sensitive or vulnerable species, populations, or other natural phenomena, for purposes of research and education. Although casual visitation of reserves is permitted if not detrimental to the resources being protected, ecological reserves are not intended for recreational use nor commercial resource harvesting (British Columbia 1971; 1975).

Robson Bight Ecological Reserve was created primarily to protect key habitats for killer whales (orcas), to prevent their harassment while using those habitats, and to maintain unique opportunities for killer whale research and education (Ministry of Environment and Parks 1987). Of special concern are the world-famous "rubbing beaches" where whales gather almost daily in summer to rest and rub their bodies on smooth pebbles near the shoreline. The reserve also encloses the pristine estuary of the Tsitika River and forested shorelines representative of the Coastal Western Hemlock Biogeoclimatic Zone.

The reserve is located 35 km southeast of Port McNeill, Vancouver Island, along the southern side of Johnstone Strait. Robson Bight, after which it is named, is a wide semi-protected bay in the west-central part of the reserve, into which the Tsitika River empties. The Bight was named by Captain Richards, H.M. surveying vessel "Hecate", circa 1861, in honour of Lieut. Commander Charles Rufus Robson, H.M. gunboat "Forward" (Walbran 1909).

The ecological reserve consists of a marine component established in 1982, and an adjacent strip of forest set aside in 1988. The reserve is 9 km in east-west extent, and 17.6 km^2 in total area. Except for the floodplain and estuary of the Tsitika River, the upland component slopes steeply toward Johnstone Strait. The shoreline is mostly steep and rocky; water depths plunge to 400 m or more in the glacially scoured center of Johnstone Strait.

The abundance and consistency of occurrence of killer whales at Robson Bight and adjacent parts of Johnstone Strait in summer has received world-wide publicity in prominent nature magazines. This has attracted steadily increasing numbers of whale-watchers and researchers over the past ten years, a trend that is expected to continue. There is currently much concern that those activities may have adverse impacts on killer whales at and around Robson Bight. Considerable commercial fishing and general boat traffic in and through the reserve, including the rubbing beach area, are also perceived as threats to the whales and/or their environment. Logging, the dominant upland land use in this area, is approaching the reserve from the landward side. Concerns with respect to logging include direct disturbance of whales due to road blasting, sedimentation or debris accumulation on the rubbing beaches, public access to the rubbing beaches via logging roads, hydrologic effects on the Tsitika River estuary, timber blow-down along the reserve margin, and loss of the pristine forest backdrop presently viewed from Johnstone Strait.

The purpose of the background report is to review and consolidate available data on biophysical features and resources in the reserve and information on surrounding and internal land uses which could adversely affect the environment, flora, and fauna of the reserve, especially killer whales. The reports also reviews management initiatives which have been undertaken to date to control adverse impacts, and their apparent success. This information is intended to provide a firm background for preparation of a management plan for Robson Bight Ecological Reserve.

Acknowledgements

This project was initiated and coordinated by Dr. Louise Goulet, Coordinator of the B.C. Ecological Reserves Program, with the support of Mr. Derek Thompson, Manager of Planning and Ecological Reserves, Park Programs Branch. The authors wish to thank Dr. Goulet and Mr. Thompson for their constructive comments on the first draft of the report, and the many individuals who contributed information which has been incorporated into it.

II Reserve Description

A. Location and access

The reserve is situated along the Vancouver Island shoreline and adjacent waters of western Johnstone Strait, 275 km northwest of Vancouver (Figure 1). The nearest towns are Port McNeill and Alert Bay, 35 and 25 km respectively to the northwest. The nearest community with road access, boat ramp, and wharfage is Telegraph Cove, 15 km northwest of the west boundary of the reserve. To the east, the closest community with such facilities is Kelsey Bay (Sayward), 45 km distant.

Access to the reserve is normally by boat. Robson Bight is not completely sheltered and not recommended as an overnight anchorage. Protected anchorage is available in Boat Bay and Growler Cove at West Cracroft Island, 3-5 km north of the reserve.

Active logging roads presently extend to within less than 1 km of the east boundary along Johnstone Strait (via Eve River and Naka Creek), and to with 7 km of the south boundary in the Tsitika River valley.

B. Size and boundaries

The marine component is 1248 ha in size (Appendix 1). East and west boundaries, about 9 km apart, project northward for 1 km into Johnstone Strait from the mouths of Schmidt (Peel) and Sir John Creeks respectively (Figure 2). The north boundary is a straight line connecting the northern ends of the east and west boundaries. Directly north of the Tsitika River mouth, the north boundary is at approximately the mid-channel point in Johnstone Strait. Intertidal (foreshore) lands are included in the marine component. About 10.7 km of Vancouver Island shoreline is within the reserve.

The upland portion of the reserve presently comprises a buffer strip of forested land extending inland 200 to 1500 m (mostly 400-700 m) from the shoreline, the greatest distance inland being in the valley bottom of the Tsitika River. This strip presently (August, 1988) extends from the mouth of Sir John Creek east to a point 1.75 km west of Schmidt Creek, and comprises 412 ha (Appendix 2). The upland component will be completed in late 1988 with addition of about 100 ha of land between the east end of the present upland reserve and Schmidt Creek.

C. History of reserve establishment

Consolidation of Robson Bight Ecological Reserve in its present form has a convoluted history. It is best visualized as two parallel processes culminating in designation of marine and upland components respectively (Appendix 3).

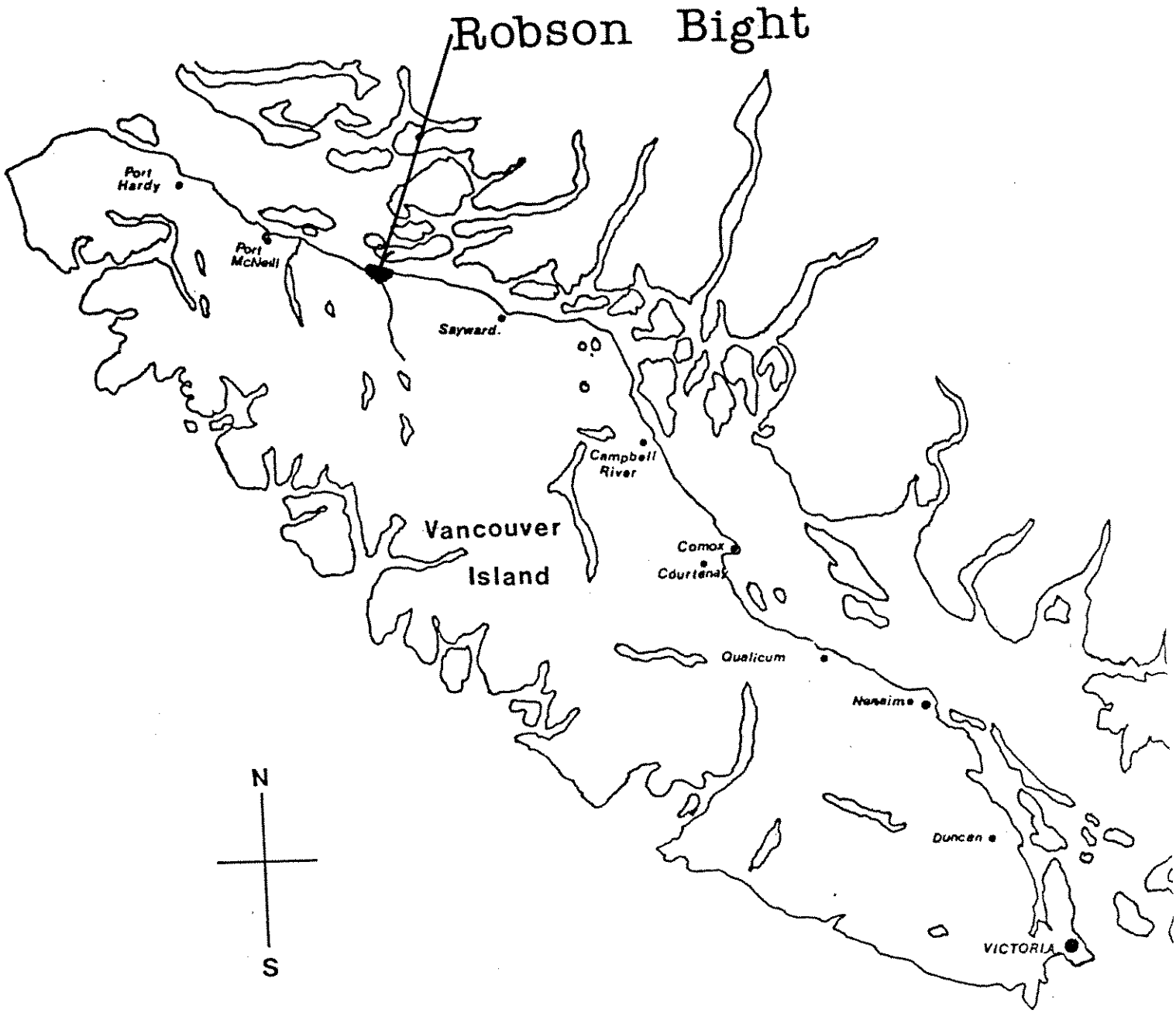

Figure 1. - Location of Robson Bight Ecological Reserve

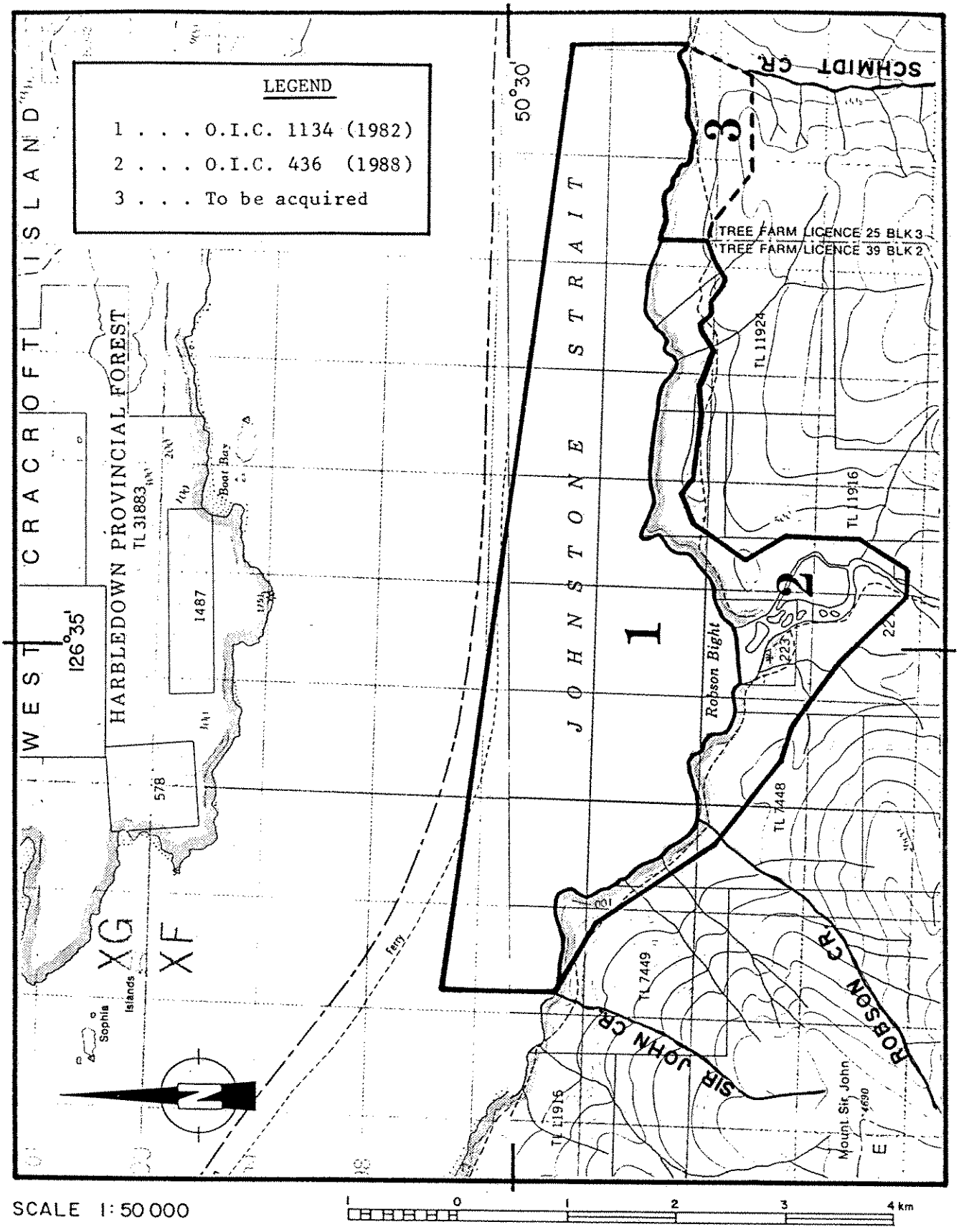

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Figure 2. - ECOLOGICAL RESERVE No. 111
ROBSON BIGHT

The original E.R. 111 application, submitted in 1972 in standard IBP format over the signature of the late Ian Smith, B.C. Fish and Wildlife Branch, was intended to secure the entire Tsitika River watershed for research and conservation purposes. At that time the Tsitika was the last unlogged watershed of any significance on the east coast of Vancouver Island. The intent of the application was quite different than the purpose of the present Robson Bight reserve and the only part of the present reserve geographically covered by it was the Tsitika River delta.

Forestry interests were opposed to preservation of the entire Tsitika watershed as an Ecological Reserve and after much study and debate an integrated resource management plan was prepared which recommended that logging be allowed to proceed subject to various environmental protection guidelines (Tsitika Planning Committee, 1978). The 1972 proposal to make the entire watershed an ecological reserve was reduced to 7 smaller units totalling 1900 ha (4.8% of the drainage basin). One of the units was at the Tsitika River estuary howevcer it included no marine component and was proposed without reference to killer whale protection.

Meanwhile, the First B.C. censuses of killer whales in 1971, 1972 and 1973 revealed a center of abundance in Johnstone Strait;the first observations of orcas using rubbing beaches near Robson Bight was made in 1973; and by 1978 it was known that these whales made predictable and virtually daily use of the Robson Bight area in summer.

Proposals by MacMillan Bloedel Ltd., the major forest tenure-holder in the Tsitika watershed, to develop a log-handling facility at Robson Bight were revealed about 1978. The potential for harmful impact on killer whales was recognized by researchers working in the Robson Bight area and conveyed to several government agencies[1]. This resulted in announcement of a 3-year moratorium on development in the Robson Bight area (January 1981), in a task force study study of the situation (Ministry of Environment 1981), and in designation of the 1248 ha ecological reserve on 17 June, 1982. That reserve included only marine waters and lands, but enclosed all of Robson Bight and adjacent rubbing beaches. This action blocked the use of Robson Bight as a log handling area.

Following 1982, public interest groups continued to press for preservation of uplands adjacent to the marine reserve as a buffer between inland logging activity and killer whale habitat, and the Ministry of Lands Parks and Housing proposed boundaries for such a reserve. The boundaries were designed to provide a wide enough buffer to protect killer whales from direct logging disturbance and to take advantage of local topographic features, while keeping timber compensation costs to a reasonable level.

1 October 11, 1978 letter from Dr. H.D. Fisher, Univ. of B.C., to R. Ostby, Chairman Tsitika Planning Committee, with copies to Dr. J.B. Foster (Ecological Reserves) and Dr. M.A. Bigg (Fisheries and Oceans).

Lands in the TFL 39 portion of the reserve were in Timber License tenure, requiring a compensation of the holder for lost timber. These were cruised, appraised and compensation agreement was reached between the government and MacMillan Bloedel. In addition, a private lot (Lot 223) held by that company was purchased with joint funding from Wildlife Habitat Canada, the B.C. Nature Trust, and Government of B.C. This cleared the way for Order-in-Council designation of the TFL 39 portion of the upland buffer, consisting of 412 ha, in early 1988. During 1988 the buffer will be completed through addition of about 100 ha of upland at the east end of the reserve (Figure 2). This is being removed from TFL 25 (Western Forest Products) under the "5% clause" and does not require compensation since Timber License tenure is not involved.

D. Biophysical framework

1. Climate

Climate in the Robson Bight area is typically West Coast Marine, dominated by maritime air masses from the Pacific Ocean. The Queen Charlotte Strait-Johnstone Strait region is one of heavy precipitation, mild winters, and relatively cool summers. Associated with the mild, moist regime is a low number of hours of sunshine and long periods without freezing temperatures.

The nearest long-term climatic records are for Alert Bay, about 25 km west-northwest of the reserve. These are expected to be quite representative in view of the proximity and sea level situation of both Alert Bay and the reserve.

Total annual precipitation at Alert Bay averages 155 cm per year (Appendix 4). There are strong seasonal variations in moisture, the wettest month, December, having over 4 times as much precipitation, on average, as the driest month, July. Measurable snowfall usually only occurs from November to March and is greatest in January. Snow accounts for only 5% of total precipitation. Mean annual precipitation at Alert Bay is lower than for any other long-term station on or around northern Vancouver Island. Based on regional precipitation data, a reasonable estimate of mean annual precipitation at sea level at Robson Bight would be 170 cm.

Mean annual temperature at Alert Bay is 8.5^0C (Appendix 4). January has the coldest mean (2.3^0C), August the mormest (14.3^0C). Temperatures as high as 33.3^0C and as low as -13.3^0C have been recorded. In contrast to precipitation, average temperatures do not vary greatly between recording stations at sea level on northern Vancouver Island. There is an average of 1421 hours/year of bright sunshine at Alert Bay (compared with 2183 at Victoria). The average frost-free period in the Johnstone Strait area is in the range of 180-220 days, and the percentage of total water requirement for plant growth met by precipitation during the growing season is over 80% (Farley 1979).

Prevailing winds over the waters of Johnstone Strait are linked to the large-scale pressure systems of the eastern Pacific Ocean. Guided by the mountainous terrain they blow predominantly in along-channel directions. Within Johnstone Strait, prevailing winds are westerly in summer and easterly in winter. Strongest winds are usually associated with the passage of frontal systems from fall to spring, and blow in an easterly or southeasterly direction. Maximum winds of 50 knots over a period of one hour and gusts up to 70 knots have been recorded at Robson Bight during such events (Associated Engineering Services Ltd., 1980). Polar outbreaks that funnel down the larger fjords such as Knight and Loughborough Inlets can produce gale force winds over limited areas, usually in winter and early spring. During summer there is a distinct sea-breeze effect in Johnstone Strait as rising air over the heated mainland coast draws cooler marine air inland. On clear sunny days these westerly winds build in strength beginning in the late morning and, combined with prevailing air flow, can lead to wind speeds of 14m/s (30 knots) by late afternoon. The western portion of Johnstone Strait apears to be especially susceptible to these winds (Thomson 1981).

2. Physical features

(a) Upland Component

Landfc rm

Except for terrace, floodplain and estuary lands associated with the Tsitika River, most of the upland slopes steeply toward Johnstone Strait (Appendix 5). Only about 35% of the upland falls within the watershed of the Tsitika River. Predominant slope exposure is to the north; slope steepness is mostly in the range of $15\text{-}40^{0}$. The only prominent valley is that of the Tsitika River which has a generally north-south axis. Small, turbulent streams to the east and west of the Tsitika, also draining northward into Johnstone Strait, have made minor incisions in the local topography. East of the Tsitika valley the generally continuous slope of land from high peaks of the Vancouver Island Ranges to the Johnstone Strait shoreline is interrupted by several low ridges 300 to 500 m inland. The summits of these ridges, mostly 200 to 400 m in elevation, mark the reserve boundary in this area. The highest point in the reserve, about 400 m, is in the southeast corner adjacent to Schmidt (Peel) Creek. The boundary crosses the Tsitika River, 1.5 km inland from the delta front, at about the 15 m elevation. The highest point along the boundary west of the Tsitika is 190 m.

Immediately upon entering the reserve the Tsitika River splits into several channels (Figure 2). Much of the lowland in this area consists of islands between these channels. The largest island is about 24 ha in size.

Geology

No geological investigations have been undertaken within the reserve however inferences can be made from regional studies such as Muller et al. (1974), Carlisle (1972) and Howes (1981a). Slopes of the Vancouver Island Ranges facing Johnstone Strait consist primarily of Upper Triassic volcanics of the Karmutsen Formation. The Karmutsen Formation consists of Triassic basaltic lava-plateau rocks in which there are 3 subdivisions; a lower pillow lava, a middle pillow breccia and tuff, and an upper unit of layered basalt flows that vary from 1 to 30 m in thickness (Carlisle, 1972). Typical pillow lavas are exposed in road cuts in the Naka Creek area, just east of the reserve (D. Blood, personal observation). The Tsitika River occupies a fault which probably originated in late Cretaceous or early Eocene time (Muller et al., 1974).

Glaciation and surficial deposits

The Tsitika area, like the B.C. coast in general, was subjected to several glacial and non-glacial events during the Pleistocene Epoch. Present surficial materials are mostly derived from the most recent glacial episode, the Fraser Glaciation of Clague (1981) and the events that followed this glaciation (Recent Epoch). By 25,000 years ago local valley glaciers had advanced down valley such as the Nimpkish (Howes 1981b) and therefore would have occurred in the Tsitika as well. During the maximum extent of Fraser Glaciation, about 15,000 years ago, huge piedmont glaciers originating in the mountains of the Mainland Coast completely overrode northern Vanouver Island in a westerly or southwesterly direction. This ice was up to 1550 m thick (Howes 1981b) and caused significant isostatic depression. Glacial recession here commenced by downwasting prior to 13,000 years ago, resulting in separate, discrete valley glaciers which were sufficiently thick to maintain a downvalley flow. As these remnant glaciers thinned and stagnated, vast quantities of melt-water flowed from, through and around the ice, depositing sequences of recessional outwash gravels in valleys such as the Tsitika. Delay in rebound of the isostatically depressed land together with a eustatic rise in sea level due to melting glaciers resulted in sea levels 100 to 150 m higher than today immediately upon deglaciation. A variety of marine landforms and deposits were laid down in these flooded lowlands as the land subsequently rose, and can be predicted to occur in the Tsitika valley.

Surficial deposits on lowlands and islands associated with the Tsitika River are of fluvial origin and sand/gravel texture. These have been deposited on flat to gently undulating surfaces between the end of the glacial period and the present. Slopes within the lower Tsitika valley have mainly moraine (till) deposits laid down as a veneer or blanket during glaciation. Uplands facing Johnstone Strait are covered by a mixture of colluvial and morrainal veneer laid down over hummocky bedrock. Bedrock exposures are present in a few places.

Soils

Soils in the area are of two general types, Regosols associated with flat alluvial sites along the Tsitika River, and Podzols on the forested mountain slopes. Regosols occur on young geological materials and unstable situations and are generally characterized by little or no profile development. In the lower Tsitika their occurrence is dependent on the fluvial process of continual lateral stream migration. Two kinds of Regosols have been identified in the lower Tsitika, Orthic Regisols in the most active flodplain area (Sitka spruce sites), and Humic Regosols in more stable areas (Douglas fir dominance). The latter is characterized by some accumulation of organic matter to give an Ah and C horizon sequence.

As mapped by Valentine et al. (1978), upland forest soils in the reserve should fall into Ferro-Humic Podzol type. Based on field investigation however, Roemer (1973) has designated these as Humo-Ferric Podzols. The latter are characterized by accumulation of Iron, Aluminum, and rather little organic material in the B horizon. Roemer (op. cit.) stated that the most widespread soil on moderately well-drained sites of the Tsitika area is the Ortho Humo-Ferric Podzol in a variant with very thick surface moder accumulations. Under uniform conditions of texture, drainage, and depth this soil shows little variation from high-to-low-elevation sites. Roemer noted that on volcanic formations in the north part of the watershed the thickness of the Ae horizon is only about 2.5 cm.

Hydrology

About 35% of the land portion of E.R. 111 is within the Tsitika River Watershed, the remainder being drained by much smaller streams which empty directly into Johnstone Strait. The reserve encloses the lower 1.5 km of the Tsitika River, a stream with a basin of 295 km^2 and mainstem length of 40 km. The river has a low gradient in this area (10m/km), and is comprised of 2 or 3 main channels with intervening islands. This reach is characterized by sinuous channels, many gravel bars, a large logjam, and several old channels. Tsitika river substrates are largely gravel near the mouth, changing to cobbles and rubble upstream. The pool to riffle ration is about 7:3. Bank stability in the river reach within the reserve was described as "low" in 1973.

Considerable amounts of wood debris clog the channels in places, and undercut banks and trees fallen into the stream course are common. As of 1986 this debris was stable and consisted entirely of natural falls of local trees. There have been some changes in debris composition resulting from a storm in January 1986, but major log jams dating from prior to that event are still in place.

Average annual flow in the Tsitika River is about 20 m^3/s (Appendix 6) however the basin has almost no lake storage and variations in flow associated with rainfall events and snowmelt can be extreme. Lowest flows are normally in August, highest flows in November. Extreme daily discharges during the period of record (1975-1988) are a maximum of 617 m^3/s on November 13, 1975, and a minimum of 0.77 m^3/s on October 8, 1985. The maximum instananeous flow was 1010 m^3/s, also recorded on November 13, 1975. These records indicate a 1300-fold variation in rate of natural flow.

Mean monthly water temperatures in the Tsitika River in 1979 ranged from a low of 5.6^0C in early May to a high of 13.4^0C in early July.

Streams east and west of the Tsitika have steep gradients and boulder bedrock substrates. Some are ephemeral; most are under 4 km in length. The reserve encloses only a few hundred meters of the lower reaches of these streams (Figure 2).

(b) Marine Component

Landform and Materials

The intertidal zone, except for the Tsitika estuary, is narrow and slopes steeply into Johnstone Strait. At the delta front of the Tsitika River the seabottom descends at about 20^0 to the 50 fathom (91 m) depth, 15^0 between the 50 fathom and 100 fathom (182 m) contours, and 10^0 from the 100 fathom to 200 fathom (266 m) depth. Gradients are somewhat steeper to the east and west of Robson Bight. Beyond the 200 fathom line a flat to gently undulating area occupies much of the width of Johnstone Strait. The northwestern part of the reserve encloses some of this level central area of the Johnstone Strait seafloor (Appendix 7).

The deepest point in Johnstone Strait, 280 fathoms (512 m) is about 5 km northwest of the reserve. The deepest known point within the reserve is 425 m. By comparison, the maximum observed depth in the Strait of Georgia is 420 m and in Juan de Fuca Strait a shallow 275 m. Only in some adjoining inlets such as Knight and Bute, are deeper basins found (Thomson, 1981).

The estuarine fan of the Tsitika River is composed of gravel with some finer materials on the surface. Elsewhere in the intertidal and shallow subtidal zone, several kinds of materials are present. These include about 40% rock substrates, 25% cobble-boulder and 15% mud, sand or gravel. The remaining 20% comprises gravel substrates of the Tsitika delta (RBPC 1981). Further offshore, Johnstone Strait has a compact muddy bottom (Thomson, 1981).

Physical oceanography

Wave heights in Johnston Strait are limited by the fetch of the wind and narrow, winding channel. Even over the longest wind fetch of 65 km in the western part of the Strait in the area of Robson Bight, much of the wave energy generated by westerly or easterly winds is lost to breakers at the shoreline. Long rolling seas and swell never have the opportunity to develop. The presence of surface currents partially makes up for short fetches and twisting coastline by contributing to the formation of a short, steep chop more that a meter or two high when winds rise above 10m/s or 20 kn (Thomson 1981). The largest seas for a specified wind speed and duration in Johnstone Strait develop for winds from the west. Especially choppy rips can develop near headlands. These conditions, while hardly affecting large craft, can be uncomfortable for small boats. The Robson Bight wave study of 1979-80 (Associated Engineering Services 1980) indicated that the significant wave height average (the average of the highest one third of the waves) was about 2 m, with the highest 10% being about 3 m and the very highest waves reaching 4 m. These heights were recorded near the shoreline under winter storm conditions.

Currents in Johnstone Strait are primarily tidal streams, associated with the astronomical tide, which change speed and direction in a regular manner throughout the day. At the surface, flood currents in Johnstone Strait are toward the east, ebb currents toward the west. Bottom currents move in the opposite direction. Near mid-channel, the larger of the two ebbs each day is generally over 50 cm/s (1 kn), sometimes reaching 75 cm/s (1.5 kn) during spring tides. The larger of the two floods often produces nothing more than a slack water period near high tide. Nearshore speeds are about 20% weaker than those near mid-channel. Surface currents are usually weaker on the Vancouver Island side of Johnstone Strait than on the mainland side (Thomson 1981). Strong persistent winds can modify the tidal currents. Wind-driven surface currents up to 30 cm/s (0.6 kn) have been predicted. In winter when prevailing winds are from the southeast the wind currents will tend to enhance the ebb currents and therefore reduce the strength and duration of flood currents. This effect occurs less often in summer when prevailing northwesterlies tend to enhance the floods and, therefore, ensure a regular

daily reversal of the flow regime. Canadian Tide and Current Tables, Volume 6, (Fisheries and Oceans 1988) provides daily current estimates for central Johnstone Strait.

Tides in Johnstone Strait may be either semidiurnal or diurnal, depending on the degree of declination of the moon. During most of the month in the vicinity of the reserve they are simidiurnal, and become diurnal only during the days of the moons' maximum declination. The tidal sequence in this area is invariably High High Water, Lower Low Water, Lower High Water, Higher Low Water. Tidal ranges for extreme spring and extreme neap tides at Alert Bay are 5.5 and 3.5 m respectively. Fisheries and Oceans (1988) provides daily tide information for Alert Bay, the nearest tidal reference port to the reserve.

Water temperatures in Johnstone Strait are relatively uniform from top to bottom due to regular tidal current mixing. They also remain quite low throughout the year. At the height of summer heating in late July, surface waters are usually colder than 10^0C, appreciably colder than values of over 20^0C reached in the central part of the Strait of Georgia. Even the oceanic surface waters of Queen Charlotte Sound to the northwest are warmer in summer than those in Johnstone Strait. Cold surface water is a principal reason for the common occurrence of summer fog in this area. During winter and spring the waters of Johnstone Strait are uniformly cold from top to bottom, with maximum readings of abour 7^0C (Thomson 1981).

Chemical oceanography

Salinity is extremely uniform in this area, reflecting the vigorous mixing of the water. However, there is always a discernible increase in salinity seaward along the channel, and a weak but permanent increase in salinity with depth. The surface salinity in Johnstone Strait is about 30 parts per thousand, while the bottom salinity reaches 32 parts.

Dissolved oxygen is also relatively uniform from top to bottom and over the length of the strait, running in the vicinity of 4 millilitres per litre of water. Near-bottom values may even exceed those close to the surface as currents carry aerated surface waters to the very depths of the basin. Because of this, benthic organisms in Johnstone Strait never suffer the devasting effects of low oxygen supply that so often plague some of the silled basins and fjords along the coast.

3. Biotic features

(a) Upland component

Biogeoclimatic position

The upland portion of Robson Bight falls within the wetter subzone of the Coastal Western Hemlock Biogeoclimatic Zone (CWHb) (Nuszdorfer et al. 1985). The zonal ecosystem association for CWHb is Western hemlock-amabilis fir-Alaskan blueberry-moss (*Rhytidiadelphus loreus*). Major additional species include western redcedar, red huckleberry, and the mosses *Hylocumium splendens* and *Rhytidiopsis robusta.*

The wetter subzone is divided into variants based on continental influence and orographic position (Klinka et. al. 1984). The variant present at Robson Bight is the Windward Submontane Maritime variant (CWHb1). On northeastern Vancouver Island this variant occurs from sea level to about the 600 m elevation. CWHb1 does not contain species which differentiate it from other variants, but deer fern and salal are more abundant and Douglas fir less abundant than in other variants; yellow cedar and the moss *Rhytidiopsis robusta* are absent. Klinka et. al. characterize CWHb1 climate with data for Loon lake near Haney. However, data for Alert Bay are undoubtedly more appropriate for this variant in the Robson Bight area.

Vegetation

Except for small rock outcrops and a few gravel bars along the Tsitika River the entire upland portion of the reserve supports forest vegetation. Community descriptions to date have been limited to the Tsitika River watershed part of the reserve, which includes only about 35% of reserve uplands. Roemer (1973) provided a brief description of communities throughout the Tsitika watershed, including plant lists for them. Ceska (1981) carried out a somewhat more intensive survey of Tsitika River estuary vegetation, including valley bottom forest stands adjacent to the estuary. He mapped plant communities on 200 ha of land in this area at a scale of 1:2000. Forest cover mapping produced by MacMillan Bloedel Ltd. and Western Forest Products is available for all of the forested upland.

The Tsitika Valley portion of the reserve, except for rocky slopes east of the estuary and lower river, is characterized by its relatively sheltered situation, flat to gently sloping topography, alluvial/floodplain deposits, and excellent moisture conditions. Tree growth is better than in parts of the reserve east and west of the valley, and much tree cover consists of associations other than zonal CWHb forest. This includes areas of Sitka spruce, Douglas fir, and red alder dominance on floodplain sites, and amabilis

fir dominance on gentle slopes (Apendix 8). Small areas of lodgepole pine occur on rocky bluffs east of the estuary. Elsewhere in the valley, more or less typical western hemlock forest is present.

Roemer (1973) noted that, in the Tsitika River valley below the 1000 ft. (305 m) elevation, large areas are occupied by the W. hemlock-amabilis fir-Alaskan blueberry-moss community. This is essentially the same hemlock community described in Appendix 8, except that amabilis fir is a more common subdominant. Roemer noted that under normal conditions the tree canopy is too dense to allow development of a dense shrub layer.

Forest stands in the reserve east and west of the Tsitika delta are on relatively steep, often rocky slopes and directly exposed to Johnstone Strait winds. Stands classified as "scrub" occur on prominent headlands marking the east and west margins of Robson Bight. Most stands east of Robson Bight are scrubby and date from about 1910. Those west of the Bight fall into the mature age class. Of 38 polygons on forest cover maps within the reserve but outside the Tsitika valley, 20 indicate hemlock dominance (including hemlock-cedar, hemlock-spruce, and hemlock-amabilis fir combinations), 17 indicate western redcedar dominance (almost entirely cedar-hemlock stands), and one is a Douglas fir-cedar type. Western redcedar appears to be a more common species on slopes facing Johnstone Strait than in the lower Tsitika Valley.

Roemer (1973) compiled lists of "average species combinations" for 15 plant communities in the Tsitika watershed. Almost all appear to be for sites outside of the reserve. His short list of 6 vascular plants and 5 bryophytes for low elevation hemlock forest (his community no. 1) probably applies to typical hemlock stands in the reserve.

In the Tsitika estuary area, Kennedy and Waters (1974) list 22 vascular plant genera or species (9 trees/shrubs, 13 herbs) which occur in Sitka spruce dominated forest immediately adjacent to the estuary. Ceska (1981) prepared a list of 114 vascular plants and 61 bryophytes found in the estuary and adjacent lowland forest. This appears to be quite a thorough list for his 200 ha study area, but additional species could occur. The list includes species of herbaceous intertidal estuarine communities as well as forest plants. Plant lists are not available for that part of the reserve east and west of the estuary.

Only one of the 114 vascular plants listed by Ceska (1981) is presently considered to be rare in British Columbia based on the list of Straley et. al. (1985). This is common scurvey grass (*Cochlearia officinalis*). On a scale of 1 to 4, this species is in the category of least rarity, R4. A plant of salt marshes and mud flats, it has been recorded at several sites in the Queen Charlotte Islands, Prince Rupert, Moore Islands, and at Hardy Bay, Grassy Island and Nimpkish River on Vancouver Island.

Fauna

Mammals known or believed to occur in the upland part of the reserve, including freshwater habitats, are listed in Appendix 9. Of the 18 species, some are known to occur based on sightings or sign (elk, deer, red squirrel, raccoon, mink, black bear) and others are more or less certain to occur as residents within the reserve (dusky shrew, deer mouse, marten) or as regular transients (wolf, river otter, cougar). Occurrence of six other species (water shrew, beaver, muskrat, Townsend vole, short-tailed weasel, and wolverine) is more speculative. Further investigation is needed. Mapping of important deer and elk habitats within the Tsitika watershed (Tsitika Folio Maps) did not include any such habitat within the present reserve boundaries. Canada Land Inventory Mapping classified the valley bottom lands in the present reserve as 3W (winter range with slight limitations) for deer and elk and the remainder of the area as Class 4 (moderate limitations) for deer. Elk and deer pellet group densities mere mapped for the entire Tsitika watershed, including the Robson Bight area, by Smith and Davies(1975).

Birds of the upland part of the reserve have not been systematically surveyed. Casual observations of a few species include the bald eagle, ruffed grouse, golden-crowned kinglet, raven, kingfisher, crow, and winter wren (file data). Typical breeding bird communities in forest stands of northern Vancouver Island have been described by Buckner et. al. (1975) and a similar assemblage can be expected at Robson Bight.

Reptiles and amphibians have not been investigated here. The reserve is within the range of 3 species of garter snakes (common; northwestern; western terrestrial) 5 salamanders (rough-skinned newt; long-toed, northwestern, red-backed, and clouded salamanders), 1 toad (western), and 2 frogs (Pacific treefrog; red-legged frog) (Gregory and Campbell 1984; Green and Campbell 1984). Local habitats may not be suitable for all of those species.

Thirteen species of anadromous and freshwater fish have been recorded in the Tsitika River, including the reach within the reserve (Apendix 10). Sources of information primarily include DFO adult escapement estimates (Appendix 11), Ministry of Environment snorkel counts for steelhead (Appendix 11), and swim surveys and fish trap sampling by RBPC (1980).

Use by and importance of the river within the reserve for each species is summarized in Appendix 10. Among the anadromous salmonids, coho and steelhead, both quite abundant, migrate through the reserve to spawn in the upper reaches. The reserve is an important rearing area for juveniles of these species, which spend 1 or more years in fresh water. Pink and chum salmon, the former considerably more abundant than the latter, both spawn in the lower

3 km of the river, i.e. largely in the reserve. Fry go directly to the sea in spring but may linger briefly in the estuary. Little is known about chinook and sockeye salmon here, but numbers are very small. Both sea-run and resident dolly varden char and cutthroat trout occur, with dolly varden the more abundant in the lower river. Waters within the reserve are important as spawning and juvenile rearing habitat for both species. An eulachon run occurs in May, with spawning confined to the reserve. Pacific lampreys enter the river to spawn. Small resident species include prickly and Coast Range sculpins and three-spined sticklebacks.

(b) Marine component

Vegetation

The Tsitika River estuary is small in area - about 30 ha compared to, for example, the 300 ha Salmon River estuary. It differs from many other B.C. estuaries in that it is not located at the head of a fjord, nor has it developed along a shallow coastal plain like many estuaries of southeast Vancouver Island. The delta front drops off very rapidly into Johnstone Strait, and the relatively exposed location and longshore currents readily carry alluvial materials into deep water. There is essentially no mudflat habitat, delta substrates being almost entirely gravel. Accretion at the delta front is probably very slow.

The estuary is defined as that part of the Tsitika River delta between mean low and mean high tide levels. The upper or inner edge is essentially the forest margin. Based on maps prepared by Ceska (1981), the 30 ha estuary consists primarily of river channels and gravel bars (23.4 ha ±), herbaceous vascular communities (4.4 ha) and algal communities (2.0 ha).

The position and composition of intertidal estuarine communities are summarized in Appendix 12. Hairgrass and sedge communities comprise the bulk of the vegetated area. Characteristic of small and medium-sized B.C. estuaries, the hairgrass type is developed in the upper intertidal zone and is gradually replaced seaward by Lyngbye's sedge stands in the middle intertidal zone.

Plants occurring in the estuary are included in the list of Ceska (1981) together with forest species. Kennedy and Waters (1974) prepared a plant list for the rye grass, hairgrass, and sedge zones at this estuary. Plant species diversity appears to be lower than in larger estuaries having more varied substrates. Further analysis of this matter is needed.

Intertidal and subtidal algae have been described in the delta fron area by Ceska (1981) and elsewhere within Robson Bight be RBPC (1980). This is about 40% of the reserve shoreline, but being partially sheltered may not be

typical of shorelines outside the Bight. A list of algae known to occur in Robson Bight is given in Appendix 13. Location of several kelp beds and of eelgrass (*Zostera marina*), a vascular plant, are shown in Appendix 14. The largest kelp bed, about 60 by 20 m, is located just east of the estuary on rocky substrates.

Invertebrates

As in the case of marine algae, invertebrates have been described only for that part of the reserve within Robson Bight (RBPC 1981).

Within the Tsitika River estuary, a caddis fly larva has been found to be abundant in brakish water of river channels in the inner estuary, and a mysid (*Neomysis mercedes*) in a broad band across the river mouth. Both are important salmonid foods. Mysid densities are typically 6,000 to 8,000 per cubic meter of water.

Within Robson Bight generally, inveretebrate diversity and density vary with current conditions and substrate types. A diversity of species has been described by RBPC (1981). These are listed in Appendix 15. Many additional species undoubtedly occur.

Deeper offshore waters with a muddy bottom are reported to support an abundance of polychaetes, brittle stars, crabs, sea urchins, and clams (Thomson 1981).

Fish

Any of the anadromous/freshwater species listed previously for the Tsitika River may be found in the estuary, and some in adjacent marine waters. As with invertebrates, abundance and species diversity vary with habitat type (Appendix 10). Marine fishes encountered to date are listed in Appendix 16. Many additional species undoubtedly occur.

Large numbers of juvenile salmonids occur in the Tsitika estuary and nearby marine waters, especially from May to July. Coho and chum are most abundant, and smaller numbers of pink, steelhead, and dolly varden occur (Fisheries and Oceans 1980). The juvenile chum salmon are felt to originate from rivers other than the Tsitika. Kelp bed and eelgrass habitats (Appendix 14) are important for these salmonids.

All species of Pacific salmon migrate through Johnstone Strait, some in very large numbers, to spawn in the Fraser and other rivers. This migration is mostly from July through October. Many additional species of fish are expected to occur in offshore waters of the reserve.

Seabirds

The reserve area is rather poor in terms of use by marine birds. Canada geese and trumpeter swans, typical over-wintering waterfowl in many small Vancouver Island estuaries, apparently do not occur here because of a lack of shelter. Small numbers of waterfowl occur during migration, and 50 mallards have been reported in winter (Kennedy and Waters 1974). Other birds recorded at the estuary include northern phalaropes, mew gulls, osprey, great blue heron, and miscellaneous sandpipers. Waterfowl census maps prepared by B.C. Fish and Wildlife Branch rate this area of Johnstone Strait coastline in the lowest of 4 density classes of wintering waterfowl (0-5 ducks/mile). Canada Land Inventory mapping for waterfowl rates this area as Class 7 (very severe limitations) for waterfowl production.

Significant numbers of seabirds probably pass through the reserve during migration, but have not been documented.

Marine mammals

In B.C. waters there is a total of 330 killer whales divided into 3 communities termed "transient", "southern resident" and "northern resident".

Co-incident with the annual salmon runs the northern community of 16 pods, totally some 172 annimals, will frequent Johnstone Strait typically from July to October.

The Robson Bight Ecological Reserve on the southern shore of Johnstone Strait contains within its boundaries two adjacent beaches that have afforded a sustained and peculiar interest for these whales since at least 1973. They provide small, smooth pebbles and shallow water (3-6 m) where killer whales will, if undisturbed, engage in regular routine of rubbing and resting up to four times daily.

An intensive study through July/August 1987 showed that for 54 days an average of 31 whales were present each day at the beaches and remained for an average of 47 minutes per visit. The data involved eight of the northern pods (Briggs 1988).

The reserve of 9 sq. km of water represents only a very minor part of the community range between Campbell River and Prince Rupert. However, whales recorded in Johnstone Strait during the above study spent approximately 17% of their time at the beaches and no site of comparable attraction for killer whales has been reported along the entire B.C. coast.

4. Representative and/or unique features

Representative features

(1) CWHb forest

Forest ecosystems in the reserve belong to the wet subzone of the Coastal Western Hemlock Biogeoclimatic Zone and are representative of exposed nearshore environments in this subzone, and representative of alluvial sites. Several other ecological reserves contain CWHb ecosystems.

(2) Estuary vegetation

Plant communities in the Tsitika River estuary have species composition and vegetation zonation that is similar to many small and medium-sized estuaries on the B.C. coast. Only two other reserves (V.J Krajina and Tahsish River) contain somewhat similar estuaries.

(3) Johnstone Strait marine environments

Intertidal and subtidal environments and communities are probably representative of Johnstone Strait in general, and perhaps a wider area including Queen Charlotte Strait.

Unique features

(1) Douglas fir stands

Alluvial sites dominated by Douglas fir forest are present in the reserve. This is an unusual situation in the CWHb subzone.

(2) Killer whales

The abundance and regularity of occurrence of killer whales in the Robson Bight area of Johnstone Strait is unique in Canada and perhaps over a larger area. The intensity of use of rubbing beaches by killer whales in this reserve, based on present knowledge, is unique in the world.

E. Cultural/historical values

Prehistoric native Indian use of the reserve has not been documented, but undoubtedly occurred, at least seasonally. Salmon and eulachon runs can be expected to have attracted at least seasonal attention. There is also a good potential for culturally modified trees in this area (B. Apland, personal communication). Lack of recorded archaeological sites here simply reflects the lack of any systematic inventory. Archaeological sites are of widespread occurrence in the Johnstone Strait area in general (Mitchell 1972).

The former telegraph line between Sayward and Telegraph Cove is of some historical interest. In some places in the reserve the old right-of-way is still visible and toppled poles lie on the ground. A telegraph line operated here around the turn of the century and then again during the Second World War. A patrol cabin and linemen were located at the Tsitika River, manned by 2 to 4 air force personnel (J. Borrowman, personal communication). Evidence of the telegraph line is rapidly being obliterated outside the reserve as logging advances, and this may be the only area where some remnant of it can be retained.

Evidence of the early hand-logging era is present in the form of large Douglas fir stumps near the shoreline. This activity was widespread on the coast and local evidence is probably only of minor historical significance.

III LAND USE AND OTHER ACTIVITIES

A. Regional socio-economic context

The "North Island" had only limited logging road access prior to 1979, when the new and more direct Island Highway was completed. The new highway led to accelerated population growth and economic activity, which continues today at a lesser rate. The region is socio-economically quite distinct, being separated from southern Vancouver Island by large areas of Crown forestland between Campbell River and the Nimpkish Valley. Regional administrative units (e.g. Mount Waddington Regional District; Port McNeill Forest District) include islands in Queen Charlotte Strait and large areas of the adjacent mainland. In 1981, the population of Mount Waddington Regional District was 14,671, the major communities being Port Hardy (5,675), Port McNeill (2,474), Port Alice (1,668), and Alert Bay (626) (Ministry of Municipal Affairs 1984). Population growth has occurred since 1981.

The forest industry dominates the regional economy, followed by mining, commercial fishing/aquaculture, and tourism (Mount Waddington Regional District 1980). The forest industry in the Port McNeill Forest District employs 2,835 people who receive $126,500,000 in wages and benefits. The district accounts for 11% of B.C. stumpage revenue and 8% of provincial timber harvest (Assoc. of Professional Foresters, 1987). Other than at the pulp mill in Port Alice, most forest products processing is done outside the region.

The Island Copper mine near Coal Harbour has been an important employer in recent years but is scheduled to close about 1992. Commercial fishing has been a significant and relatively stable economic activity for many years. It is expecially important for the more isolated communities like Alert Bay. Salmon are the most important catch, but a wide variety of marine resources is harvested. Like forestry, most processing is outside the region. The aquaculture industry, including both on-shore hatcheries and ocean net-pen systems, is in a period of rapid growth (Mossop, 1988) and, together with tourism, is being promoted in the north-island area as a means of off-setting future declines in the mining sector.

Tourism has shown rapid growth in the region and has much potential. The main destination point of travellers is the Prince Rupert Ferry. Sport fishing and whale-watching are major activities of tourists who stop in the area. Several new campgrounds, marinas, and resort facilities are in the planning stage in the Port McNeill-Telegraph Cove area. Robson Bight is considered to be the most important world-class tourist destination point on northern Vancouver Island (W. Shephard, personal communication).

B. On-site uses

1. Research and education

Research

Almost all research in the reserve, other than that sponsored by the Ecological Reserves Program to describe reserve resources, has been directly or indirectly oriented toward killer whales. Killer whale research began in this area of Johnstone Strait before the reserve was established. The first coast-wide census of orcas in 1971 revealed a concentration in Johnstone Strait and this was followed by Fisheries and Oceans field-work on photo-identification of individual whales and on description of communities, pods, and sub-pods and their home ranges, primarily in the period 1972-1974 (Appendix 17). Johnstone Strait was one of several intensive study areas, and some of the work there was undoubtedly within what is now the reserve. The rubbing beaches were discovered in 1973, but not widely known until several years later. Studies of killer whale vocalizations began in the area in 1978.

By the time the reserve was established in 1982 there was considerable interest in killer whale research in the Robson Bight area by university and independent researchers. Taylor (1988a) indicated the number of whale research projects in western Johnstone Strait increased from one in 1970 to 10 in 1986. Some of these involved several workers. Most projects have been of a long-term nature and many researchers are from outside British Columbia. Permits for conducting research in the reserve were not formally issued until 1983. Three permits were issued that year, 3 in 1984, 6 in 1985, 6 in 1986, and 5 in 1987.[1] These permits were for closely approaching whales within the reserve. Approaching whales in the rest of Johnstone Strait does not require a permit, however approaches closer than 300 m for research or photographic purposes require obtaining a yellow pennant from the Department of Fisheries and Oceans in Nanaimo. Several researchers have not obtained permits because they observed whales from shore and did not closely approach them. Many research requests have been turned down for reasons of incomplete description of the intended work, potential disturbance of whales, or the fact that the studies can be done elsewhere.

Major approved research projects since reserve establishment have involved killer whale acoustics/communication, respiration rates, resident versus transient behaviour, pod relationships, daily incidence of whales in the area, and amounts and impacts of boat traffic, both offshore and at the rubbing beaches (Appendix 17).

[redacted]1 does not include photography permits

Much research in the past two or three years has been impact-related and aimed at providing management information. Almost all research in this area is in summer and early fall when killer whales are regularly present.

Whale research in this area has been both boat-based and shore-based. Researchers needing close observations of behaviors and individual or group identification normally use boats and follow pods at distances often closer than 300 m for periods of 20 minutes to several hours. Shore-based researchers have generally been more interested in acoustic behaviors and overall movements of pods, recording with hydrophones and tracking with theodolites.

Surveys of boat traffic (Table 1; Appendix 18) indicate that a very small percentage is attributable to research activity, either in the reserve or in adjacent waters. However, studies by Duffus and Dearden (1987) show that researchers spend considerable time in close contact with killer whales in the Robson Bight area. Researchers accounted for 30% of all observed contacts between boats and killer whales in this area in summer 1986, and the mean duration of these contacts, about one hour, was longer than for recreational encounters. Researchers accounted for 35% of total minutes spent by boats in contact with whales, compared to 64% for recreationists (Table 2).

Responses of whales such as fluke slapping and gradual change of direction have been noted. It appears that whales gradually try to swim away from or negatively orient to the anticipated direction of researchers boats. Researchers were responsible for only two of 135 observed responses of whales to boats at the rubbing beaches in 1987 (Briggs 1988). Whether the level of research activity to date has or could be harmful to the whales is still the subject of debate and on-going study.

According to Taylor (1988b), most researchers in 1987 avoided entering the reserve to observe whales unless an unusual behaviour or group needed documentation. While this trend may be desirable with respect to Ecological Reserve objectives, it should be noted that the mere transfer of disturbing influences, whatever their cause, from one location to another does not reduce their over-all impact on these whales. Taylor (op cit) noted that researchers, as a group, were very cooperative with respect to adherence to reserve guidelines and often volunteered to distribute information brochures, and to provide observations relative to her visitor program. The generally good conduct of whale researchers is at least partially attributable to their need for co-operation, assistance, and peer approval from the researcher "community" and charter operators in Johnstone Strait. Some interference with research work has been caused by photographers and recreational whale-watchers, but this does not appear to date to have seriously jeopardized any research results. In general, researchers have received much cooperation from photographers and recreational users, especially the charter operators.

Table 1 - Composition of boat traffic in Johnstone Strait, in and adjacent to Robson Bight Ecological Reserve

Year	Location	Observation period	No. of[1] counts	% of vessells counted[2]				Source
				Commercial. fishing	Recreation	Research	Tranzsp	
'84	Shore to shore	Jul. 11-Sept. 1	1079	91	6	1	2	Briggs 1987
'85	Shore to shore	July 1-Sept. 1	1796	89	8	1	2	Briggs 1987
"87	- In Reserve	June 28-Sept. 5	844	91	8	tr.	1	Taylor 1988b
	- Outside Reserve	June 28-Sept. 5	838	74	18	2	6	Taylor 1988b
	- Rubbing Beaches	July 1-August 27	*[3]	80	18	1	2	Briggs 1988

1 Counts usually made at half hour intervals during daylight hours

2 Commercial fishing includes seiners and gillnetters, whether actively fishing or not. Skiffs launched from fishing boats also included in Rubbing Beach data.

Recreational boats includes kayaks/canoes; large and small sailboats; large and small powered pleasure boats; chartered whale-watching boats.

Research boats includes those known to be engaged in whale-oriented research.

Transp. includes all commercial traffic passing through the Strait, i.e. cruise ships, freighters, tankers, self-propelled barges, tugs pulling log booms or barges, and a few miscellaneous vessels.

3 All boats within 300 m of reserve shoreline were recorded (1047 boats)..

Table 2 - Researcher and recreationist encounters with killer whales, western Johnstone Strait, July and August 1986[1]

Boat type	% of 339 encounters	Mean duration of encounters (min.)	% of 14,785 encounter-minutes
Recreational			
- commercial charter[2]	26%	50	29%
- independent rec. boats[3]	37%	40	33%
- kayaks	5%	17	2%
Subtotal	68%	42	64%
Research[4]	30%	59	35%
Other/Misc.	2%	19	1%
Total	100%	46	100%

1 derived from Tables 1 and 2 in Duffus and Dearden (1987)
2 includes both motor and sail charter vessels
3 includes large and small sail and motorized boats
4 includes professional photographers

Researchers seem aware that much of their work can be carried out outside the reserve, however those working in Johnstone Strait will continue to need permits if they are to follow whales which move into and out of the reserve. Much is still unknown about killer whales and there will continue to be a demand to do research in accessible locations where large numbers of whales are regularly present, i.e. western Johnstone Strait. However, the demand should not exceed that in recent years, and research activity appears to be largely controllable through the permit system and monitoring of performance. Research at the rubbing beaches has quite thoroughly documented the intensity of use of the area in summer and the sensitivity of whales there to disturbance (Briggs 1988).

Educaton

Educational use of the reserve is difficult to define. Dissemination of the results of research studies has educational value, and recreational whale-watchers become better informed about whales and their habitat. For purposes of the report however, educational use of the reserve is restricted to use by professional photographers and media representatives whose accounts serve to educate people in distant places about Robson Bight and killer whales.

Levels of use by this group have been low, probably under 20 professionals per year, in recent years. However, they invariably want to approach whales closely, and concerns have been expressed about their potential disturbance of whales. Not all photographers have applied for permits, and some have reportedly shown little regard for locally accepted standards of conduct around whales. Recent policy has been to refuse permits for close-up photography of whales at sea in the reserve on the basis that such photos can be obtained outside the reserve. One or two permits per year are granted for remote photography at the rubbing beaches in view of the international educational significance of whale activities there. Only reputable professionals are considered, and permit provisions include timing (usually after the main tourist season), size of crew, duration of visit (usually a few days), and restrictions on scuba diving when whales are present.

Demand for photographic use of the reserve can be expected to contine at a rate similar to recent years, but involves relatively few people and should be controllable through the permit system and casual monitoring of activities in the reserve. If the situation does not deteriorate then direct impacts on killer whales in the reserve should not be of much concern. It should be noted however that this small group of reserve users, through their world-wide dissemination of photos and stories, has indirectly had a greater impact on the reserve than any other. The results of this educational effort are now undoubtedly irreversible and, in fact, are expected to result in increasing visitation.

2. Recreational use

Robson Bight and vicinity has seen increasing use by recreationists since its status as a core habitat for killer whales became widely known in 1978. Accessibility to the region increased dramatically with completion of the Island Highway to Port Hardy in 1979. Development of campsites, boat ramps, and boat charter operations has been rapid since that time (Darling 1986).

Whale-watching

Recreational whale-watchers are of two main groups, those who travel on commercial charter boats and those who have their own boats. Charters mostly operate daily throughout the summer season from Telegraph Cove or Alert Bay; both motor and sail tours are available. Other charter boats from outside the area, e.g. from Campbell River and Vancouver, may tour the area intermittently. A list of know charter operators is given in Appendix 19. Non-charter recreationists include those who trailer small boats or bring kayaks into the area, who rent boats at Port McNeill or other locations, or who travel into the area by boat. Boats used by these people vary greatly in size and include both power and sail types. Most recreational use if from early July through Labour Day weekend, and most visitors during this period see killer whales.

The total number of recreationists using the reserve and adjacent waters in any one year is not known. Boat surveys in western Johnstone Strait indicate the recreational boats made up from 6 to 18% of total observed summer boat traffic in recent years (Table 1). The maximum number of various types of recreational boats visible in the area on any one count was 17 kayaks, 4 sail boats, 11 power boats, and 4 charter boats (Briggs 1987). During summer 1987, Taylor (1988b) contacted 1500 on-the-water visitors at Robson Bight and nearby areas. Contacts were made 6 days per week in July and 5 days per week in August and early September except during inclement weather. It is likely that the total number of visitors was considerably higher than 1500. About 52% of these recreationists were aboard charter whale-watching boats, 17% were in kayaks, and 31% travelled in other boats.

Duffus and Dearden (1987) noted that recreational boat traffic was dispersed across Johnstone Strait with relatively similar use levels inside and outside the reserve. More specifically they found that non-charter recreational boat use was concentrated in mid-Strait off the western end of the Bight and in open water of the Bight within the reserve boundary; charter vessels focussed on open water areas along the reserve boundary and avoided nearshore areas and the rubbing beaches; kayakers focussed specifically on the western edge of the Bight well within the reserve.

Recreational boats account for over 60% of the time spent in contact with whales in the reserve and adjacent waters (Table 2). This time is approximately equally split between commercial charter boats and independent recreational boats. Average duration of encounters with whales is about 50 minutes for commercial charter boats and 17 minutes for kayaks.

Of 339 encounters between recreation/research boats and killer whales recorded by Duffus and Dearden (1987), 28 (8%) had examples of running into or chasing a whale group. Twenty instances were attributed to recreationists, 8 to researchers. The major boat type involved was the small pleasure motor vessel, some of which were launched from larger boats. These investigators also noted that violation of the 100 m approach distance guideline was commonplace. This apparently involved people who were ignorant of the guidelines as well as some photographers, and non-local charter operators with a committment to their customers for close encounters.

Briggs (1988) recorded 135 instances in which whales reacted to boat traffic at the rubbing beaches in summer 1987. Only 18% involved recreational boats, mostly motorized boats under 18 ft. (5.5 m) in length. Kayaks, and skiffs with the motor off, though few in number, appeared to elicit the greatest response by whales.

Because of the great public interest in killer whales, the scarcity of accessible locations to predictably observe them, and the fame accorded Robson Bight as a result of its rubbing beaches, recreational use of this area is expected to steadily increase in the foreseeable future. However, whale-watching activity here will probably eventually stabilize, as it has apparently done in California (Tilt 1985).

Other recreational activities

Sport fishing activity has increased markedly in the Port McNeill-Port Hardy area in the past 10 years, however boats do not have to travel as far as Robson Bight to get good fishing, and so levels of use within the reserve are low. This situation is not expected to change significantly in the foreseeable future.

To date there has been virtually no recreational use of the upland part of the reserve other than low levels of illegal camping at or near the shoreline. This situation is expected to change, though perhaps not dramatically, as logging roads come closer to reserve boundaries. In the absence of development of camping facilities near the reserve boundary, day-use levels in the upland part of the reserve should remain low for some time. The objective of visitors approaching the reserve from the land side would be to get access to the shoreline to launch kayaks or to observe whales from the beach or headlands. The dense bush and steep terrain of most of the upland part of the reserve will never have much appeal to recreationists. A few recreationists may be interested in walking to the Tsitika estuary once logging road access is near. Since activities like camping and sport fishing are not allowed in ecological reserves, casual day-use of the area will probably remain low for many years.

Recreationists presently launch kayaks via logging roads in the Naka Creek area east of the reserve. The logging road down the Tsitika valley, once it is extended to proposed cut-blocks adjacent to the reserve on the west side of the Tsitika, may entice similar activity. This could involve launching kayaks in the low-gradient waters of the Tsitika immediately above (south of) the boundary, carrying them to the beach through a narrow portion of the reserve to the west, or going around the west end of the reserve if the road extends that far.

3. Other uses

Commercial fishing

Commercial fishing is a major industry in Department of Fisheries and Oceans Statistical Area 12, which includes Johnstone and Queen Charlotte Straits and adjacent inlets. Many species of invertebrates and fish are landed, however salmon stocks are of paramount importance, expecially in Johnstone Strait where commercial fishermen and killer whales show a similar seasonal pattern of occurrence and intensity of interest. Up to 5 million pink salmon, 2.4 million sockeye, 700,000 chum, 250,000 coho and 75,000 chinook have been caught per year in Area 12, mostly in Johnstone Strait. There is also a native food fishery in Johnstone Strait. A variety of non-salmonid fish (herring,; halibut; sole) and invertebrates (sea urchins, clams, prawns, abalone) are harvested in Area 12 but little of this activity is in Johnstone Strait and vertually none in Robson Bight ecological reserve.

In 1986 the salmon troll fishery lasted from the last week of May till the end of September, the seine fishery from late July until late September, and gill net fishery from the first week in July to the last week in September. The bulk of salmon here are taken in the net catch, expecially pinks, sockeye, and chum. Largest catches of all species combined are in August, September, and October. Smaller gill net catches ocur in July and troll catches June.

Boat counts during July and August in western Johnstone Strait, including the reserve, indicate the 75 to 91% of boats present at any one time are commercial fishing boats (Table 1). Up to 141 have been tallied on a single count in that area (Briggs 1987), and some boats are present virtually every day. The same situation probably occurs in September, and perhaps part of October.

Taylor (1988b) found that although indices of use for all boat types combined were lower inside than outside the reserve in 1987, the opposite was true for seiners. This is because seine boats often anchor along the reserve shoreline between fishing openings, arriving as much as a week before an opening in order to pre-empt a valued spot. Small motorized skiffs are frequently launched from these boats, and the crews spend much time fishing, whale-watching, and visiting other boats to kill time between fishery openings. Gill netters, being smaller, normally moor in protected

anchorages such as Boat Bay between openings, and are only present in the reserve while fishing. However, during fishery openings, they may be more abundant than seiners.

Most commercial fishing in the reserve appears to take place to the east of the Bight. That part of the Bight adjacent to the Tsitika River mouth is closed to to fishing to allow escapement into the river. The average number of commercial fishing boats inside the reserve, based on half hourly counts in 1987, was less than 1 in July, and 11 in August (Taylor 1988b). Most of these were seiners.

Briggs (1988) found that commercial fishing boats accounted for 80% of boat use of waters within 300 m of the rubbing beaches in 1987. Seiners were present 24 hours a day through most of August. Of 135 observed reactions of killer whales to boats in the rubbing beach area, 76% were attributed to commercial fishing activity, including skiffs launched from purse seiners. The most common response of the whales was to cease rubbing and leave the area. According to Briggs (op cit) "Commercial fishing boats and skiffs often stopped to whale watch, sometimes following whales to within 10 meters from shore. The whales left the area each time."

Future levels of commercial fishing activity in the reserve are expected to be, on average, similar to those observed in the recent past. Year-to-year variation will occur in response to cyclical strength of salmon runs, which varies considerably.

Marine transport

Considerable boat traffic passes through Johnstone Strait, some of it through the reserve. This includes tugs with or without tows (booms; barges), self-propelled barges, coast guard and fishery patrol vessels, freighters, and cruise ships. These make up a small percentage of total boat traffic in western Johnstone Strait (Table 1). Taylor (1988b) noted that in July and August 1987 such traffic accounted for 6% of boats outside the reserve and 1% inside it. A reserve designated for temporary moorage of tugs pulling booms is located along the western shoreline of Robson Bight. This provides some protection from storm winds on Johnstone Strait.

Briggs (1988) found that commercial transport traffic of this nature accounted for only 2% of boat use within 300 m of the rubbing beaches in July and August 1987. Tugs with log tows frequently hug the shoreline as they move through the reserve. Briggs (op cit) reported that 2 of 135 reactions of whales to boats in the rubbing beach area were attributable to tugs pulling booms. In two other instances of tugs with booms passing when whales were at the beaches, no response was observed. Briggs (op cit) found that boats passing by caused less reaction than those which stopped to whale-watch, and that the reaction rate of whales to passing boats decreased with distance of boats from the rubbing beaches.

A gradual increase in general marine traffic is expected in future years but this appears to pose no significant threat to the reserve environment or killer whales.

Land-based uses

Historical uses of the upland component of the reserve included a telegraph line and its cleared right-of-way which passed completely across the reserve, and selective hand-logging of large trees. Such use does not occur at present and will not occur in future.

C. Off-site uses

1. Whale-oriented uses

As noted in Sec. III B, whale-watching and research programs occur widely in western Johnstone Strait, both outside and inside the reserve. It has not been possible to state precisely the relative levels of such activities inside and outside the reserve, although some approximations are available (Duffus and Dearden 1987). Numbers of whale-watchers are expected to increase steadily, perhaps even dramatically, in the region in the next few years, and the proportion of that activity outside the reserve should increase as people become more aware of the purpose of the reserve, reserve regulations and guidelines, and whale observation opportunities outside the reserve. (This however assumes an information/education program). Development of land-based whale-watching and interpretive facilities outside the reserve, e.g. on West Cracroft, Parson, or Hanson Islands, could divert some pressure away from the reserve. On the other hand, increasing disturbance of whales outside the reserve could affect use of the reserve by whales. Briggs (1988) noted that whales at the rubbing beaches sometimes departed prematurely when members of their social group which had remained out in the Strait were followed or disturbed by boats. It is also possible that if disturbance levels became much higher outside thean inside the reserve that the whales would use it even more heavily than at present.

2. Other marine activities

As noted in Sec. III b, considerable commercial fishing occurs in waters adjacent to the reserve. This has been going on for decades so it can be assumed that the whales have adjusted to the seasonal presence of fishing boats, and to the removal of a proportion of their forage resource. Commercial fishing intensity in waters adjacent to the reserve should not increase significantly in the future, and is unlikely to affecting the occurrence of whales in the reserve.

Commercial shipping through Johnstone Strait is expected to gradually increase but should pose no threat to the reserve or killer whale use of it, in the absence of a disaster such as a major oil spill.

3. The forest industry

The upland component of the reserve is surrounded by relatively high-capability forest land. This is predominantly Crown land having Tree Farm License (TFL) status. Two TFL's are involved, no. 25 (Western Forest Products) bordering the eastern end of the reserve, and no. 39 (MacMillan Bloedel) surrounding the remainder of the reserve.

Active logging is approaching the reserve from both the east and the south. On the east, a logging road has recently been built along Johnstone Strait from the Beban Logging camp at the mouth of Naka Creek into the valley of Schmidt (Peel) Creek, and some logging has taken place along the east side of the latter creek. This is within a few hundred meters of the reserve boundary. To the south, active logging is still some distance away, in the upper Tsitika drainage, however a new logging road (Tsitika Mainline) now extends down the Tsitika to within 7 km of the reserve and is projected to be built to the vicinity of the boundary west of the Tsitika River by 1992. MacMillan Bloedel have proposed two cut-blocks near the reserve, where logging would be started about 1992. Potential effects of logging on lands surrounding the reserve are discussed below.

Public access

Logging roads have the potential to greatly increase public access to and use of the upland area and shorelines of the reserve. This can have a direct impact on reserve values, i.e. trampling of estuary vegetation or disturbing whales at the rubbing beaches, and/or an impact on the level of management effort needed to prevent or control those undesirable effects. To date, land access has been negligible, although the first effects have been noted in terms of kayak launching via the logging road just east of the reserve (Briggs 1988). This has greatly increased the potential for disturbance of whales at the rubbing beaches.

The Tsitika Watershed Intergrated Resource Plan (Tsitika Planning Committee 1978) states that "The development of a network of logging roads will facilitate the public use of the watershed for recreational purposes." Over 1,000 km of roads are planning over an 80 year period, including early construction of a main logging road to the vicinity of Robson Bight. Implications of this for recreational use of the reserve were discussed previously (Sec. II-B-2). Fortunately this road, in the lower valley, will be west of the tsitika River and will not provide convenient land access to the rubbing beaches. The possibility that recreationists could launch kayaks into the Tsitika River at or near the reserve boundary and travel down it to tidewater and thence to the rubbing beaches cannot be evaluated without further on-site inspection.

Noise disturbance

Concern has been expressed that blasting, heavy equipment operation and tree felling could disturb whales at the rubbing beaches. In 1987 these activities took place in Schmidt (Peel) Creek valley, adjacent to the east reserve boundary. Blasting was readily heard by researchers at the rubbing beaches but apparently did not cause a reaction by whales there (Briggs 1988). The upland buffer behind (south of) the rubbing beaches varies from about 300 to 700 m in planimetric width. This should be sufficient for prevention of direct noise impacts on whales at the rubbing beaches, if indeed logging does proceed to the immediate boundary in this area. Road access to TFL 39 lands east of the Tsitika and upslope from the rubbing beaches does not appear to be easily had, and some timber in that area is immature. Planned MacMillan Bloedel logging near the reserve boundary west of the Tsitika should not result in noise-related disturbance of whales.

Hydrologic effects

About 60% of the area of the Tsitika watershed is scheduled for predominantly clear-cut logging over a period 60 to 80 years. Average removal rate will be about 295 ha per year (Tsitika Planning Committee 1978). Logging of extensive areas is known to result in more rapid run-off and to magnify differences between low ahd high flow events. Higher and/or more frequent flood events could erode river banks in the reserve or carry sediment and debris from upstream into the lower reaches and estuary of the river and into Robson Bight. Several factors suggest that the hydrologic effects of logging the Tsitika drainage may have minor implications for resource features of most concern:

- Environmental protection guidelines such as establishment of 6 Ecological Reserves, streamside strips, a dispersed pattern of cut-blocks, and deferred cutting of deer winter range should mitigate hydrologic effects,
- the watershed currently has little lake storage and very wide flow variations. The delta and estuary have adjusted to serious flood events,
- the integrity of estuaries associated with heavily logged east coast Vancouver Island watersheds appears to have been affected much less by upstream effects than by industrial development within them,
- the rubbing beaches are several kilometers away from the mouth of the Tsitika River.

Despite these mitigating circumstances, some impact on the reserve is possible. Relatively minor flow changes could affect salmon spawning substrates in the lower river.

Logging the watersheds of small, high-gradient streams east and west of the Tsitika could also affect the reserve, e.g. via debris and sediment transport downstream into the reserve during extreme rainfall/snowmelt events. This would be of greatest significance in the rubbing beach area. Schmidt (Peel) Creek and the small stream in TL0074 are of most concern. Further examination of road-building and logging plans for this area, as well as soil and slope stability, exact proximity of major rubbing beaches, and patterns of littoral drift would be needed to evaluate this matter further.

Windthrow (Blow-down)

Blow-down has had a harmful effect in some small ecological reserves (e.g. Clanninick Creek) where logging of dense, tall forest stands has reached reserve boundaries. In the Robson Bight reserve, forest stands fronting Johnstone Strait appear to be quite wind-firm. The greatest potential for windthrow occurs in mature amabilis fir-hemlock stands on lowlands adjacent to and west of the Tsitika River (Dr. H. Roemer, personal communication). Windthrow here is not a certainty, but could occur. Limited blowdown however is not expected to threaten major reserve features such a Sitka spruce and Douglas fir stands on river islands, herbaceous estuary vegetation, or the rubbing beaches.

4. Park proposal in lower Tsitika

This proposal (Sierra Club 1981; Wood and Wood 1986) involves about 4,450 ha of land in the Lower Tsitika Valley and adjacent areas. It would adjoin the entire south boundary of the present upland portion of E.R. 111 and extend southward about 7 km up the Tsitika valley, enclosing proposed ecological reserves at Mudge Lake and Mount Derby.

Beneficial effects of such a park would include;

- retention of a larger proportion of the tsitika watershed in an unlogged state. This should reduce adverse hydrologic effects such as flash flooding and sedimentation of spawning habitats in the present reserve,
- logging noise and disturbance near the present reserve would be precluded, except in Schmidt (Peel) Creek valley at its eastern edge,
- blow-down along the present reserve boundary would not be a problem (but might merely be transferred up-valley to the south edge of the proposed park),
- a scenic backdrop behind the reserve would be preserved (this does not necessarily have value for the reserve itself),
- public access could be controlled by park officials (however this does not appear to be the intent of the proposal).

The land in question does not have high park (outdoor recreation) value in its own right. The main interest of visitors attracted to it would be to gain access to the shoreline, i.e. the ecological reserve. Should the park be established its major benefit for the present reserve would be to greatly widen the upland buffer between the marine environment and logging activity. Whether it would have adverse effects would depend on the kind, location, and level of internal development for recreational purposes. Development of recreational access and camping facilities near the reserve boundary would encourage recreational use of the reserve. Since recreational use is not an objective of the Ecological Reserves Program, and because such activity could easily cause adverse impacts like trampling of estuary vegetation or disturbing whales at the rubbing beaches, recreational facilities development within the proposed park appears to be undesirable. This might be less so if such development was kept west of the Tsitika River, and the upland portion of the present reserve west of Lot 223 was given park rather than ecological reserve status.

5. Other land uses

Hunting, trapping, and sport fishing presently occur in the Tsitika River area but are largely confined to the upper reaches where road access available. These uses will become more prominent near the reserve as road access is developed, increasing the likelihood of inadvertent or purposeful killing of fish or wildlife inside the reserve.

IV MANAGEMENT ISSUES AND PRACTICES

The major objectives of the Ecological Reserves Program, as stipulated in the Ecological Reserves Act, are to conserve natural resources in the reserves and to provide long-term research and educational opportunities. The priority given to these goals is conservation of the resources first; then allow/encourage research activities that are not detrimental to the resources; and thirdly to allow/encourage educational activities which do not adversely affect reserve resources or research projects.

In Robson Bight Ecological Reserve, these goals are more specifically to:

(1) Protect the terrestrial and aquatic resources contained in the reserve. This includes protection of killer whales from disturbances which might affect their normal occurrence and behavior in the reserve.

(2) Allow/encourage research activities that do not significantly disturb whales or affect other resources in the reserve.

(3) Allow/encourage educational activities which are not detrimental to the land and marine resources and do not disturb the whales nor the research activities taking place in the reserve.

Management issues at Robson Bight can be related to the above goals as follows:

Goal	Management Issue
<u>Resource protection</u>	
a). Killer whales	· control of recreational boating disturbance
	· control of disturbance by researchers/photographers
	· control of disturbance by commercial fishermen
	· control of land access
	· control of external land uses which may disturb whales or their habitat
b). Estuary vegetation	· control of land access
	· control of camping by boaters
	· control of external land uses (logging) which could cause erosion/sedimentation.
c). Freshwater fishes	· control of external land uses which could cause erosion/sedimentation.

Research opportunity	• control of disturbances which would interfere with research on killer whales.
Educational opportunity	• control of disturbances which would interfere with educational activities.

Several issues are associated with more than one goal. For example, the issue of control of disturbance of killer whales by recreational or other boaters is important for resource (killer whale) protection, for preventing interference with research projects (either directly or indirectly), and for preventing interference with educational programs. The above issues can basically be condensed as followed:

- control of killer whale disturbance by boaters (recreationists, researchers/photographers, fishermen, and others).
- control of land access.
- control of external land uses which may adversely affect reserve resources.

ISSUE NO. 1. - CONTROL OF DISTURBANCE BY RECREATIONAL BOATERS, RESEARCHERS/PHOTOGRAPHERS AND FISHERMEN

The problem

The main purpose of E.R. 111 is to protect killer whales from disturbance, particularly when resting in the reserve or using the rubbing beaches. Recreational and research interest in killer whales at Robson Bight and vicinity has grown markedly in recent years and is expected to increase for the foreseeable future. These activities result in frequent, prolonged, close contact with whale groups, possibly resulting in increased energetic expenditure and altered behaviour. Whales are frequently disturbed at the rubbing beaches, the only well known site of its kind in the world. Disturbance in this area is caused by both commercial fishermen and whale-watchers. Disruption of the predictable seasonal and daily occurrence of killer whales in this area would severely impact the most reliable site in the world for killer whale research and photography, and could adversely affect North-Island tourism.

Recent management practices

1 Recreational whale-watchers

Guidelines have been issued for recreational whale-watching inside the reserve. Principal among these are requests to:

- refrain from entering the reserve when whales are present,
- if whales are encountered within the reserve, boaters should keep at least 300 m away from them.

The guidelines also include suggestions on how to approach and depart whales, on travel speed, and on keeping noise levels down. This informaiton has been disseminated via a widely distributed pamphlet, a conspicuous sign at Telegraph Cove, commercial tour operators, media reports, on-site information officers, and volunteer wardens. The level of compliance has been generally good, and seems to be improving as more visitors become aware of the guidelines (Taylor 1988b).

2 Researchers and professional photographers

Control of researcher/commercial photographer disturbance of killer whales has been achieved through a permit system and by conditions written in to each permit. Only research of benefit to the ecological reserve program and which cannot reasonable be carried out elsewhere is presently allowed. Stipulations for researchers in the offshore area normally include:

- approaching whales to less than 300 m should be done only when essential to research,
- there should be no photo-identification of whales (this requires close approaches and can be done outside the boundary),
- no diving with the whales,
- researchers should stay away from the rubbing beaches.

Only 2 or 3 researcher/photographer permits are issued per year for work at the rubbing beaches. Conditions for permitees there (primarily professional photographers) have included limitations on timing (e.g. after Labour Day),on duration of project and on crew size; use of remote equipment only; and no camping or boat moorage at the beaches.

The above management measures have been quite effective in limiting disturbance of whales inside the reserve by legitimate researchers and photographers, i.e. those who apply for and receive permits. While reactions of whales to researchers, e.g. increased speed and gradual change of direction, have been noted in western Johnstone Strait (Darling 1986), much of this "disturbance" is outside the reserve. Duffus and Dearden (1987) noted 8 cases of "running into" or "chasing" of whales by researchers but did not state if this was inside or outside the reserve or if the researchers had permits. Only 2 of 135 cases of disturbance at the rubbing beaches in 1987 involved researchers (Briggs 1988). It is not known if they were permitees. Taylor (1988a) suggests that non-permitted researchers and professional photographers could become a more serious problem in future.

3 Commercial fishing

Essentially no management practices have been attempted for control of whale disturbance by commercial fishermen. Darling (1986) described apparently undisturbed foraging whales winding in, out, and under 200-300 fish boats and nets during commercial openings, and suggested that this form of activity at current levels does not significantly disturb the animals. Commercial fishing is by far the most frequent cause of whale disturbance at the rubbing beaches (Briggs 1988), but there has been no overt attempt to control it. Despite 900% greater use of the reserve by commercial fishing craft than by recreational boats in summer 1987, Taylor (1988b) reported that less than 1% of her visitor program contacts were with commercial fishermen.

Jurisdiction and legislation

The B.C. Ministry of Environment and Parks has very limited jurisdiction with respect to ensuring that the major purpose of this reserve, protection of killer whales against disturbance, is met. This is because the federal government has jurisdiction over marine animals, including whales (Fisheries Act; Cetacean Protection Regulations) and over marine navigation. Commercial fishing, a significant cause of whale disturbance at the rubbing beaches, is also federally regulated.

Under federal cetacean protection regulations it is an offence to "chase" or "harass" cetaceans in any manner. Federal officials have not laid charges of this nature against researchers or whale-watchers in B.C. because the terms chase and harass have not been adequately defined, and because fishery officers do not view whale disturbance as a signigicant problem. Provincial officers could lay charges under the federal regulations but would be plagued by the same problem of lack of definition.

Although the Ecological Reserves Act gives the Ministry the power to require researchers in such reserves to apply for permits, and the power to apply conditions to those permits, it seems doubtful that this authority extends to research on marine animals at sea, or in subtidal waters at the rubbing beaches. The power to limit public entry into the marine part of the reserve, for example by recreational whale-watchers, is similarlly limited.

Key agencies and groups

Major agencies and groups having an influence on the killer whale disturbance problem are as follows:

Group	Role in whale protection
1. Recreational whale-watchers including charter operators	· General adherence to guidelines. Charter operators play important role through having control over large number of whale-watchers and dissemination of information to them.

2.	Whale research community	• General adherence to guidelines. Provision of research information needed to assess and control disturbance impacts. Assistance with visitor program.
3.	Commercial fishing industry	• No known protective activities.
4.	Department of Fisheries and Oceans	• Has issued guidelines for whale-watching in Johnstone Strait. No apparent attempt to enforce those guidelines or the cetacean protection regulations. DFO researchers have provided information relative to whale protection.
5.	Ecological Reserves program	• Formulation and dissemination of guidelines; regulation of research and commercial photography permits; administration of volunteer warden program; visitor information program in 1987. Influence on protection of killer whales from disturbance extends far beyond the reserve boundary.

The future

Disturbance by researchers is expected to be controllable through the existing permit system despite a lack of legislative authority. Disturbance by commercial fishermen, largely a problem at the rubbing beaches, should not worsen over the long term. Cooperative management by federal and provincial governments is desirable to lessen the present impact of fishermen in that area. Recreational whale-watching is expected to increase steadily, and perhaps even dramatically, in the near future. In the lack of an information/education program (primarily directed at independent boaters/kayakers), and without a regional strategy to direct recreational use away from the reserve and to reduce boating disturbance, recreational disturbance levels could disrupt the predictable occurrence of killer whales in western Johnstone Strait and adversely affect research and educational opportunities inside the reserve and tourism in the region.

ISSUE NO. 2. - CONTROL OF LAND ACCESS

The problem

Construction of logging roads to the vicinity of the reserve boundary will facilitate public access into the reserve. This could result in disturbance of whales at the rubbing beaches, trampling of estuary vegetation, and illegal activities like fishing, hunting, and camping. While not yet a significant problem, this issue is bound to become more prominent with time. The impacts of improved public access could compromise all three of the previously listed goals of this reserve.

Recent management practices

The upland portion of the reserve was not proclaimed until 1988, and management efforts to control land access into or through it have not been initiated. Acquisition of the buffer strip itself provides some deterrent against access to the shoreline.

Jurisdiction and legislation

Access into the land portion of the reserve (from either the inland or seaward sides) is controllable under the Ecological Reserves Act and Regulstions. This could be accomplished for all or a portion of the reserve by Order-in-Council, as has been done for some other reserves. Assuming adequate enforcement, this could serve to control land-based disturbance at the rubbing beaches and elsewhere.

Key agencies and groups

The key agency with respect to this issue is the Ecological Reserves Program. Other agencies having an influence on public land access are those who plan and/or build roads near the reserve, i.e. the Ministry of Forests, MacMillan Bloedel, and Western Forest Products.

The future

Public land access to the reserve will undoubtedly improve and some management action to control adverse impacts will probably be needed.

ISSUE NO. 3. - CONTROL OVER THOSE EXTERNAL LAND USES WHICH MAY ADVERSELY AFFECT RESERVE RESOURCES

The problem

A Sub-component of this problem, the construction of access roads on surrounding lands, was considered above. Logging of surrounding lands can result in more variable flows in the Tsitika River; in erosion, sedimentation or debris accumulation in salmonid spawning habitats, the Tsitika River estuary, or at the rubbing beaches; in blow-down of timber around the reserve boundary, and in noise and disturbance associated with active logging operations. This is largely an anticipated problem because logging is in its early stages in watersheds surrounding the resserve and, other than noise from road-blasting which could be heard at the rubbing beaches, the above potential impacts have not yet been shown to occur. Land uses other than logging do not appear to be an issue at this time.

Recent management practices

In anticipation of future logging development near the reserve the major management action has been to acquire an upland buffer to prevent shoreline habitat degredation and direct disturbance of whales at the rubbing beaches. Logging impacts, for the most part, have not yet occurred and additional management initiatives have not been undertaken.

Jurisdiction and legislation

The Ecological Reserves Program has no direct jurisdiction over activities on adjacent lands. Some influence on surrounding land uses is possible via Ecological Reserves Program representation on land use committees, through Ministry of Forests referrals, or by direct petitioning of tenure holders.

Key agencies and groups

Major agencies having an influence on logging impacts are as follows:

	Group	Role in Prevention of logging impacts
1.	Ecological Reserves Program	· Periodic inspection of reserve and enforcement of Act and Regulstions so as to maintain integrity of the buffer land. Influence on peripheral land use via referral process and representation on Tsitika Follow-up Committee.
2.	Ministry of Forests	· Ensure that logging operators adhere to Coast Logging Guidelines and the Tsitika Watershed Integrated Resource Plan. Support research recommendations of the Tsitika Follow-up Committee.
3.	Tsitika Follow-up Committee	· Ensure that the Tsitika Watershed Intergrated Resource Plan is followed. Facilitate required research and monitoring.
4.	MacMillan Bloedel Ltd.	· Adherence to Tsitika guidelines; liaison with Ecological reserves Program re potential wind-throw, access, and related problems.
5.	Western Forest Products Ltd.	· Adherence to Coast Logging Guidelines; liaison with Ecological Reserves Program re logging plans adjacent to reserve boundary in rubbing beach area.

The future

Problems related to logging impact on reserve integrity are in their infancy. Although they may never become serious, they will require increasing attention in the near future.

V KEY RESOURCES AND MANAGEMENT ISSUES

A. Reserve boundary and legal status

(1) The marine boundary (except the shoreline) is not marked and is not obvious to boaters.

(2) The Province lacks jurisdiction over marine fauna, boat traffic, and commercial fisheries. Provincial whale-watching guidelines and marine research/photography permit requirements cannot be enforced.

(3) The features of major concern at this reserve, the rubbing beaches, are located near the edge of the reserve rather than in the middle. The eastern boundary is close to the beaches, which are vulnerable to encroachments from that direction.

(4) The upland buffer may be too narrow to prevent impacts at the shoreline, especially public access. However, public access can be legally prohibited.

B. Resource preservation/representation

(1) Key resources include estuary vegetation, spawning salmon, marine environments, and killer whales. The predictable pattern of killer whale travel through Johnstone Strait provides world-class opportunities for whale research and viewing.

(2) Killer whales, the major resource feature, range widely on the B.C. coast and the reserve encloses a very small part of their total home range. The reserve has little effectiveness as an over-all tool for killer whale protection.

(3) The major purpose of the reserve is to prevent disturbance of whales at the rubbing beaches and while engaged in resting or related behavior anywhere in the reserve. Scientists have suggested that there is less resting activity in the reserve now than in previous years (Darling 1986) and have documented considerable disturbance at the rubbing beaches (Briggs 1988). Therefore the objective of preventing disturbance to killer whales has apparently not been met.

(4) Despite lack of jurisdiction in the marine area, anti-disturbance guidelines plus information and education programs appear to have been sufficient to date to keep recreational, research, and photographic disturbance within reasonable levels. However increasing recreational use and/or decreased information/education effort could result in higher levels of disturbance and in disruption of the predictable pattern of whale movement in western Johnstone Strait.

(5) Commercial net-fishing has been going on in Johnstone Strait for decades, and such activity, including skiffs launched from seiners, is responsible for most whale disturbance at the rubbing beaches (Briggs 1988). Despite a probable history of such disturbance predating significant recreational whale-watching in this area, high levels of killer whale use of the rubbing beaches were documented in 1987 (157 different whales; mean of 31 whales at beaches per day; mean of 3 visits/whale/day; mean length of visit 46 min.). Comparative

figures for past decades are not available so it is not known whether current use by whales is different than in earlier years. However, current use of the beaches by whales is certainly more than casual and suggests the animals have been able to adapt to considerable disturbance caused by fishermen. Adaptability is also suggested by observations that whales use the beaches more at night if disturbance is primarily by day, that they will wait to rub if a disturbance is present, and will return to rub after being interrupted (Briggs 1988).

(6) Increasing numbers of kayakers pose a threat which may be difficult to control via traditional information programs and surveillance. These users do not appear to be a threat in offshore waters because, lacking motor power, their average time period in contact with whales is short. However, most kayak use is near shore, to date in the western part of the reserve (Duffus and Dearden 1987 Fig. 8), although increased kayak occurrence can be expected in the rubbing beach area now that logging road access is available to Schmidt (Peel) Creek. Compared to other boaters, kayakers are difficult to contact and to control because they do not require launching ramps or dock moorage, can land anywhere and take their craft ashore with them, and can camp in a variety of places with little fear of detection. Kayak disturbance of killer whales at the rubbing beaches can be expected to increase, and would appear to need early attention.

(7) To date there has been little involvement by officers of the Ministry of Environment and Parks (Park Officers; Conservation Officers) or Federal Department of Fisheries and Oceans (Fishery Officers) with respect to enforcement of legislation or guidelines concerning whale disturbance in the reserve.

(8) The reach of the Tsitika River within the reserve contains important spawning habitat for pink and chum salmon, anadromous cutthroat trout and dolly varden char, and eulachons. It is also important juvenile rearing habitat for coho salmon, steelhead, cutthroat and dolly varden. Those habitats could be adversely affected by logging-induced erosion or siltation.

(9) Marine environments at Robson Bight are probably representative of western Johnston Strait and an even wider area. Eleven ecological reserves in B.C. contain a subtidal component. Four of these, plus Robson Bight, fall into the Vancouver Island Inland Sea marine natural region of Harper et al. 1983. Those 4 however are all in the Victoria area where oceanographic conditions are quite different than at Johnstone Strait.

(10) The Tsitika River estuary is representative of small estuaries on the B.C. coast. Only two other ecological reserves contain significant estuaries. Increased public access could result in trampling of restricted herbaceous communities in the estuary.

(11) Upland forest stands are probably representative of wide areas of the wet subzone of the Coastal Western Hemlock Biogeoclimatic Zone. More unique forest stands occur in floodplain habitats, i.e. an alluvial Sitka spruce community, and Douglas fir forest north of its usual range.

C. Research

(1) Unique opportunities result in a high demand for research on killer whales in and around the reserve. The present permit system together with peer pressure appears adequate to protect whales from excessive research disturbance while allowing most requests for legitimate research to proceed for the foreseeable future.

(2) Increasing recreational whale-watching if not controlled and/or directed elsewhere, will eventually interfere directly or indirectly with research programs.

D. Education

(1) The educational function of this reserve is met primarily through professional photographers/writers who publish in international nature publications. The present permit system appears adequate to control these users and, at the same time, allow educational objectives to be met. Educational objectives are also furthered by scientists who publish research results, and by tour operators who provide interpretive material to the visiting public.

(2) The 1987 visitor program was very successful in terms of informing the public about ecological reserve objectives and killer whale ecology, and in reducing recreational disturbance. This kind of program probably has more potential than any other for improving public compliance with anti-disturbance guidelines.

E. Recreational use

(1) This reserve is undoubtedly unique in the amount of recreational use it receives. This has the potential to conflict with its major purposes - conservation, research, and education. To date, informal guidelines and public information programs appear to have been sufficient to keep impacts at an acceptable level. This may not be the case in future if recreational activity continues to increase and is not directed away from the reserve.

(2) Good whale-watching opportunities occur outside the reserve. Increased emphasis on whale-watching outside the reservce could serve to prevent disturbance inside it from increasing in the face of an upward trend in whale-watching in the region. However, the same community of whales is involved.

(3) Guidelines which discourage recreational whale-watching inside the reserve should not adversely affect the viability of charter operations or general tourism in the north-Island area because whales can be reliably seen outside the reserve. In fact, protection of whales from recreational disturbance inside the reserve, especially at and near the rubbing beaches, is necessary in order to maintain the predictable pattern of whale travel on which commercial whale-watching is based.

F. Other uses

(1) Commercial net fishing, directed at the same salmon resource which attracts killer whales, has a long history in this area. Considerable fishing occurs inside reserve boundaries at times of peak whale occurrence and recreational/research activity. Commercial fishing accounts for over 80% of boat traffic in the reserve in summer/fall, and for 75% of whale disturbance at the rubbing beaches. Provincial government agencies have no jurisdiction and little or no control over marine commercial fishing. Commercial fishing in Johnstone Strait can be expected to continue at levels similar to the recent past. Disturbance of whales at the rubbing beaches could be significantly reduced by removal of commercial fishing from a small area fronting those beaches.

(2) Through boat traffic is gradually increasing in Johnstone Strait, but causes little or no disturbance of killer whales and is not likely to be of concern for the foreseeable future. Tugs pulling booms sometimes hug the reserve shoreline and have been reported to disturb whales at the rubbing beaches however the incidence of such disturbance is low.

G. Surrounding land uses.

(1) Logging is the dominant surrounding land use and the one of major concern with respect to reserve integrity. Logging is or soon will be proceeding near the reserve boundary, and most low and middle-elevation lands near it will eventually be logged. Impacts such as logging noise, blow-down, and altered flow regime of the Tsitika River are expected to be minor, and should not affect killer whale use of the reserve. Logging of small drainage basins south of the rubbing beaches may require special attention. Improved public land access to the reserve is the major potential impact of logging. This is controllable by regulation on reserve lands proper, but not on immediately adjacent lands.

(2) Improved land access will allow other uses such as hunting, trapping, and sport fishing to increase significantly on adjacent lands. These may require some management attention but are not significant threats to the reserve.

H. Wardenship

High levels of public use and predominantly federal jurisdiction over reserve resources result in a unique and demanding situation with respect to wardenship. Neverless, the traditional functions of volunteer wardens, periodic reporting on activities observed in the reserve, and informing the local public about ecological reserve objectives and resources, have been and are being met. The present wardens, being tour operators in the area, are an excellent position to serve both of those functions. However, their information/education role cannot be expected to extend to the large number of summer visitors who come from outside the north-Island region. The 1987 visitor information program (Taylor 1988b) filled the latter role admirably.

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APPENCICES.

BRITISH COLUMBIA

1134

APPROVED AND ORDERED JUL 17 1982

Appendix 1

~~Lieutenant-Governor~~
Administrator

EXECUTIVE COUNCIL CHAMBERS, VICTORIA JUL 16 1982

On the recommendation of the undersigned, the ~~Lieutenant-Governor~~ *Administrator*, by and with the advice and consent of the Executive Council, orders that, on publication in the B.C. Gazette of a notice signed by the Minister of Lands, Parks and Housing, the following land is established as an ecological reserve:

All that foreshore or land covered by water in the vicinity of Robson Bight, Rupert District more particularly described as commencing at the point of intersection of the right bank of Sir John Creek with the southerly boundary of Johnstone Strait; thence due north a distance of 1000 metres; thence southeasterly in a straight line 8900 metres more or less to a point 1000 metres due north of the point of intersection of the left bank of Schmidt Creek and the southerly boundary of the aforementioned Johnstone Strait; thence due south 1000 metres to said point; thence in a general northwesterly and southwesterly direction along the southerly boundary of Johnstone Strait to a point due east of the northwest corner of Lot 223, Rupert District; thence due west to said point; thence continuing along said southerly boundary of Johnstone Strait in a general northwesterly direction to the aforementioned point of commencement, containing 1248 ha more or less.

Minister of Lands, Parks and Housing

Presiding Member of the Executive Council

cc to: M. McArdle
BC Assessment Authority
B. Foster
R. Ahers
C. Gray
G. Craig
D. McColl

Appendix 2

ROBSON BIGHT SCHEDULE

All land in Rupert Land District described as:

1) Commencing at a point on the natural boundary of Johnstone Strait on the southeasterly shore thereof, said point being 1.380 kilometres East and 1.280 kilometres North of the southwest corner of Lot 223, Rupert District;

thence South 370 metres;

thence South 32° West 460 metres;

thence South 29° East 490 metres;

thence South 710 metres;

thence South 38° 30' West 560 metres;

thence West 140 metres;

thence North 43° 30' West 1.024 kilometres;

thence North 50° West 750 metres to a point on a height of land, said point being 405 metres West and 195 metres North of the southwest corner of said Lot 223;

thence in a general Northwesterly direction along said height of land to a point 955 metres West and 450 metres North of the southwest corner of said Lot 223;

thence North 62° West 540 metres;

thence North 35° 30' West 1.413 kilometres;

thence North 56° West 630 metres to the natural boundary of aforesaid Johnstone Strait on the southwesterly shore thereof;

thence in a general Southeasterly direction along the natural boundary of said Johnstone Strait on the southwesterly shore thereof to the northwest corner of said Lot 223;

thence Southerly, Easterly and Northerly along the westerly, southerly and easterly boundaries of said Lot 223 to the natural boundary of said Johnstone Strait on the southeasterly shore thereof;

thence in a general northeastely direction along the natural boundary of said Johnstone Strait on the southeasterly shore thereof to the point of commencement;

and containing 266 hectares, more or less.

OIC/ROBSONBIGHT/1

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Appendix 2 - Continued

2) Commencing at a point on the natural boundary of Johnstone Strait o the southerly shore thereof, said point being 4.120 kilometres East and 1.280 kilometres North of the southwest corner of Lot 223, Rupert District;

thence South 390 metres, more or less, to the northeasterly boundar of the watershed of an unnamed creek, said unnamed creek flowing in a general northwesterly direction into Johnstone Strait at a point 3.410 kilometres East and 1.310 kilometres North of the southwest corner of said Lot 223;

thence in a general Westerly direction along the northeasterly boundary of the watershed of said unnamed creek to a point 3.920 kilometres East and 845 metres North of the southwest corner of sai Lot 223;

thence South 60° West 230 metres, more or less, to the southwesterl boundary of the watershed of said unnamed creek;

thence in a general Northwesterly direction along the southwesterly boundary of the watershed of said unnamed creek to a point 3.260 kilometres East and 940 metres North of the southwest corner of aforesaid Lot 223;

thence South 60° West 295 metres, more or less, to a point on a height of land, said point being 3.010 kilometres East and 800 metres North of the southwest corner of said Lot 223;

thence in a general Northwesterly direction along said height of land to a point 2.545 kilometres East and 1.050 kilometres North of the southwest corner of said Lot 223;

thence North 280 metres, more or less, to the natural boundary of aforesaid Johnstone Strait on the southerly shore thereof;

thence in a general Easterly direction along the natural boundary o said Johnstone Strait on the southerly shore thereof to the point o commencement;

and that part of Robson Bight, the estuary of Tsitika River and Tsitika River described as lying South of a line which commences at the northwest corner of District Lot 223 Rupert District and proceeds due East to the point of intersection with the east boundary of said District Lot 223;

and containing 70 hectares, more or less.

3) District Lot 223, Rupert District for so long as this land is lease to the Crown;

and containing 38 hectares, more or less.

The whole containing 412 hectares, more or less.

File: 6-6-3-547

Appendix 3

Chronology of the establishment of Robson Bight Ecological Reserve

Year	Land area	Marine area
1971		First B.C. killer whale census revealed a concentration in Johnstone Str. area
1972	Original E.R.P. 111 application submitted for entire Tsitika River watershed.	Second killer whale census confirmed concentration in Johnstone Strait.
1973	Min. of Lands and Forests declares moratorium on logging and road-building in Tsitika-Schoen area.	Third killer whale census confirms concentration in Johnstone Str. area. Discovery of Rubbing Beaches near Robson Bight.
1974	North Island Study Group (NISG) initiated to evaluate potential conservation-logging conflicts in Tsitika-Schoen area.	Intensive photo-identification of orcas, Johnstone Str. and other areas.
1975	NISG continues its evaluation. Moratorium still in place.	Johnstone Str. killer whales determined to belong to northern resident community.
1976	NISG presents report with 4 land use options. Public hearings held. Moratorium continued.	
1977	Moratorium continued for Tsitika area only; other areas released. ELUC announced that an integrated resource management plan would be prepared for Tsitika.	
1978	Tsitika Watershed Integrated Resource Plan (TWIRP) submitted to ELUC. Included 7 Ecological Reserve proposals, one in estuary (130 ha)	MacMillan Bloedel plans for log handling in Robson Bight revealed. Whale researchers contact government officials re. potential impact.
1979	TWIRP plan accepted by ELUC.	
1980	Tsitika Follow-up Committee formed to implement TWIRP plan.	Min. of Environment announces study team to report on potential impact of log handling at Robson Bight.
1981	Min. of lands, Parks, and Housing (MLPH) announces 3-year interim reserve which includes 100 m strip of upland. Sierra Club submits park proposal for lower Tsitika. MLPH studies conservation strategies and selects Ecological Reserve option.	Ministry of Lands, Parks, and Housing (MLPH) announces moratorium on industrial development at Robson Bight. Robson Bight Study Team report released; Recommends no industrial development at Robson Bight.

Appendix 3. - Continued

Year	Land area	Marine area
1982	MLPH announces intention of acquiring uplands fronting the marine reserve; proposes new boundary and wider buffer. Joint inspection of enclosed TFL 39 lands, by MacMillan Bloedel and MLPH.	Robson Bight Ecological Reserve (marine component) designated by O.I.C. 1134 (1248 ha).
1983	Cabinet reviews compensation needs and authorizes timber cruises and appraisals for TFL 39 portion of upland.	
1985	Timber cruises carried out. MLPH prepares report proposing 515 ha upland buffer (TFL 39 and 25).	
1986	Wilderness Advisory Committee recommends acquisition of the 515 ha upland area for Ecological Reserve purposes.	
1987	Nature Trust of B.C. submits proposal for acquisition of D.L. 223 from MacMillan Bloedel.	
1988	Upland buffer in TFL 39 including D.L. 223 incorporated into E.R. 111 by O.I.C. 436 (412 ha). Process initiated to acquire remaining buffer land in TFL 25 (100 ha).	

Appendix 4. - Mean monthly temperature and precipitation at Alert Bay[1]

Month	Temperature[2] (°C)	Precipitation (mm)[3]		
		Rain	Snow	Total
Jan.	2.8	162	34	196
Feb.	4.6	124	10	134
Mar.	5.2	112	10	122
Apr.	7.5	82	1	83
May	10.2	60	0	60
June	12.3	66	0	66
July	14.0	52	0	52
Aug.	14.3	67	0	67
Sept.	12.6	119	0	119
Oct.	9.3	209	tr.	209
Nov.	5.7	204	7	211
Dec.	3.9	217	16	233
Year	8.5	1474	78	1552

1 Data from "Canadian Climate Normals, British Columbia - Temperature and Precipitation, 1951-1980" Environment Canada, Atmospheric Environment Service.

2 32 years of record

3 60 years of record

Appendix 5. - General landform characteristics of the upland part of E.R. 111.[1]

Parameter	Tsitika R. watershed		Peripheral to Tsitika R.
	Lowlands*	Slopes	
Approx. area (ha)	130	50	335
% of total area	25%	10%	65%
Drainage	into Tsitika R.	into Tsitika R.	Small streams flowing directly into Johnstone Strait
Slope exposure	none	ne (w. of estuary) sw (e. of estuary)	nw to ne
Slope steepness**	flat	15° (w. of estuary) 40° (e. of estuary)	mostly 15-30°

1 includes lands in both TFL 39 and TFL 25

* includes estuary, floodplain, islands, river channels and adjacent terraces to about the 30 m elevation

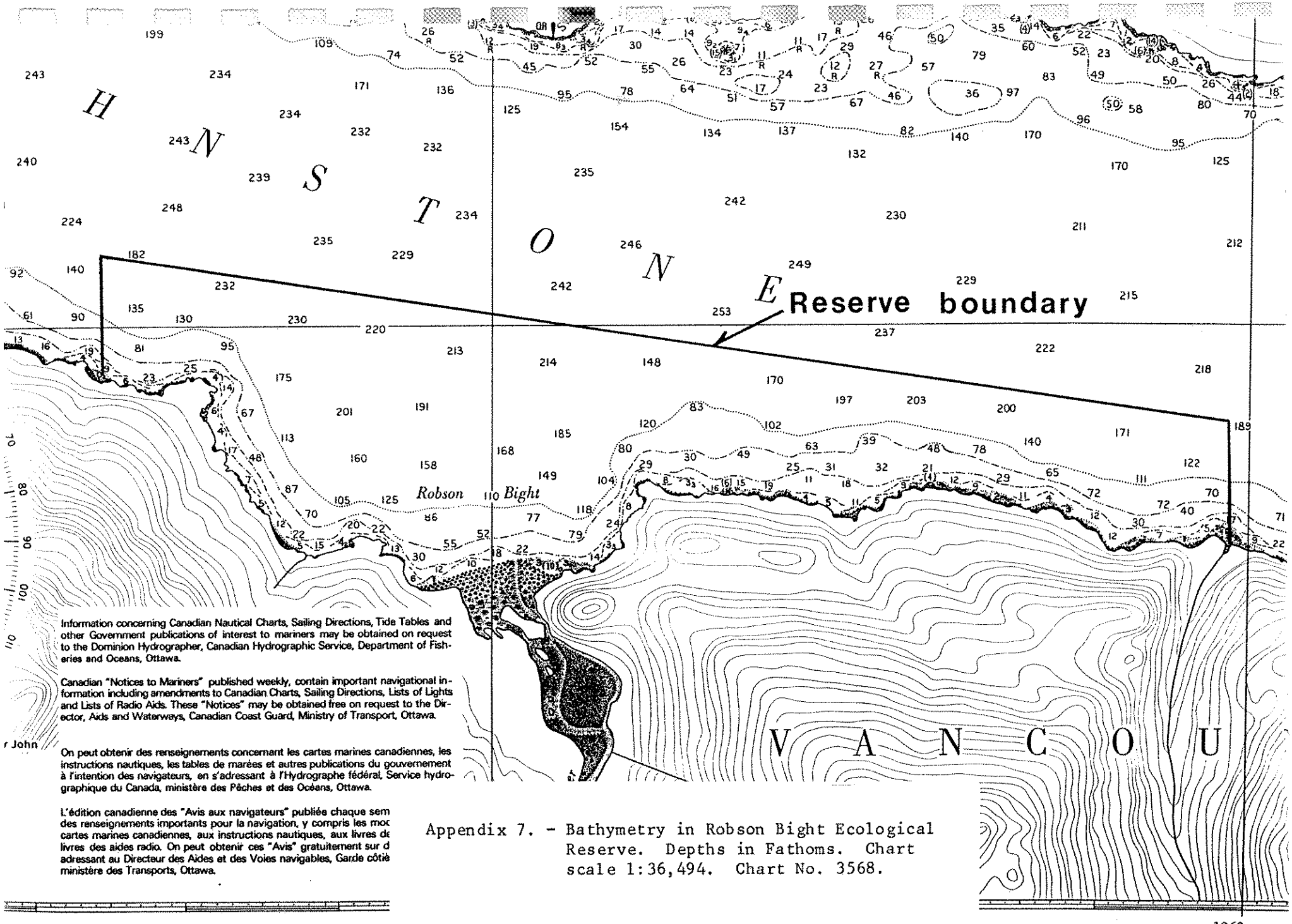
** based on 1:50,000 topographic maps with 100 ft (30 m) contours.

Appendix 6

Mean monthly flows, Tsitika River, 1975-1987.[1]

Month	Mean flow (cubic m/s)	Range (cubic m/s)
Jan.	24.9	4.5-50.5
Feb.	24.5	9.3-40.5
Mar.	19.0	9.1-31.8
Apr.	19.4	11.5-31.8
May	24.7	15.5-33.9
June	20.9	15.2-34.7
July	11.1	4.8-18.8
Aug.	5.2	1.9-12.8
Sept.	9.7	1.5-19.8
Oct.	23.9	4.0-37.0
Nov.	35.1	12.3-102
Dec.	28.0	9.6-53.9
TOTAL	20.4	1.5-53.9

[1] Source: Environment Canada, Water Survey of Canada, Station No. 08HF004 (below Catherine Creek).



Appendix 7. - Bathymetry in Robson Bight Ecological Reserve. Depths in Fathoms. Chart scale 1:36,494. Chart No. 3568.

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Appendix 8

Forest communities of the lower Tsitika River Valley within E.R. 111.[1]

1. Primarily Floodplain Types

1.1 Sitka Spruce Forest

Location: pure stands are in alluvial sites adjacent to the estuary and on islands further upstream.

Tree layer: Sitka spruce-W. hemlock-W. redcedar

Shrub layer: poorly developed. Only common species is red huckleberry.

Herb layer: great variety of herbs and grasses. Ferns dominate this layer. Grasses include bearded fescue, California brome, Alaska oniongrass, bluejoint, nodding wood-reed, and nodding trisetum. Common herbs are little buttercup, and sweet-scented bedstraw.

Moss layer: dominant species are Hylocomium splendens, Stokesiella oregana, and Rhytidiadelphus loreus.

Remarks: Sitka spruce-sword fern community of Roemer (1973).

1.2 Douglas Fir Forest

Location: well-drained islands in Tsitika R. just south of estuary

Tree layer: Douglas fir-Sitka spruce-w. hemlock

Shrub layer: poorly developed. Contains red huckleberry

Herb layer: floristically similar to rich herb layer in Sitka Spruce forest. Additional species include twinflower, cut-leaved foamflower, and coral root.

Remarks: Douglas fir-w. hemlock-Sitka spruce-sword fern-moss community of Roemer (1973).

1.3 Red Alder Forest/Scrub

Location: on gravel bars and low islands along Tsitika River.

Tree layer: mostly young, shrubby red alder. Occasional mature alders.

Shrub layer: red alder

Herb layer (mature stand): includes nodding wood-reed, small-flowered wood-rush, broad-leaved starflower, enchanger's nightshade, boykinia, and w. fescue.

Moss layer: Atrichum selwynii and Sphagnum girgensohnii occur.

2. Primarily Valley Slope Types

2.1 Western Hemlock Forest

Location: valley floor behind estuary; slopes to the east

Tree layer: formed almost exclusively by w. hemlock

Shrub layer: oval-leaved blueberry, red huckleberry, false azalea, salal, and juvenile hemlock occur.

Herb layer: poorly developed. Deer fern, sword fern and single delight are constant species.

Moss layer: well developed. Mosses include Hylocomium splendens, Plagiothecium undulatum and Rhytidiadelphus loreus. Numerous liverworts present.

Remarks: w. hemlock-amabilis fir-(Alaskan blueberry)-moss community of Roemer (1973).

2.1a Western Hemlock Pygmy Forest variant

Location: dry rocky knoll east of estuary

Tree layer: stunted, relatively low, open stands

Shrub layer: includes Sitka alder

Herb layer: ?

Moss layer: rich assemblage includes Diplophyllum albicans, Scapania bolanderi, Claopodium bolanderi, Sphagnum girgensohnii and Dicranum fuscescens.

2.2 Amabilis Fir Forest

Location: replaces w. hemlock on gentle lower slopes, especially southwest of the estuary.

Tree layer: frequently contains w. hemlock as sub-dominant

Shrub layer: similar to w. hemlock forest

Herb layer: " " " " " . Fire-leaved bramble and cordilleran bunchberry are additional species.

Moss layer: similar to w. hemlock forest.

2.3 Lodgepole Pine Forest

Location: small rocky outcrops east of the estuary

Tree layer: stunted pine, w. redcedar and w. hemlock

Shrub layer: dense growth of salal and red huckleberry

Herb layer: poorly developed.

Moss layer: Hylocomium splendens, Rhytidiadelphus loreus, and Pleurozium schreberi occur.

[1] from Ceska (1981)

Appendix 9

Known and probable occurrence of mammals in the land component of the reserve.

Species[1]	Occurrence[2]	Probable abundance[3]			Evidence[4]
		Riparian/ aquatic hab.	Lowland forest	Mountain slopes	
1. Water shrew *Sorex palustris*	?	R			?
2. Dusky shrew *Sorex monticolus*	Res.		C	C/U	Range
3. Red squirrel *Tamiasciurus hudsonicus*	Res.		C	C	Sign
4. Beaver *Castor canadensis*	Res.?	U/R			Range
5. Deer mouse *Peromyscus maniculatus*	Res.		A	A	Range
6. Townsend vole *Microtus townsendii*	Res.?	R	R	R	Range
7. Muskrat *Ondatra zibethicus*	Res.?	U/R			Range
8. Wolf *Canis lupus*	Tr.		C/U	C/U	Range
9. Black bear *Ursus americanus*	Tr.	C	C	U	Sign/Sight
10. Raccoon *Procyon lotor*	Res.	C	U	R	Sign
11. Short-tailed weasel *Mustela erminea*	Res.?		R	R	Range
12. Mink *Mustela vison*	Res.	C	C	R	Sign/Sight
13. Marten *Martes americana*	Res.		U	U	Range
14. Wolverine *Gulo gulo*	Tr.?		R	R	?
15. River otter *Lutra canadensis*	Res./Tr.	C			Sight
16. Cougar *Felis concolor*	Tr.		U	U	Range
17. Roosevelt elk *Cervus elaphus*	Tr./Res.	C/U	C/U	U	Sign/Sight
18. Black-tailed deer *Odocoileus hemionus*	Tr./Res.		C/A	C	Sign/Sight

1 includes one introduced species, the muskrat. Marine mammals and bats excluded.

2 Tr = transient (home range significantly larger than the reserve)
Res. = resident (reserve should contain year-round populations)
? = unknown

3 A = abundant; C = common; U = uncommon; R = rare

4 Sign = animal sign such as tracks, faeces, shed antlers, feeding sign (file data)
Sight = sighting of animal within reserve boundaries (file data)
Range = reserve is within known distribution range and habitat is suitable therefore the species is assumed to occur
? = no definite evidence

Appendix 10

Fishes of the lower Tsitika River

Species	Use of Tsitika R. Within the Reserve	
	Adults	Juveniles
1. Coho salmon *Oncorhyneus kisutch*	- average of 2,000 adults pass through to spawn in upper reaches, mostly August, September and October.	- up to 800 counted in reserve in May. Important year-round rearing area. Smolts move through from upstream in April and May.
2. Pink salmon *O. gorbuscha*	- average spawning run 6,000; max. 30,000. Spawning entirely below Catherine Cr. Much spawning within reserve; July, August, and September. 5,200 adults counted in reserve in 1980.	- fry use river and estuary in reserve briefly after hatching in spring. Have departed by late April.
3. Chum salmon *O. keta*	- average escapement 1200. Spawning area mostly within the reserve, late fall.	- as for pink salmon.
4. Chinook salmon *O. tshawytscha*	- reported to occur. No quantitative information. Not seen by RBPC (1980) and run undoubtedly small.	- little information. Two fry captured in fish trap in reserve in 1980.
5. Sockeye salmon *O. nerka*	- as for chinook.	- no information (juveniles normally smolt in lakes).
6. Steelhead *Salmo gairdnen*	- estimate of 3,500 in 1950 probably erroneous. Summer run of 700-800 adults estimated in 1980's. Winter run present but size not known. Almost all spawning above the reserve.	- up to 2000 juveniles estimated in reserve in July. Juveniles in river 1-3 years. Reserve is important rearing area. Smolts from upstream move through in late May and June. Estuary is important temporary holding area for smolts in June.
7. Cutthroat trout *S. clarki*	- both anadromous and resident populations occur. Anadromous run apparently small, occurs in spring, with spawning mostly in lower river including the reserve.	- not readily separated from juv. steelhead during swim surveys. Small number caught in fish trap, 1980, and undoubtedly present.
8. Dolly varden *Salvelinus malma*	- both resident and anadromous populations occur. Up to 300 adults estimated in river below Catherine Creek in October. Anadromous adults hold in estuary in June and July, enter river August and September. Reserve area important for spawning.	- swim surveys and fish trap indicate juveniles common in reserve. Smolts migrate out of river about May. Reserve is important as rearing habitat.
9. Eulachon *Thaleichthys pacificus*	- run of unknown size, with peak in first half of May. Spawning entirely in lower 2 km of river (virtually entirely in reserve).	- young hatch soon after spawning and drift to sea.
10. Pacific lamprey *Entosphenus tridentatus*	- 4 caught in fish trap in reserve in May and June. May spawn above reserve. Adults marine except at spawning time.	- juveniles spend several years as larvae in gravel.
11. Prickly sculpin *Cottus asper*	- 8 caught in fish trap in reserve. Resident in brakish a[illegible]eshw[illegible]	- assumed to occur.

Appendix 10 - Continued

Species	Use of Tsitika R. Within the Reserve: Adults	Use of Tsitika R. Within the Reserve: Juveniles
12. Coast range sculpin *Cottus aleuticus*	- 6 caught in fish trap in reserve. Resident.	- assumed to occur.
13. Three-spined stickleback *Gasterosteus aculeatus*	- Observed within the reserve. Resident.	- assumed to occur.

Appendix 11

Escapement of salmonids, Tsitika River

Year	Coho*	Chum*	Pink*	S
1948	0	25	0	
1949	3,52 [illegible]00	7,500	7,500	
1950	7500 [illegible]	400	1,500	
1951	7500 [illegible]	1,500	7,500	
1952	7500 [illegible]	750	7,500	
1953	1,52 [illegible]500	1,500	7,500	
1954	3,52 [illegible]500	1,500	15,000	
1955	3,52 [illegible]500	1,500	7,500	
1956	3,52 [illegible]500	1,500	15,000	
1957	1,52 [illegible]500	0	30,000	
1958	3,52 [illegible]500	750	15,000	
1959	1,52 [illegible]500	750	7,500	
1960	750 [illegible]	0	200	
1961	1,5 [illegible]500	0	750	
1962	1,5 [illegible]500	0	200	
1963	1,5 [illegible]500	0	3,500	
1964	1,5 [illegible]500	200	400	
1965	3,5 [illegible]500	0	3,500	
1966	1,5 [illegible]500	75	74	
1967	no [illegible] records			
1968	0	0	750	
1969	0	0	200	
1970	0	0	25	
1971	0	0	7,500	
1972		400	750	
1973		300	4,000	
1974			5,000	
1975			2,000	
1976			4,000	
1977			200	
1978			800	
1979			100	
1980			600	
1981	no [illegible] records			
1982	no [illegible] records			
1983			80	
1984	no [illegible] records			
1985			25	
1986				
1987				

* Records from Fisher[illegible]eries and Oceans Canada. Lack of data on a species/date d imply that the run[illegible] failed, but rather that the observers were not present a correct time to re[illegible]ecord numbers. Very little work has been done in the fall winter when most [illegible]of these salmonids are entering the streams.

** Records from Mini[illegible]stry of Environment and Parks for the snorkel counts on st apply only to the [illegible] summer run race.

Appendix 12

Herbaceous plant communities of the intertidal zone in the Tsitika River estuary.[1]

Community name (Dominant(s))	Position in estuary	Area[2] (ha)	Major Sub-dominant plants	Biomass (g/m^2)
1. VASCULAR COMMUNITIES				
Dune wild rye grass	Forest fringe	0.05	- Amer. vetch	368 (1)*
Bering's hairgrass	Upper intertidal	3.50	- red fescue - meadow barley - Pacific silverweed	326-639 (8)
Sea plantain	Upper intertidal (gravel ridges)	0.07	- sea milkwort - Pacific silverweed - Bering's hairgrass - Lyngbye's sedge	266-389 (2)
Lyngbye's sedge	Mid-intertidal	0.75	- rockweed (Fucus distichus) - (red fescue)	134-843 (4)
2. ALGAL COMMUNITIES				
Fucus distichus	Mid to lower intertidal and dead water channels		- Enteromorpha intestinalis - Spongomorpha coalita	
Gigartina/Ulva	Shallow pools in lower intertidal		- Fucus distichus - Spongomorpha coalita	

1 information from Ceska (1981)

2 determined with dot grid on 1:2000 scale maps

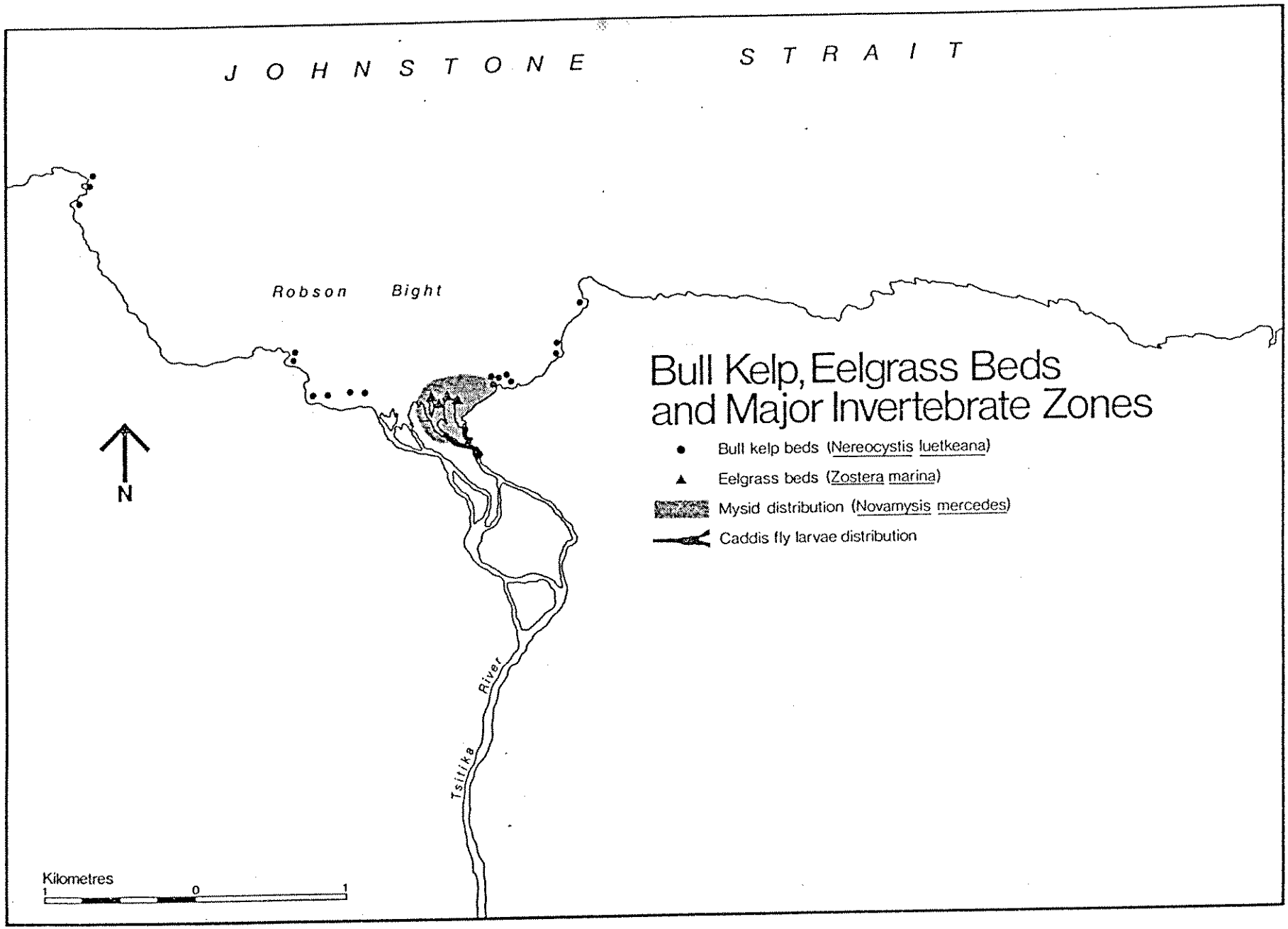
* number of plots clipped.

Appendix 13

ALGAL SPECIES WITHIN ROBSON BIGHT AND ESTUARY*

Latin Name	Habitat- Tidal Zone
Alaria marginata	Upper subtidal zone
Alaria nana	Upper subtidal zone
Cymathere triplicata	Lower subtidal zone intermixed with kelp
Enteromorpha intestinalis	Lower river channels, with Fucus
Fucus distichus	Estuary, intermixed with Carex, deadwater channels, lower intertidal zone
Gigartina spp.	Lower intertital zone
Hedophyllum sessile	Upper subtidal zone
Iridaea cordata	Upper subtidal zone
Laminaria saccharina	Lower subtidal zone intermixed with kelp
Nereocystis luetkeana (Bull Kelp)	Stands, particularly along eastern shore of bight, rocky habitat
Porphyra perforata	Upper subtidal zone
Rhodomela larix	Upper subtidal zone
Rhodymenia pertusa	Upper subtidal zone
Spongomorpha coalita	Dead water channels with Fucus
Ulva fenestrata	Lower intertidal, upper subtidal zones
Zostera marina (Eelgrass)	Lower subtidal zone (Bed)
Corraline Algae-encrusting and brachiated,, pink and white	Rocks

* Algal species identified by the Robson Bight Preservation Committee of the Top Island Econauts Society (Report, 1981) and by Ceska (1981).


J O H N S T O N E S T R A I T
Robson Bight
N
Tsitika River
Kilometres
1 0 1
Bull Kelp, Eelgrass Beds and Major Invertebrate Zones
Bull kelp beds (Nereocystis luetkeana)
Eelgrass beds (Zostera marina)
Mysid distribution (Novamysis mercedes)
Caddis fly larvae distribution

Appendix 15. - Invertebrate species recorded in Robson Bight (from RBPC 1981)

Species	Habitat
Arthropoda:	
Caddis fly, unid.	Lower river/upper estuary
Neomysis mercedis	River mouth/estuary
Balanus nubilus	High-current rock
Unid. barnacles	Low-current rock and kelp
Unid. shrimp	Cobble/boulder areas and sand and gravel
Cancer magister (dungeness crab)	Sand and gravel
Mollusca	
Haliotis kamschatkana (abalone)	High-current rock
Hinnites multirugosus (rock scallop)	High-current rock
"Orange peel nudibranch"	High-current rock
"Opalescent nudibranch"	High-current rock
Tonicella lineata (Lined chiton)	Low-current rock and boulders and kelp
"Snails"	Low-current rock
Panope generosa (geoducks)	Sand
"Squid"	Sand
Diadora aspera? (keyhole limpets)	Kelp
"Dog whelks" (*Nucella*?)	Kelp
Cnidaria	
Metridium senile (white-plumed anemone)	High-current rock
"Sea strawberry hydrocoral"	High-current rock and low-current rock
"Burrowing anemones"	Sand
"Sea anemones"	Kelp
Echinodermata	
"Starfish"	High-current rock and low current rock
Strongylocentrotus franciscanus (giant red sea urchin)	Low current rock and cobble/boulder and gravel and kelp
Parastichopus californicus (sea cucumber)	Sand and gravel and kelp
Pycnopodia helianthoides (sunflower star)	Kelp
Solaster dawsoni (morning sun star)	Kelp
Henricia leviuscula (blood star)	Kelp
Dermasterias imbricata (leather star)	Kelp
"Burrowing sea cucumbers" (*Cucumaria*?)	Sand and kelp
Annelida	
"tube worms"	Cobble/boulder and kelp

Appendix 16. - Fishes recorded in marine waters at Robson Bight (RBPC 1981)

Latin Name	Common Name
Oncorhyncus gorbuscha	Pink Salmon
Oncorhyncus keta	Chum Salmon
Oncorhyncus kisutch	Coho Salmon
Salmo gairdneri	Steelhead Trout
Salmo clarki clarki	Cutthroat Trout
Oncorhyncus nerka	Sockeye Salmon
Oncorhyncus tshawytscha	Chinook Salmon
Salvelinus malma	Dolly Varden Char
Thaleichthys pacificus	Eulachon
Cottus asper	Prickly Sculpin
Entosphenus tridentatus	Pacific Lamprey
Nautichtys oculofasciatus	Sailfin Sculpin
Pholis laeta	Crescent Gunnel
Pholis schultzi	Red Gunnel
Xererpes fucorum	Rockweed Gunnel
Sebastes flavidus	Yellowtail Rockfish
Sebastes melanops	Black Rockfish
Sebastes maliger	Quillback Rockfish
Ophiodon elongatus	Ling Cod
Hexagrammos decagrammus	Kelp Greenling
Coryphopterus nicholsi	Blackeye Goby
Sebastes nebulosus	China Rockfish
Oxylebius pictus	Painted Greenling
Platichthys stellatus	Starry Flounder
Clupea harengus pallasi	Pacific Herring

Appendix 17. - A chronological report on the history of Killer Whale (*Orcinus orca*) research in British Columbia, by I.B. MacAskie

Prior to 1959

Killer whales were taken by Norwegian whalers in the early 1930's (Jonsgard and Lyshoel 1970) and by the Japanese in the late 1940's (Nishiwako and Handa 1958).

There was no such fishery in British Columbia, and though frequently seen in coastal waters, knowledge of killer whales remained virtually limited to the strandings of 11 animals at Masset, Q.C.I. in 1941 and 20 at Estevan Point, Vancouver Island in 1945 (Pike and MacAskie 1969).

Observations made in Puget Sound, Washington State in the 1930's and 1940's showed the animal as gregarious, seen in all seasons and congregating, especially in summer, at the mouth of the Fraser River, British Columbia (Scheffer and Slipp 1948).

1959

To obtain information on all species of marine mammals to be found off the Canadian west coast, the Marine Mammal Group of the Fisheries Research Board of Canada issued long books to Fisheries patrol vessels, lighthouses, whaling vessels out of Coal Harbour and weather ships at Swiftsure and Station Papa.

During the period 1959-1964, more than 5,000 killer whale sightings were recorded. Covering every month of the year, the figures did not reveal any orderly pattern of migration, but they suggested a resident population travelling in groups of from 1-100. Information on their breeding, gestation, birth and mortality remained scarce and their usual diet in B.C. was unknown. There was circumstantial evidence that salmon were being taken and evidence of attacks on Northern sea lions, Harbour seals, Gray and Fin whales (Pike and MacAskie 1969). Such accounts gave rise to the commonly held perception of a dangerous predator best avoided.

1960

As a result of complaints that killer whales were adversely affecting commercial spring salmon catches and intimidating tourist sport-fishermen in the area of Campbell River, Vancouver Island, a meeting was held by the Department of Fisheries, the local Chamber of Commerce, the Pacific Biological Station and the local Fish and Game Club. While it was evident that there was little information on the distribution and habits of the killer whale it was thought that their numbers were high

and increasing and that control measures should be taken. These included the use of a machine gun, depth charges, fragmentation bombs, dynamite and mortars (Department of Fisheries 1960).

A machine gun was later mounted overlooking Seymour Narrows. Though never used its placement indicated the prevailing attitude. Many commercial fishermen habitually used rifle fire on passing killer whales, sea lions, seals, or eagles judged to be in competition for fish.

1964

The Vancouver Aquarium harpooned a young male killer whale off Saturna Island with intention of obtaining accurate body measurements for a display replica. The animal unexpectedly survived the harpoon strike and was taken to a holding pen in Vancouver. It showed a complete and surprising lack of agressive behavior and eventually took food fish offered by hand (Newman and McGeer 1966).

As the only killer whale in captivity it was of considerable interest to biologists and provided them with the first close-up view of a living specimen.

Recordings made of the animal's underwater sounds were the first to be analysed in detail and provided evidence that killer whales could echo-locate (Ford 1986).

Death occurred after 86 days and an autopsy attributed the cause to internal mycotic infections (Newman and McGeer 1966).

1965

The entertainment possibilities were not ignored following the Vancouver experience and the accidental entanglement of a large male in a fisherman's net at Namu, B.C. resulted in its transfer to Seattle where it responded cooperatively and attracted much public interest. A second animal, a female, was caught and held in the same facility and both became the subject of underwater recordings. The sounds of the two were quite different and it was thought at the time to be related to sex (Ford 1986).

The Seattle Aquarium developed a netting technique to capture more whales and began a profitable new industry in Puget Sound from sales to world oceanaria.

1968

Canadian entrepreneurs began netting killer whales commercially in British Columbia. During 1962-1973, U.S. and Canadian operations removed 62 animals from

Puget Sound and southeast Vancouver Island, of which 12 drowned in the process. The peak harvest years were between 1967 and 1970 (Bigg and Wolman 1975). No animals have been taken in British Columbia since 1975.

1970-1988

Acoustic and behavioral studies on wild killer whales began from a field station on Hanson Island, Johnstone Strait, June 16-September 20, 1970 (Spong *et al.* 1970).

1970

Growing public opposition to the harassment and exploitation of whales in both the U.S. and Canada, and a concern for the stock resulted in Federal authority being given to the Marine Mammal Group at the Pacific Biological Station, Nanaimo, to carry out a population study. Though generally assumed that killer whales were abundant, no scientific data were available and therefore no meaningful management of the resource possible.

1971

The first census by the Marine Mammal Group involved sending 15,000 questionnaires to light-stations, ferries, boats, fishermen and individuals whose houses overlooked the water along the British Columbia coast. It was requested that information on the number of killer whales seen, their location, the time of day and direction of travel be recorded on one day only, 27 July, 1971. Subsequent analysis of returned forms suggested a population of 200-350 animals with a concentration in Johnstone Strait.

1972

A second census was made over a 3 day period, 1-3 August, 1972, with similar results. A vessel was chartered August-September to verify the reported numbers in Johnstone Strait and to observe their behavior. Many whales were encountered and incidentally photographed, including one with a severely injured dorsal fin that later became significant.

1973

Questionnaires were issued for a third census on 1-2 August and the estimated total for B.C. remained between 200-350 whales. The consistency of the three annual

counts indicated a far smaller population than had been supposed and was remarkably close to being accurate. By 1987, it was established as 330 (Bigg *et al.* 1987).

A photograph of the mutilated dorsal fin taken in 1972 led to the detailed examination of other fins and the revelation that most showed some degree of injury. It was realized that if these marks were long lasting (as in fact they are), they could be used for individual identification.

A return was made to Johnstone Strait 1-31 August, 1973, where an intensive study quickly confirmed that several animals were indeed familiar. Variations in the pigmentation of the "saddle" patch also promised to provide more known whales and the determination of abundance, movement and population dynamics could begin (Bigg *et al.* 1983).

The "rubbing" beach was discovered east of Robson Bight in Johnstone Strait, 17 August, 1973. Whales were seen to visit the beach regularly, either to rest or to rub upon the small, smooth pebbles in shallow water. This area, comprising two closely adjacent beaches, was to become the focus of concern in succeeding years.

1974

Field operations were expanded to include eastern and southern Vancouver Island by placing boats in seven strategic areas between Johnstone Strait and Victoria, 1-10 August, 1974, to intercept and photograph all whales encountered (Bigg 1982). It appeared probable that the population consisted of discrete groups, termed pods, many of whose members could now be assigned a letter and number.

For the benefit of historical background, perhaps it should be mentioned that running parallel with scientific studies, there were those in the mid-1970's who felt that communication between man and whale was not only desirable but possible. This was to be achieved by telepathy or music, and many a promontory along the shores of Johnstone Strait became a stage for drums and guitars. No results have been published, but the activity represented a marked change of attitude towards killer whales since 1960.

1975

Year round interceptions began and field work extended from Johnstone Strait to Bella Bella, 1-31 August, 1975. From a file of many thousands of photographs taken from repeated encounters, questions of social structure were becoming better understood. The whales were travelling in highly stable family pods and no permanent exchange of individuals was observed.

It was also becoming clear that the pods were members of two separate communities with a dividing line in northern Georgia Strait. The range of the southern community encompassed Juan de Fuca Strait, Puget Sound and Georgia Strait, while the range of the northern community extended north from Campbell River. Pods within these two communities were judged as northern or southern "residents" as opposed to a third community classified as "transients" that differ in several respects. These travel throughout the coastal waters from Washington State to southeast Alaska, and are seldom encountered. While residents feed on fish, transients seem to seek out mammals as their main prey and are probably a separate race of killer whale (Bigg et al. 1987).

The government of B.C. in 1975 legislated a change in its Wildlife Act which required netters to apply for permission to capture killer whales. The intent of the legislation was to place a moratorium on capturing until the population status was determined (Bigg et al. 1976).

1976

The Marine Mammal Group continued to monitor with boat and camera to register births and deaths within each pod.

The U.S. prohibited the capture of whales in Puget Sound and began a programme photo-identification similar to Canadian practice. The results confirmed that the southern residents included Puget Sound in their territory and no new pods were found.

1977-1987

The development of photo-identification opened a window on the study of a unique population of wild whales. As the result of 17 years of data collection and analysis, the Marine Mammal Group has compiled information on total numbers, social organization movement patterns, birth and death rates, feeding habits, breeding cycle and the impact of early captures on productivity (Bigg et al. 1987).

1978-1988

Intensive studies began in 1978 (Ford and Fisher 1982) on killer whale acoustics in Johnstone Strait and southern Vancouver Island. These have since established that there are not only differences in the highly vocal sounds made by northern and southern residents, but between pods within those communities. Transients, far

quieter and seldom seen, provide less data. What the functional significance of killer whale dialects may be is yet to be resolved through ongoing research (Ford 1986).

1982

In 1982, the B.C. Ministry of Environment established the Robson Bight Ecological Reserve #111, which included the rubbing beaches within its boundaries. This area has been recognized as a rendezvous of peculiar importance to northern residents for daily periods of rubbing or of resting during the summer months. Though it represents only a small part of the total range, there is no known site of comparable attraction for killer whales on the B.C. coast.

1982-1984

Respiration of northern resident killer whales was studied in Johnstone Strait in an attempt to describe foraging, travelling, rest and play behaviors by measuring respiratory activity. The study continues (Jacobsen 1985).

1983

To try to assess the effects of boat traffic, a study of interactions between boats and whales was made in the Robson Bight area of Johnstone Strait, 20 July-1 September, 1983. A theodolite tracking technique from a commanding shore station allowed precise measurements of distance and speed of movement.

Killer whales showed a clear response to the close approach of boats by swimming faster than when undisturbed. This response did not diminish over the course of the study (Kruse 1984).

1984

To study the effects of specific types of boat traffic on killer whales, boats in the Robson Bight-Johnstone Strait area from 11 July-1 September, 1984 were classified by type of vessel and frequency of occurrence throughout the study. The associated reaction of killer whales, such as respiration, swimming speed, breaching, fluke and pectoral slapping were recorded (Briggs 1985).

1984-1988

An ongoing study is being made to quantify behavioral differences between northern residents and transient killer whales in Johnstone Strait, Queen Charlotte

Strait and adjacent waters. Year round data have been collected on 55 resident and 39 transient encounters that include comparisons of social dynamics, acoustics, prey selection, seasonality of occurrence and travel patterns (Morton 1988).

Information on transients is difficult to acquire. A population of 80 animals with a long range makes research essentially opportunistic and time consuming.

1985-1987

Acoustic studies were made in Johnstone Strait to determine matrilineal realationships of adult killer whales, the mating system in the population, the structure of vocalization of individuals and to examine the evolution of the vocal behavior of northern residents. The study continues (Bain 1985).

1985

The daily incidence of killer whales in the Johnstone Strait region has been recorded for the summer of 1985 (Symonds *et al.* 1985).

1986

A study was made in the Robson Bight-Johnstone Strait area, 2 July-27 August, 1986, to determine how to minimize whale disturbance by whale-watching boats. The types of boats involved, their use for research or pleasure, and the boats behaviour during encounters were recorded in conjunction with a variety of whale responses (Duffus and Dearden 1987).

An impact study in Johnstone Strait, 1986, found that killer whales face increasing human activities within their core summer feeding and rest areas that include the Robson Bight Ecological Reserve. "There is concern that human disturbance will interfere with the critical natural behaviour patterns of the animal" (Darling 1986).

1987

To record the response of killer whales to boats in the vicinity of the rubbing beaches, daily observations were made from a hidden site, 26 June-22 August, 1987. The beaches were visited regularly by whales who spend considerable time resting or rubbing unless interrupted. They appeared especially sensitive to the near approach of any kind of boat or kayak and usually left the beach as a consequence (Briggs 1988).

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Appendix 18

Mean and maximum numbers of boats seen per half-hour count in Johnstone Strait, 1984 and 1985[1]

Boat type	1984		1985	
	$\bar{x}$	max	$\bar{x}$	max
1. Commercial Fishing	23.6	141	23.0	137
2. Recreational				
- kayak/canoe	0.3	13	0.5	17
- sail boats	0.1	3	0.2	4
- power boats	1.0	11	0.9	8
- whale-watching charters	0.1	1	0.2	4
Sub-total	1.5		1.8	
3. Through transport*	0.1	3	0.1	4
4. Research	0.2	2	0.2	3
5. Miscellaneous	0.5		0.8	
TOTAL	25.9	141	25.9	143

1 data from Briggs (1987). Counts made at half-hourly intervals during daylight hours.

* Tugs with or without tows; freighters; cruise liners.

Appendix 19. - Companies and organizations currently advertising whale-watching cruises in the Johnstone Strait area.

STUBBS ISLAND CHARTERS
Telegraph Cove, B.C. V0N 3J0
Phone: 928-3185/928-3117

SEASMOKE SAILING CHARTERS AND TOURS
Box 483
Alert Bay, B.C. VON 1A0
Phone: 974-5225/5974

BASTION CITY CHARTERS LTD.
R.R. #1, Site X-3
Nanaimo, B.C. V9R 5K1
Phone: 753-2852/748-2723

CLAVELLA ADVENTURE
Box 866
Nanaimo, B.C. V9R 5N2
Phone: 753-3751

VIKING CHARTERS
Box 1557
Port McNeill, B.C. VON 2R0
Phone: 956-3739

THE SEA CLOUD CHARTERS
Box 1239
Port McNeill, B.C. VON 2R0
Phone: 956-3739

BLACKFISH EXPEDITIONS
1608 Quadra Street
Victoria, B.C. V8W 2L4
Phone: 381-6455

SWIFTSURE TOURS
119 - 645 Fort Street
Victoria, B.C. V8W 1G2
Phone: 388-4227

ECOSUMMER CANADA EXPEDITIONS
1516 Duranleau Street
Granville Island
Vancouver, B.C. V6H 3S4
Phone: 669-7741

PACIFIC SYNERGIES
Box 86773
North Vancouver, B.C. V7L 4L3
Phone: 929-5373

BLUEWATER ADVERTURES (sailboat trips)
1812 Maritime Mews
Vancouver, B.C. V6H 3X2
Phone: 689-7238

UNIVERSITY OF B.C.
(Centre for Continuing Ed.)
5997 Iona Drive
Vancouver, B.C. V6T 2A4
Phone: 222-5207/5244

VANCOUVER COMMUNITY COLLEGE
(Continuing Education Division)
Vancouver, B.C.
Phone: 875-8200

FIESTA WAYFARER HOLIDAYS
235 Yorkland Blvd.
Willowdale, Ontario M2J 4Y8
Phone: (416) 498-5566

NORTHERN LIGHTS EXPEDITIONS (kayaking trips)
5220 NE 180th St.
Seattle, Washington 98155
Phone: (206) 362-4506