BACKGROUND REPORT

CHECLESET BAY ECOLOGICAL RESERVE
(E.R. 109)

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SUMMARY

1.0 INTRODUCTION

Ecological Reserves protect representative ecosystems or special features for research and education. Checleset Bay (E.R. 109) was established in 1981 largely to protect sea otters and their habitat. This Background Report compiles available information for management planning purposes.

2.0 RESERVE DESCRIPTION

Location, Size and Access

This large marine reserve, 34,650 ha in area and 30 km across, is on the west coast of Vancouver Island between Brooks Peninsula and Kyuquot. Access is only possible by boat or aircraft.

Physical Features

Ninety-eight percent of the reserve is marine; the remainder consists of over 40 small islands. Forty km of Vancouver Island shoreline, predominantly rocky with a few small sandy beaches, is included. The largest islands (Bunsby Group) have rocky, indented shorelines and a few sheltered bays or lagoons. Low cliffs, sea stacks, and caves are fairly common shoreline features. Small islands and reefs extend offshore for 6 to 8 km. The sand and gravel seafloor between those islands and seaward from them is relatively smooth and slopes gently to the west. Water depths inshore from the outer reefs are generally under 55 m, increase to 90 m at the edge of the Continental Shelf, then plunge to 450 m on the Continental Slope in the southwest corner of the reserve.

Biotic Features

The larger islands support forest stands dominated by Sitka spruce, western hemlock and western redcedar. Three species of rare vascular plants are present. Seabirds totalling over 1,700 pairs - primarily Storm-petrels, Cormorants and Gulls - nest at 3 locations. Two Red-listed and 17 Blue-listed birds have been recorded. Several species of terrestrial mammals occur on the Bunsby Islands.

Diverse marine habitats are present. Kelp stands are extensive around reefs and 49 species of macro-algae have been reported. Eighty-eight species of marine invertebrates have been documented, many of which are important sea otter foods. Many show adaptations to heavy surf. Regularly occurring marine mammals include gray and killer whales, northern sea lions, harbour seals and sea otters. Up to 600 sea lions use two islets in the reserve as year-round haulouts.

Eighty-nine sea otters were introduced to Checleset Bay from 1969 - 1972. They have increased, colonized all suitable habitat in the reserve, and spread south to Nootka Sound and north to

Brooks Bay. The present British Columbia population is estimated to be about 600, of which 250 to 350 regularly occur in Checleset Bay. The sea otters have caused dramatic changes in the community structure of reef habitats. Their predation on grazers such as sea urchins has resulted in much greater abundance of kelp.

Cultural Features

Virtually the entire reserve was once used by native people. At least 10 documented archaeological sites are present, including habitation, burial and fishing sites. Two Indian Reserves are inside E.R. 109.

3.0 LAND USE AND OTHER ACTIVITIES

The reserve is in a remote, sparsely populated area where commercial fishing and logging are the major economic activities.

Within-reserve uses include research on the abundance, distribution, and ecological effects of sea otters; recreational kayaking; and commercial, sport, and sustenance fishing. Levels of use are currently low, but recreational activity appears to be increasing. Most fishing in the reserve is for finfish. Harvest of several species of shellfish important for sea otters (clams, sea urchins, abalone) is prohibited, however potential or actual fisheries for other species (mussels, sea cucumber, goose barnacle, crab, octopus, scallop) are present.

4.0 RESERVE MANAGEMENT

Identified management issues include:

1. Increasing recreational use (potential disturbance of wildlife and of archaeological sites).
2. Commercial fishing (removal of sea otter foods; reduced research potential).
3. Logging adjacent land (siltation effects on sea otters; loss of avian nest sites).
4. Oil spills (sea otter mortality).
5. Reserve use by native people (removal of sea otter foods; reduced research potential).

Current management practices are as follows:

1. Regulation of research/educational use through permits.
2. Cooperative control of shellfish harvests.
3. Dissemination of information.
4. Monitoring of sea otter populations.

5.0 KEY RESOURCE AND MANAGEMENT ISSUES

Key resources are sea otters and their habitat. Seabird colonies, sea lion haulouts, and archaeological sites are also important.

The following are felt to be key management issues:

1. Boundaries

- no metes-and-bounds description available
- not shown on marine charts or topographic maps; no signing
- may not include winter shelter habitat of sea otters.

2. Resource Protection

- lack of provincial control over marine resources; conflicting mandates of B.C. Parks and D.F.O.
- non-protected species might be important sea otter foods, and their commercial and/or sustenance use may increase
- sea otters could be adversely affected by increased recreational use, logging on adjacent lands, or oil spills.

3. Research and Education

- marine resource harvesting could reduce opportunities for research on natural ecosystems
- increasing recreational use could conflict with research and educational programs.

4. Wardenship

- large size and remote location make patrol and surveillance difficult.

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1.0 INTRODUCTION

The objective of B.C. Parks Ecological Reserves Program is to preserve representative ecosystems and unique or special biological and geological features for research and educational purposes. In contrast to Provincial Parks, recreational use is not an objective (British Columbia, 1971; 1975).

Checleset Bay Ecological Reserve (E.R. No. 109), a large (34,650 ha), remote, marine reserve on the West Coast of Vancouver Island, was established in 1981 to protect an introduced population of sea otters (*Enhydra lutris*) and their habitat. It also encloses important seabird colonies, sea lion haulouts, and a variety of marine ecosystems representative of the outer coast. The reserve is used for research and education on sea otters and their habitat, but is also subject to some recreational use and to commercial fishing, largely for finfish. Management activities primarily involve control of research/education uses by permit, sea otter inventory, control of shellfish harvests, and surveillance by volunteer wardens.

The purpose of this Background Report is to compile all available information about the reserve and surrounding lands or waters as a basis for management planning. It includes a description of the reserve, documentation of activities taking place in or around it, and discussion of past or present management practices. Key resources and management issues are identified for consideration in a Management Plan.

Acknowledgements

A number of people and agencies provided information or comments which aided in the preparation of this report. A list of people contacted in included (Appendix 1).

2.0 RESERVE DESCRIPTION

2.1 Location and Access

Checleset Bay Ecological Reserve is located on the northwest coast of Vancouver Island, between the Brooks Peninsula and the village of Kyuquot (Figure 1). It is not accessible by road. Float plane access is possible from charter bases at Gold River (100 km SE of the reserve), Port McNeill (65 km NE) or Port Hardy (70 km N). Weekly motor vessel transport is available from Gold River to Kyuquot, which is 4 km from the east boundary of the reserve. From Kyuquot, kayak or small boat access into the reserve is possible in good weather. Trailered boats may be launched at Fair Harbour, the nearest road terminus to the reserve. Most of the 25 km distance from Fair Harbour to the east edge of the reserve is relatively sheltered.

2.2 Size and Boundaries

The reserve is 34,650 ha in size. Forty-eight islands that are identifiable at 1:36,493 scale (Marine Chart 3683) comprise about 400 ha, or 1.1% the reserve. The remaining area is intertidal and subtidal. The boundary is shown on Figure 2, however a metes-and-bounds description is apparently not available. Two Indian Reserves, Checkaklis Island in the Bunsby Group and Hub-toul Island 1.3 km northeast of Cuttle Island, are within the reserve but excluded from it.

2.3 History

Following a survey of potential sea otter introduction sites on the west coast of Vancouver Island in 1967 (Kenyon 1967) the Bunsby Islands were chosen as a release site, and a formal proposal for the release was prepared (MacAskie and Blood, 1968). Sea otters from Amchitka Island, Alaska, became available in 1969 and the first introduction was made in July of that year. Additional animals were released at the same site in 1970 and 1972. A proposal to establish an Ecological Reserve at Checleset Bay was submitted by I. MacAskie, J.B. Foster and J. Pojar in 1977 (Krajina *et al.* 1978). On December 10, 1981, the reserve in its present form was proclaimed by passage of Order-in-Council No. 2566. This Order-in-Council also deleted the terrestrial part of the reserve from the Kyuquot Provincial Forest. An Order-in-Council of March 11, 1982, reserved the area from any disposition under the Land Act.

2.4 Environment

2.4.1 Climate

The reserve is within the Southern Hypermaritime climatic zone of Klinka *et al.* (1984), and is typically wet, mild and windy. Climatic data for Spring Island, located 1.5 km from

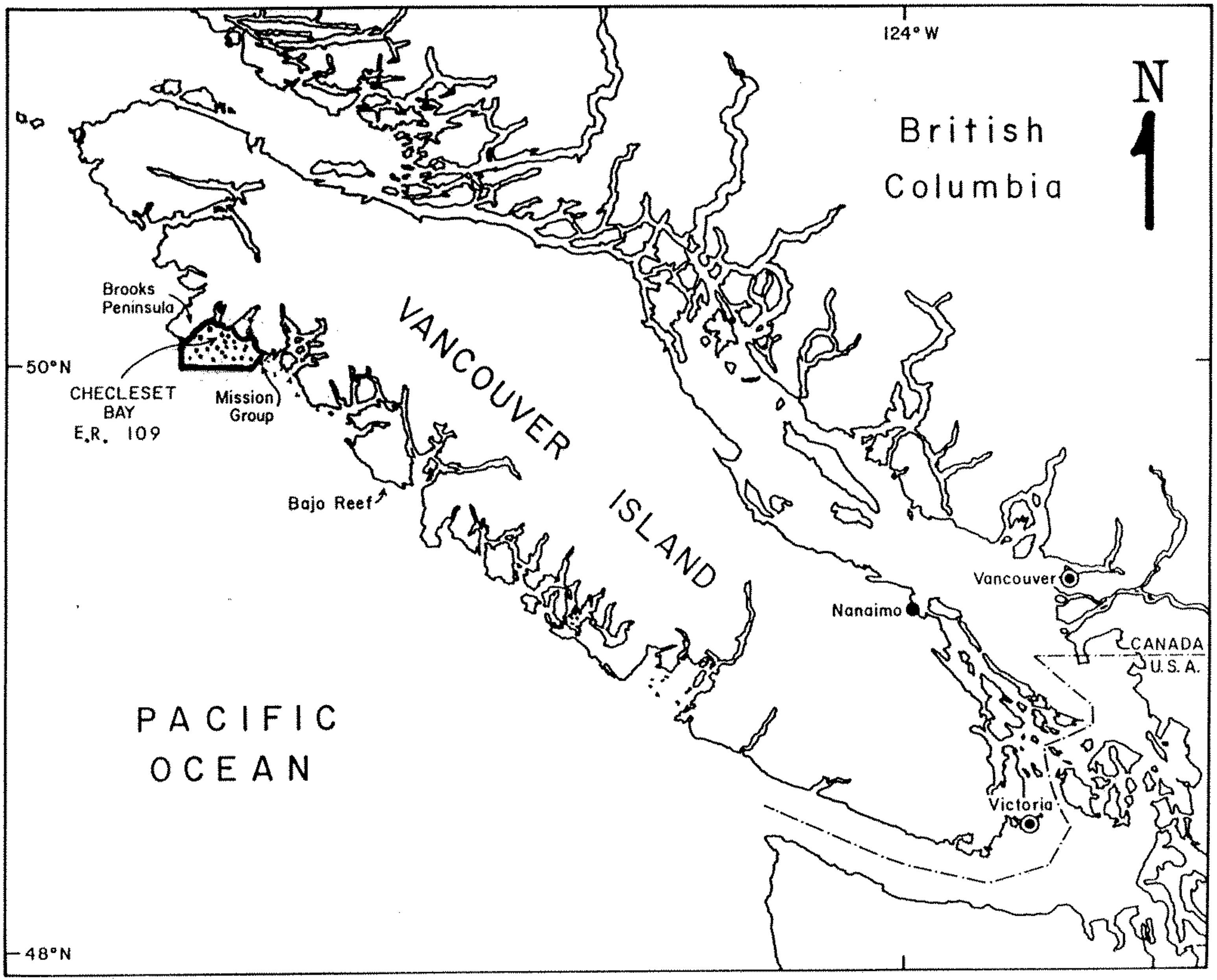

Figure 1. - Location of Checleset Bay Ecological Reserve.

the reserve boundary, are given in Table 1. August is the warmest month; December the coldest. Precipitation is very high from October to March. Total annual precipitation, almost all of which falls as rain, is about 315 cm. The freeze-free period should be similar to Tofino, about 213 days (Chilton 1981).

Climatic data for Tofino show that August is the peak month for fog, with an average of 15 days. The foggy period there lasts from about June to October and corresponds to the time of prevailing northwest winds. Fog forms when the warm, moist air carried by these winds contacts the colder coastal water (Thomson 1981). These conditions also apply to Checleset Bay. From October to March, when cyclonic winds are most prevalent over the open ocean, prevailing winds are from the southeast. In summer, the predominantly anticyclonic oceanic winds are from the west and northwest. Maximum winds of 115 km/hr have been recorded at Spring Island.

2.4.2 Physical Setting

Geology

Bedrock geology of lands surrounding the reserve has been described by Muller *et al.* (1974) and reviewed by Howes (1981). Rocks of volcanic and intrusive origin and Triassic or Jurassic age predominate in the region. The distribution of major bedrock types is shown in Appendix 2. Bedrock geology of the Bunsby Islands has not been specifically studied.

The offshore area is at the northern end of the Tofino Basin where thick (4,000 m) sections of sediments of late Tertiary age have been identified by seismic profiling (Procter *et al.* 1983). The sediments unconformably overlie early Tertiary and Mesozoic deformed volcanic, plutonic and sedimentary rocks. The sediment layer thickens seaward toward the base of the Continental Slope and include mainly marine, poorly consolidated, calcareous mudstones and minor siltstones of Miocene to Pliocene age.

Landform and Glaciation

The reserve is adjacent to the Fiord-land Subunit of the Vancouver Island Ranges, and at the northwestern extremity of the Estevan Coastal Plain (Holland 1964; Howes 1981). The Coastal Plain is largely under 50 m above sea level, but contains knolls up to 100 m, and extends seaward to include the shallow waters of the Continental Shelf. Therefore, most of the reserve is within this physiographic unit.

This large reserve, about 30 km in east-west extent, consists mostly of marine waters and seabed of the Continental Shelf. The farthest point seaward from Vancouver Island is about 12.4 km. Forty-eight identifiable islands are present,

Table 1. Climatic Information for Spring Island, 1949 - 1979[1].

Month	Mean High Temp.°C	Mean Low Temp.°C	Mean Monthly Temp°C	Mean Monthly Precip. (mm)
January	6.9	2.2	4.6	373
February	8.0	3.0	5.5	316
March	8.3	2.6	5.5	303
April	10.2	4.1	7.2	222
May	12.8	6.6	9.7	138
June	14.9	9.1	12.0	128
July	16.9	10.8	13.9	97
August	17.1	11.3	14.3	122
September	16.3	10.1	13.2	215
October	12.9	7.5	10.2	405
November	9.6	4.7	7.2	405
December	7.9	5.5	3.2	432

Extreme High Temp. = 34.4 C
Extreme Low Temp. = -11.1 C

Annual Precip. = 3,155 mm

[1] 50'0"N 127'25"W at 11 m elevation. Information from Atmospheric Environment Service, Environment Canada, Vancouver.

plus numerous rocky reefs. The islands vary in size from <1 ha to 224 ha (West Bunsby), but in total comprise only 1.1% of the reserve area. The largest islands (the Bunsby Group) are near the Vancouver Island Shoreline; small islands and reefs occur as far as 9 km offshore. An outer tier of islands and reefs, the Barrier Group, extends in a relatively straight line from Quineex Reef at Brooks Peninsula to Lookout Island at the southeast corner of the reserve. The Bunsby Islands have irregular, indented, rocky shorelines, and rolling uplands with a maximum elevation of 80 m.

The marine part of the reserve consists of intertidal habitats along about 40 km of Vancouver Island shoreline and around the offshore islands and reefs, a large subtidal area on the Continental Shelf, and a small segment of Continental Slope. Most of the Vancouver Island shoreline is a rocky, high-energy environment, however a few small estuaries and pocket beaches are present. Low cliffs, sea stacks, arches, and caves are fairly common coastal features.

Between the islands and reefs the Continental Shelf seafloor is quite flat, with a gentle slope to the southwest. Inshore from the outermost reefs the water depth is mostly under 60 m, except for glacial deepening to about 100 m at the mouth of Ououkinsh Inlet. Seaward from the outermost reefs the ocean floor drops gradually to 90 m and then plunges to 450 m on the Continental Slope at the southwest corner of the reserve.

Most uplands bordering the reserve are believed to have been glaciated during the final phase (Fraser Glaciation) of the Pleistocene (Clague 1981). However, unglaciated refugia are believed to have occurred on the Brooks Peninsula and on other mountains in the area (Ogilvie and Ceska, 1984). Ice tongues undoubtedly moved southwestward along inlets such as Nasparti and Quoukinsh, over-deepening these troughs in relation to the adjacent Continental Shelf. It is doubtful that the entire shelf area in the reserve was ice covered during the Fraser Glaciation, and likely that some of it was subaerially exposed because sea levels were 100 m lower at the glacial maximum. Isostatic depression of 25 to 45 m occurred in ice-covered areas, particularly at the heads of inlets, but this probably did not occur over the entire shelf.

<u>Surficial Deposits and Soils</u>

Based on mapping in Howes (1981), surficial materials on the Bunsby Islands and much of adjacent Vancouver Island consist of colluvium. This colluvium is derived from bedrock by frost shattering and other weathering processes. Although most commonly found on mountain slopes, Howes (*op. cit.*) notes that bedrock-derived colluvial mantles occur on "hummocky, bedrock controlled topography on the Estevan Coastal Plain." Although not specifically examined in the Bunsby Islands, upland soils on forested sites are expected to be Ferro-Humic

Podzols (Valentine *et al*. 1978).

Based on surveys on the Continental Shelf to the north and south of Checleset Bay (Luternauer and Murray, 1983; Carter 1973), seafloor materials in the reserve are expected to be predominantly sands and gravels, with some sand and mud in troughs. This blanket is punctuated by bedrock reefs and small islands in the northeastern half of the reserve. Shorelines consist largely of exposed bedrock, boulder and cobble, however small pockets of sandy or muddy beach occur.

Oceanography

From Barkley Sound to Cape Scott, tidal fluctuations occur almost simultaneously and have a mean range of about 3 m. Tidal ranges are slightly greater in June and December and smaller in March and September. Tides here are classified as mixed (both diurnal and semidiurnal frequency), but are predominantly semidiurnal. The range of tides changes progressively each day over a cyclic period of about 2 weeks (Thomson 1981).

Currents over the Continental Shelf are a result of tides and wind. Flood streams are northerly; ebb streams southerly. Maximum flood occurs within a few hours of high water at the coast and maximum ebb within a few hours of low water. Both attain maximum speeds of around 50 cm/s (1 km) during spring tides. The strongest tidal streams likely to be encountered on the west coast occur near points of land such as Brooks Peninsula and around offshore islands. Despite largely semidiurnal tides in this area, nearshore tidal currents tend to be mostly diurnal in periodicity (Thomson 1981).

Surface salinity in offshore waters is about $32^{o}/_{oo}$ (grams of salt per 1,000 g seawater), but nearshore salinity may drop to $29.5^{o}/_{oo}$ at times of high freshwater discharge. Surface temperatures average about 8°C in winter; maximum summer temperatures are about 18°C but may reach 20°C in a thin top layer. There is little seasonal variation in temperature at depths below 200 m, which are about 7°C in this area (Thomson 1981).

2.4.3 Terrestrial Flora and Fauna

Vegetation

The Bunsby Islands are within the very wet hypermaritime subzone of the Coastal Western Hemlock Biogeoclimatic Zone (CWHvh). This is the wettest forest subzone in British Columbia. The mean percent cover for zonal vegetation is given in Figure 20 of Pojar *et al*. 1991. This subzone was previously mapped and described as CWHd1 (Nuszdorfer *et al*. 1985; Klinka *et al*. 1984).

All islands in the reserve that are forested support old-growth. Forest cover maps indicate that Sitka spruce is the leading species on 18% of the area of the Bunsby Islands, western hemlock on 21%, and western redcedar on 60% (Appendix 3). Age classes vary from 7 (121 - 140 years) to 9 (251 + years), but age class 9 is most common. Height classes vary from 3 (19.5 - 28.4 m) to 6 (46.5 - 55.4 m), with Class 5 (37.5 - 46.4 m) being most common. Site (productivity) classes vary from poor to good, with medium being the most frequent rating.

A list of 91 vascular plants that have been recorded in the reserve is given in Appendix 4. This is based on Carl and Guiguet (1956) and subsequent reconnaissance by Ecological Reserves Programme staff. The list includes records for East Bunsby Island, which is outside the reserve. Rare plants include the following:

Lasthenia maritima (Hairy goldfields)	R2
Stachys mexicana (Mexican hedge-nettle)	R3
~~*Rhamnus alnifolius* (Alder-leaved buckthorn)~~	~~R4~~

not on W. Coast; must be based on mistake JR.

Quantitative studies of plant community structure have not been done. However, IBP forms for E.R. 109 list two communities, as follows:

1. *Picea sitchensis - Tsuga heterophylla - Rubus spectabilis - Polystichum munitum.*

2. *Picea sitchensis - Gaultheria shallon - Maianthemum dilatatum - Eurhynchium - Isothecium.*

This appears to be an incomplete list because forest cover maps indicate that western redcedar is the leading tree species on most islands.

<u>Birds</u> (including seabirds)

Written records of the avifauna of Checleset Bay include the following main sources:

1. Campbell and Summers (in press). This annotated list of 120 marine and terrestrial birds of Brooks Peninsula is based on a RBCM expedition in August 1981, and review of vertebrate observations made by 69 previous people since 1934. An important source was the migration watches made at Clerke Point by K.R. Summers and his co-workers from May 14 to June 27, 1973. All marine birds seen there would have been in the reserve.

2. Carson and Foster (1978 a). This is a typewritten, partially annotated list of 36 marine and terrestrial species seen in the reserve from June 13 to 16 and July 22 to 26, 1978.

3. Carl and Guiguet (1956). A non-annotated list of 36 species, primarily forest and shoreline birds, seen in the Bunsby Islands in August of 1955.

4. Campbell (1976) and RBCM Seabird Files. This includes a map and tabulation of Vancouver Island and adjacent seabird colonies (published by Friends of the Provincial Museum) and seabird survey record forms (Ecological Reserves Program files, Victoria). Some land birds were also recorded during the seabird surveys. Most surveys were in June or July. Data are available only for 1975 and 1978.

A list of birds known or expected to occur in the reserve (Appendix 5) was based on those sources. It includes 106 species, but is probably incomplete. Appendix 5 relies heavily on Campbell and Summers (in press), however some judgement had to be used in determining whether species on their list were actually seen in the reserve (Clerke Point - Quineex Reef - Jacobsen Point area) or in other parts of the Brooks Peninsula. Species recorded very infrequently in the Brooks Peninsula area (e.g. Laysan Albatross; Pink-footed Shearwater; Green-backed Heron) are not included in Appendix 5 unless actually recorded inside the reserve.

Nesting seabirds have been recorded on 6 Islets or complexes (Figure 2) and are an important component of the avifauna. The only complete survey was done in 1975, when over 1,700 breeding pairs were present (Table 2). Leach's storm Petrel, Glaucous-winged Gull, and Pelagic Cormorant are the numerically most important species, and Thomas Island (and associated islets) is the most important site. A thorough and up-to-date survey is needed to assess population trends.

A second important component of the avifauna includes the pelagic and migratory species which occur seasonally in offshore parts of the reserve. Brooks Peninsula juts well out into the Pacific Ocean, making it one of the best places on the Pacific Coast to see wandering pelagic species and regular migrants from land. During migration watches in May and June 1973, an estimated 146,000 Sooty Shearwaters (up to 2,000/hr), 200,000 Red-necked Phalaropes, 44,000 Scoters, and 30,000 Bonaparte's Gulls passed by Clerke Point. Other migrants there included the Canada Goose, Brant, Parasitic Jaeger, and Black-legged Kittiwake.

Inlets adjacent to the reserve (Nasparti, Ououkinsh, Malksope), and particularly estuaries at their heads, are important for wintering waterfowl. The reserve itself is much less important, probably because of its lack of sheltered water. Ministry of Environment aerial waterfowl counts for the area from Clerke Point to Nasparti Inlet are given in Appendix 6.

Table 2. Estimated number of breeding pairs of seabirds on islands in Checleset Bay[1].

		Species*						
Island[2]	**Year**	**FTSP**	**LESP**	**PECO**	**GWGU**	**PIGU**	**BLOY**	**TOTAL**
Thomas & Islets	1975	50	1,200		31	20	11	1,312
Thomas & Islets	1988		7,300					
Gull Islet	1975				190			190
Gull Islet	1978				125		2	127
Clara Islet	1975				39	10		49
O'Leary Islets	1975			83	115	20		218
O'Leary Islets	1978			41	54		1	96
Cuttle Islets	1975				2	1		3
Yule Rock	1975				1	1		2
TOTAL (1975)		**50**	**1,200**	**83**	**378**	**52**	**11**	**1,774**

[1] 1975 data from Campbell 1976. 1978 data (some islands only) from Ecological Reserves files, Victoria. 1988 data from Birds of British Columbia.

[2] see Figure 2 for locations.

* FTSP = Fork-tailed Storm-Petrel
LESP = Leach's Storm-Petrel
PECO = Pelagic Cormorant
GWGU = Glaucous-winged Gull
PIGU = Pigeon Guillemot
BLOY = Black Oystercatcher

Nineteen of the species listed in Appendix 5 are included in B.C. Environment (1991) Red or Blue lists (Table 3). Of the two red-listed species, the Peregrine Falcon nests nearby at Solander Island (Beebe 1960), and has been seen hunting in the reserve, but probably does not nest inside it. The Marbled Murrelet forages in marine habitats in the reserve and probably nests in nearby forests. Of the 17 Blue-listed species, the reserve is most important for the two species of Storm-Petrels and the Bald Eagle, all of which nest there. It is also of some importance for foraging by Common Murres, Rhinoceros Auklets and Tufted Puffins which nest at other sites along the west coast of Vancouver Island. Most other species in Table 3 are on the Blue List because of small breeding populations elsewhere in the province and occur only sporadically in the reserve during the non-breeding season.

Mammals

Mammals that have been recorded in the reserve or, based on nearby records are expected to occur there periodically, are listed in Appendix 7. For convenience, the list of 26 species includes both terrestrial and marine mammals. Information sources include Carl and Guiguet (1956), Watson (1989), Carson and Foster (1978 b), Bigg (1985), Campbell and Summers (in press), and vanZyll de Jong (1985).

The reserve provides very limited and somewhat isolated habitat for land mammals, however the Dusky Shrew, Deer Mouse, Townsend Vole, Red Squirrel and Black-tailed Deer are permanent residents on one or more of the Bunsby Islands. Raccoons probably do so as well. Mink and river otters are widespread in the reserve. The islands are too small to support Black Bears or Wolves, but they may occur there from time to time. Of 9 species of bats which could potentially occur, only the Little Brown Bat has been collected in the reserve. However, the Silver-haired and Hoary Bats have been collected nearby at Brooks Peninsula. Of the terrestrial mammals in Appendix 7, only Keen's Bat is on the B.C. Environment (1991) Red List, and none are on the Blue List. Checleset Bay is not likely to provide important habitat for Keen's Bat. None of the terrestrial mammals have evolved distinct forms, presumably because the Bunsby Islands are very close to Vancouver Island (Carl and Guiguet, 1956).

Reptiles and Amphibians

The following species have been found in the Bunsby Islands (Carl and Guiguet, 1956):

Clouded Salamander (Little Bunsby)
Western Toad (East Bunsby; Checkaklis)
Northwestern Garter Snake (East and West Bunsby)
Common Garter Snake (East Bunsby)

Table 3. Red-listed and Blue-listed birds of the Checleset Bay area[1].

Species	Red List	Blue List
Pacific Loon		X
Western Grebe		X
Leach's Storm-Petrel		X
Fork-tailed Storm-Petrel		X
Brandt's Cormorant		X
Great Blue Heron		X
Bald Eagle		X
Peregrine Falcon	X	
Wandering Tattler		X
Least Sandpiper		X
Short-Billed Dowitcher		X
California Gull		X
Caspian Tern		X
Common Murre		X
Marbled Murrelet	X	
Cassin's Auklet		X
Rhinoceros Auklet		X
Tufted Puffin		X
Horned Puffin		X
TOTAL	**2**	**17**

[1] Based on B.C. Environment (1991) and Appendix 5.

Campbell and Summers (in press) also recorded the Northwestern, Long-toed and Western Red-backed Salamanders, Rough-skinned Newt, Pacific Treefrog and Red-legged Frog at Brooks Peninsula. In view of the scarcity of freshwater habitats on the Bunsby Islands, those species are unlikely to occur in the reserve. No species in the reserve are on Red or Blue Lists.

Terrestrial invertebrates

Carl and Guiguet (1956) reported 29 species of invertebrates from the Bunsby Islands. Their list is included as Appendix 8, however the taxonomy is likely to be outdated for some species. Cannings and Cannings (1987) collected over 500 species on the Brooks Peninsula, therefore the Bunsby Island list is undoubtedly very incomplete.

2.4.4 Marine Flora and Fauna

Studies of sea otter food resources (Morris *et al.* 1979 a) and of effects of sea otter predation on invertebrates, and indirectly on algae (Breen *et al.* 1982; Stewart *et al.* 1982; Watson 1989, 1991) have resulted in a considerable body of information on invertebrates and algae in selected parts of the reserve, to a depth of about 12 m (6 fathoms). Although this is a small part of the total area of the reserve, it is the most productive and diverse. Both species diversity and community structure have been described in those limited, usually rocky locations. Much less is known about the fishes in general and about benthic invertebrates of sand/gravel substrates between the reefs and seaward from the Barrier Islands. There appears to be no available information on plankton.

Algae

A total of 49 species of macro-algae have been reported (Appendix 9). Distribution and abundance of the dominant species of kelp has been greatly influenced by sea otters through their predation on sea urchins which normally graze on kelp. Kelp communities throughout the reserve have flourished due to removal of sea urchins by the otters. In typical sea otter feeding sites, the bull kelp (*Nereocystis leutkeana*) forms a dense surface canopy and the understorey contains *Pterygophora californica*, *Laminaria setchellii*, other *Laminaria* species, or a mixture of these species. These kelps occur from shallow water (near "datum") to a lower limit where the bottom changes to shell at 7 to 10 m depth. There is a characteristic dense turf of bladed red algae underneath the kelps. The most abundant and consistent species are *Constantinea subulifera* and *C. Simplex*, which have 10 to 75% cover, but several other species are also present. Large quantities of algal drift and detritus are trapped in crevices and depressions under these kelp stands. Studies of similar sites before sea otters had spread to them indicated that the dominant kelps were mostly the same species, however they were restricted to a very narrow near-surface zone, or other topographical sites not frequented by sea urchins. Watson (1991) has documented pronounced increases in brown algae abundance of several sites that were monitored over a period of 4 years as they became colonized by sea otters.

Invertebrates

A total of 88 species of marine invertebrates has been documented in the reserve (Appendix 10). In rocky habitats down to 12 m depth, molluscs are particularly diverse (32 species), followed by echinoderms (19 species) and crustaceans (14 species). Barnacles, tunicates, hydroids, bryozoans, polychaetes, and ascidians make up the remaining 23 species (Stewart *et al*. 1982; Morris *et al*. 1979 a).

Prior to sea otter colonization, subtidal reef communities were dominated by red sea urchins (up to 4 to 10 per sq. m, Chitons, limpets, turban snails, colonial polychaetes, and coralline algae. At sea otter feeding sites, sea urchins are now extremely scarce, small in size, and mostly confined to deep fissures or beneath rocks. Other scarce species, apparently due to sea otter predation, include abalones, crabs, turban snails, sea mussels, keyhole limpets and rock scallops. Species which are abundant in the otter-induced kelp forests include barnacles, bryozoans, hydroids, sponges, colonial ascidians, tunicates, sea anemones, and small snails (Breen *et al*. 1982).

Fish

Fishes that have been visually identified in the reserve are listed in Appendix 11, which is based on Stewart *et al*. 1982. Many additional species should occur, including 5 species of Pacific Salmon which pass through the reserve to spawning streams in Malksope, Ououkinsh and Nasparti Inlets.

Pinnipeds and Cetaceans

Marine mammals recorded in the reserve are listed in Appendix 7. Regularly occurring pinnipeds include the northern sea lion and harbour seal. Northern sea lions have year-round haulouts at O'Leary Islets and Barrier Rocks (Figure 2) where average counts total about 300 animals (Table 4). Sea lions do not breed in the reserve. Harbour seals are abundant in nearshore waters. Based on a mean occurrence of 2.3 seals per km of shoreline on the West Coast of Vancouver Island, the reserve probably contains 100 or more seals.

The California sea lion and elephant seal occur sporadically at Brooks Peninsula (Campbell and Summers, in press) and probably also occur in the reserve from time to time. There are written records of only two species of

Table 4. Numbers of Northern Sea Lions counted at Barrier Rocks and O'Leary Islets[1].

Parameter	Barrier Rocks	O'Leary Islets	Total
Summer			
(June - August)			
Mean count	115	155	270
Max. count	250	331	581
No. surveys	7	15	
Winter			
(September - May)			
Mean count	155	162	317
Max. count	298	305	703
No. surveys	4	14	
Year first noted	1955	1955	

[1] data from Bigg 1985. See Figure 2 for haulout locations.

cetaceous in the reserve (killer whale and gray whale) however several additional species should occur as transients in its offshore waters (Pike and MacAskie, 1969). Gray whales pass through the reserve primarily during spring migration (March - April). Transient killer whales pass through more regularly, attracted by the sea lions and seals which are their major prey.

Sea otter

1. Status in the Checleset Bay area

Sea otters were essentially exterminated on the British Columbia coast during the intensive period of maritime for trade (Blood 1967; Munro 1985), however Cowan and Guiguet (1965) cite a 1929 record for Grassie Island, Kyuquot. This is the last known occurrence of the species in Canada. Following surveys in 1967 to locate a suitable re-introduction site (Kenyon 1969; MacAskie 1967), the Bunsby Islands were chosen and a formal proposal prepared (MacAskie and Blood, 1968). A total of 89 sea otters from Alaska were introduced at the Bunsby Islands, Checleset Bay, during 1969 - 1972 (Table 5).

The number of sea otters counted during surveys of Checleset Bay and adjacent areas from 1977 through 1992 is summarized in Table 6. The surveys varied greatly in intensity and geographic coverage (see footnotes to Table 6), however they allow some generalizations to be made concerning population increase and spread of the animals.

There is expected to have been some early post-release mortality of otters due to capture and transport-related stress, and some random dispersal of individuals out of Checleset Bay. It is very likely therefore that the 1972 population in Checleset Bay was lower than 89 individuals. In the late 1970's, about 50 to 60 otters were counted there. The population increased to nearly 200 by 1984, suggesting that the 1980 - 1983 counts in Table 6 are under-estimates. The maximum count to date in Checleset Bay, 328 otters on July 26, 1989, was obtained by Watson (1990). It included 30 animals just east of the reserve, near the entrance to Kyuquot Harbour. Her 1988 and 1989 survey route did not include the Quineex Reef or other areas along Brooks Peninsula.

By 1977, some otters had moved to the Bajo Reef area of Nootka Island, about 75 km south of the Bunsby Island release site. This was well before their spread to all suitable habitats in Checleset Bay, and apparently not motivated by food scarcity in Checleset Bay (Breen *et al.* 1982). A population has continued to occupy the Bajo Reef - Skuna Bay area to the present, where 149 otters were present by 1984, and 156 in 1988.

Table 5. Sex, maturity and health of 89 sea otters released at the Bunsby Islands[1].

Transplant date	Origin	Transport	Number released: Total	Adult ♂	Adult ♀	Immature ♂	Immature ♀	?	Health
Jul.31 '69	Amchitka	Air	29	9*	19*			1	Fair-good
Jul.27 '70	Pr. William Sound	Boat	14	6	8				Excellent
Jul.15 '72	Pr. William Sound	Boat	46	8	22	7**	9**		Excellent
Total			89	23	49	7	9	1	

[1] from Bigg and MacAskie 1978.

* Approximate.

** Includes four male and two female pups.

Table 6. Sea otter surveys on the west coast of Vancouver Island, including Checleset Bay, 1977 - 1992.

		Checleset Bay		Other areas			
Date	Method*	No.	Location	No.	Location	Total	Source**
May - Sept/77	F.W.	55+	Bunsby Islands	15+	Bajo Reef	70+	1
June 15/78	Air	51	Humpback; Farout	16	Bajo Reef	67	2
July 14 - 18/80	Boat	29-58	O'Leary to Lookout	-	--	-	3
Aug. 9/82	Boat	35	Jacobsen to Lookout	-	--	-	4
Sept 1/83	Boat	58	O'Leary to Farout	-	--	-	5
1984	Boat/ Air	196	"Checleset Bay"	149	Bajo Reef	345	6
July 20/87	Air	234	Checleset/ Mission Grp.	136	Skuna-Bajo	370	7
Aug. 26/87	Air	231	Checleset/ Mission Grp.	97	Bajo Reef	328	7
Aug. 30/87	Boat	-	--	86	Bajo Reef	-	7
Aug. - Sept/88	Boat	213	Checleset/ Mission Grp.	156	Skuna-Bajo	369	8
July - Sept/89	Boat	328	Checleset	-	--	-	9
Mar. 30/92	Hel.	23	Bunsby and Thomas Isl.	57	Bajo-Skuna	203	10
				114	Nuchatlitz-Kyuquot		
				9	N. side Brooks Pen		
Sept. 17/92	Hel.	231	Checleset (except Mission)	138	N. side Brooks Pen		10

* F.W. = Fixed-wing aircraft; Hel. = Helicopter; Air = Aerial survey but aircraft type not stated.

** Sources of information:

[1] Bigg and MacAskie. 1978. Based on four aerial surveys in a DeHavilland Beaver: May 11 (Bajo Pt. - Cape Scott); June 27 and September 8 (Bajo Pt. to Bunsby Islands) and July 2 (Bajo Pt. area).

[2] Morris *et al.* 1981. Aerial survey carried out by B.C. Fish and Wildlife Branch, Bajo Reef to south side of Brooks Peninsula.

[3] Farr. 1980. Boat survey carried out over 4 $^{1}/2$ days.

[4] Farr. 1982. Includes first observations in Cuttle Islands. One-day survey.

[5] Breen *et al.* 1983. A quick 2 $^{1}/2$ hour survey by boat.

[6] MacAskie. 1987 a. Exact dates and kind of aircraft used not given. Aerial survey covered Nootka Sound to Quatsino Sound. Boat survey confined to Checleset Bay.

[7] MacAskie. 1987 b. Aerial surveys from Tofino to south side of Brooks Peninsula. Kind of aircraft not stated. Boat surveys from Tofino to Bajo Reef. Weather ideal.

[8] Watson. 1988. Includes 7 surveys in 1988 (111 to 213 otters). Quineex area not surveyed. Mission Group was included. One survey of Nootka Island.

[9] Watson. 1990. Includes 8 surveys (149 to 328 otters). Quineex area not surveyed. Mission group apparently not included.

[10] R. Simmons, personal communication. Data from B.C. Parks files, Parksville. Note that one survey was under winter conditions. Aircraft was a helicopter.

The maximum sea otter count for the west coast of Vancouver Island has been about 370 animals (1987 and 1988, Table 6). The variability in counts indicates that some animals are easily missed, even during intensive surveys, and suggests a population higher than 370. Watson (1991), estimated a total population of about 600 sea otters originating from the 1969 - 1972 introductions.

The spread of sea otters from the original point of release has two major components: 1) the widespread dispersal of pioneering individuals or small groups, usually males, and 2) the gradual spread of larger "resident' matriarchal groups, usually accompanied by evidence of marine community changes due to otter foraging. Following the initial releases, individual otters were reported at scattered locations along the British Columbia Coast from Barkley Sound to Harvey Island (Lat. 52° 30'). Within Checleset Bay, sea otters were first reported at Thomas Island in 1972 (Bigg and MacAskie 1978), in the Cuttle Island area in 1977, in the Mission Group in 1977, at Lookout Island in 1980 (Farr 1980) and Thornton Island in 1988 (Watson 1990). The spread of resident female/pup groups shows a more conservative pattern, based on otter observations and community studies of Morris *et al*. 1979 a, b; Breen *et al*. 1982, and Watson 1989; 1991. Approximate boundaries of the resident population over time are shown on Figure 3.

Sea otters were first recorded on surveys in Brooks Bay in early 1992, although they were probably there earlier. A winter (March 30) aerial survey from Nootka Sound to Brooks Bay in 1992 located only 203 sea otters, but suggested that winter distribution may be different than that in summer, and that most of the area between Checleset Bay and Nootka Sound may be used. Thirty otters were noted at Union Island, 24 in the Tatchu Creek - Tatchu Point area, and 60 near Nuchatlitz on the south side of Esperanza Inlet. Only 23 were counted in Checleset Bay, mostly in the Gay Passage area.

Radio monitoring studies in Alaska have shown that male sea otters may make lengthy movements (Garshelis and Garshelis 1984). Those authors documented movements of 11 km in 2 hours, and stated that "Adult males in both Prince William Sound and California ... frequently (at least yearly) make trips of 80 - 145 km between male and female areas ..." Similar movements can be expected on the coast of British Columbia.

2. <u>Biology of Sea Otters</u>

There is an extensive body of scientific literature on sea otters, based mostly on research done in Alaska and California. A monographic treatment prepared by Kenyon (1969), and a book on the community ecology of sea otters edited by Van Blaricom and Estes (1987) contain lengthy bibliographies. The status and biology of sea otters in

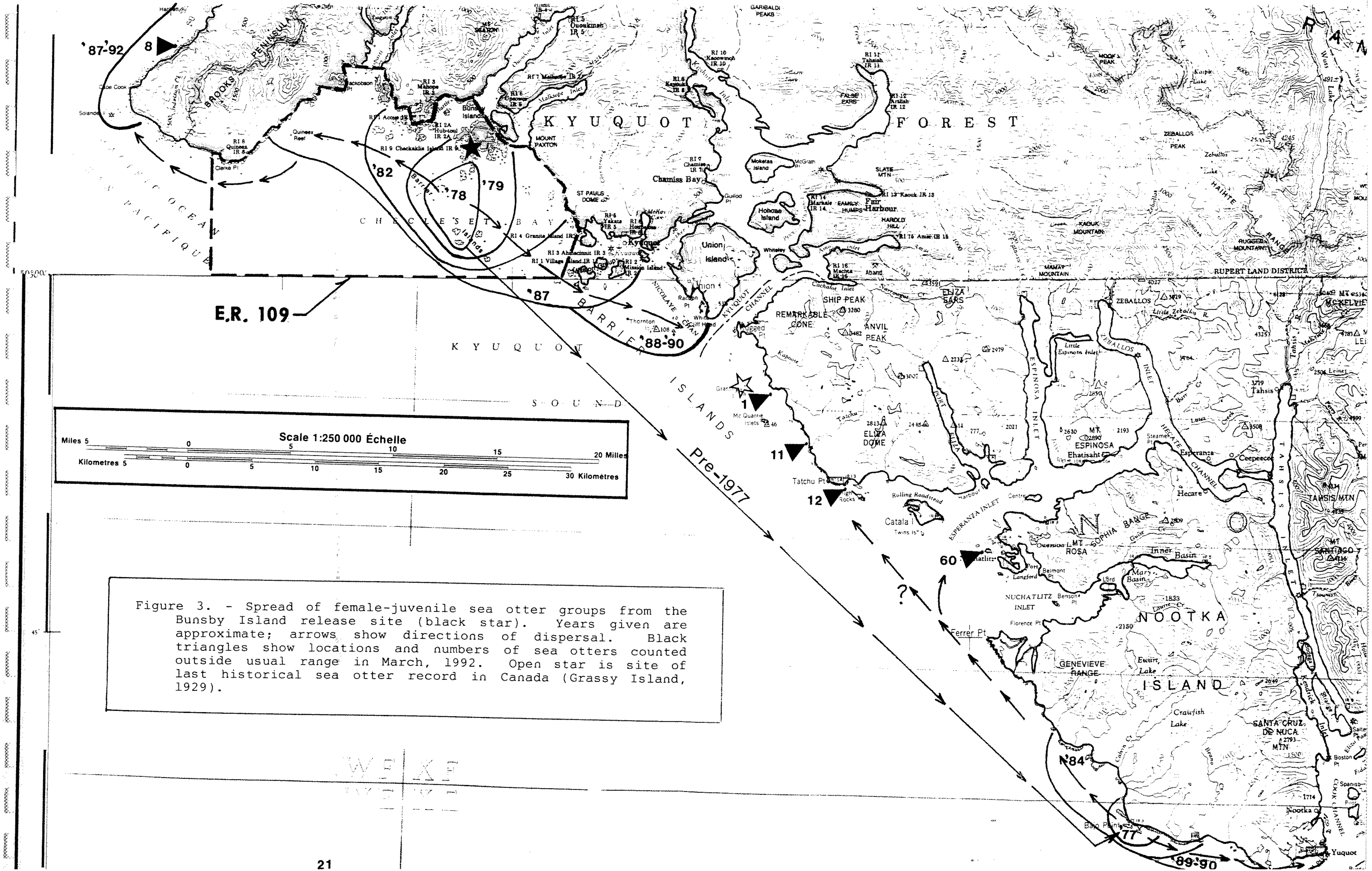

Figure 3. - Spread of female-juvenile sea otter groups from the Bunsby Island release site (black star). Years given are approximate; arrows show directions of dispersal. Black triangles show locations and numbers of sea otters counted outside usual range in March, 1992. Open star is site of last historical sea otter record in Canada (Grassy Island, 1929).

Washington State was recently reviewed by Bowlby *et al.* (1988).

The biology of the sea otter was thoroughly and concisely reviewed by Estes (1980). That paper is included in this report as Appendix 12.

Other than the excellent work by Watson (1989; 1991), Breen *et al.* (1982), Stewart *et al.* (1982) and Morris *et al.* (1979 a, b) on the effects of sea otters at Checleset Bay and adjacent areas on marine invertebrates and algae, there has been little research on the biology of this species in British Columbia. Effects of the otters on marine communities were discussed previously under the headings of Algae and Invertebrates.

Based on spotting scope observations, Morris *et al.* (1987) concluded that the butter clam was the dominant food item at Checleset Bay, and that sea urchins, starfish, mussels, chitons and snails were also eaten. Based on comparisons of foraging and non-foraging sites, sea urchins appear to be the most important food, at least initially, and abalones are also taken.

Morris *et al.* (1979 b) documented movements of sea otters to more sheltered locations in Checleset Bay in response to stormy weather; segregation into female-juvenile and male groups; social interactions such as grooming, food sharing, nursing and play; and daily activity patterns. Travel between rafting areas and feeding locations occurred at all times of the day but was concentrated in early morning and late evening. Repeated use of the same feeding sites and travel paths was noted. The longest feeding session recorded was two hours on white clams. The longest food dive was 127 seconds; the shortest 45 seconds. The longest interval between food dives was 180 seconds.

3. <u>Management of Sea Otters</u>

Management activities in British Columbia include 1) the original re-introduction program, 2) establishment of E.R. 109 to protect the introduced population and its habitat, and 3) closure of fisheries for some invertebrates that are important sea otter foods. Related activities have included inventories of distribution and abundance, and research on sea otter effects on marine ecosystems. There has been no active management such as additional transplants, control of dispersal, or sea otter harvest. Some management activities in other jurisdictions are summarized in Appendix 13.

2.5 Cultural Values

2.5.1 Native Use and Archaeological Sites

Virtually the entire Ecological Reserve has been used by native people for several thousand years. Archaeological surveys have revealed primarily habitation and burial sites near present sea level (Table 7; Figure 2). Additional sites probably occur, some of which may have been inundated by rising sea levels. There are also many known archaeological sites in immediately adjacent areas such as Kyuquot, the Mission Group, Malksope and Ououkinsh Inlets, East Bunsby Island, Battle Creek, and Acous Peninsula.

The Ecological Reserve area was originally inhabited by the Checkliset Band, the northernmost of 6 Tribes or Bands of the Nootka ethnic division (Duff 1964). The Nootka-speaking people extended from Brooks Peninsula south to the Port Renfrew area.

At the time of white contact the Checklisets had a winter village at Acous, a summer village at Opsowis (on Vancouver Island adjacent to East Bunsby) and other seasonal camps on Nasparti, Ououkinsh, and Malksope Inlets. By the late 1800's the summer site at Opsowis became the main year-round village. By the 1930's there was no longer a school in the Checleset Bay area, and by the 1950's the Checklisets had all moved to Kyuquot (Mission Island = Kamils Island) where they became amalgamated, at least administratively, with the Kyuquot Band by 1963. Some remains of buildings were still present at Opsowis until at least the 1950's (Jones 1991).

Native people from the Kyuquot area continue to utilize marine resources in the Ecological Reserve for sustenance purposes.

2.5.2 Other Historical Values

Within reserve boundaries there are not known to be any visible sites of historical significance dating from the period of European/American exploration or settlement.

2.6 Representative and Special Features

2.6.1 Representative Features

1. <u>Marine ecosystems</u>

   A variety of intertidal and subtidal communities is present, although most have not been described. In view of the large size of the reserve, these communities should be representative of much of the exposed west coast of Vañcouver Island and adjacent Continental Shelf.

2. Old-growth forest

Forest vegetation on the Buns ... ts a
variant of the very wet hypermaritim ... istal
Western Hemlock Biogeoclimatic Zone. ... been
extensively modified by logging, ... rooks
Peninsula, where similar ecosystems ...

Page 24 (Table 7)
Removed at request
of the Kyuquot Band

2.6.2 Special Features

1. Sea otters

E.R. 109 is of special significance as the site of re-introduction of the sea otter to Canada. Its present population of about 350 otters is a nucleus from which other parts of the coast are gradually being colonized. Pioneering research is being done on the impact of sea otters on marine communities and shellfish resources.

2. Other marine mammals

The reserve contains two of 12 known year-round haulouts of the northern (Steller's) sea lion, where up to 400 animals may be regularly found. Many harbour seals are also present. Gray and killer whales regularly pass through the reserve, and other cetaceans are expected to occur.

3. Nesting seabirds

Five species of colonial seabirds nest at 6 locations in the reserve. Two of these, Leach's and Fork-tailed Storm Petrels are on the B.C. Environment (1991) Blue List. Thomas Island is the most important nesting site. Up to 11,000 pairs of Leach's Storm-Petrels have been estimated at Thomas Island, making this one of the most important nesting sites in British Columbia.

4. Archaeological Sites

The reserve area has a rich native history and numerous archaeological sites. Although archaeological sites are legally protected wherever they occur, Ecological Reserve status provides additional control over public access and should help to control the degradation of sites which has been widespread along the coast.

5. Wilderness value

This reserve is relatively unique in terms of the size of marine area enclosed and its remoteness. Unfortunately, this has resulted in increasing levels of recreational use, a purpose for which Ecological Reserves are not intended.

3.0 LAND USE AND OTHER ACTIVITIES

3.1 Regional Socio-economic Context

Checleset Bay Ecological Reserve is in a very remote and sparsely populated area. The roadless wilderness of Brooks Peninsula Recreation Area forms a natural boundary to the north (Figure 4). The nearest road terminus, Fair Harbour (25 km east of the reserve), is 265 km from Campbell River, 113 km from Port McNeill, and 33 km from Zeballos. Kyuquot, one of very few Vancouver Island communities with no road access, is located 3.5 km east of the reserve, and Chamiss Bay, a logging camp, is 12 km to the east.

The reserve is in Area 6 of the Comox-Strathcona Regional District. This huge area of over 5,000 sq. km, excluding the incorporated communities of Gold River, Tahsis and Zeballos, has a total population of only 477 people (Ministry of Municipal Affairs, 1988). Just over half the population lives on Indian Reserves. Kyuquot, with a population of about 200 people has a store, marine fuel and moorage, post office, Indian Band office, bed and breakfast accommodation, restaurant, nursing station, and school. It has scheduled air service by float plane and weekly motor vessel service (M.V. Uchuk III), both from Gold River.

Commercial fishing is the main economic activity at Kyuquot. Commercial fishermen from other south-coast communities also fish in the area. In D.F.O. Management Area 26 (Cape Cook to Tatchu Point), an average of about 800 tonnes of salmon, 800 tonnes of ground fish, and 400 tonnes of shellfish were taken per year from 1985 through 1989. Important catches include all 5 species of Pacific salmon, rockfish, sablefish, ling cod, halibut, Pacific cod, red snapper, geoducks, clams, sea cucumbers, goose barnacles, and sea urchins (Appendix 14). Virtually all seafood processing is done outside the region. There is only one aquaculture operation in the Kyuquot Sound area.

Logging is the only significant land-based economic activity in the region. Logging camps occur at Chamiss Bay and Ououkinsh Inlet. Although connected to Kyuquot by road, they appear to have little economic impact on that village.

Tourism is of growing importance, though still a minor contributor to the local economy, largely due to remoteness and difficult access.

Sustenance use of marine resources is of importance for most residents of Kyuquot and particularly for the native people.

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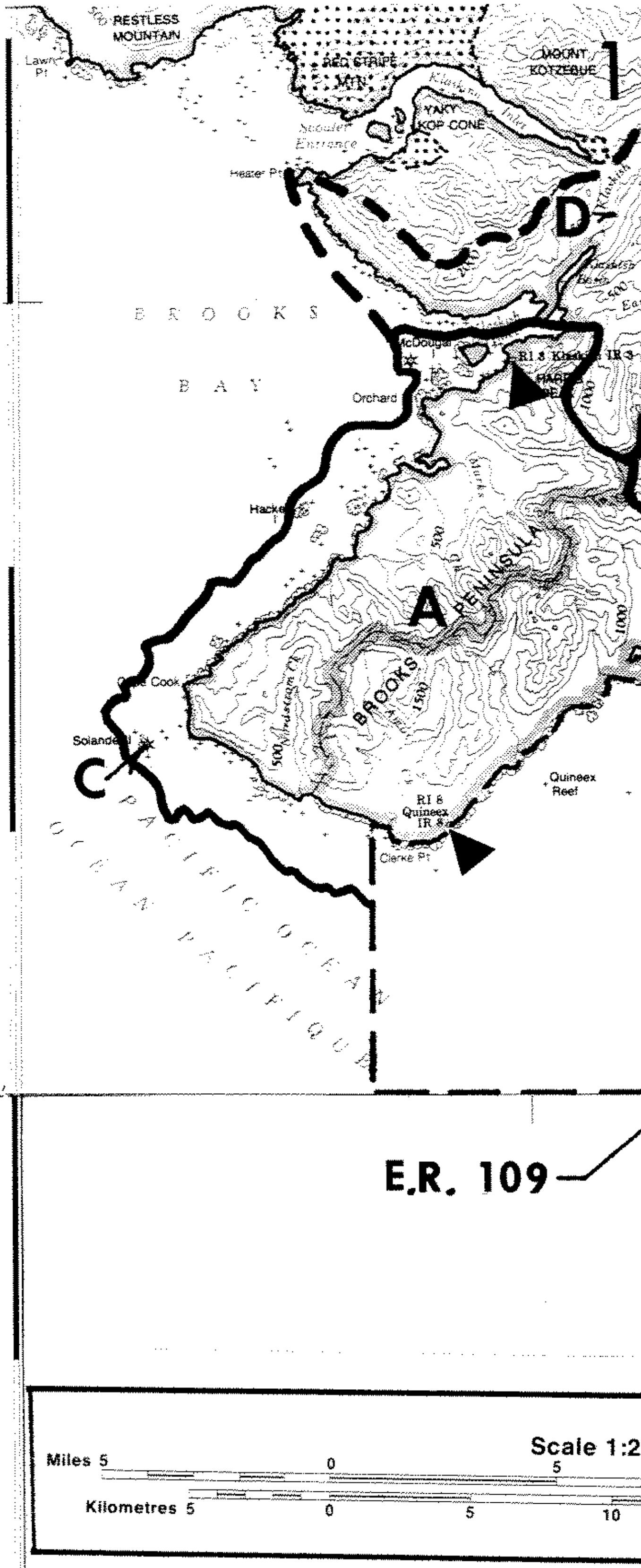

4. - Regional Land Tenure and Use

FORESTRY

›ks S.B.; Kingcome T.S.A.	1
›ks S.B.; Kingcome T.S.A. (Moratorium)	2
quot S.B.; Strathcona T.S.A. (Moratorium)	3
quot S.B.; Strathcona T.S.A.	4
e Farm License No. 6	5
e Farm License No. 39	6
g Camps	(star in circle)
Land	(dotted area)

CONSERVATION LANDS

Peninsula Recreation Area	A
set Bay E.R. (109)	B
er Island E.R. (14)	C
sh River E.R. (129)	D
nick Creek E.R. (75)	E
n River E.R. (119)	F
Point Marine Park	G
roposals	H

RECREATION

ccess/boat launch	★
boat route	(dotted line)
oast Expeditions Camp	●

INDIAN RESERVES . . . . . . ▶

3.2 On-site Uses

3.2.1 Research and Education

Research since establishment of E.R. 109 in December 1981 has largely been on the impact of introduced sea otters on marine community structure. Surveys of sea otter distribution and abundance and of nesting seabird abundance have also been carried out. Some of this research began before the reserve was established (e.g. Morris *et al*. 1979 a, b).

Impacts of Sea Otters (Breen *et al*. 1982; Stewart *et al*. 1982; Watson 1989, 1990, 1991).

These have been pioneering baseline studies of dramatic changes in invertebrate and kelp abundance in reef communities. The reserve continues to be an important site for monitoring such changes. This research has tremendous implications for the future of the shellfish industry in British Columbia.

Sea Otter Status and Distribution (see sources listed in Table 6).

Surveys have not always involved the issuance of a research permit, and now usually involve areas well outside the reserve, as well as the reserve. Continued monitoring of population size, seasonal distribution, movements, and sexual segregation of sea otters within the reserve is anticipated. This will provide information on carrying capacity, population trend, and location of key seasonal habitats.

Other Species

Seabird surveys have been carried out but results do not appear to have been provided to B.C. Parks. The following agencies/institutions have sponsored research in the reserve:

B.C. Parks (Ecological Reserves Program), Victoria, B.C.
Friends of Ecological Reserves, Victoria, B.C.
University of Victoria, Biology Department, Victoria, B.C.
D.F.O., Pacific Biological Station, Nanaimo, B.C.
University of California at Santa Cruz.
West Coast Whale Research Foundation, Vancouver, B.C.
Bamfield Marine Station, Bamfield, B.C.
Canadian Wildlife Service, Delta, B.C.

The reserve provides a variety of intertidal and marine habitats that are of interest for research purposes. However, similar habitats occur in the Bamfield - Barkley Sound area, which is more accessible and has an established university - sponsored research/education facility. The demand for research on species other than sea otters will probably not be substantial at Checleset Bay in the foreseeable future.

However, research to document biodiversity in the reserve is desirable. Research programs to date have not had any adverse effect on flora or fauna of the reserve.

The reserve has served an educational role through the media of television, magazine articles and lectures. These programs/articles have largely featured the sea otter, including the conservation story resulting from its reintroduction, and its effects on the structure of reef communities. A smaller number of people, primarily kayakers, have received educational benefits from visiting the reserve, particularly those guided by local expedition operators. Educational programs have stimulated increasing recreational use, which may become a future management problem.

3.2.2 Recreational Use

Kayakers and sport fishermen from outside the Kyuquot area are the major recreational users. Exact numbers are not known, but are felt to be relatively low in view of the remote location and relatively difficult access. However, recreational use is definitely increasing annually (personal communication with Kyuquot residents). Recreational use was negligible prior to completion of the road to Fair Harbour.

Kayakers mostly launch at Fair Harbour and paddle to the reserve via Kyuquot, or travel to Kyuquot in the Uchuk III from Gold River. Both un-escorted parties and organized tours are involved. The usual destination point is the Bunsby Islands, although some travel to Brooks Peninsula. Articles and advertisements in magazines such as the "Sea Kayaker" and "Wave Length" and descriptive guidebooks (Ince and Kottner 1982) have made the area well known to the kayak fraternity. West Coast Expeditions operates a summer base camp at Spring Island near Kyuquot (Figure 4) and caters primarily to kayakers. Their excursions involve areas inside and outside the reserve. Kayakers utilize a number of informal camping sites inside the reserve (Figure 2). These have resulted in minimal site damage to date, but continued and/or expanded use could result in localized site degradation.

Sport fishermen launch trailered boats at Fair Harbour and mostly fish in the Kyuquot Sound area, although some venture to the Bunsby Islands. Local residents expressed concern about increasing numbers of sport fishermen. These recreationists seldom go ashore in the reserve.

There is a potential for both kayakers and sport fishermen to disturb sea otters, but this is not known to be a problem at present.

3.2.3 Other Uses

Commercial fishing: Trolling for salmon in waters outside the Barrier Islands is the major commercial fishing activity in the reserve. The proportion of the Area 26 catch taken in the reserve is not known. Based on the list of species harvested in Area 26 (Appendix 14), it is likely that a variety of species beside salmon are also taken in E.R. 109.

Marine resource harvesting is regulated by the Federal Department of Fisheries and Oceans. Fisheries interests have been reluctant to institute or accept closures in the reserve, however recommendations from Ecological Reserve supporters/managers have resulted in harvest closures for some shellfish that are of importance to sea otters. In 1992 this included all species of intertidal clams; subtidal clams (geoducks and horse clams); red and green sea urchins; and abalone (closed on the entire coast). Closures are a condition of the commercial fishing license for the individual species affected (R. Harbo, personal communication). There have been documented fisheries for sea cucumbers and goose barnacles within the reserve. Crab, octopus and scallop fisheries occur in the area, possibly including the reserve. There is no mussel fishery at present, but commercial stocks occur. There are intertidal clam populations in the reserve which could be harvested commercially, if not for the closure.

The extent to which the above closures are violated and level of enforcement effort are not known. The nearest D.F.O. Officer is stationed at Tahsis.

Sustenance fishing: Residents of Kyuquot engage in some sustenance use of shellfish and finfish in the reserve. However, in view of the small human population involved, and availability of marine resources outside the reserve (e.g. Mission Group), this use is felt to be minimal and to presently be no threat to sea otters or to the general integrity of the reserve.

Other uses: Other activities in the reserve are few. Some marine traffic up and down the west coast of Vancouver Island passes through the outer part of the reserve. There is little marine transport through the reserve to Malksope or Ououkinsh Inlets, both of which are connected by road to Chamiss Bay. Navigation markers are present 2 km southwest and 1.5 km northwest of Thomas Island (Marine Chart 3683).

3.3 Off-site Uses

3.3.1 Logging

Lands surrounding the reserve, with the exception of Brooks Peninsula Recreation Area, are in the Kyuquot Provincial Forest (Figure 4). For administrative purposes these forestlands are in the Kyuquot Supply Block (S.B.) of the Strathcona Timber Supply Area (T.S.A.). Lands within the Ecological Reserve have never been logged. Logging has occurred to the reserve boundary (The Shoreline) along the slopes of Mt. Paxton from Malksope Point to the vicinity of

McLean Island. This was mostly from 1980 to 1989, and is strikingly apparent from almost anywhere in the reserve.

Active logging operations are presently based at Chamiss Bay (International Forest Products) and the head of Ououkinsh Inlet (Hecate Logging). Operators under the Small Business Program also log along Ououkinsh Inlet. The Power and Nasparti River drainage basins are unlogged, and form part of the "Brooks Extension" which is presently (late 1992) subject to a logging moratorium pending a review by the Commission on Resources and Environment. Logging tenure in at least part of that area is held by Doman Forest Products. Near the reserve, logging occurred on East Bunsby Island in 1964/65 and 1976, along Johnson Lagoon in 1980, at scattered locations along the east side of Nasparti Inlet (to within 400 m of the reserve) from 1980 to 1990 and at various locations along Ououkinsh Inlet (1960's and 1983) and Malksope Inlet (1934 - 1969). Most of these were small hand-logging operations along the shoreline. More extensive logging is presently underway around the heads of Ououkinsh Inlet and Malksope Inlet, and at Clanninick and St. Pauls Creeks. These logs are trucked to Chamiss Bay.

Hand loggers along the inlets have moved their logs by water through the reserve. This may continue, particularly if hand logging is allowed in Nasparti Inlet and Johnson Lagoon.

Logging appears to have had little direct impact on the reserve. However Kyuquot residents state that heavy rainstorms in the winter of 1990/91 caused extensive siltation in the inlets, and this carried out into Checleset Bay. They blame this on logging, and claim that it caused sea otters to climb out of the water onto land, rocks or logs. There is no conclusive evidence that this resulted in sea otter mortality.

3.3.2 Commercial Fishing

Commercial fishing for finfish and shellfish is a major activity in waters surrounding the reserve. Recent commercial catches for D.F.O. Management Area 26 are given in Appendix 14.

3.3.3 Outdoor Recreation

The Brooks Peninsula Recreation Area borders the northwest side of the reserve (Figure 3). Except for limited recreational use of its shorelines by kayakers, this roadless wilderness is little used at present. A few kayakers and sport fishermen probe Nasparti, Ououkinsh and Malksope Inlets via the reserve. Sport fishing and kayaking also occur in the Kyuquot Sound area, southeast of the reserve. Low levels of sport hunting occur, and primarily involve local people. Black-tailed deer and black bears are widespread, though not particularly abundant in this area. Limited-entry hunting for Roosevelt elk occurs in the Klaskish, Power and Nasparti River valleys.

3.3.4 Mineral Exploration and Mining

There are many mineral claims in the surrounding area but no active mines. Almost all of the Brooks Peninsula is staked and other claims are present in the headwaters of the Nasparti and Power Rivers. The likelihood that any of these could become active mines is not known. Mineral extraction near the reserve boundaries could have an adverse impact, depending largely on the kind and scale of operation.

Offshore oil and gas reserves are predicted to occur in the Winona Basin, north of Brooks Peninsula, and Tofino Basin, south of Brooks Peninsula (Procter *et al*. 1983). Four wells have been drilled in the Tofino Basin, none in the Winona Basin. Exploration ceased when a moratorium on offshore drilling was declared in 1969. Should the moratorium be lifted, renewed drilling could have implications for the reserve.

4.0 RESERVE MANAGEMENT

4.1 Management Issues

Management issues are considered to involve any activities which have threatened or presently threaten the integrity of the reserve and the purposes for which it was established (preservation; research; education).

1. Increasing recreational use

Potential adverse effects include:

- disturbance of sea otters
- disturbance of nesting seabirds
- damage/looting of archaeological sites
- site damage and littering at camps.

To date these problems have been minor, but they can be expected to increase in the future. Creation of a new Provincial Park in the East Bunsby Island - Battle Bay area, and provision of recreational facilities at Brooks Peninsula (Columbia Cove) could have implications for the Ecological Reserve. These developments could increase recreational use of the general area, with spin-off impacts on the reserve, or could draw some recreational use out of the reserve into adjacent sites having basic facilities. Two factors suggest that the above-mentioned developments would cause the existing situation to change little in the foreseeable future: 1) The area is remote and access to it is not likely to improve. Visitation at the new park and at Brooks Peninsula would be low. 2) Kayakers, the predominant recreational users at present, prefer to camp in remote, dispersed, unimproved locations. They would probably not be attracted to the new park or to facilities at Columbia Cove.

2. Commercial fishing

Potential adverse effects include:

- removal of forage resources needed for survival of sea otters and other species
- reduced opportunity for research on natural, unexploited ecosystems.

The extent of this perceived problem has not been determined. Fishery closures on key invertebrates have been instituted, reducing the profile of this issue.

3. Logging on adjacent lands

Potential adverse effects include:

- siltation of marine waters during heavy rainfalls, with adverse effects on sea otters and possibly other species
- loss of nesting sites for Red or Blue-listed birds which forage in the reserve (Marbled Murrelet; Bald Eagle)
- wildlife disturbance caused by movement of boats, barges or booms through the reserve.

Siltation of marine habitats has been reported and may have affected sea otters, but whether any mortality occurred or is likely from this source is not known. The expected frequency of siltation events, and extent to which logging is responsible are not reliably known. Increased logging in the Nasparti, Power, Ououkinsh or Malksope watersheds could cause more severe or more frequent discharge of turbid water into the reserve.

Logging to the shoreline on Mt. Paxton has removed potential nest trees of Bald Eagles, and any similar logging elsewhere along the boundary (e.g. between Ououkinsh and Nasparti Inlets) could do the same. Although the nest trees are outside the reserve proper, any eagles using them would forage in the reserve. Logging has probably also removed potential nesting habitat of Marbled Murrelets which feed in the reserve. Logging on adjacent lands therefore, can diminish the diversity and abundance of wildlife inside the reserve.

Movement of logging-related boat traffic through the reserve does not appear to have been a problem to date, and should not increase in the foreseeable future.

4. <u>Oil spills</u>

Potential adverse effects include:

- sea otter mortality due to loss of insulation
- fouling of other marine organisms and beaches.

The Nestuca oil spill in the winter of 1988/89 resulted in at least one sea otter death in the reserve, and circumstantial evidence (oiled sea otter fur in a wolf scat) suggested that others also died (Watson 1990). Oil collected on a number of beaches, but subtidal communities appear not to have been directly affected. This spill did not have a measurable effect on size of the Checleset Bay sea otter population, or on its distribution. The threat of oil spills will always exist, but they should be of very infrequent occurrence.

5. <u>Native sustenance or commercial use of marine resources</u>

Potential adverse effects include:

- removal of forage resources needed for survival of sea otters and other species
- reduced opportunity for research and education concerning natural, unexploited ecosystems.

This is not believed to have been an issue to date, but in view of recent and developing trends with respect to native land claims, resumption of traditional land uses, and co-management of resources, it is likely to be a future issue. There can be no doubt that the Checkliset/Kyuquot people lived in and used the area for several thousand years. Two Indian Reserves (Hub-toul 2A and Checkaklis Island No. 9) are completely surrounded by the Ecological Reserve, and 3 others (Quineex No. 8; Acous No. 1; Mahope No. 3) abut its boundary. The latter 3, plus Upsowis No. 6, Hisnit No. 4; Ououkinsh No. 5 and Malksope No. 5, can only reasonably be reached (by water) by travelling through E.R. 109. The reserve boundary also passes through the intertidal zone on the west side of Granite (McLean) Island No. 4, near Kyuquot. Five additional Indian Reserves (Yakats No. 5; Houpsitas No. 6; Ahmacinnit No. 3; Village (Aktis) Island No. 1; Mission (Kamils) Island No. 2) are within 4 km of the east boundary of the Ecological Reserve (Figure 4). Despite this native presence it appears that the Kyuquot Band was not consulted about establishment of E.R. 109 (B.C. Parks File Update, June 1989). The Band appears to have constrained its criticism of the Ecological Reserve because E.R. status protects it from harmful exploitation, but does not, at least in the opinion of Band members, preclude their continued use of the area for sustenance or other traditional purposes.

4.2 Management Practices

1. Control of research and educational uses

This has been achieved through the Ecological Reserve permit system. Most, though not all permittees appear to have reported their results to B.C. Parks.

2. Control of marine resource harvesting

D.F.O. has cooperated in instituting closures for important sea otter food species. Further research is needed to determine if additional closures are required. The degree to which the present closures are respected is not known.

3. Dissemination of information

Magazine articles have helped to educate people about the purpose of the reserve. Past and present Volunteer Wardens regularly inform reserve users about reserve regulations. No boundary signs have been erected and no information brochures printed.

4. Monitoring sea otter populations

Regular surveys have been sponsored or carried out by B.C. Parks. These have documented the growth and spread of the population.

4.3 Key Management Agencies/Groups

The following is a list of government agencies and non-government organizations which have had or could have a role in management or protection of Checleset Bay Ecological Reserve:

Agency or Group	Actual/potential Role
B.C. Parks (Ministry of Environment, Land and Parks) - E.R. Program, Victoria - Strathcona District, Parksville - Strathcona Zone, Miracle Beach	- E.R. protection; planning; management; volunteer Warden Program. Parks and recreation planning on adjacent lands
B.C. Environment (Ministry of Environment, Land and Parks)	
- Wildlife program Nanaimo	- Wildlife surveys
- Conservation Officer, Port Hardy	- Wildlife protection
Canada Department Fisheries and Oceans	
- Management Biology Unit, P.B.S., Nanaimo	- Shellfish management and Native food fishery
- Marine Mammal Unit, P.B.S., Nanaimo	- Inventory and Research
- Fisheries Officer, Tahsis	- Fisheries enforcement
Environment Canada	
- Canadian Wildlife Service, Delta	- Seabird inventory; protection
B.C. Ministry of Forests	
- Campbell River Forest District	- Forest management, Kyuquot S.B.
B.C. Ministry of Tourism and Culture	
- Archaeology Program, Victoria	- Inventory and protection of sites
Regional District of Comox-Strathcona	- Regional planning
Kyuquot Indian Band	- Sustenance fishery; protection of archaeology sites; access to reserves

Kyuquot Economic and Environmental Protection Society (KEEPS)	- Information on local conservation issues
Friends of Ecological Reserves, Victoria	- Support of research; dissemination of information
Ocean Kayaking Association of B.C.	- Promote ethical practices

5.0 KEY RESOURCES AND MANAGEMENT ISSUES

5.1 Key Resources

The reserve was established primarily to protect an introduced sea otter population and its habitat. A large reserve (34,650 ha) was needed in order to provide habitat for a viable, self-sustaining population. The otters have now spread to all suitable habitats in the reserve (Figure 2) and to sites outside it (Figure 3). They are expected to colonize the entire outer coast of British Columbia within a few decades; the population should reach 10,000 or more and could then be removed from the endangered list. E.R. 109 will become progressively less important in terms of the relative numbers of sea otters using it. However, in view of the extra protection that Ecological Reserve status gives to sea otters, their forage species and habitat in general, the reserve will always be a site of above-average importance for the species. The key resource is not just the otters, but must also include their forage resources and the complete reef ecosystems which they inhabit. Sheltered areas that are used by the otters during winter storms are probably also important. These have not been identified, but could include such areas as Columbia Cove, Battle Bay, and East Bunsby Island which are outside the reserve.

Seabird nesting colonies and archaeological sites are also significant resources.

5.2 Key Management Issues

5.2.1 Reserve Boundary

The following boundary issues have been noted:

1. Lack of boundary description

   There has apparently never been a metes-and-bounds description of reserve boundaries. Order-in-council 2566 and the Gazette Notice refer respectively to an area "... shown outlined in bold black on the plan attached hereto ..." and "... as shown outlined on a map deposited in the Ministry's Regional Office for Vancouver Island ..." The Boundary shown on various government maps is complicated and open to interpretation in some locations.

2. The boundary is not shown on Marine Charts or on 1:50,000 topographic maps.

3. There are no boundary signs in place.

4. As noted in Section 5.1, the boundary may not include winter habitats used by sea otters.

5.2.2 Resource Preservation

Significant issues involving preservation of key resources (sea otters and their habitat) are as follows:

1. Jurisdiction over resources

The Ecological Reserve designation is provincial but marine resources are under federal jurisdiction. D.F.O. has a mandate to promote economic benefit from marine resources; B.C. Parks has a mandate to preserve natural conditions. However, neither level of government has undisputed authority in the offshore area (Dorcey 1986). Under E.R. Regulations it is an offence to remove animals from an Ecological Reserve. Checleset Bay is a large reserve, contains economically significant and harvestable marine resources, and was subject to various fisheries prior to becoming a reserve.

The jurisdictional problem is one that all parties will have to live with. Conflicts can be reduced by more frequent communication and by providing scientific documentation in support of management recommendations.

2. Control of harvests of marine resources

This issue is related to the previous one. It seems to have been at least partially solved through commercial harvest closures on various invertebrates. However, sport and sustenance harvests continue and could increase. Further documentation of sea otter food habits and foraging sites and of shellfish and finfish populations is needed in order to identify potential conflicts.

3. Control of recreational use

Excessive recreational use could disturb sea otters and conflict with the objective of otter preservation. It could also interfere with research and educational programs. On the other hand, sea otters may be quite adaptable to non-threatening human activity. Evaluation of this potential problem is needed.

Damage to seabird colonies and archaeological sites could also occur.

4. Impact of logging adjacent lands

Siltation of marine waters as a result of logging may or may not be a problem for sea otters. Siltation could become worse if the Nasparti and Power drainages and the peninsula between Nasparti and Ououkinsh Inlets are logged. Sea otters and logging will soon occur along most of the coast of British Columbia. E.R. 109 is a suitable study area for evaluation of the contribution of logging to marine sedimentation, and the impact of that sedimentation on sea otters.

5. <u>Oil spills</u>

Oil spills some distance from the reserve have and can affect sea otters and their habitat at Checleset Bay. Though of infrequent occurrence the magnitude of such an impact can be high, as demonstrated by the Exxon Valdez incident.

5.2.3 Research Opportunity

Research to date has focused on the impact of sea otters on marine community structure. This is of considerable importance for prediction of sea otter impacts on shellfish resources along the entire outer coast of British Columbia. That impact is expected to be substantial.

As noted previously, harvesting of marine resources could preclude research on natural populations or communities, and excessive recreational activity could interfere with research on sea otters or perhaps other species. Such problems do not appear to have arisen to date.

5.2.4 Educational Opportunity

As in the case of research, excessive recreational activity could interfere with educational use of the reserve. However, levels of both recreational and educational use are relatively low, and no significant problems are anticipated in the foreseeable future.

5.2.5 Recreational Use

See Sec. 5.2.2

5.2.6 Other Uses

See Sec. 5.2.2

5.2.7 Surrounding Land Uses

See Sec. 5.2.2

5.2.8 Wardenship

Large, remote reserves such as this present unique problems for the wardenship program. Past and present wardens have done an admirable job of coping with those difficulties, however the same level of attention that is accorded smaller, on-land reserves having ready access cannot be expected here.

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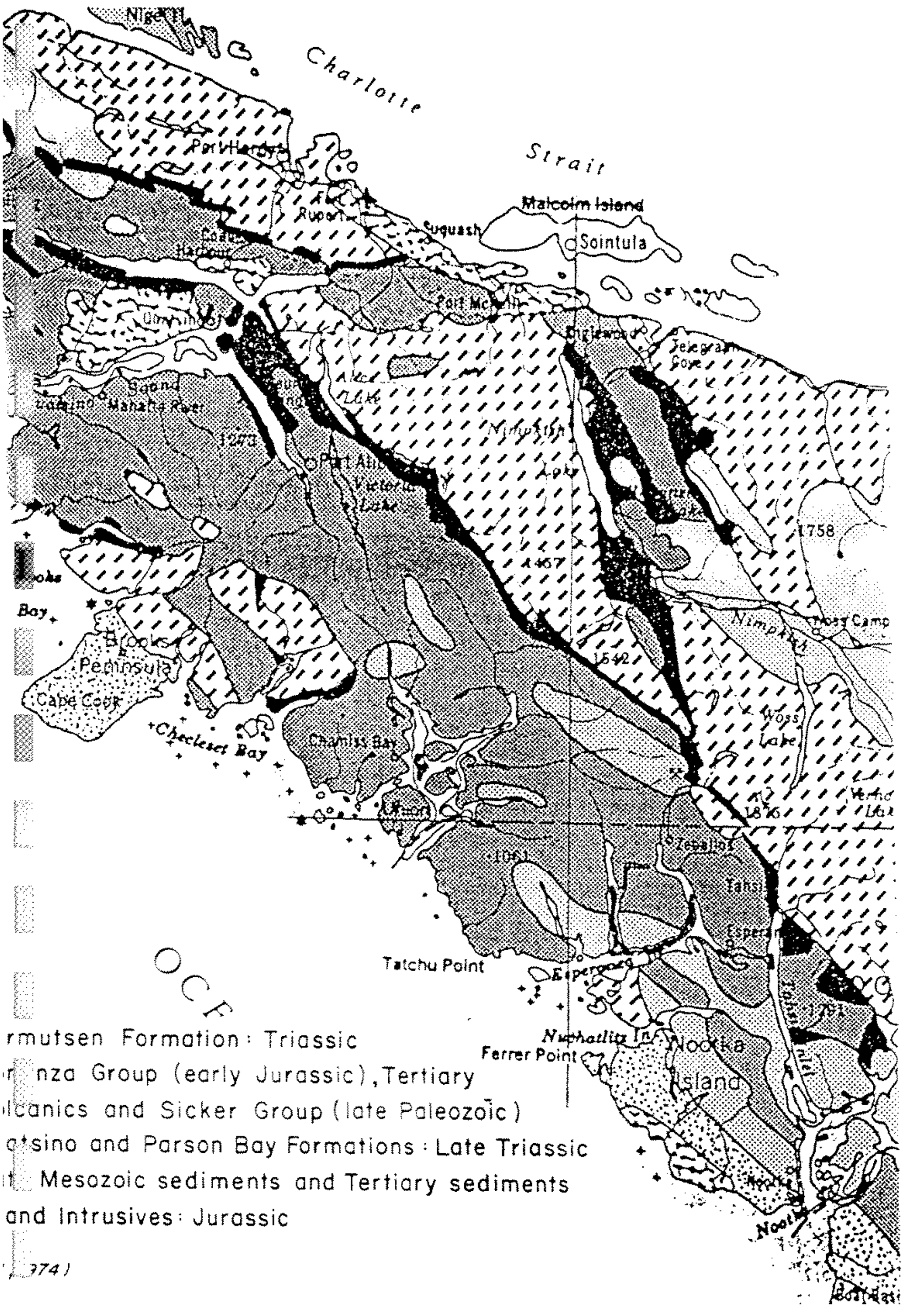
Appendix 1. - List of Contacts

Name	Affiliation and Phone	Information
Annett, Rory	MOF, Campbell River 286-3282	Forest tenures in Kyuquot area.
Campbell, R.W.	Wildlife Br., Victoria 356-1376	Report on vertebrates of Brooks Peninsula.
Doroff, Angela	U.S. Fish and Wildl. Serv., Anchorage. (907) 271-2465	Information on sea otter management in Alaska.
Harbo, Rick	DFO, South Coast Div., Nanaimo. 756-7270	Shellfish harvests and regulations.
Kaiser, G.	CWS, Delta. 946-8546	Seabird surveys.
Kayra, Sandra	Kyuquot Econ. and Env. Protection Soc. 332-5293	Chaired meeting on community concerns. Provided local information.
Miller, G.	Librarian, Pac. Biol. Stn., Nanaimo. 756-7000	Provided a variety of reports and statistical information.
Nash, Laurel	B.C. Parks, Victoria 387-4608	Provided access to E.R. files and report library.
Olesiuk, P.	Marine Mammals Group, Pac. Biol. Stn., 756-7254	Information on pinniped surveys.
Simmons, R.	B.C. Parks, Parksville 929-1291	Files, reports, and a range of background material.
Smith, Tessie	Assist. Chief, Kyuquot 332-5260	Comments on Band use of the area.
Watson, June	Contacted in field.	Discussion re. her research on sea otters.
Wong, R.	West Coast Expeditions. 926-1110	Discussion re recreational use of the reserve.
A.E.S.	Atmos. Env. Service, Van. 664-9156	Climatic data for Spring Island.

ıistribution of bedrock types (by origin and lithology)

rc Howes (1981)



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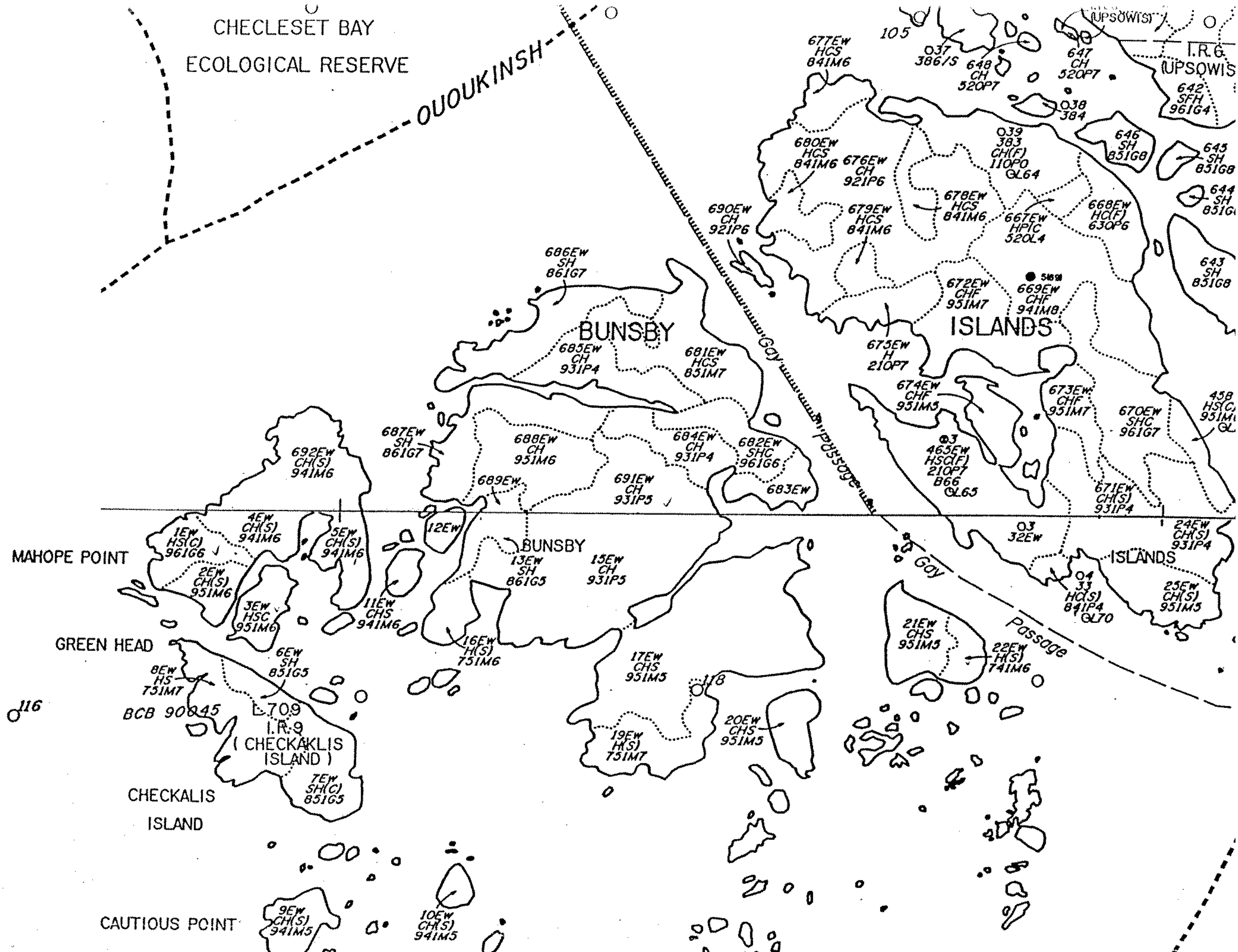

CHECLESET BAY
ECOLOGICAL RESERVE
OUOUKINSH
BUNSBY
ISLANDS
BUNSBY
ISLANDS
Gay Passage
Gay Passage
MAHOPE POINT
GREEN HEAD
CHECKALIS
ISLAND
CAUTIOUS POINT
I.R.9
(CHECKAKLIS
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BCB 90845
116
118
105
686EW SH 861G7
685EW CH 931P4
681EW HCS 851M7
690EW CH 921P6
680EW HCS 841M6
676EW CH 921P6
679EW HCS 841M6
678EW HCS 841M6
677EW HCS 841M6
667EW HPIC 520L4
668EW HC(F) 630P6
669EW CHF 941M8
672EW CHF 951M7
675EW H 210P7
674EW CHF 951M5
673EW CHF 951M7
670EW SHC 961G7
671EW CH(S) 931P4
692EW CH(S) 941M6
687EW SH 861G7
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684EW CH 931P4
682EW SHC 961G6
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691EW CH 931P5
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3EW HSC 951M6
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5EW CH(S) 941M6
6EW SH 851G5
7EW SH(C) 851G5
8EW HS 751M7
9EW CH(S) 941M5
10EW CH(S) 941M5
11EW CHS 941M6
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13EW SH 861G5
15EW CH 931P5
16EW H(S) 751M6
17EW CHS 951M5
19EW H(S) 751M7
20EW CHS 951M5
21EW CHS 951M5
22EW H(S) 741M6
23EW CH(S) 951M5
24EW CH(S) 931P4
03 32EW
04 33 HC(S) 841P4 GL70
03 465EW HSC(F) 210P7 B66 GL65
039 383 CH(F) 110P0 GL64
037 386/S
038 384
648 CH 520P7
647 CH 520P7
646 SH 851G8
645 SH 851G8
644 SH 851G
643 SH 851G8
642 SFH 961G4
458 HS(C 951M

FOREST COVER MAP LEGEND

I. FOREST LAND

A. FOREST LAND (FORESTED)

SPECIES COMPOSITION

Species are listed in their order of predominance. Major species are listed first followed by minor species in brackets.

SPECIES SYMBOLS

The standard symbols for some species are abbreviated, e.g. Fd is shown as F; Cw is shown as C.

F	-Douglas-fir	*Pl*	-Lodgepole pine
C	-Western redcedar	*Py*	-Yellow pine
H	-Hemlock	*L*	-Larch
B	-Balsam (True fir)	*Ct*	-Cottonwood
S	-Spruce	*D*	-Red alder
Sb	-Black spruce	*Mb*	-Broadleaf maple
Cy	-Yellow cedar	*Bi*	-Birch
Pw	-Western white pine	*A*	-Aspen
Pa	-Whitebark pine		

EXAMPLE OF A FOREST COVER LABEL

○12 / 66Es/LA / SB(Pl) / 210P2 / L72 P76

○12	-SILVICULTURE SYMBOL AND OPENING NUMBER
66	-POLYGON NUMBER
Es	-E.S.A. CATEGORY
L	-SECONDARY ELEMENT
A	-QUALIFIER
SB(Pl)	-SPECIES COMPOSITION
2	-AGE CLASS CODE
1	-HEIGHT CLASS CODE
0	-STOCKING CLASS CODE
P	-SITE CLASS CODE
2	-CROWN CLOSURE CLASS CODE
L72 P76	-HISTORY SYMBOLS AND CODES

HISTORY RECORD OPENING NUMBER

○12	-opening number valid for BCGS mapsheet
⊗12	-opening number valid for adjacent BCGS mapsheet
○12N	-opening number valid for NTS mapsheet
blank	-opening number has not been assigned

AGE CLASS CODES

CODE	LIMITS (years)
1	1-20
2	21-40
3	41-60
4	61-80
5	81-100
6	101-120
7	121-140
8	141-250
9	251+

HEIGHT CLASS CODES

CODE	LIMITS (metres)
1	0-10.4
2	10.5-19.4
3	19.5-28.4
4	28.5-37.4
5	37.5-46.4
6	46.5-55.4
7	55.5-64.4
8	64.5+

SITE CLASS CODES

CODE	SITE
L	Low
P	Poor
M	Medium
G	Good

SPECIAL SITE

e.g. *SB(Pl) 110P/M3*

P: Site class derived from age and height of leading species.

M: Special site. A special site class code may be entered to show productive capability when site cannot be reliably derived from the actual age and height of the leading species, i.e., for stands less than 20 years or for suppressed stands released following a disturbance.

STOCKING CLASS CODES

CODE		APPLIES TO	LIMITS No. of trees/hectare, d.b.h. limits
0		all immature *	N.A.
1		all mature *	≥76/ ha, 27.5 cm+ d.b.h.
2		all mature	<76/ ha, 27.5 cm+ d.b.h.
Subdivision of 2	3	mature, with leading species *Pl*	≥311/ ha, 17.5 cm+ d.b.h. and ≥50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
Subdivision of 2	4	mature, with leading species *Pl*	<311/ ha, 17.5 cm+ d.b.h., or ≥311/ ha, 17.5 cm+ d.b.h. and <50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
R		immature; mature	stands disturbed 26-75% by area or volume

*	All deciduous species; *Pl* ; *Pa*	All coniferous species except *Pl* and *Pa*
Immature	1-80 yrs.	1-120 yrs.
Mature	≥81 yrs.	≥121 yrs.

CROWN CLOSURE CLASS CODES

CODE	LIMITS (percentage)
0	0-5
1	6-15
2	16-25
3	26-35
4	36-45
5	46-55
6	56-65
7	66-75
8	76-85
9	86-95
10	96-100

SECONDARY ELEMENTS

L -Multi-layered stand (a separate description of each layer is available in the data base).
S -A separate silviculture description is available in the data base.
V -Veteran component.

QUALIFIERS

A -Complex stand (all-aged, uneven-aged).
E -Environmentally sensitive area.
I -Inoperable.

ENVIRONMENTALLY SENSITIVE AREA (E.S.A.) CATEGORIES

E.S.A. CLASS	E.S.A. CATEGORY	E.S.A. DESCRIPTION
High	*Es*	Areas having extremely fragile or unstable soils.
	Ep	Areas having severe regeneration problems caused by geoclimatic factors.
	Ea	Areas having severe snow chute and avalanche problems.
	Er	Areas having exceptionally high recreational values.
	Ew	Areas having critical importance to wildlife.
	Eh	Areas having very high water values and extreme sensitivity to harvesting.
Moderate	*E2s*	Areas having significantly fragile or unstable soils but less than those for *Es*.
	E2p	Areas having severe regeneration problems caused by biotic factors.
	E2r	Areas having high recreational values but less than those for *Er*.
	E2w *	Areas having high value for wildlife but less than that for *Ew*.
	E2h	Areas having very high water values and high sensitivity but less sensitivity than that for *Eh*.
	Ec	Areas having specific limitations (forest regeneration, snow avalanche areas, water, and operability). Used from 1973 to 1975 inclusive.
Nil		Management practices on these lands are subject only to operational constraints consistent with the policies of the Forest Region.

* Important areas for grizzly bears along salmon-producing streams are identified by <E2wb>.

	SYMBOL	STREAM VALUE TO FISH AND STREAM SENSITIVITY TO HARVESTING
Fisheries	▲	Nil
	■	Low
	●	Moderate
	◆	High

Note: Absence of fisheries symbols indicates information is not available.

HISTORY SYMBOLS

CLASS AND SYMBOL	CODE	HISTORY
Disturbance	*L*	Logging
	B	Wildfire
	W	Windthrow
	I	Insect
	D	Disease
	K	Fume kill
	S	Slide
	F	Flooding
Regeneration	*P*	Planted

CLASS AND SYMBOL	CODE	HISTORY
Stand Tending	*J*	Juvenile spacing
	M	Mistletoe control
	W	Brushing + weeding
	R	Conifer release
	S	Sanitation spacing
	P	Pruning
	T	Commercial thinning
	F	Fertilization
Site Preparation	*M*	Mechanical
	B	Broadcast burn
	S	Spot burn
	C	Chemical
	G	Grass seeded
	MS	Mechanical + spot burn

B. FOREST LAND (NON-FORESTED)

NSR -Not satisfactorily restocked
NCBr -Non-commercial brush

C. FOREST LAND (UNPRODUCTIVE)

A + Forest description
NP + Forest description

NCBr SPECIES SYMBOLS

D	-Alder (Mountain, Green, Sitka)	*R*	-Arbutus
E	-Birch (Water)	*K*	-Cascara
G	-Dogwood	*V*	-Cherry
M	-Maple (Vine, Rocky Mountain)	*J*	-Juniper
W	-Willow	*Q*	-Garry Oak
		T	-Western Yew

II. NON-FOREST LAND

A	-Alpine	(swamp symbol)	-Swamp or muskeg
R	-Rock	*C*	-Cultivated, cleared
(slide symbol)	-Slide	*U*	-Urban
NPBB	-Non-productive burn	*OR*	-Open range
NPBr	-Non-productive brush	*M*	-Wild hay meadow
NP	-Miscellaneous non-productive		

Note: Other categories of non-forest land are written in full, e.g. Claybank, Tidal Flat, Gravel Bar.

Appendix 4 . - Vascular plant list for Checleset Bay Ecological Reserve

Achillea millefolium - yarrow
Allium cernuum - nodding onion
Alnus rubra - red alder
Anaphalis margaritacea - pearly everlasting
Angelica genuflexa - kneeling angelica
Arabis sp. - rockress
Aquilegia formosa - red columbine
Arctostaphylos uva-ursi - kinnikinnick
Blechnum spicant - deer fern
Bromus carinatus - California brome
Cakile edentula - American searocket
Calamagrostis canadensis - bluejoint
Calamagrostis nutkaensis - Pacific reedgrass
Campanula rotundifolia - common harebell
Carex lyngbyei - Lyngbye's sedge
Castilleja hispida - harsh paintbrush
Castilleja miniata - common red paintbrush
Cerastium arvense - field chickweed
Cirsium vulgare - spear thistle
Conioselinum pacificum - Pacific hemlock parsley
Deschampsia cespitosa - tufted hairgrass
Elymus mollis - dune wildrye
Equisetum arvense - common horsetail
Fragaria chiloensis - coastal strawberry
Franseria chamissonis - sand-bar ragweed
Fritillaria chamschatcensis - northern rice-root
Galium aparine - cleavers
Galium triflorum - sweet-scented bedstraw
Gaultheria shallon - salal
Heracleum lanatum - cow parsnip
Holodiscus discolor - ocean-spray
Heuchera micrantha - small flowered alumroot
Honckenya peploides - seabeach sandwort
Hordeum b rachyantherum - meadow barley
Hypochaeris radicata - hairy cat's ear
Juncus balticus - Arctic rush
Lasthenia maritima - hairy goldfields
Lilium columbianum - tiger lily
Listera caurina - northwestern tway blade
Lonicera involucrata - black twinberry
Maianthemum dilatatum - false lily-of-the-valley
Menziesia ferruginea - false azalea
Mimulus guttatus - yellow monkey-flower
Montia sibirica - Siberian miner's lettuce
Phyllospadix scouleri - Scouler's surf-grass
Picea sitchensis - Sitka spruce
Pinus contorta - lodgepole pine (shorepine)
Plantago maritima - sea plantain
Poa pratensis - Kentucky bluegrass
Polypodium hesperium - western poly pody
Polystichum braunii - Braun's holly-fern
Polystichum munitum - sword-fern
Potentilla villosa - villous cinquefoil
Pteridium aquilinum - bracken fern

Appendix 4. - Continued

Malus fusca - Pacific crab apple
Ranunculus occidentalis - western buttercup
Rhamnus alnifolius - alderleafed buckthorn
Rhamnus purshiana - cascara
Ribes inerme - white-stemmed gooseberry
Rosa gymnocarpa - baldhip rose
Rosa nutkana - Nootka rose
Rubus parviflorus - thimbleberry
Rubus pedatus - five-leaved bramble
Rubus spectabilis - salmonberry
Rumex occidentalis - western dock
Sagina procumbens - bird's-eye pearlwort
Salicornia pacifica - American glasswort
Salix hookeriana - hooker's willow
Salix sp. - willow
Sambucus racemosa - red elderberry
Saxifraga ferruginea - Alaska saxifrage
Sedum spathulifolium - broad-leaved stonecrop
Scrophularia lanceolata - lance-leaved figwort
Sisyrinchium bellum - blue-eyed grass
Sonchus asper - prickly sow-thistle
Spergularia canadensis - Canadian sand-spurry
Stachys cooleyae - Cooley's hedge-nettle
Stachys mexicana - Mexican hedge-nettle
Stellaria borealis - Boreal starwort
Stellaria crispa - crisp starwort
Taraxacum officinale - dandelian
Thuja plicata - western red cedar
Tiarella trifoliata - three-leaved foamflower
Trifolium wormskjoldii - springbank clover
Tsuga heterophylla - western hemlock
Tellima grandiflora - tall fringecup
Urtica dioica - stingingnettle
Vicia gigantea - giant vetch
Vaccinium parvifolium - red huckleberry
Zostera marina - eel-grass

Appendix 5 . - Birds of the Checleset Bay area.

Species	Status[2]	Location	Source[3]
Red-throated Loon	(sV)	Brooks Pen. (Lakes)	1
Pacific Loon	M	Gull Isl.; Bunsby	2
Common Loon	R	Gull Isl.; Bunsby Isl.	2,3
Horned Grebe	(wV)	Brooks Pen. (Klaskish In.)	1
Red-necked Grebe	R	Checleset Bay	1
Western Grebe	sV	" "	1
Sooty Shearwater	V	Clerke Pt. Clara Islet	1,2
Leach's Storm-Petrel	sV,B	Thomas Isl.	2,4
Fork-tailed Storm-Petrel	sV,B	" "	2,4
Brandt's Cormorant	V	Clerke Point	1
Pelagic Cormorant	R,B	O'Leary Islets	2,4
Great-blue Heron	V	Bunsby Islands	3
Cattle Egret	V	South tip Brooks Pen.	1
Trumpeter Swan	(wV)	Klaskish and Nasparti estuaries	1
Brant	sM	Checleset Bay	1,2
Canada Goose	M,wV	Estuaries around Brooks Pen.	1
Green-winged Teal	fM	" " " "	1
Mallard	R	" " " "	1
Northern Pintail	M	Clerke Point	1
Blue-winged Teal	V	" "	1
Amer. Wigeon	(wV)	Estuaries	1
Greater Scaup	M	Clerke Point	1
Harlequin Duck	sV	Gull Islet	2
Surf Scoter	R	Clerke Point	1
White-winged Scoter	R	Clerke Point; O'Leary Isl.; Bunsby	1,2,3
Bufflehead	wV	Bays along Brooks Pen.	1
Common Merganser	R	Bunsby Islands	3
Red-breasted Merganser	V	Jacobsen Point	1
Osprey	(sV)	Brooks Peninsula	1
Bald Eagle	R,B	Brooks; Bunsby; Thomas	1,2,3,4
Sharp-shinned Hawk	sV	Bunsby Islands	3
Northern Goshawk	(V)	Nasparti Inlet	1
Red-tailed Hawk	(V)	Brooks Pen.	1
Peregrine Falcon	R(B)	Solander Isl., Quineex	1
Blue Grouse	R(B)	Bunsby Islands	2,3
Ruffed Grouse	R(B)	" "	3
Black-bellied Plover	(fM)	Brooks Pen.	1
Semipalmated Plover	(fM)	" "	1
Killdeer	(V)	Nasparti estuary	1
Black Oystercatcher	R,B	Bunsby; Thomas; Clara; Gull	2,3,4
Greater Yellowlegs	fM	Bunsby Islands	3
Wandering Tattler	(sV)	Brooks Pen., Thomas Isl.	1,2
Spotted Sandpiper	sV	Brooks Pen.; Bunsby Isl.	1,3
Whimbrel	sV	Clerke Point; Clara Islets	1
Black Turnstone	R	Brooks Pen., Bunsby Isl.	1,3
Sanderling	M	Bunsby Islands	3
Western Sandpiper	M	Clerke Point	1
Least Sandpiper	M	" "	1

Appendix 5. - Continued

Species	Status	Location	Source
Short-billed Dowitcher	(M)	Brooks Pen.	1
Red-necked Phalarope	M	Clerke Point	1
Parasitic Jaeger	M	" "	1
Bonaparte's Gull	M	" "	1
Mew Gull	R	Brooks Pen.	1
California Gull	V	Brooks Pen., Bunsby Isl.	1.2
Herring Gull	V	Clerke Point	1
Glaucous-winged Gull	R,B	Thomas, Gull, Clara, O'Leary	1,2,3,4
Western Gull	V	Brooks Pen.	1,2
Black-legged Kittiwake	V	Clerke Point, Thomas Isl.	1,4
Caspian Tern	V	Quineex Reef; Battle Bay	1,2
Common Murre	R	Barrier Isl's.; Bunsby Isl's.	1,2
Pigeon Guillemot	R,B	Most islands in Checleset Bay	2,3,4
Marbled Murrelet	V	Checleset Bay	2
Cassin's Auklet	sV	Brooks Pen., Solander Isl.	1
Rhinoceros Auklet	V	Clerke Point, Bunsby Isl.	1,2
Tufted Puffin	sV	Brooks Pen.	1
Horned Puffin	sV	Quineex Reef	2
Band-tailed Pigeon	sV	Quineex, Bunsby Islands	1,2,3
Western Screech-Owl	(V)	Nasparti River	1
Great-Horned Owl	(V)	Brooks Pen.	2
Rufous Hummingbird	sV(B)	Brooks Pen., Bunsby Isl., Thomas Isl.	1,2,3,4
Belted Kingfisher	R(B)	Brooks Pen., Bunsby Isl.	2,3
Hairy Woodpecker	R	Bunsby Islands	2,3
Northern Flicker	R(B)	Brooks Pen., Bunsby Isl.	1,3
Pileated Woodpecker	V	Bunsby Islands	3
Western Flycatcher	sV(B)	Jacobsen Pt.; BUnsby Isl.	2,3
Eastern Kingbird	V	Quineex Reef	1
Tree Swallow	sV	Bunsby Islands	2
Rough-winged Swallow	(sV)	Nasparti Estuary	1
Steller's Jay	R(B)	Brooks Pen., Bunsby Isl.	1,3
Northwestern Crow	R,B	Quineex, Bunsby, Thomas	1,2,3,4
Common Raven	R	Brooks Pen., Bunsby Isl.	1,3
Chestnut-backed Chickadee	R(B)	" " " "	1,3
Red-breasted Nuthatch	R	Bunsby Islands	2
Brown Creeper	R	" "	2
Winter Wren	R,B	Brooks, Bunsby, Thomas	1,2,3,4
Golden-crowned Kinglet	V	Bunsby Islands	2,3
Swainson's Thrush	sV,(B)	" "	2,3
Hermit Thrush	sV	" "	2,3
American Robin	R(B)	Brooks, Bunsby Islands	1,2,3
Varied Thrush	R(B)	" " "	1,2
Townsend's Solitaire	M	Bunsby Island	2
Cedar Waxwing	(sV)	Brooks Pen.	1
European Starling	(sV)	" "	1
Red-eyed Vireo	sV	Bunsby Islands	2
Orange-crowned Warbler	sV(B)	Brooks Pen., Thomas Isl.	2,4
Yellow-rumped Warbler	(sV)	Brooks Pen.	1
Townsend's Warbler	sV(B)	Brooks Pen., Bunsby Isl.	1,2,3
Wilson's Warbler	sV	Brooks Pen.	1,2

Appendix 5. - Continued

Species	Status	Location	Source
Savannah Sparrow	(M)	Brooks Pen.	1
Fox Sparrow	sV(B)	Brooks, Bunsby, Thomas	1,2,3,4
Song Sparrow	R,B	" " "	1,2,3,4
Dark-eyed Junco	(R)	Brooks Pen.	1
Red-winged Blackbird	(fM)	Nasparti R. Estuary	1
Brown-headed Cowbird	(fM)	" " "	1
Red Crossbill	R	Bunsby islands	3
Pine Siskin	sV	Brooks Pen., Bunsby Islands	1,2

[1] Species names and sequence follow Cannings and Harcombe (1990).

[2] V = VISITANT: Species which visit the area to breed or move northward from southern breeding ground. Also includes species for which there are only one or two records in the general area.

R = RESIDENT: Occurs at all seasons, but may or may not breed here.

M = MIGRANT: Species which pass through the reserve on spring and/or fall migration, but do not breed there.

B = BREEDER: Species for which breeding evidence (eggs and/or flightless or recently fledged young has been reported.

Seasonal occurrence (where known): s = summer; f = fall; w = winter; v = spring

Brackets indicate status of species which are expected to occur in the reserve from time to time, but have not been officially recorded there. (B) = probable but unconfirmed breeding.

[3] Sources:

1 = Campbell and Summers (in press).

2 = Carson and Foster 1978a.

3 = Carl and Guiguet 1956.

4 = Campbell (1976) and Royal B.C. Museum Seabird Files.

Appendix 6. - Aerial counts of Waterbirds along south side of Brooks Peninsula (Clerke Point to Nasparti Inlet).[1]

Waterbird Group	Date and number counted			
	20 Apr./76	5 Jan./77	19 Jan./78	30 Oct./79
Grebes	0	0	0	11
Cormorants	0	1	0	1
Swans	0	0	0	0
Geese	0	20	0	35
Dabbling Ducks	0	0	0	61
Diving Ducks	0	58	25	70
Gulls	0	28	0	81
Alcids	6	0	0	7
TOTAL	6	107	26	266

[1] data from Campbell and Summers (in press).

Appendix 7. - Mammals observed in or expected to occur at Checleset Bay Ecological Reserve.

Species	Recorded in the reserve[1]		Expected[2]	
	Location	Source	Brooks Pen.	Other
Dusky shrew	W. Bunsby; Little Bunsby; N. & S. Checkaklis	1		
Deer mouse	W. Bunsby; N. & S. Checkaklis	1		
Townsend vole	Little Bunsby	1		
Little brown bat	East Bunsby	1		
Yuma bat				X
Long-legged bat				X
Keen's bat				X
Long-eared bat				X
California bat				X
Silver-haired bat			X	
Hoary bat			X	
Big brown bat				X
Red squirrel	W. bunsby; N. & S. Checkaklis	1		
Gray wolf	"Bunsby Islands"; Cuttle Isl., Brooks Pen.	1,6,5		
Sea otter	Throughout Checleset Bay	2,3		
River otter	Thomas Island; Brooks Pen.	3		
Mink	Little Bunsby; Checkaklis	1		
Raccoon	W. Bunsby	1		
Black bear	W. Bunsby	1		
Black-tailed deer	All Bunsby Islands	1		
Northern Sea lion	O'leary; Clara; Barrier Islets	3,4		
California Sea lion			X	
N. Elephant seal			X	
Harbour seal	Throughout the reserve	1,3,5		
Killer whale	Pass through the reserve	3,5		
Dall's porpoise			X	
Gray whale	Pass through the reserve	5		

Appendix 7. - Continued

[1] Sources as follows: 1 = Carl and Guiguet (1956); 2 = Watson (1989); 3 = Carson and Foster 1978b; 4 = Bigg (1985); 5 = Campbell and Summers (in press); 6 = Watson 1990.

[2] Indicates that the species is expected to occur based on known occurrence at Brooks Pen. (Campbell and Summers, in press) or from Other sources (range maps in Van Zyll de Jong, 1985).

Appendix 8. - Terrestrial invertebrates of the Bunsby Islands[1]

MOLLUSCS

Ariolimax maximus. Giant Slug.

This large land form was abundant on all the islands, particularly on Checkaklis where it was a serious pest to the mouse-trapper, springing traps, covering the mechanism with sticky mucus, and damaging specimens.

Prophysaon andersoni. Anderson Slug.

This handsome native species was observed on East Bunsby and was probably present on all the islands. Both the common grey colour phase and a yellow colour phase were noted.

Haplotrema sportella.

Polygyra columbiana.

Both the above species of snails were present; on several occasions they were found damaging mice or shrews in traps.

MILLIPEDES AND CENTIPEDES

The following species were kindly identified by Dr. R. V. Chamberlin, of the University of Utah, Salt Lake City, Utah.

AMPHIPODS

Anisogammarus ramellus (Weckel). Fresh-water Amphipod.

These fresh-water "shrimp" were abundant in a small stream near our camp-site on East Bunsby. Many were found feeding upon a drowned mouse, and others were located under stones and other debris. The species has previously been reported only from Triangle and Lanz Islands (Carl, Guiguet, and Hardy, 1952).

ISOPODS

Porcellio scaber Latreille. Sow-bug (Wood-louse).

The common sow-bug was present on both East and West Bunsby Islands.

Otocryptops sexspinosus (Say). Centipede.

East and West Bunsby Islands.

Geophilus glyptus Chamberlin. Centipede.

Little Bunsby Island.

Cheiletha kincaidi Chamberlin. Centipede.

East Bunsby Island.

Nearctodesmus malkini Chamberlin. Millipede.

East Bunsby and Little Bunsby Islands.

Saiulus setifer Chamberlin. Millipede.

East Bunsby Island.

INSECTS

The following insects have been kindly identified by Mr. George A. Hardy, of the Museum staff, except in the case of the Hemiptera, which have been named by Mr. William Downes, of Victoria, B.C.

BEETLES (COLEOPTERA)

Pterostichus lama Men. Large Ground-beetle.
Pterostichus herculeanus Mann. Common Ground-beetle.
Zacotus matthewsi LeC. Bronze Beetle.
Necrophorus melsheimeri Kby. Burying-beetle.
Athous vittiger LeC. Click-beetle.

SNAKE-FLIES (RAPHIDIIDÆ)

Raphidia sp.

TWO-WING FLIES (DIPTERA)

Tabanus sonomensis O.S. Horse-fly.

BEES AND WASPS (HYMENOPTERA)

Vespula consobrina DeSauss. Black Hornet.
Bremus sp. Bumble-bee.
Camponotus levigatus (F. Smith). Carpenter-ant.
Coleocentrus sp. Ichneumon Fly.
Trichiosoma triangulum Kby. Sawfly.

BUTTERFLIES AND MOTHS (LEPIDOPTERA)

Septis vulturosa Grt. Quaker.

STRAIGHT-WINGED INSECTS (ORTHOPTERA)

Ceuthophilus sp. Camel-cricket.

BUGS (HEMIPTERA)

Philænus leucopthalmus (L.) vars. *fabricii* and *pallidus*. Common Spittle-bug.
Aphrophora permutata Uhl. Leaf-hopper.
Lopidea ampla Van D. Leaf-hopper.
Stenodema vicinum (Prov.). Leaf-hopper.

[1] from Carl and Guiguet 1956.

Appendix 9. - Algae in Checleset Bay, E.R. 109[1]

Agarum fimbriatum
Alaria marginata
Ahnfeltia gigartinoides
Botryoglossum farlowianum
Callophyllis firma
Callophyllis sp.
Codium fragile
Codium setchellii
Constantinea simplex
Constantinea subulifera
Costaria costata
Derbenia maritima
Desmarestia ligulata
Dictyota binghamiae
Egregia menziesii
Eisenia arborea
Fauchea sp.
Fucus distichus
Gigartina exasperata
Gigartina sp.
Gracilaria sp.
Gymnogongrus platyphyllus
Halosaccion glandiforme
Halymenia sp.
Hedophyllum sessile
Hildenbrandia sp.
Iridaea sp.
Laminaria groenlandica
Laminaria setchellii
Laurencia spectabilis
Lessoniopsis littoralis
Lithothamnion sp.
Lomentaria hakodatensis
Macrocystis integrifolia
Neoagardhiella baileyi
Nereocystis luetkeana
Opuntiella californica
Palmaria palmata
Pikea californica
Pleurophycus gardneri
Plocamium sp.
Polyneura latissima
Prionitis filiformis
Prionitis lanceolata
Prionitis lyalli
Pterygophora californica
Rhodymenia californica
Rhodymenia pacifica
Rhodoglossum californica

Marine Vascular Plants

Zostera sp.	eelgrass
Phyllospadix sp.	seagrass, surfgrass

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1 from Stewart et al. 1982

Appendix 10. - Marine invertebrates of Checleset Bay E.R. #109[1]

STARFISHES AND RELATIVES

Cucumaria miniata - Sea Cucumber
Crossaster papposus - Rose Star
Dermasterias imbricata - Leather Star
Eupentacta sp. - Sea Cucumber
Evasterias troschelii - Long-rayed Star
Henricia leviuscula - Red Starfish
Leptasterias hexactis - Brooding Sea Star
Mediaster aequalis - Red Star
Orthasterias koehleri -
Parastichopus californicus - Sea Cucumber
Patiria miniata - Sea Bat
Pisaster ochraceus - Purple Starfish
Pycnopodia helianthoides - Sunflower Star
Solaster dawsoni - Dawson Sun Star
Solaster stimpsoni - Stimpson Sun Star
Stichopus californicus - Giant Sea Cucumber
Strongylocentrotus droebachiensis - Green Sea Urchin
Strongylocentrotus franciscanus - Large Purple Urchin
Strongylocentrotus purpuratus - Small Purple Urchin

MOLLUSCS

Acmaea mitra - limpet
Amphissa columbiana - snail
Archiodoris montereyensis - sea lemon
Ariolimax maximus - giant slug
Astraea gibberosa -
Astraea inaequalis - turban shell
Calliostoma foliatum - snail
Chlamys sp. - swimming scallop
Cryptochiton stelleri - gumboot chiton
Diodora aspera - keyhole limpet
Dirona albolineata - nudibranch
Haplotrema sportella - snail
Haliotis kamschatkana - Northern abalone
Hinnites giganteus - rock scallop
Katherina tunicata - leather chiton
Mopalia muscosa - mossy chiton
Mya arenaria - soft shell
Mytilus californianus - mussel
Mytilus edulis - edible mussel
Ostrea lurida - native oyster
Polinices lewisi - moon snail
Polygyra columbiana - snail
Prophysaon andersoni - Anderson slug
Protothaca staminea - little-neck clam
Saxidomus giganteus - butter clam
Schizothaerus nuttali - horse clam
Searlesia dira - dire whelk
Tegula funebralis - black turban

Appendix 10. - Continued

Tegula pulligo - snail
Thais emarginata - short-spired purple snail
Tonicella sp. - chiton
Triopha carpenteri - sea slug

CRUSTACEANS

Cancer oregonensis - Oregon crab
Cancer magister - edible crab
Hemigrapsus nudus - purple shore crab
Pophopanepeus bellus bellus - black-clawed crab
Mimulus foliatus - decorator crab
Oregonia gracilis - decorator crab
Pachycheles rudis
Pugettia gracilis - graceful kelp crab
Pugettia producta - northern kelp crab
Pugettia richii
Scyra acutifrons

Hermit Crabs

Pagurus granosimanus - granular hermit crab
Pagurus hirsutiusculus - hairy hermit crab
Petrolisthes cinctipes - flat-topped crab

BARNACLES

Balanus cariosus
Balanus glandulus
Balanus nubilus
Pollicipes polymerus - goose-necked barnacle

ANEMONE AND ALLIES

Anthropleura elegantissima - sea anemone
Epiactis prolifera - brooding anemone
Metridium senile - anemone
Tealia piscivora
Tealia sp. - sea anemone

TUNICATE

Aplidium sp. - colonial tunicate
Didemnum sp. - tunicate
Balanophyllia elegans - cup coral
Metandrocarpa taylori - tunicate

HYDROID

Ophlita spongia pennata - encrusting sponge
Plumaria sp. - hydroid

Appendix 10. - Continued

BRYOZOAN

Bugula sp.
Hippodiplosia infundibulum
Hippodiplosia insculpta

POLYCHAETE
Dodecaceria fewkesi

Serpula vermicularis - tube worm
Spirorbis sp. - tube worm

ASCIDIAN

Styela montereyensis
Styela gibsii

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1 compiled from Stewart, E.A. et al. 1982.

Appendix 11. - Fish in Checleset Bay, E.R. 109[1]

Cymatogaster aggregata - sea perch
Embiotoca laterallis - striped sea perch
Enophrys bison - buffalo sculpin
Hexagrammos decagrammus - kelp greenling
Ophiodon elongatus - ling cod
Oxylobias pictus
Scorpaenicthys marmoratus - cabezon
Sebastes caurinus
Sebastes melanops - black rockfish
Sebastes nebulosus

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1 from Stewart, E.A. *et al*. 1982.

MAMMALIAN SPECIES No. 133, pp. 1–8, 3 figs.
Appendix 12

Enhydra lutris.

By James A. Estes

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Enhydra Fleming, 1822

Enhydra Fleming, 1822:187. Type species *Mustela lutris* Linnaeus, 1758.

Pusa Oken, 1816:985. Type species *Pusa orientalis* Oken. Oken's names not available, by ruling of International Commission on Zoological Nomenclature.

Latax Gloger, 1827:511. Type species *Mustela lutris* Linnaeus. Replacement name for *Enhydra*.

Enydris Fischer, 1829:288, an emendation of *Enhydra* Fleming.

CONTEXT AND CONTENT. Order Carnivora, Family Mustelidae, Subfamily Lutrinae. G. B. Corbet (1978), following Pocock (1921) allocated *Enhydra* to a separate subfamily—the Enhydrinae. The genus *Enhydra* contains one extant species, *Enhydra lutris*, as treated below.

Enhydra lutris (Linnaeus, 1758)
Sea Otter

Mustela lutris Linnaeus, 1758:45. Type locality Kamchatka, USSR.

Lutra gracilis Bechstein, 1800:408. Type locality "Stattenland" (=southernmost of the Kuril Islands).

Pusa orientalis Oken, 1816:986. Oken's names are not available.

Lutra stelleri Lesson, 1827:156. Type locality Kamchatka, USSR.

CONTEXT AND CONTENT. Context noted above. Three subspecies are currently recognized. Roest (1973) suggested that *E. l. lutris* and *E. l. nereis* be synonymized, but Davis and Lidicker (1975) disagreed.

E. l. lutris (Linnaeus, 1758:45), see above.

E. l. nereis (Merriam, 1904:159). Type locality San Miguel Island, Santa Barbara Islands, California.

E. l. gracilis (Bechstein, 1800:408), see above.

DIAGNOSIS. The following diagnosis applies to both genus and species. The sea otter is the largest species in the Mustelidae; adult males attain weights of 45 kg (100 lbs) and total lengths of 148 cm (58 inches). Adult females attain weights of 32.5 kg (72 lbs) and total lengths of 140 cm (55 inches) (Kenyon, 1969). Adult dental formula is i 3/2, c 1/1, p 3/3, m 1/2, total 32. *Enhydra lutris* is the only species of fissiped carnivore with two pairs of lower incisors. All other species in the Lutrinae have three incisors on each lower jaw and 34 (*Amblyonyx cinerea*) or 36 (all remaining species) teeth. Molars are broad and flat with no cutting surfaces. The upper molars are large and quadrate with massive, rounded crowns, and medial tubercular portions expanded anteroposteriorly (Blair et al., 1957). Posteriorly oriented hind limbs are elongate and flipper-like (Murie, 1959); the tarsals and metatarsals are flattened. Digits on the hind limbs increase in length from the first to the fifth; forepaws are mitten-like and have retractile claws. The tail is less than one-third the body length, somewhat flattened dorsoventrally, and of similar thickness from base to tip. The fur is dense and glossy and contains 100,000 or more hairs/cm^2 (Kenyon, 1969). The teres ligament is absent (Taylor, 1914).

GENERAL CHARACTERS. The head is large and blunt; the neck short and thick (Bisaillon et al., 1976); and front limbs short (Fig. 1). Males average 34% heavier and 8% longer than females, and the head and neck of males are comparatively more robust. The only definitive characters by which the sexes may be distinguished in the field are the presence of a penial bulge in males and two abdominal mammae in females (Barabash-Nikiforov, 1947; Kenyon, 1969).

Pelage color varies from dark brown to reddish brown. Pelage consists of sparse guard hairs and a dense, soft underfur. Old individuals often become grizzled, with the head, neck, and shoulders taking on a paler color than the remainder of the body. The skin is loose and moves easily about the body (Lekh, 1907); a particularly loose flap of skin under each forelimb is used to hold and transport food. The body is entirely furred except for the rhinarium, inside the ear pinnae, the palmar surface of the forefoot, and small patches on the plantar surface of each digit of the hindlimbs. Fur covering the hindfeet is comparatively short and sparse.

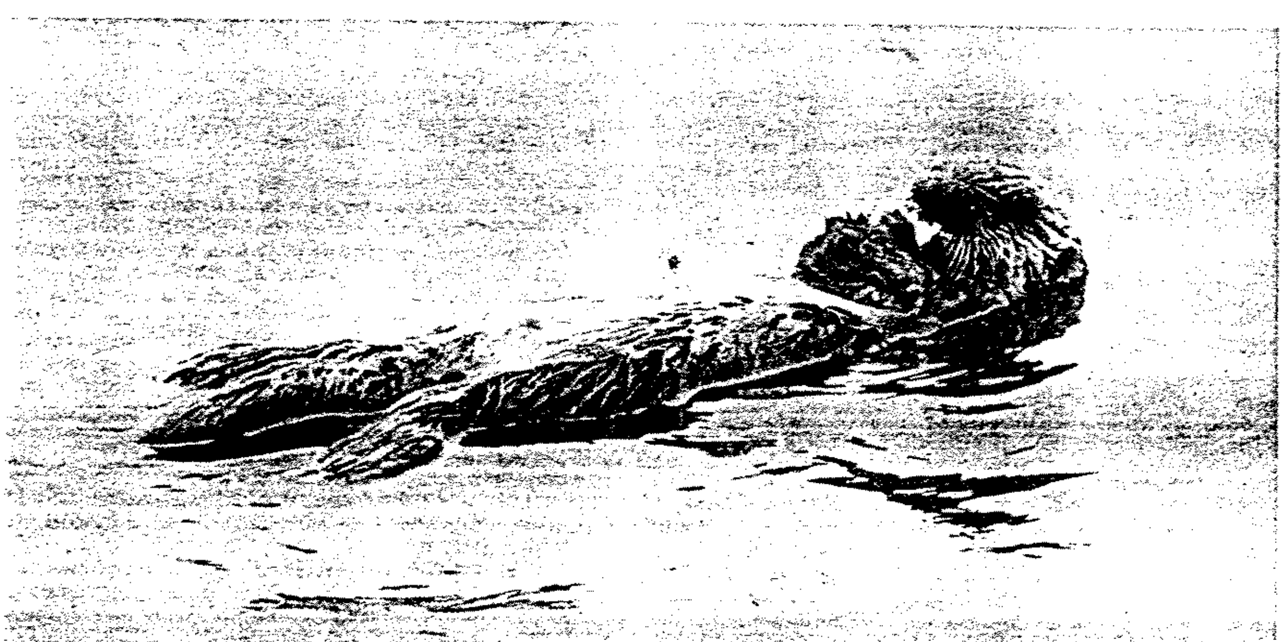

FIGURE 1. A sea otter consuming food. Only the surface of the fur is wetted. Photograph by James A. Mattison.

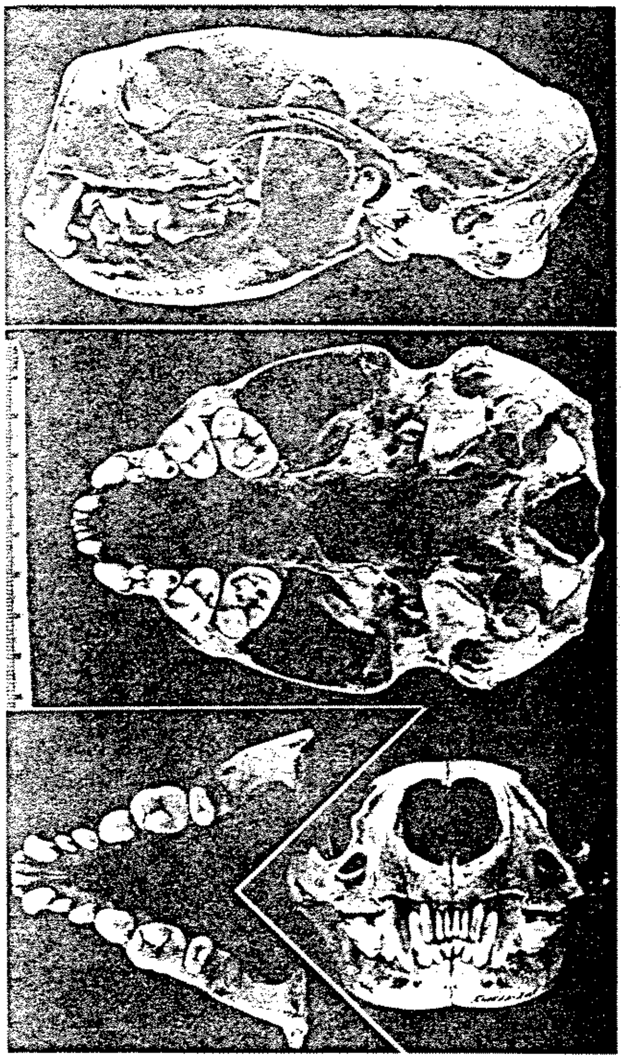

FIGURE 2. Skull of *Enhydra lutris* in lateral, ventral, and anterior views, and lower jaw in occlusal view. Photographs by Karl W. Kenyon.

In some individuals the left side of the cranium is slightly larger than the right, creating bilateral asymmetry of the skull in the form of a bend in the sagittal crest behind the interorbital constriction. There is a gap between the upper outer incisors and canines into which the lower canines fit when the jaw is closed (Fig. 2). Malocclusion is common (Kenyon, 1969). The skeleton often is purple due to polyhydroxynaphthoquinone ingested from sea urchin tests (Fox, 1953).

Ranges of external body measurements of adults from Scheffer (1951) and Kenyon (1969) are as follows: total length, males 126 to 145 cm, females 107 to 140 cm; weight, males 21.8 to 44.9 kg, females 14.5 to 32.7 kg. Kenyon (1969) reported that the average weights of adult males and females are, respectively, 28 and 16% greater in sparse than in crowded populations. Range of condylobasal length of skull is 125 to 144 mm in adult males and 115 to 136 mm in adult females (Roest, 1973). Barabash-Nikiforov (1947) and Ognev (1931) presented other skull and body measurements.

DISTRIBUTION. The original distribution was from 27°32'N on the Pacific coast of Baja California (Ogden, 1941), northward along the Pacific coast of North America to Prince William Sound, southwestward along the Alaska Peninsula and through the Aleutian, Pribilof, and Commander islands to Kamchatka, and south through the Kuril Islands to Sakhalin and Hokkaido (Fig. 3). The longest gap in the original distribution was 300 km between the Near and Commander islands (Lensink, 1960). Abundance was greatly reduced by human exploitation. Between 1751 and 1911 the distribution was reduced to 13 known remnant populations: two in the Kuril Islands and Kamchatka; one in the Commander Islands; five in the Aleutian Islands and along the Alaska Peninsula; and one each at Kodiak Island, Prince William Sound, the Queen Charlotte Islands, central California, and San Benito Islands. Several of these subsequently declined to extinction (Kenyon, 1969). A history of the populations and a thorough review of distributional records prior to 1968 are given by Kenyon (1969). Today much of the original range is occupied from the Kuril Islands, across the north Pacific to Prince William Sound; they are largely absent to the southeast of Prince William Sound. Translocations have reestablished sea otters at Chichagof and Baranof islands, southeast Alaska (Jameson et al., 1978), and Vancouver Island (Bigg and MacAskie, 1978); other translocated populations are probably declining (the coasts of Washington and Oregon) or extinct (Pribilof Islands and Near Islands, Aleutian archipelago).

Sizes of these populations are not precisely known. Presently, there probably are at least 100,000 sea otters from Prince William Sound, west through the Kuril Islands: 500 to 1000 in southeast Alaska (A. M. Johnson, pers. comm.); about 100 at Vancouver Island (Bigg and MacAskie, 1978); less than 50 in Washington and Oregon (R. J. Jameson, A. M. Johnson, and K. W. Kenyon, in litt.); and about 2000 in California (J. A. Ames, pers. comm.).

Sea ice limits the northern permanent range (Nikolaev, 1965; Schneider and Faro, 1975) which Gribkov (1963) and Kenyon (1969) believed is about 57°N. Individuals sighted in the northern Bering Sea (Lensink, 1960) and Arctic Ocean (Bee and Hall, 1956) may have drifted north on currents or retreating ice (Kenyon, 1969). The northernmost substantiated record is from Chaun Bay (70°N, 170°E) in the East Siberian Sea (Zimushko et al., 1968). Factors limiting permanent range to the south are unknown although on the Pacific coast the southern limit coincides with the 20 to 22°C isotherm, which also is about the southern limit of cool water upwelling and distribution of giant kelp (*Macrocystis*). Sea otters from central California occasionally wander south of Point Conception and into northern Baja California, Mexico (Leatherwood et al., 1978).

FOSSIL RECORD. Fossil remains of *Enhydra* are known from the eastern North Pacific: the earliest record is early Pleistocene (Leffler, 1964; Mitchell, 1966; Repenning, 1976). One extinct species, *Enhydra macrodonta* Kilmer (1972), is known from the late Pleistocene in California. Two lineages of *Enhydriodon* are suggested by Repenning (1976). One (from the Old World Miocene) gave rise to *Enhydriodon sivalensis*, which is known from the late Pliocene in India. The other branch (from the Old World Pliocene) apparently led to *Enhydriodon reevei* in the early Pleistocene of the North Atlantic, and to *Enhydra* in the North Pacific. *Enhydra* probably was confined subsequently to the North Pacific by the barriers of sea ice to the north and warm water to the south.

The different arrangements of gyri in the forelimb cortical projection area of the brain suggest that *Enhydriodon* evolved independently from aonychoid otters (Radinsky, 1968) for at least as long as their known fossil records. Repenning (1976) suggested that *Enhydriodon* and the aonychoid otters represent two separate derivations of crab-eating otters from earlier fish-eating forms.

FORM. Hairs are pale gray at their bases and are dark distally, varying from pale buff to nearly black. Guard hairs and underfur are slightly longer on the dorsum than on the venter (Barabash-Nikiforov, 1947). The absence of arrector pili permits the hairs to lie flat when wetted (Ling, 1970). A single guard hair associated with about 70 underfur hairs, a sweat gland, and two sebaceous glands that join on the anterior side of the guard hair comprise the pelage unit. Hair density and length decrease from mid-back to the hind foot (Tarasoff, 1972). Molting occurs throughout the year, although maximum follicular activity is during spring (Ognev, 1931; Kenyon, 1969). Fur density is lower in summer than winter (Barabash-Nikiforov, 1947). There are mystacial, superciliary, and nasal sensory vibrissae (Kenyon, 1969). There is little subcutaneous fat. Anal scent glands are absent (Tarasoff et al., 1972). The ear pinnae, when diving, fold back and close (Pocock, 1928).

High fat and low lactose content of milk, and a high fat/protein ratio, resemble these values in the milk of cetaceans and pinnipeds more than in the milk of terrestrial mustelids (Jenness and Williams, 1979).

Some myological and osteological characters are intermediate between those of *Lutra* and phocid seals (Tarasoff, 1972). The

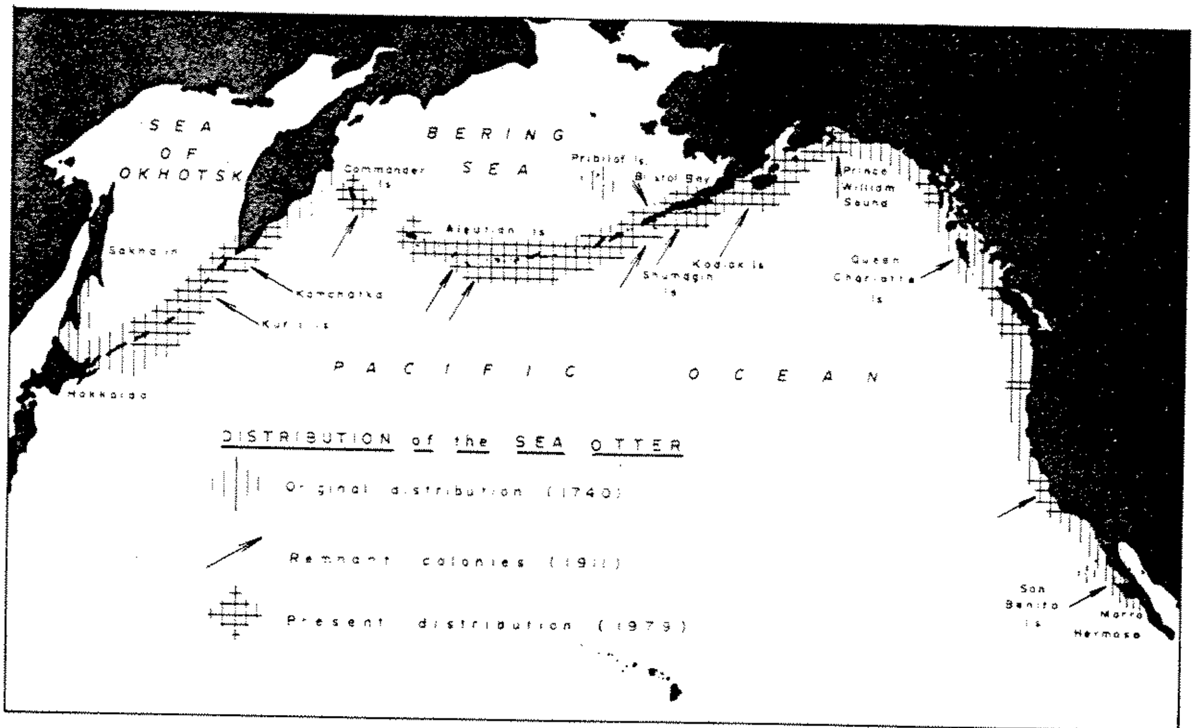

FIGURE 3. Original and present distribution of *Enhydra lutris*. Updated and redrawn from Kenyon (1969).

nasal aperture is large. The sagittal, lambdoidal, and occipital crests of adults are well developed (Scheffer, 1950). The auditory ossicles are similar to those of other diving mammals (Solntseva, 1975). Juvenile dentition consists of 44 teeth, of which 26 (i 3/2, c 1/1, p 3/3) are gingivally erupted at birth. Adult dentition is attained in less than one year. The postcanine teeth are bunodont (Murie, 1959; Kenyon, 1969) and are adapted for crushing (Ognev, 1931; Fisher, 1941). Lower incisors protrude and are spade-shaped to scoop food organisms from their shells (Hildebrand, 1954; Fig. 2). The size of the pulp cavity decreases with age from deposition of secondary dentine (Fisher, 1941). Malocclusion and dental attrition are common and may contribute substantially to mortality (Kenyon, 1969). Schneider (1973) estimated age in young animals on the basis of tooth eruption and skull changes, and in older animals by patterns of cementum deposition. The canines generally are broadest in males (Scheffer, 1951).

The vertebral column consists of seven cervical, 14 thoracic, six lumbar, three sacral, and 20 to 21 caudal vertebrae (Barabash-Nikiforov, 1947). Great flexibility in the spine has been achieved by reduction of vertebral processes, shortening and heightening of the centra, and enlargement of the intervertebral foramina (Taylor, 1914). The sternum and ribs are loosely articulated (Barabash-Nikiforov, 1947). A small scapula is related to the lack of dependence on forelimbs for support (Taylor, 1914). There is no clavicle, allowing extreme mobility of the pectoral girdle (Howard, 1975). The humerus is massive and twisted: the forelimb in general, and the wrist in particular, are highly mobile. Grasp function of individual forelimbs is poor; most forelimb functions are performed by apposing the forepaws (Murie, 1959; Howard, 1975). A long, narrow pelvis is loosely connected with the sacrum and extends posteriorly, parallel to the vertebral column. The pubic symphysis is weakly formed. The short hindlimbs extend posteriorly (Taylor, 1914). There is no pit in the head of the femur, corresponding to the absence of the ligamentum teres; this permits greater freedom of movement. Body skin encloses the femur and most of the shank (Tarasoff, 1972). Lengths of the rear digits and the interdigital web surface are relatively great (Zur Strasen, 1914). The fourth and fifth digits are closely bound to give rigidity to the hind flipper for propulsion (Pocock, 1928). The ventral surface of the calcaneus is shifted internally which makes it the most distinctive among Mustelidae (Stains, 1976).

Superficial and deep parts of the masseter muscles are unusually indistinct (Kenyon, 1969), although jaw muscles are well developed. The *arrector spinae* and *rectus abdominus* are well developed for the undulating movements of swimming (Barabash-Nikiforov, 1947). Howard (1973, 1975) described the structure and function of the limb musculature.

Extensive arterial and venous networks cover the dorsal and plantar surfaces of each flipper (Tarasoff, 1972). Blood characteristics of normal and pathological animals are described by Stullken and Kirkpatrick (1955).

The cerebrum is complexly fissured. Distinctive features of the cerbrum include an anterior arm of the ectosylvian gyrus depressed into the pseudosylvian sulcus and partially overlaid by the coronal and rear arm of the ectosylvian gyri, marked postcruciate sulcus, large ursine lozenge, well developed ansate fissures, long cruciate sulcus that curves caudally at its distal end, and a postrhinal sulcus with interrupted ventral surface such that the pyriform lobe and neopallium are superficially fused (England and Dillon, 1972). Cortical expansion of the lateral part of the posterior sigmoid gyrus is a common feature of *Amblyonyx*, *Aonyx*, *Paraonyx*, and *Enhydra*, and is associated with increased forepaw tactile sensitivity.

The thoracic cavity is large and the diaphragm is positioned obliquely (Barabash-Nikiforov, 1947). The right lung has four lobes, the left two (Tarasoff and Kooyman, 1973*a*). The trachea is incomplete dorsally; its rings are partially calcified, and its length and width are intermediate between *Lutra* and phocid seals (Tarasoff and Kooyman, 1973*b*). Cartilage-supported airways empty directly into alveolar sacs.

The stomach is large, the intestine is over 10 times body length, and the liver is five or six lobed. The gall bladder has a maximum length of 150 mm and a diameter of 20 mm, relatively thick walls, and many gland-like openings throughout the mucosa (Rausch, 1953). Various organ weights were given by Stullken and Kirkpatrick (1955), Kenyon (1969), and Morejohn et al. (1975).

The bicornuate uterus (Pearson, 1952) is compressed dorsoventrally (Sinha et al., 1966). The ovary is roughly a lenticulate, compressed oval with simple or complexly branched surface fissures. Sinha and Conaway (1968) described the ovarian microanatomy. A single Graafian follicle typically reaches the preovulatory stage while others atrophy. The corpus luteum of preimplantation pregnancy has a medium- to large-sized antrum, which is obliterated by the time the blastocyst implants. During delayed implantation, the luteal cells progressively hypertrophy and, by the time of implantation, they are polygonal and uniformly granular. The corpus luteum of pregnancy is 9 to 17 mm in diameter; luteal cells are small and spindle-shaped with basophilic vesicular nuclei (Sinha et al., 1966). The corpus luteum degenerates rapidly following parturition. A corpus albicans persists for at least two years (Sinha and Conaway, 1968). Changes in ovarian form, and in the gross anatomy and histology of the uterus during various stages of estrus and through pregnancy are described by Sinha et al. (1966). The chorioallantoic placenta is labyrinthine, zonary, and endotheliochorial; its development from implantation to birth is described by Sinha and Mossman (1966). The kidneys are large compared to other marine mammals (Kenyon, 1969) and consist of oval clusters divided into reniculi (Barabash-Nikiforov, 1947).

FUNCTION. The sea otter probably typifies early transitional forms in the evolution of semi-aquatic to more highly adapted marine species (Murie, 1959). Numerous characteristics of from, function, and behavior have convergently evolved with those of pinnipeds, cetaceans, and sirenians.

Standard metabolic rate is about 2.5 met, or 0.67 to 0.72 cm^3 O_2 $(g\ h)^{-1}$; elevated basal metabolic rate is an aquatic adaptation (Morrison et al., 1974). Maximum metabolic rate is about 10 met. Captives require, between 190 and 250 kcal/kg/day (Kenyon, 1969; Costa, 1976), or about 20 to 25% of their body weight. Costa (1978) estimated free ranging energy consumption to be 270 kcal/kg/day. Assimilation efficiency is 80 to 85% (Costa, 1976; Fausett, 1976). Food passes through the gut in about 3 h (Stullken and Kirkpatrick, 1955). Starved sea otters lose 10% of their body weight per day (Kenyon, 1969) and rapidly develop gastroenteritis.

Sea otters can maintain body temperature by basal metabolism under normal environmental conditions in air or water (Morrison et al., 1974). The thermoneutral zone in air is at least −19 to 21°C. Minimum thermal conductance in air is less than 0.012 cm^3 O_2 $(g\ h\ ^\circ C)^{-1}$ and only doubles on immersion in water due to the fact that insulation from cold seawater is provided entirely by air trapped in the fur (Morrison et al., 1974). A well developed medulla in the guard hairs probably also contributes to insulation (Tarasoff, 1974). Infrared emissivity is nearly equivalent to that of a perfect black-body radiator (Hammel, 1956). Arterial and venous networks over the dorsal and plantar surfaces of the large flippers are important avenues of heat flux (Iverson and Krog, 1973). Morrison et al. (1974) estimated that two-thirds of the heat load passes through the flippers in water at 26°C and four-fifths in air at 28°C. The flippers are removed from the water during quiescent periods and the frequency of digital expansions is positively correlated with ambient temperature. The flipper is expanded during warm conditions to facilitate heat loss (Tarasoff, 1972). During cold conditions, thermal absorption by solar radiation is enhanced by dark color and the highly developed superficial venous circulation on the dorsal surface of the flipper (Tarasoff, 1974).

The sea otter is awkward on land. Terrestrial locomotion is achieved by walking with alternate movements of opposing forelimb and hindlimb; by moving the forelimbs and dragging the hindlimbs; or by bounding, in which the back is arched and the hindlimbs are drawn toward the forelimbs (Barabash-Nikiforov, 1947, Tarasoff et al., 1972). There are three modes of aquatic locomotion. Paddling with the hindlimbs and sculling with the tail are used only when supine on the surface. Dorsoventral undulations of the body are used for more rapid surface locomotion and when diving (Howell, 1930; Sokolov and Sokolov, 1970; Tarasoff et al., 1972). In this mode, the hindlimbs are extended posteriorly to increase the propulsive effect of body undulations (Sokolov and Sokolov, 1970). Aquatic locomotion in *Lutra* is achieved by movement of both forelimbs and hindlimbs whereas in *Enhydra* limb movement is restricted to the hindfoot (Tarasoff, 1972). Tarasoff (1972) suggested that reduction in hair density and length from the mid-back to hindfoot increases efficiency of locomotion by reducing water turbulence. Swimming velocity is about 1 to 1.5 km/h on the surface and up to 9 km/h underwater (Kenyon, 1969).

Underwater vision of sea otters is slightly poorer than that of *Zalophus* and *Phoca* and is probably no better than that of terrestrial mammals (Gentry and Peterson, 1967). Vision in air is poor although olfaction apparently is well developed. Tactile sensation in the forelimb and vision are used in food gathering (Kenyon, 1969).

The large lungs may function in buoyancy (associated with the absence of blubber, and also to support food, tools, and young while on the surface) and oxygen storage (Kooyman, 1973). Of the total oxygen storage capacity, 67% occurs in the lungs and 33% in the blood and muscle (Lenfant et al., 1970). Cartilagenous airways, by emptying directly into alveolar sacs, insure patency until compression collapse. This structure is found in other marine mammals but is absent in terrestrial mammals and *Lutra* (Kooyman, 1973). The blood has a higher buffering capacity than that of non-diving species (Lenfant et al., 1970). Resting heart rate is 132/min and respiration is irregular at about 12/min (Stullken and Kirkpatrick, 1955).

Sea otters drink seawater. Costa (1976) calculated a total water input of 0.266 liters/kg/day, of which 67.5% came from food, 9.2% from respiration, and 23.3% from consumption of seawater. Water is lost in the urine (71%) and feces (18%), and via respiration (11%) (Costa, 1978).

ONTOGENY AND REPRODUCTION. Breeding and pupping occur throughout the year (Fisher, 1940; Murie, 1940; Kenyon, 1969). In the Aleutian Islands, the number of estrous females and occurrence of breeding activity is greatest in October and November (Schneider, 1972); maximum birth rate occurs in late May or June. In California, maximum birth rate occurs from December to February (Sandegren et al., 1973); seasonal occurrence of estrous females and of breeding activity are unknown. Gestation has been estimated to last 7.5 to 9 months (Lensink, 1962; Schneider, 1972). Based on time between observed copulation and parturition in a captive sea otter, Brosseau et al. (1975) estimated the gestation period to be 6.5 to 7 months. Delayed implantation occurs (Sinha et al., 1966), but duration of the preimplantation period is not known. Most females ovulate or develop large follicles every year, and Schneider (1972) suggested that induced ovulation may occur. Kenyon (1969) and Schneider (1972) estimated that females give birth, on the average, once every two years, but females can give birth every year. The average interval between births is unknown. Implantation occurs with about equal frequency in each uterine horn. There is no tendency to alternate ovaries between successive pregnancies although in some individuals one ovary may be more active than the other (Schneider, 1972). Most implantations occur in the central third of the uterine horn (Kenyon, 1969; Schneider, 1972). Successful birth weights average 1.8 to 1.9 kg and range from 1.4 to 2.3 kg (Kenyon, 1969). Gestation may be shorter and birth weights less at high population levels. There are no differences between the sexes in fetal growth rates or birth weights (Schneider, 1972). Based on a sample of 313 fetuses, Schneider (1972) found the fetal sex ratio to be 44% males and 56% females. Kenyon (1969) estimated a birth rate of about 16 young per 100 independent animals per year. Mortality rate apparently is higher in males than in females during the first year of life.

About 4% of the ovulations and 2% of the pregnancies are multiple (Schneider, 1972). There is one report of twin births (Snow, 1910), although twins probably cannot be reared successfully and have not been reported from field observations. Resorption in utero may occur in about 5% of the pregnancies in high density populations. Mortality at or near parturition is less than 5% (Schneider, 1972). Females seldom copulate until after separation from their previous young (Kenyon, 1969; Schneider, 1972). Postpartum estrus may occur within a month after birth if the young does not survive (Brosseau et al., 1975). Caudal and cephalic fetal orientation are equally frequent (Kenyon, 1969; Schneider, 1972) although fetuses tend to assume cephalic orientation near term. Kenyon (1969) believed that females attain sexual maturity at about 4 years.

Spermatogenesis occurs in the population throughout the year (Lensink, 1962) although sperm probably are produced intermittently by individuals. Schneider (1978) suggested that males reach reproductive maturity at 5 or 6 years, and that they become active breeders several years later. There is no evidence of reproductive senility (Kenyon, 1969).

Birth probably occurs most often in water. The young are nearly helpless at birth and females provide a great deal of care and training until they are almost adult size. The period of dependency probably is 6 to 8 months (R. Hardy and F. Wendell, pers. comm.). Pups nurse about 8% of the time during daylight (Sandegren et al., 1973) and suckle until they reach almost adult size. Small pups suckle while lying on the female's chest; larger pups suckle while lying in the water perpendicular to the female. In the water, the young is supported on the female's chest where it is manipulated between her forepaws. On land, the female grasps the young in her mouth and drags it. Females share food with the young shortly after birth (Kenyon, 1969); larger young aggressively take food from their mothers (Sandegren et al., 1973). The young begin to dive in the second month following birth; the duration of dives and foraging success increase as they develop. Motor patterns develop slowly and apparently there is considerable learning associated with swimming, grooming, and feeding during the period of dependency (Sandegren et al., 1973; Kenyon, 1969). Females with small young tend to be solitary and act aggressively toward other individuals. Sandegren et al. (1973) noted that this behavior was most common when inclement weather limited the locations suitable for care of the young. They suggested that competition among females with young occurred during winter in California when parturition rate was highest and kelp beds were sparse. Choppy sea conditions may distress the young, to which females respond by swimming downwind or seeking sheltered coves. Females with young in California are most active at dawn and dusk. When the young are very small, they seldom feed during daylight, but daylight foraging increases as the young grow larger (Sandegren et al., 1973). Females may adopt and nurse orphaned young (Kenyon, 1969).

ECOLOGY. Sea otters forage in rocky and soft-sediment communities, on or near the ocean floor. In central California, they seldom feed beyond a depth of 20 m, whereas in the Aleutian Islands they commonly forage at depths of 40 m or more. The maximum confirmed depth of dive was 97 m (Newby, 1975). Maximum depth of dive apparently varies geographically and among individuals, and probably is related more to the distribution, abundance, and quality of food than physiological constraints. Diet consists of invertebrates and, in some areas, fish.

Populations of certain invertebrates are limited by sea otter predation. Adult abalones and sea urchins in central California occur almost exclusively in substrate crevices which serve as refuges from sea otter predation (Lowry and Pearse, 1973). Sea otters greatly reduce the size and density of sea urchins in the Aleutian Islands (Estes and Palmisano, 1974). Subsequent to the overexploitation of sea otters by man, these invertebrate populations probably increased throughout much of the North Pacific Ocean and southern Bering Sea.

Where sea otters are absent in the Aleutian Islands, uncontrolled populations of sea urchins apparently are limited by competitive interactions; kelp beds are reduced or absent; and nearshore fishes are relatively uncommon. Where sea otters are abundant, sea urchins are small and scarce; there is a robust assemblage of macroalgae which are limited by competitive interactions (Dayton, 1975); and nearshore fishes are relatively abundant (Estes and Palmisano, 1974; Estes et al., 1978). Sea otters may enhance primary production and the abundance of higher trophic forms (Estes et al., 1978). Dense sublittoral kelp beds facilitate siltation of littoral zones in some sea otter-dominated communities by sheltering them from wave exposure. Silt accumulation smothers filter feeding mussels and barnacles, thus reducing their densities. Gastropod and asteroid predators on mussels and barnacles are consequently reduced. Hermit crabs apparently depend on gastropod shell resources and they also are reduced (Palmisano and Estes, 1977).

Diet varies according to location and time occupied by sea otters. Sea urchins, abalones and rock crabs are the sea otters' principal prey in newly reoccupied habitats of central California (Ebert, 1968; Vandevere, 1969). The number of abalones captured per dive subsequently declined in these areas (Ebert, 1968). Reduction of preferred prey (McLean, 1962; Wild, 1973) was followed by expansion of the diet to include such forms as mussels, turban snails, squid, octopus, chitons, tubeworms, large barnacles, scallops, and sea stars (Wild and Ames, 1974).

In recently repopulated areas of the Aleutian Islands, the diet consists largely of sea urchins, mollusks and crustaceans. Sluggish, epibenthic fishes are the most important prey in populations near equilibrium density. Prey switching apparently is related to reduced herbivorous invertebrates, enhanced kelp beds, and the consequent increase in abundance of nearshore fishes, many of which are dependent on kelp for protection or as a source of nutrition (Simenstad et al., 1977). Diet in the Commander Islands varies seasonally, with mollusks, crabs and fish most commonly eaten in summer and sea urchins most commonly eaten in winter (Barabash-Nikiforov, 1947). Bivalve mollusks are excavated by digging in sand or mud bottoms and are the most common prey in soft-sediment communities (Calkins, 1978). In some areas of central California, sea otters have reduced pismo clam populations (Miller et al., 1975; Stephenson, 1977).

Young sea otters are preyed on by bald eagles at Amchitka Island (Sherrod et al., 1975). Shark teeth have been found in wounded sea otters (Snow, 1910) and numerous beached carcasses in California (Orr, 1959; Morejohn et al., 1975; Ames and Morejohn, in litt.). Nikolaev (1965) observed an attack by a killer whale in the Kuril Islands, and Tikhomirov (1959) provided a possible instance of predation by Steller sea lions. Aside from man, no other predators are known. The distribution and composition of faunal remains in prehistoric kitchen middens suggested that aboriginal Aleuts reduced or eliminated sea otters from localized areas (Simenstad et al., 1978).

Voronov (1969) reported that a tsunami reduced sublittoral food resources at Urup Island in the Kuril archipelago causing sea otters to die and disperse to other islands.

The sea otter is definitive host for 14 known species of parasites (Dailey and Brownell, 1972; Hennessy and Morejohn, 1977). *Porrocaecum decipiens* (Nematoda) and *Microphallus pirum* (Trematoda) are thought to be highly pathogenic (Rausch, 1953). Hermit crabs (*Pagurus* spp.) and perhaps other decapod crustaceans are intermediate hosts to *M. pirum* (Rausch, 1953; Schiller, 1954). Rock greenling (*Hexagrammos superciliosus*) and red Irish lord (*Hemilepidotus hemilepidotus*) are intermediate hosts to small numbers of *P. decipiens* per fish (Schiller, 1954); hence the species is highly pathogenic only where fish are common in the sea otters' diet. Other helminth parasites recorded from sea otters in the North Pacific/Bering Sea are: *Orothosplanchus fraterculus*, *Phocitrema fusiforme*, *Pricetrema zalophi* (Trematoda); *Diplogonoporus tetrapterus*, *Pyramicocephalus phocarum* (Cestoda); and *Corynosoma strumosum*, *C. villosum*, *C. enhydri*, *C. macrosomum* and two unidentified species of *Corynosoma* (Acanthocephala) (Rausch and Locker, 1951; Morozov, 1957; Rausch, 1964; Dailey and Brownell, 1972). In central California, the acanthocephalan parasites, *Corynosoma enhydri*, *Polymorphus kenti*, *P. major*, and *P. altmani*, have been recorded in the sea otter. *Polymorphus* were rare in the specimens examined, but may be pathogenic when common (Hennessy and Morejohn, 1977). Sand crabs (*Emerita* and *Blepharipoda*) are common intermediate hosts to *Polymorphus*. About 3% of sea otters examined at Amchitka Island were lightly infested with nasal mites (*Halarachne miroungae*; Acarina) (Kenyon et al., 1965).

Forepaw infections may be caused by sea urchin spines (Kenyon, 1969). Enteritis is the most frequent symptom in dead animals (Kenyon, 1969; Morejohn et al., 1975); pneumonia-like conditions also have been reported (Morejohn et al., 1975).

Age composition of otter populations is unknown but probably varies according to the size and status. The rate of increase is about 10 to 12% per year in populations below equilibrium density.

Return of the Bering Expedition to Russia in 1742 with 900 sea otter pelts initiated exploitation of the sea otter in the Aleutian Islands and along the northwest coast of North America. Intense and uncontrolled exploitation occurred from 1742 to 1799, at which time Russia recognized the possibility of overexploitation and implemented conservation measures. After the sale of Alaska to the United States, intense overexploitation recurred until by the end of the nineteenth century the species was nearly extinct. In 1903 a high-quality skin was worth $1100 on the London market (Kenyon, 1971). Lensink (1960) estimated that more than 800,000 sea otters were taken by all nations during the period of Russian occupation of Alaska.

BEHAVIOR. Sea otters apparently are polygynous, although the exact nature of the mating system may vary. Mating occurs without pair bonding in some instances (Vandevere, 1970), but in others, a consortship lasts 3 to 4 days (Kenyon, 1969; Vandevere, 1970), during which time there are multiple copulations. Termination occurs when the female abandons the male. Copulation occurs in the water after the male clasps the female from behind and secures her nose or face between his jaws. There is considerable thrashing and rolling around the longitudinal axis of the pair during copulation, which may last 35 minutes with occasional periods of rest (Kenyon, 1969). The bloody nose of a female generally is indicative of mating activity (Brosseau et al., 1975), and the resultant nose scars, which vary in size, shape, and color, often are individually recognizable (Foott, 1970).

Kenyon (1972) believed that males searched for estrous females, and that distinct breeding territories were not established by males in the Aleutian Islands. Territorial behavior by males was observed by Vandevere (1970) and Loughlin (1977) in California, and by Calkins and Lent (1975) in Prince Willaim Sound. The mean area of territories of males observed by Loughlin (1977) was about 30 ha; these territories were located contiguously along the coast, adjacent to female resting areas. Several were maintained continuously for at least a year. Fighting is rare and is not the method usually employed in territorial defense. In Prince William Sound, males actively defended well-defined territories by patrolling their borders while vigorously kicking and splashing, which Calkins and Lent (1975) interpreted as visual and auditory displays. Territorial males often steal food from other individuals in their territory. In captivity, dominant males tolerate subordinate males only until they reach sexual maturity (Brosseau et al., 1975).

Sea otters segregate by sex and age (Schneider, 1978). In California, concentrations of animals at the ends of the range consist mostly of males (Vandevere, 1970; Wild and Ames, 1974; R. J. Jameson, pers. comm.). Permanent male and female areas occur in populations at equilibrium density in the Aleutian Islands. Male areas generally include only 400 to 800 m of shoreline and are densely populated; they include males of all ages except pups. Females rarely occur in male areas. Male areas tend to occur near exposed points where shallow water extends far offshore, and frequently they have the roughest sea conditions in the vicinity. They usually are 10 to 40 km apart and include only a small part of the available shoreline. Female areas are larger, less discrete, and less densely populated than male areas. They comprise most of the acceptable habitat between male areas and contain females of all ages. The number of adult males in female areas is correlated with the number of estrous females. Subadult males seldom occur in female areas. Schneider (1978) believed that competition for food, space, and breeding opportunities was the primary cause of sex and age segregation, and that variation in physiography, the distribution of food, and population status were the most likely causes of differences among areas in patterns of sex and age segregation. Loughlin (1977) estimated that the home range averaged 56 ha and was about twice as large for females as males.

Sea otters can spend their entire lives at sea (Ognev, 1931). They often rest in large groups, but otherwise they are solitary (Kenyon, 1972). They may rest on land or at sea. Resting on land is most common in areas where otter population density is high and they are not disturbed. At sea they prefer to rest in kelp beds and often wrap themselves in kelp to remain stationary (Kenyon, 1969). However, the largest congregations of resting animals have been seen where kelp beds are absent (up to 2000 animals in Bristol Bay; K. B. Schneider, pers. comm.). Sea otters rest in the water by lying supine on the surface with their paws held together on the chest and their flippers removed from the water (Fisher, 1939; Tarasoff, 1974). In some areas resting locations tend to remain constant over many years. Sea otters are non-migratory although both seasonal movements and long distance wandering of individuals may occur (Miller, 1974). Juveniles apparently wander more than adults (Kenyon, 1969). Translocated animals tend to disperse or return to the site of capture (Wild and Ames, 1974).

Foraging activity is greatest during morning and evening (Estes, 1977; Shimek and Monk, 1977). An average of 15 to 55% of the time during daylight hours is spent foraging; apparently this varies largely as a function of population status. Loughlin (1977) found that there was no difference between daylight and darkness in the length of foraging bouts, foraging areas, or the allocation of time to different activities. Larger animals were less active than smaller ones.

The tactile sense is important in locating food (Radinsky, 1968; Kenyon, 1969; Shimek, 1977). Prey generally are captured with the forepaws rather than between the jaws. Vision apparently is used to orient while on the surface and to capture elusive prey such as fish (Kenyon, 1969). Sea otters raise vertically in the water preceding a foraging dive, from which position they roll forward into the dive. They usually dive obliquely rather than straight down (Fisher, 1939). Average reported dive times vary from 52 to 90 seconds. The longest dive recorded by Loughlin (1977) was 4 min 25 s; Kenyon (1969) believed that the maximum duration of a dive was less than 6 min. In California, shorter dive times were required for snails and kelp crabs than for clams and abalones (Loughlin, 1977; Costa, 1978). Several dives in succession often are required to obtain a single abalone (Hall and Schaller, 1964). Some individuals feed successively on the same species for short numbers of dives (Hall and Schaller, 1964). Captured prey are transported in loose flaps of skin beneath the axilla (Barabash-Nikiforov, 1947; Kirkpatrick et al., 1955) and are consumed on the surface.

A rock tool or other object is often used to break the prey's shell or exoskeleton (Fisher, 1939; Murie, 1940; Hall and Schaller, 1964), or to dislodge prey underwater (Houk and Giebel, 1974). This permitted significant expansion of exploitable food resources to sea otters (Alcock, 1972). Ebert (1968) found that 80% of the abalone shells he examined had breakage planes suggesting that they were struck with tools by sea otters. Rock tools range in diameter from about 6 to 15 cm (Limbaugh, 1961). Variation in the incidence of tool use throughout the range is due largely to the nature of available food (Woodhouse et al., 1977). It is more common in California than in the Aleutian or Kuril islands (Murie, 1940; Barabash-Nikiforov, 1947; Novikov, 1956). Food items and other objects occasionally are pounded against the bare chest, particularly by pups. McCleneghan and Ames (1976) reported that one individual learned to tear open aluminum containers, and to extract octopuses that inhabited them. Sea urchins are opened primarily with the paws or teeth and the viscera and gonads are scooped out by the lower incisors and tongue (Hildebrand, 1954). Sea otters often roll laterally in the water while feeding, apparently to wash discarded scraps of food from their fur.

Sea otters meticulously and vigorously groom their fur to maintain its waterproof character (Kenyon, 1969). They commonly blow air into their fur, beat the water, and pleat the skin to renew entrapped air (Tarasoff, 1972). Loughlin (1977) described grooming as a stereotyped, five-step sequence with high fidelity in stage repetition and with strong correlation to hair density and exposure of different body areas to the water.

Fisher (1939), Kenyon (1969), and Sandegren et al. (1973) described the sea otters' vocalizations for which Kenyon identified eight distinct kinds.

GENETICS. There are 38 chromosomes (2n). Anbinder (1976) reported that the sea otter karyotype was similar to that of *Lutra conadensis*, *Martes zibellina*, and *M. americana*.

REMARKS. The economic value of sea otter fur played an important role in early exploration and development of the Pacific coast of North America. Discovery and decimation of sea otters greatly influenced world history and politics through trade and territorial acquisition by many of the major seafaring nations. Today sea otters are protected throughout their range although some animals are killed illegally or incidentally where contact with humans is frequent. I thank M. A. Bogan, R. L. Brownell, Jr., A. L. Gardner, E. R. Hall, E. T. Hooper, R. J. Jameson, J. Jones, K. W. Kenyon, and K. Ralls for advice or assistance in preparation of this account.

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Appendix 13. - Summary of Management Activities in Other Jurisdictions

LEGAL PROTECTION

Alaska: Marine Mammal Protection Act (MMPA) 1972 (Federal)
Washington: MMPA, 1972 (Federal)
: Wash. Dep't. Wildl., Endangered Species, 1988 (WAC 232-12-014)
California: MMPA, 1972 ("depleted" species)
: Endangered Species Act (1977). "Threatened" status
: California State Law "fully protected mammal".

PROTECTED AREAS

1. Specifically for Sea Otters
   Alaska: no information
   Washington: apparently none
   California: Calif. Sea Otter Refuge (Carmel to Cambria)
   : San Nicolas Island (Channel Islands).

2. Other areas
   Alaska: Alaska Maritime National Wildlife Refuge (Aleutian Islands; Alaska Pen., and Gulf of Alaska Units.
   : Other smaller National Interest Lands (Conservation Act, 1980) and State Preserves.
   Washington: Olympic National Park
   : Flattery Rocks and Quillayute Needles Nat. Wildlife Refuges.
   California: Monterey Bay National Marine Sanctuary; Point Lobos State Reserve; Ano Nuevo State Park (probably others).

ENFORCEMENT PROGRAMS

Alaska: Not a high priority. Don't presecute for incidental mortality (e.g. in fish nets).
Washington: no information
California: Has officers which spend considerable time enforcing regulations. Have had several prosecutions involving jail sentences (up to 75 days) and fines (up to $3,000).

TRANSPLANTS

Alaska: Pribiloff Islands, 1968 (55 otters) - not successful
: Southeast Alaska, 1965-1969 (412 otters) - successful
: No further transplants planned.
Washington: Pt. Grenville/La Push, 1969-1970 (59 otters) - successful.
: Apparently no within - State transplants are contemplated.
Oregon: Port Orford/Cape Arago (93 otters) - unsuccessful.
California: San Nicolas Island, 1987-1989 (127 otters) - poor success.Conservation groups still wish to establish a second population in the State.

CONTROL OF DISTRIBUTION

Alaska: No attempts to control spread
Washington: No attempts to control spread
California: Have attempted to capture and remove sea otters straying south of Point Conception (some success). This "otter free zone" has high fisheries and recreational use.

HARVESTS

Alaska: Pre-1972 - 2,000 otters taken in experimental harvests
: 1983-1986 - 1,049 (minimum) taken legally by native people for handicraft industry. (Some smuggled to Japan (Love, 1992).
: Native harvests occur in Aleutians, Kodiak Isl., Prince William Sound, and southeast Alaska. Presently illegal for natives to market pelts but they wish to change this. Possible severe overharvest in southeast Alaska in past year (Angela Doroff, pers. comm.).
Washington: No legal harvests.
California: " " " .

FISHERY RESTRICTIONS

Alaska: No information.
Washington: No information (probably no restrictions because important commercial shellfish areas are north and south of present otter range).
California: State waters classified as otter zones and otter-free zones, with protective regulations in the latter. Use of gill nets prohibited in depths under 30 fathoms in otter zone.

RESEARCH TO AID IN MANAGEMENT

Alaska: On-going research projects are as follows (primarily USFWS):

I. Zonal Management
   a. Reproduction, survival, and movements of sea otters at Kodiak Island, Alaska.
   b. Genetic relationships of sea otter populations.
   c. Sea otter census development.
   d. Sea otter reproduction.

II. Fisheries Interactions
   a. Interactions between sea otters and their prey in the Kodiak Archipelago.
   b. Sea otter-population assessment.

III. Sea Otter Oil Spill
   a. Assess the fate of sea otters oiled and rehabilitated as a result of the "Exxon Valdez" oil spill.

b. Intersection model of sea otter mortality.

c. Radio telemetry studies on sea otters in Prince William Sound.

d. Sea otter prey selection and foraging success in western Prince William Sound.

e. Bioindicators of damage to sea otters from exposure to oil.

f. Assessment of pathological processes and mechanisms of toxicity in sea otters that died following the "Exxon Valdez" oil spill.

g. Sea otter damage assessment studies: Data base management and data analysis.

Washington: Research has been carried out on distribution, abundance, activity patterns, and impacts on rocky subtidal communities. A number of research projects have been recommended (Bowlby et al. (1988). No information on current research.

California: No current information.

MANAGEMENT PLANS

Alaska: USFWS has put together a long-term management plan. Native Sea Otter Commission, Marine Mammal Commission and public groups are involved. The plan presents management options, and is still being reviewed and ammended. Sea otters are very controversial in Alaska.

Washington: No information.

California: Management Plan and Recovery Plan prepared.

REHABILITATION PROGRAMS

Alaska: Intensive rehabilitation carried out following "Exxon Valdes" oil spill. Most of sea otter range is remote and individuals needing medical care are seldom encountered.

Washington: No information.

California: Monterey Bay Aquarium has rehabilitated many sea otters since 1985 and has an on-going program, with emphasis on orphaned pups. Rehabilitation efforts are more common in California because this subspecies has "Threatened" status and because otters in distress are more frequently found by people.

THREATS TO POPULATIONS

Alaska: Native harvests; oil spills; fishing nets.
Washington: No significant threats at present. Offshore oil and gas leases, if developed, could pose a threat. Population expansion will take otters into commercial and native fishery areas.
California: Fishing nets; shooting/vandalism; oil exploration (potential) and transport.

VIEWING PROGRAMS

Alaska: Looking at possibilities but little demand to date.
Washington: State activities, if any, not known. Sea Otters featured in Olympic National Park interpretive material.
California: Well developed tour boat industry at Monterey Bay, Morro Bay, other locations. Featured species at Point Lobos State Reserve.

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Appendix 14. - British Columbia commercial catch statistics, Area 26.

Table I. Salmon Landings by Species and Year in Tonnes for Area 26.

Species	1985	1986	1987	1988	1989	Ave
CH	120.2	102.0	191.3	250.3	89.3	150.6
SK	143.3	671.0	93.7	15.0	231.9	231.0
CO	305.9	260.4	277.4	320.5	322.1	297.3
PK	225.1	25.2	75.8	53.3	222.6	120.4
CM	222.8	103.4	12.2	36.5	7.0	76.4
ST	7.7	0.3	0.1	*	0.1	1.6
Total	722.7	1162.3	650.5	675.6	873.0	816.8

* = less than 50 kg

Table II. Salmon Landings by Species and Year in Number of Fish per Days Fished for Area 26.

Species	1985	1986	1987	1988	1989	Ave
CH	21624	18015	31956	34428	13059	238164
SK	66048	251633	37215	6305	107667	93774
CO	114256	119038	124943	144787	139849	128575
PK	134046	16203	41953	45897	136921	75994
CM	62488	32012	2720	9920	2176	21863
ST	2562	111	17	13	38	548
Total	401024	437012	238804	241350	399710	343580

Table III. Shellfish and Other Landings by Species and Year in Tonnes for Area 26.

Species	1985	1986	1987	1988	1989	Ave
Octopus	*	0.6	0.2	0.1	0.8	0.3
Sea Urchin	14.8	2.5	8.4	4.3	0.0	7.5
Butter Clams	0	0	2.5	2.9	0.0	1.1
J.Ln Clams	98.5	22.5	122.7	182.5	94.7	104.2
N.Ln Clams	*	3.0	1.9	4.1	0.7	1.9
Mixed Clams	21.1	1.0	1.8	0.3	0.0	4.8
Geoduck Clams	272.0	226.0	397.7	205.9	1.7	220.7
Horse Clams	*	0.0	0.0	4.2	0.0	0.8
G. Barnacles	0.0	0.0	1.3	17.1	12.8	6.2
Sea Cucumber	0.0	2.7	89.4	62.1	1.6	31.2
Hagfish	0.0	0.0	0.0	0.0	29.1	5.8
Sturgeon	0.1	0.4	0.0	0.3	0.0	0.2
Tuna	0.0	0.0	0.0	0.0	8.2	1.6
Other Fish	0.0	0.0	*	0.1	0.0	0
Non-food Fish	0.0	0.0	1.7	15.6	0.0	3.5

Table III. Continued

Species	1985	1986	1987	1988	1989	Ave
Prawns	1.4	0.3	1.7	17.2	41.9	12.5
Shrimp	0.0	0.0	1.2	0.0	0.4	0.3
Crab	1.1	3.0	3.1	6.7	3.0	3.4
Total	406.5	258.7	627.6	523.4	194.9	402.2

Table IV. Groundfish Landings by Species and Year in Tonnes for Area 26.

Species	1985	1986	1987	1988	1989	Ave
Halibut	24.0	60.1	51.3	29.1	63.3	45.6
Brill Sole	6.6	4.2	5.0	10.8	2.8	5.9
Dover Sole	*	0.3	0.2	4.3	30.9	7.1
Lemon Sole	3.6	1.6	0.3	1.2	1.6	1.7
Rex Sole	0.0	*	0.0	0.4	0.1	0.1
Rock Sole	2.0	2.6	0.4	1.7	0.1	1.4
Mixed Sole	0.6	0.2	0.2	0.1	*	0.2
Lingcod	132.4	165.7	102.2	88.7	62.7	110.3
Pacific Cod	26.3	41.5	3.0	47.8	29.7	29.7
Sablefish	191.7	35.5	26.1	299.7	18.4	114.3
P.O. Perch	11.7	12.7	19.6	27.6	56.8	25.7
Reedi Rockfish	0.0	0.0	1.0	10.8	0.9	2.5
Greenies	0.0	0.0	178.7	367.9	148.3	139.0
Unsp. Rockfish	235.7	0.0	252.4	516.0	403.3	281.5
Red Snapper	0.0	0.0	57.6	29.3	26.1	22.6
Flounder	2.9	0.0	1.1	0.0	0.0	0.8
Skate	1.7	0.0	0.1	0.7	1.1	0.7
Idiotfish	0.0	0.0	*	3.0	1.4	0.9
Turbot	0.0	0.2	0.0	7.3	0.0	1.5
Pollock	0.0	0.0	0.0	0.1	0.0	0
Dogfish	11.3	36.3	7.6	17.1	11.9	16.8
Total	650.5	360.9	706.9	1463.3	865.5	809.4

CH = chinook
SK = sockeye
CO = coho
PK = pink
CM = chum
ST = steelhead