The Sea Otter in British Columbia - A Problem or Opportunity

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Sea otters (Enhydra lutris) once inhabited a great arc from Hokkaido up and across the Commander and Aleutian Islands, then south along the North American coast to the San Benito Islands off Baja, California. The arc is now broken; the gaps in it were fuel that propelled the Pacific coast's history.

Along the oriental sweep of the arc, Chinese were already receiving sea otter pelts from Ainu hunting in the Kuriles during the early 17th Century. Along North American coasts, Spanish missionaries and explorers bartered for sea otter pelts at least as early as 1733 (Ogden 1941). The high value of pelts in the orient was apparently unknown to them and the New World harvest at that time was likely small. Conditions changed in 1742 with the return of the Bering expedition from Alaska to Russia with 900 pelts. At the time of Bering, otter pelts commanded prices of about $10 U.S. in Kamchatka or $25 in Irkutsk. As numbers declined, prices increased from about $75 in 1872 to $440-$1125 per pelt on the London market in 1903 (Fisher 1941). One year before harvest was terminated in 1911, $1703.33 was paid for a sea otter pelt on the London market. The increase in prices mirrors the sea otter's decline from about 150,000 animals in 1741 to near 2000 in 1911 (see Lensink 1960 and Kenyon 1969 for the rationale used in deriving these estimates).

When the remnant populations of North American sea otters were first given protection in 1911, it was feared that the species might not survive. Otter populations, however, responded positively. On 1 January 1968 the first collection of sea otter skins taken for commercial use since 1911 was offered for sale at the Seattle Fur Exchange. The sea otter had re-appeared on the fur market, but with it new problems. The otter shares man's taste for abalone and clams. Furthermore, it is a more efficient predator and ignores legal size limits.

The otter has gone from unknown animal, through avidly sought resource, to the very brink of extinction only to emerge as a carefully nurtured "problem child". Our objectives here are to describe the status of the sea otter in British Columbia and to offer some prognoses about potential problems and opportunities. Little is known of the species in British Columbia. Prognoses must be generated largely from its biology as studied elsewhere. Our approach is to review first its status, provide some biological background, then examine the problems and opportunities its way of life presents.

Status - Numbers and Distribution

It is helpful to consider the status of British Columbia populations in the context of the entire population of the eastern Pacific Ocean. Given the widely spread nature of the species accurate estimates are impossible, but trends are apparent. When global population estimates are considered the trend since 1911 is gratifying (Fig. 1a). During the 170 year period from 1741 to 1911 about 800,000 to 1,000,000 pelts were

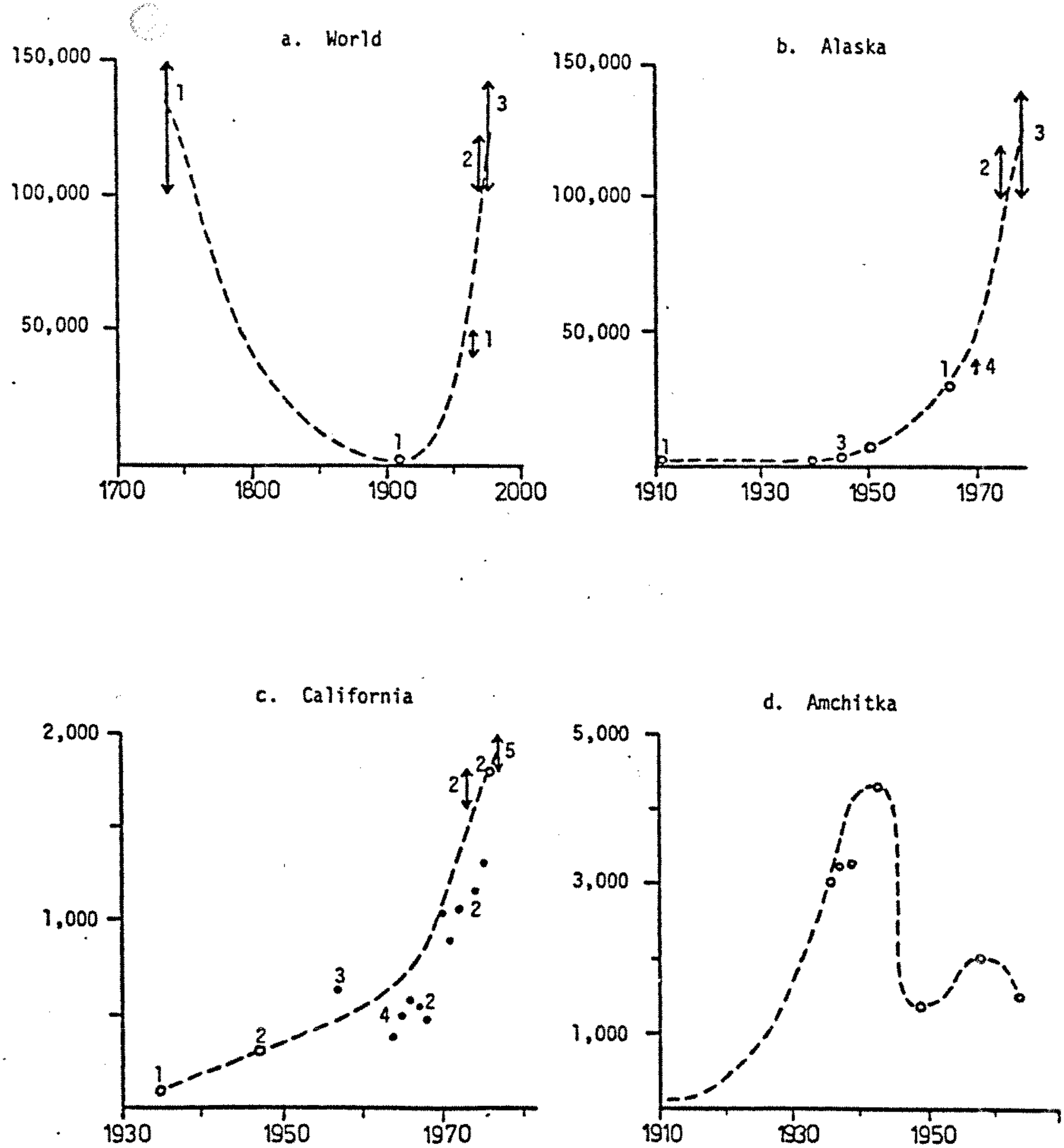
a. World
150,000
100,000
50,000
1700
1800
1900
2000
b. Alaska
150,000
100,000
50,000
1910
1930
1950
1970
c. California
2,000
1,000
1930
1950
1970
d. Amchitka
5,000
3,000
1,000
1910
1930
1950

Fig 1

taken from North American waters. The population declined by about [illegible]%. In the 70 years since, under almost complete protection and careful management, the eastern Pacific population has recovered to its former level, estimated at between 100,000 and 150,000 (Fig. 1a). The recovery represents a growth rate of about 10% per annum, most of it occurring in Alaska. The Alaskan population itself has increased from an estimate of less than 2000 in 1911 to over 120,000 today.

The trend has been similar in California, although the numbers are much smaller (Fig. 1c). The population has grown from less than 200 to 2000, exhibiting annual growth rates of up to 13% from 1964 to 1976. Prior to 1964, the population appears to have increased steadily but slowly. A dramatic shift in growth rate occurred when the population reached about 600 or 700 animals.

Kenyon (1969) described the only natural population for which a natural decline has been well documented, that at Amchitka Island, Alaska (Fig. 1d). The estimated population size again increased steeply but peaked at about 4500 animals, when the density was 16 to 17 otters per km². The population then crashed to about 1500 animals in the six years following, and fluctuated between 1500 and 2000 for the next 16 years.

The threshold number or density at which these populations suddenly increased or decreased appears related to the quality of the habitat and, thus, may differ widely between populations. However, if the other Alaskan and Californian populations continue to increase at their present rates, it is likely that they too will follow the Amchitka Island pattern of a sharp decline followed by more stable fluctuations.

Between 1965 and 1972, ~~a number of~~ sea otters were transplanted from the Aleutian Islands or Prince William Sound, Alaska to southeastern Alaska, British Columbia, Washington, and Oregon. The growth trends of transplanted populations differ markedly from those of natural populations (cf. Figs. 1 and 2). The southeastern Alaskan transplants show the most encouraging trend. During 1965 to 1969 a total of 378 otters were transplanted from Prince William Sound to several locations in the outer islands of the Alaskan panhandle, or Alaskan Game Management Units 2 and 4. In 1973, maximum number of the population in these units was estimated to be 500. Recently, 450 to 500 otters may have been counted (A. Johnson, pers. comm. 1980) but this information has not been verified.

Experience farther south has been less encouraging. During 1970 to 1971, 93 sea otters were transplanted from Amchitka, Alaska to Oregon. A count in 1977 found only four animals. We have been unable to verify whether the second transplant (of 33 animals) to Oregon also occurred at Blanco Reef, but have included it with the data derived from Blanco Reef in Figure 2b. In Washington, a total of 59 otters were transplanted from Amchitka to Point Grenville and La Push during 1969-70. Fourteen of these became soiled en route, and died of stress within a few days of release. The total number of transplanted, presumably healthy, otters in Fig. 2c is thus 45. The most recent count, in 1977, found only 18 otters. In 1979, 17 otters were observed during other coastal work (L. Leschner, in litt. 1980). It is important to recognize that aerial counts may miss

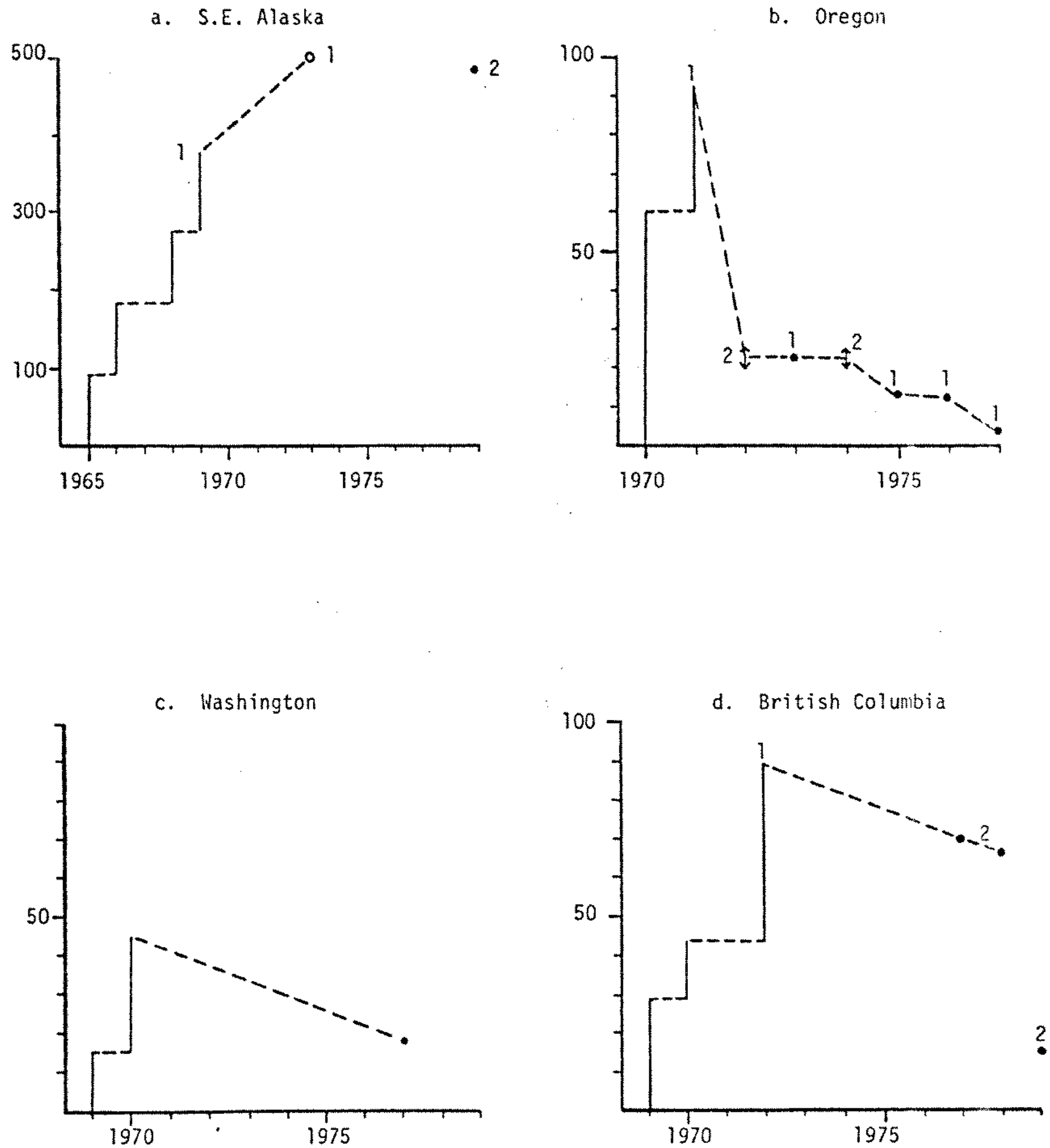
a. S.E. Alaska
500
300
100
1965
1970
1975
1
1
2
b. Oregon
100
50
1970
1975
1
2
1
2
1
1
1
c. Washington
50
1970
1975
d. British Columbia
100
50
1970
1975
1
2
2

Fig 2

a considerable percent of the population. Kenyon (1969) developed a sliding scale of correction factors for aerial counts of sea otters in Alaska. The correction factor increases as population density decreases. Thus, if 1 to 15 otters were counted, he estimated 50% were missed, if 16 to 100 were counted, he estimated 40% were missed, and if over 100 were counted he estimated 25% were missed. If these correction factors can be applied to transplanted populations farther south, then the Oregon population may be estimated at 8 and the Washington population at 25. In neither case can the transplants be considered well-established.

When sea otters were re-introduced to British Columbia, it was unlikely that the sea otter survived anywhere on the B.C. coast. In 1910, the year prior to protection of sea otters under the Fur Seal Treaty, two British Columbian vessels obtained only seven otters, none in B.C. waters (Marsh and Cobb 1911). Although the sea otter had once inhabited the entire B.C. coast, it was near extinction. Cowan and Guiguet (1965) reported only two recent records (Nootka Island, 15 November 1909 and Grassie Island, Kyuquot 1929). From 1969 to 1972, 89 otters were released at the Bunsby Islands in three transplants from Alaska (Fig. 2d). Details of the transplants were provided by Smith (1969), MacAskie (1971 and 1975) and were summarized by Bigg and MacAskie (1978). In 1977 and 1978 about 70 sea otters were counted. The 1979 count of 15 animals was made in winter when sea otters are generally more dispersed, so it may reflect a poor estimate rather than a population decline. Using the summer counts and assuming 40% of the animals were missed, the

B.C. population may number about 120. Of the 70 actually counted, 55 were in Checleset Bay and 15 at Bajo Reef (Fig. 3).

Reasons why transplants may succeed or fail to become established are not known. It appears that the likelihood of success increases with increased transplant size. The most successful transplanted population is in Unit 4 of southeastern Alaska, where the number of transplanted otters was 48, 30, and 194 at three sites within 85 km of each other. Sex and age composition of the transplants could also affect success. In B.C. the transplant composition was probably ideal. About 80% of the transplanted animals were adults of breeding age, with a male:female ratio of 1:2, similar to that observed by Kenyon (1969) in natural, growing populations.

Success may also depend on the degree to which sea otters disperse. Kenyon (1969) described two types of dispersal, which can be termed dispersal of individuals and population expansion. Individual dispersal can be described as wandering individuals which may accumulate at an ideal site to form a new colony many km away from their original site. Population expansion occurs when the population has exceeded an area's carrying capacity and expands outwards to occupy adjacent habitat. Factors determining rates of population expansion are discussed later.

In British Columbia, as in other transplant areas, the main type of dispersal has been that of individuals. Bigg and MacAskie (1978) collated confirmed sightings of sea otters from 1970 to 1977 (Fig. 3). Of the eight sightings (aside from the Bunsby Island Bajo Reef), six were of solitary animals, one was of a mother and pup, and one was of two individuals.

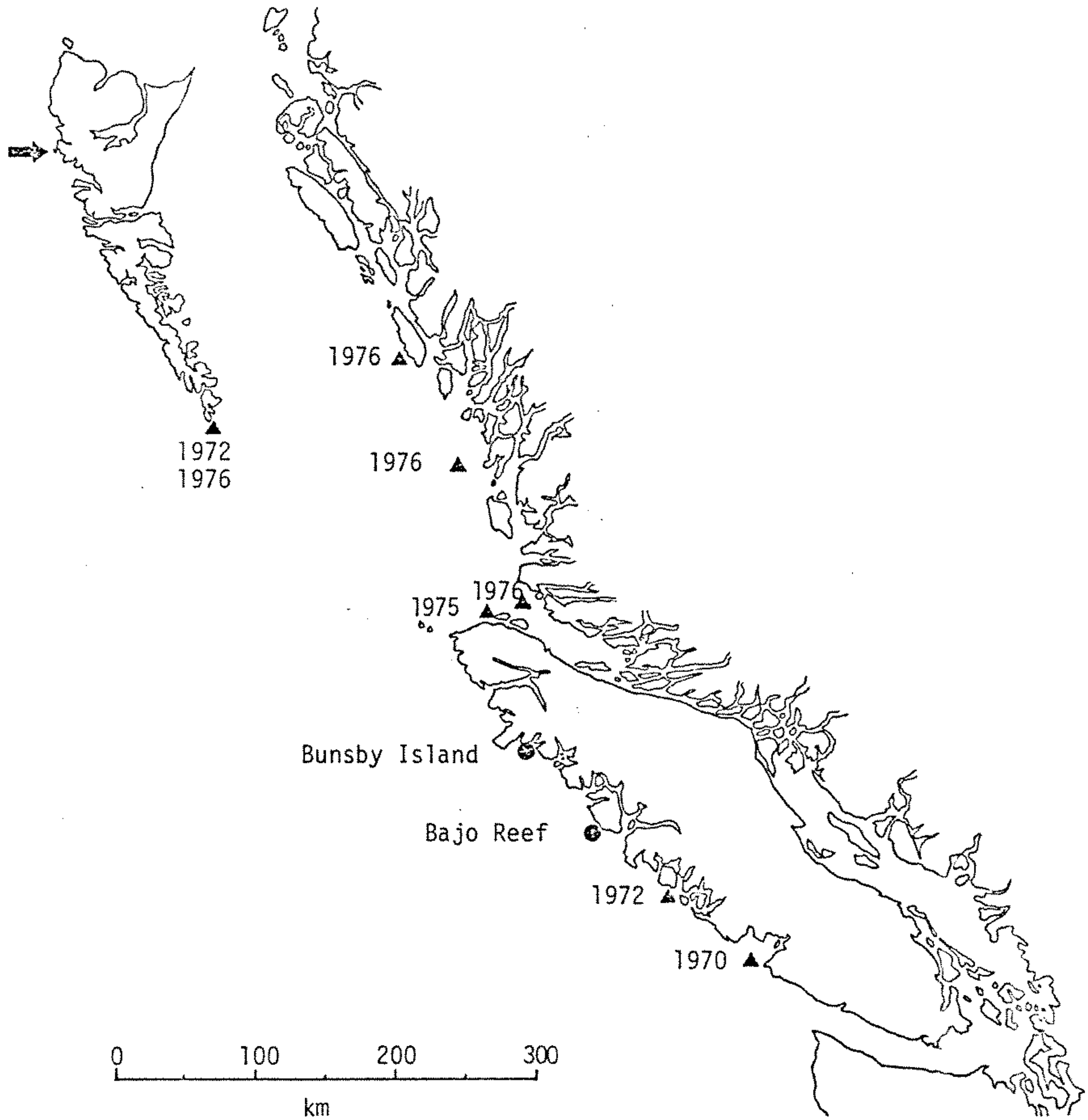
1972
1976
1976
1976
1975
1976
Bunsby Island
Bajo Reef
1972
1970
0
100
200
300
km

Fig 3

Individuals were observed in Barkley Sound and Cleland Island, 220 km southeast of the transplant site, only one month after the second transplant. Two confirmed sightings off the Queen Charlottes Islands are 320 km northwest of the transplant area. These individuals may have originated from transplants in Washington or Alaska, but still would have dispersed about 300 km. Most of the B.C. sightings are so widely scattered it is unlikely that this pattern of dispersal will result in the formation of new breeding aggregations. However, conditions at Bajo Reef, about 72 km from Checleset Bay, may represent a "new" colony as pups were identified among the 15 animals sighted there. The Bajo Reef colony does not represent gradual range expansion, but rather a group of otters moving to a disjunct but favourable site. The pattern is similar in Washington. R.D. Everitt (*in litt*. 1980) noted that otters of the Washington transplant are now concentrated on Destruction and Ozette islands, and occur sparingly on the islands or islets between those points. Those otters apparently have dispersed and established a new colony or colonies about 28 to 45 km from the original transplant sites.

Several features emerge from our consideration of numbers and distribution. First, the numerical status of the sea otter in British Columbia is unclear but likely ranges between 70 and 120 animals. Second, although concentrated at the Bunsby Islands and Bajo Reef, sightings of individuals in British Columbia are widely scattered. Third, transplants generally have been plagued by early mortality, apparently high rates of individual dispersal, and growth rates far below those reported for naturally occurring populations (cf. Figs. 1 and 2). Potential causal factors producing these observations are better understood in terms of the sea otter's biology.

Biology of Sea Otters

Numerical abundance and distribution, just discussed, provide some indication of the "health" of populations. Biological parameters providing additional information on population condition include population dynamics (reproductive, mortality and dispersal rates), and habitat relations (as manifested by feeding behaviour and home range size). By comparing data from well-studied populations with preliminary observations of the B.C. population, we can better assess the apparent health of sea otters in B.C. Data for B.C. are derived from occasional aerial surveys conducted by the Pacific Biological Station and the B.C. Fish and Wildlife Branch, a short but intensive study of the Bunsby Islands sea otters conducted by Morris and Emerson in June and July of 1978, and scuba surveys in Checleset Bay during September 1979 reported by Breen et al. (1980).

Population Dynamics

Reproduction

The northern sea otter becomes sexually mature at three or four years of age (Kenyon 1969). The species exhibits delayed implantation but the durations of unimplanted and implanted stages are not known. Kenyon believed the total gestation period to be 12 to 13 months and, similarly, the period of pup dependence to be about 12 months. It was thus generally believed that the sea otter produced one offspring every second year. Recent studies of tagged females in Prince William Sound, Alaska, have revealed that females are capable of producing a single pup annually for at least two to three consecutive years (Johnson and Jameson 1979). In that population gestation length may be a maximum of six to eight months and pup dependency may last only four to five months.

Mating may occur at any time of the year, although in the north it peaks in the fall (Kenyon 1969) and presumably in the south it peaks in the spring. There may be some "tending" of females by males but the close association seldom lasts more than three days. Parturition also occurs in any month although in Alaska it peaks in summer (Kenyon 1969) while in California it peaks in winter (Sandegren et al. 1973). It is not known when parturition peaks in B.C. Morris et al. (1979) reported recognizeable pups in June and July off the Bunsby Islands. The single pup is born at sea or, in a few northern cases, on a rocky shore.

Mortality

Causes of mortality among sea otters appear to be primarily density-dependent. Overcrowded populations, such as that on Amchitka Island, have suffered annual die-offs of 9 to 11%, most of which were juveniles and elderly animals dying from starvation (Kenyon 1969). Density-independent factors such as stormy weather often operate together with food shortages. Natural predation has been little documented. Because potential predators such as killer whales and sea lions have been observed in close proximity to sea otters with neither showing much regard for the other (Orr and Poulter 1964, Kenyon 1969), predation is generally believed to be of little importance. There is only one recorded observation of a killer whale catching a sea otter (Nikolaev 1965 in Kenyon 1969). Sharks and bald eagles are the only predators for which substantial evidence of effective predation exists. Shark teeth and gashes have been found in several Californian sea otter carcasses (Orr 1959) and recently in an Oregon carcass (Kenyon 1978). Bald eagles take considerable numbers of live sea otter pups off Amchitka Island, but this is, in part, due to an unnaturally high increase in the bald eagle population due to man's activities on Amchitka (Sherrod et al. 1975). Predation or evidence of predation on B.C. sea otters has not been observed.

Longevity of sea otters is equally poorly documented. Soviet workers have reported otters 8 years old; Kenyon (1969) estimated maximum longevity as 15 years in optimum habitat.

Dispersal

Sea otters may cover considerable distances as part of their daily movements within a home range. Sandegren et al. (1973) reported that a female, southern sea otter moved 2.2 miles (3.5 km) along the coast in 125 min against a wind of 15 to 20 knots (28 to 37 kph). Three other females carried their young from 1.6 to 3.2 km in periods of 20, 40, and 45 min respectively. Given their normal daily mobility it is not surprising that sea otters sometimes disperse widely (Fig. 3). Kenyon (1969) believed the most important factor limiting population dispersal was behaviour: the individual's traditional adherence to an established home range. That adherence is evident in California. The population's range was described in 1914. During the next 24 years the population advanced less than 10 km north or south. During the following 18 years the population spread about 30 km north and almost 100 km south or the original site. Possibly a threshold in density was reached, after which range expansion occurred more swiftly. It has also been suggested that long, sandy beaches formed temporary barriers generating a stepwise rate of expansion rather than a continuous flow (Bailey 1979). The rate of population expansion in 1976 was estimated to be about 6.5 km per year (Bailey 1979).

The pattern of dispersal in Alaskan populations has been similar. Only when populations built up to high densities (> $16/km^2$ in unexploited habitat of the Aleutians) did emigration of significant numbers and/or starvation occur, leaving the remaining population in depleted habitat but at lower densities (4 to 6 km^2 in the Aleutians). Deep, wide oceanic passes swept by swift tidal currents act as formidable barriers to dispersal in the Aleutians. Thus, specific populations only 100 km away from unoccupied islands have remained sedentary for decades despite overcrowding and starvation (Kenyon 1969, Estes et al. 1978). In both Alaska and California dispersing animals have been identified as primarily subadults.

When sea otters are transplanted to a new area, they are removed from their traditional home range and the large distances covered by dispersing individuals may be attempts to re-discover it. It is evident from the B.C. sightings of dispersing otters that there are few, if any, natural barriers to dispersal in B.C. Also, data from B.C. and California indicate that rates of dispersal by individuals greatly exceeds the rates of population expansion. If the sea otter reported by Edie (1973) at Cape St. James originated from the Bunsby Islands transplant, the minimum rate of dispersal was 107 km per year. Other minimal rates of dispersal can be computed from the dates provided in Figure 3. Despite these high rates, the fact that the majority of the sea otters transplanted to B.C. are still located near the Bunsby Islands is an encouraging sign that their new home range has been accepted.

Feeding and Habitat Requirements

Feeding Ecology

The feeding behaviour of the sea otter has a profound impact on benthic communities. Sea otters are opportunistic feeders and consume a great variety of benthic organisms. Preferred food items include sea urchins and shellfish such as clams, abalones, and mussels. This preference is related to both nutritional value and availability. For example, sea urchins are lower in nutritional value than fish, but the fact that they are easily obtainable partly compensates for their lower value. Both the sea urchin and the abalone are herbivores that graze primarily on kelp. When sea otters enter new habitat, they encounter abundant large sea urchins and shellfish and relatively little kelp is present as the herbivores have restricted it to shallow depths. After a few years of sea otter feeding, the only sea urchins and shellfish present are small or inaccessible, the kelp growth is much advanced and there is an influx of kelp-associated fish. This pattern has been documented in Alaska (Estes and Palmisano 1974, Estes et al. 1978) in California (Ebert 1968, Lowry and Pearse 1973) and it is the pattern now emerging in Checleset Bay in B.C. (Breen et al. 1980).

The shift in feeding habits and benthic communities is probably most advanced at Amchitka Island, Alaska. In 1954 Wilke (in Estes et al. 1978) found that sea urchins comprised 86% and fish comprised 6% of the total volume of a small sample of sea otter stomach contents. In 1963 sea urchins comprised only 11% and fish comprised 50% of the volume of sea otter stomach contents (Kenyon 1969). As fish could be captured easily only by otters in their prime, the sea otter population began to decline. It is thus possible that the sea otter/herbivore/kelp association may be cyclic or follow a growth and crash pattern similar to that of many predator/prey relationships.

In 1972 scuba surveys in the Bunsby Islands area by Miller revealed that sea urchins were abundant and kelp was restricted to shallow water (Morris et al. 1979). Scuba surveys there in 1978 (Morris et al. 1979) revealed that sea urchins were scarce and kelp growth was vigorous. Scuba surveys reported by Breen et al. (1980) inside and outside of sea otter feeding range revealed a sharp contrast in underwater community structure. The most common sea urchin in both areas was the red sea urchin, Strongylocentrotus franciscanus, recognized for its ability to prevent the downward extension of kelp. Within the sea otter feeding range they found very few red sea urchins, most of which were in crevices, and extensive kelp at depths down to 33 feet (10 m). Outside sea otter feeding range, they found high densities of red sea urchins and a sharp delineation between the downward extension of kelp and upward range of sea urchins at depths as shallow as 1 m.

Preliminary observations of the Bunsby Islands sea otters indicated that the dominant food item in their diet was a white clam, tentatively identified as the butter clam (Saxidomus gigantus) with sea urchins, crabs, mussels, starfish, chiton and turban and top-shell snails ranking lower (Morris et al. 1979). Clams were not recorded in scuba surveys, presumably because they exist in deeper substrate than was surveyed (Breen et al. 1980). Abundance of species such as whelks and top-shells (Tegula spp.) recorded in underwater surveys suggests that less preferred species are still available within sea otter range (Breen et al. 1980). However, it is doubtful whether sea otters could extract enough meat from small snails or whelks to meet their high, daily caloric requirements. Adult sea otters require 20 to 23% of their body weight in meat per day, or 3000+ calories per day (Kenyon 1969).

Given that food resources have been depleted in the Bunsby Islands, sea otter range expansion to adjacent habitat can be expected. Some indication that this may be occurring already is the partial depletion of a sea urchin population southeast of the Bunsby Islands (Breen et al. 1980).

Habitat Requirements and Home Ranges

Kenyon (1969) considered the general habitat preference of the sea otter to be waters adjacent to rocky coast, particularly where kelp beds and underwater reefs occurred. No evidence exists of sea otters occupying inland waters far from the open coast, such as Puget Sound or the inside passages of southeastern Alaska.

Kenyon also noted that hauling out onto rocks was common in the Aleutian and Shumagin Islands. Hauling out is extremely rare in the southern part of the sea otter's range and has seldom been observed in B.C. Protection from storms is usually sought within kelp beds or sheltered coves. Preliminary observations of the Bunsby Islands sea otters during summer storms revealed that they abandoned the exposed Far-Out Reefs, one of their three main rafting locations, for the relative shelt of inshore reefs off Gull Island, another one of their main rafting locations.

These rafting locations were all within or adjacent to kelp beds. Movements of the Bunsby Island sea otters during severe winter storms are not known; the only aerial survey flown in winter located a total of only 15 sea otters less than 1 km away from the Gull Island rafting area.

Home range size of the sea otter is largely unknown. Based on the sightings of a few marked individuals, Kenyon (1969) estimated the female home range size to be about 8 to 16 km of coastline. In the Bunsby Islands the female and juvenile group had a roughly triangular summer home range of about 9 km^2 (Morris et al. 1979). Breen et al. (1980) found that the feeding range of the sea otter population in Checleset Bay, based on underwater surveys, covered roughly 26 km^2, part of which was probably too deep for sea otter feeding. That area is about 10% of the total area proposed as an ecological reserve.

The Future - Problems and Opportunities

Problems?

Oil pollution may well be the most serious problem faced by the sea otter in B.C. Oil slicks and sea otters must be kept apart as even a small patch of oil on the sea otter's coat will result in chilling and death. They have no layer of blubber and their thermoregulation is dependent on the insulation provided by the dense pelage. The recent increase in oil tanker traffic off B.C.'s coast increases the risk to all marine life; however, even non-tanker shipwrecks are cause for concern. For example, the shipwreck of the Lee Wang Zin on 25 December 1979 occurred within a few miles of one of the re-introduced, southeastern Alaskan populations. Fortunately, the resultant slicks of bunker oil were washed into two bays not inhabited by sea otters. A small population of gregarious animals is particularly vulnerable. The B.C. population of 70 or more occasionally congregates in one raft of 45 to 55 individuals; one oilspill could exterminate more than half the population.

Other potential problems include conflicts over shellfish resources. To date, such conflicts have been limited to California, where the red abalone (Haliotis rufescens)/sea otter problem has generated considerable publicity. Although it is seldom easy to separate the effects of predation by man from those of wildlife, there is conclusive evidence of the sea otter's ability to deplete abalone populations and eliminate effective commercial fisheries. Cox (1963 in Bailey 1979) reported tagging 513 abalone in Shelter Cove near Monterey and a year later, after three days of searching, finding only five abalone of which one was marked. A herd of sea otters had spent the winter foraging in Shelter Cove. The California Department of Fish and Game, in the introduction of a detailed report on the problem stated: "... extensive sport and commercial abalone fisheries and sport rock crab fisheries have virtually disappeared in the wake of the expanding sea otter population." (Wild and Williams 1974, in Bailey 1979). In addition to the commercial abalone and sport crab fisheries, the Pismo clam

(*Tivela stultorum*) sport fishery is also threatened by the expansion of Californian sea otters. Stephenson (1977) reported one sea otter eating 22 large Pismo clams in 2 hours. The California Department of Fish and Game stated: "... Pismo clam stocks in California appear to be on a healthy sustainable yield outside the sea otter's range .. inside the sea otter's foraging range virtually no clams were taken [by clammers] ... considering that some sea otters continue to frequent areas previously heavily foraged, it can be expected that the small sublegal clams remaining in the intertidal zone will not reach legal size in sufficient numbers to develop another recreational fishery as long as sea otters are present." (Miller et al. 1975, in Bailey 1979).

In B.C., the pinto abalone (*Haliotis kamtschatkana*) may be a potential "problem" species. The pinto abalone ranges from California to Alaska; in B.C. it is found off the Queen Charlottes, the northern mainland coast, the west coast of Vancouver Island , Johnstone Strait, and several areas in Georgia Strait (Griffith 1967). Preferred habit is rocky exposed beaches from low tide level to 11 m depth. Commercially, it is the most important shellfish (mollusc) in B.C., yielding wholesale values of $1,005,000 in 1976, $2,259,000 in 1977, and $2,152,000 in 1978. The 1978 revenue represented 36.5% of total revenue from shellfish and 0.4% of all fisheries revenue.

In 1978, 37.6% of all abalone harvested in BC. came off the east coast of the Queen Charlottes. Nearly all the rest, 58.2% of the total, was taken off the mainland coast opposite the Queen Charlottes (Fig. 4). In 1977 some commercial abalone fishing also occurred off the west coast of Vancouver Island , where 11 metric tons (2.7% of the total harvest) were taken. Total number of metric tons of abalone taken in B.C. in the last four years was 57, 273, 428, and 433 in 1975 through 1978 respectively (Fig. 5).

Several populations of abalone have been overfished. Commercial fishing in 1972 and 1973 reduced the abundance of abalone in Barkley Sound and Clayoquot Sound such that future landings in these areas have been limited severely (Miller 1974, in Proverbs 1979). Abalone (H. kamtschatkana) takes about 7 years to reach minimum legal size (102 mm) and about 15 to 25 years to reach the maximum size of 140 mm (Breen and Adkins 1978, in Proverbs 1979). Breen found that 75 to 80% of the accumulated historical stocks from the north coast had been harvested in 3 years, 1976 to 1978 (Proverbs 1979).

Re-introduction or dispersal of sea otters to the east coast of the Charlottes or north coast of the mainland could contribute to further abalone depletion. However, a significant sea otter population is unlikely to become established in these areas in the near future. Further, historical evidence such as the presence of sea otter bones in Indian middens suggests that sea otters were most abundant along the outer coast of B.C. If sea otters expand their range to include Barkley Sound and Clayoquot Sound on the west coast of Vancouver Island , recovery

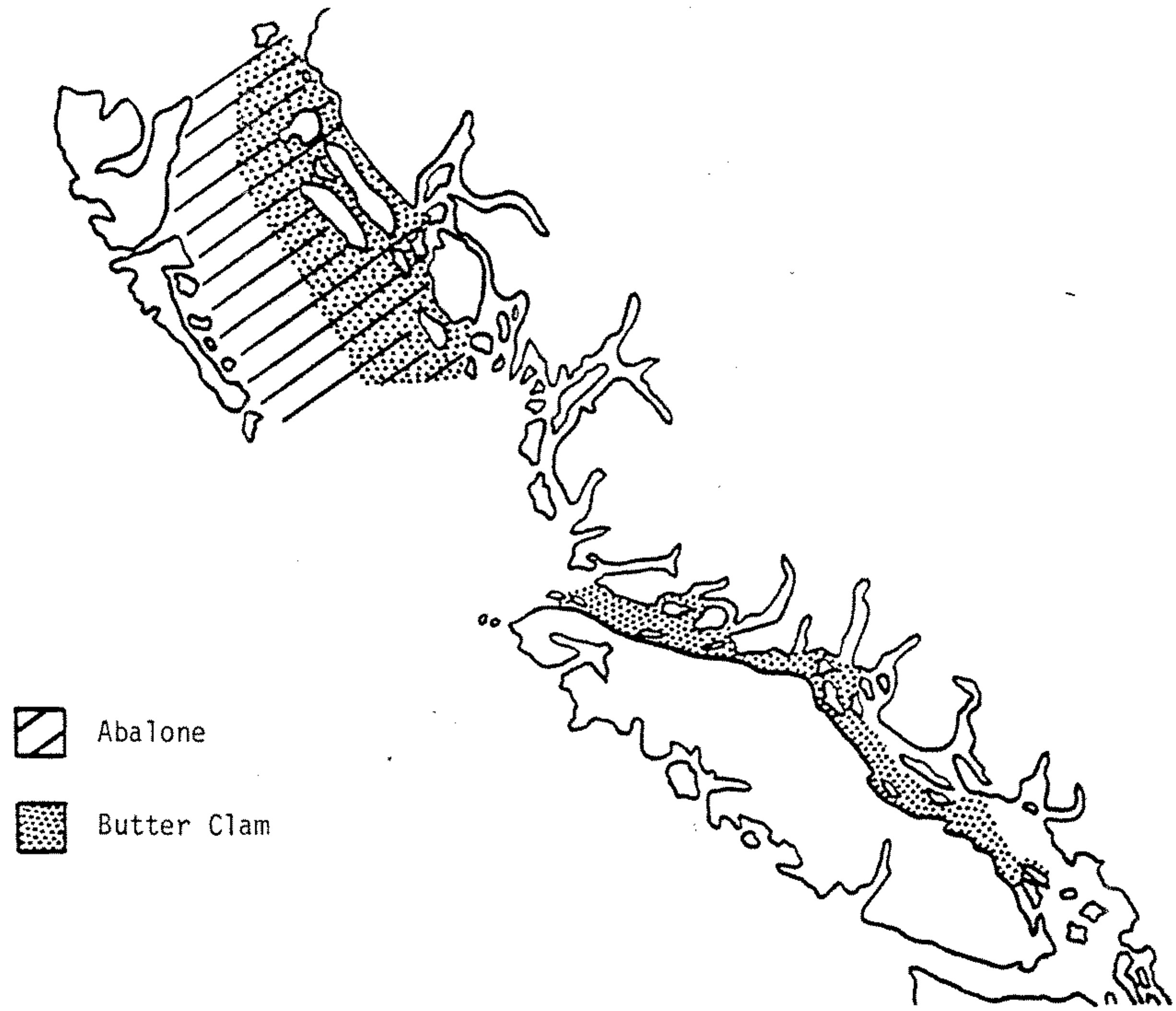

Fig 4

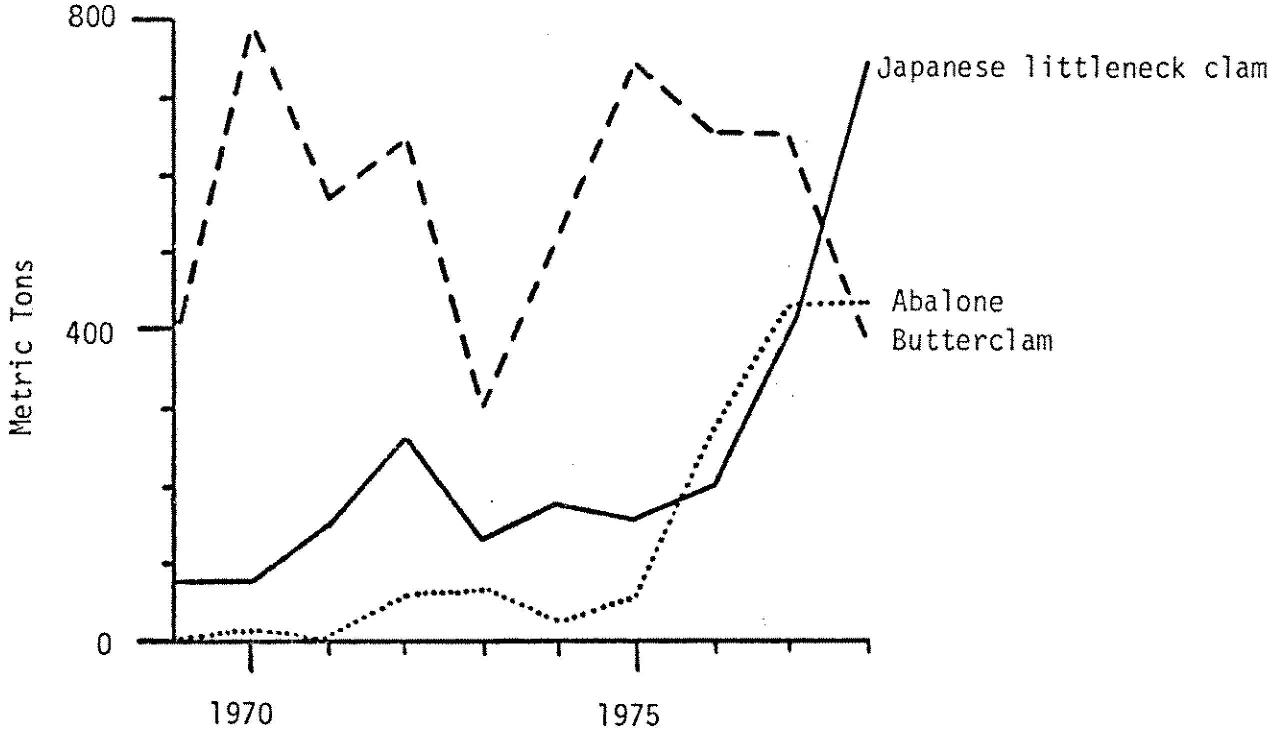
800
400
0
Metric Tons
1970
1975
Japanese littleneck clam
Abalone
Butterclam

Fig 5

of those commercial abalone stocks will probably not occur.

As noted previously, the butter clam (Saxidomus giganteus) was tentatively identified as the predominant food item in the diet of the sea otters in the Bunsby Islands. The butter clam occurs throughout B.C., generally in well-protected, sand-gravel beaches in the lower third of tidal range and occasionally to depths of 9 m (Quayle 1960). Originally one of the main food items of the Indians, the butter clam was also the most important commercial clam in B.C. until 1978, when it was surpassed by the rapidly expanding, introduced Japanese littleneck clam (Venerupis japonica) (Fig. 5). In 1978, 46.2% of the total take was from the mainland coast opposite the Queen Charlottes and 53.0% was from the waters between Vancouver Island and the mainland (Fig. 4). Again, neither of these areas are likely to be populated by significant sea otter populations in the near future so it is unlikely a conflict over the butter clam resource will arise. Sea otter foraging on the Japanese littleneck clam, the only mollusc significantly increasing in the shellfish harvest, has not been documented.

In terms of sport fishing in B.C., fishing for shellfish is prohibited off the Queen Charlottes and off the west coast of Vancouver Island due to the danger of red tides. As these are the two areas initially most likely to support significant sea otter populations, sport fishing/sea otter conflicts over shellfish can probably be disregarded.

Another species meriting some consideration is the sea urchin (Strongylocentrotus spp.). Sea urchins are one of the most important food items of sea otters. Commercial harvesting of sea urchins in sea otter habitat is probably detrimental to small sea otter colonies attempting to "gain a foothold" in B.C. Before 1979 sea urchins were lumped under "other species" which included octopus and miscellaneous in the fisheries statistics so it was not possible to determine trends in quantities harvested or past locations of harvest. Dave Smith, of the B.C. Marine Resource Branch, reported that some commercial harvesting of sea urchins had occurred in the area of the Bunsby Islands (Morris et al. 1979). Preliminary Fisheries Statistics for 1979 indicate that 317 metric tons of sea urchins were harvested in B.C., all of which came from the "south coast". The southern Gulf Islands area ranked highest in harvest taken.

Although in the past the sea urchin was a relatively minor commercial species in BC., there is now a growing market for it in Toronto as well as Japan. There is also some indication that the sea urchin may be the next "gold rush" fisheries species in B.C. Such species are rapidly exploited and subsequently much reduced in stock; recent examples are the abalone and goeduck (Panope generosa). The fact that the 1979 harvest of sea urchins is close to the 1978 harvests of both the butter clam and the abalone seems to corroborate this prediction. Intensive sea urchin harvesting on the west coast of Vancouver Island could have a negative effect on sea otter population growth and range expansion.

With regard to sport fishing, there is no limit to the number or sizes of sea urchins taken per day anywhere in B.C., except within half a mile of the Broken Islands group in Barkley Sound and waters of the Pacific Rim Park area where the daily bag limit is 12. If the sea otter is to be managed in B.C., it is obvious that there should be some method available to manage one of its most important prey items; "no limit" infers a lack of concern for the sea urchin resource.

Opportunities

Some of the opportunities which the sea otter may provide include public viewing, increased kelp and commercial kelp fish production, and controlled harvesting of otter pelts.

Public viewing could occur in suitable areas once the population reached high numbers. Sea otters and gray whales are a big attraction in California, just as sea lions are in Oregon. Locations of public access should be selected to minimize or eliminate human harassment; unlike gray whales, sea otters probably do not enjoy physical contact. In California, power boat-sea otter collisions have caused over 47 sea otter deaths.

Feeding by sea otters will cause an increase in kelp abundance. Commercial harvesting of kelp for chemical extraction is being considered seriously for B.C. The areas best suited for this operation, in terms of kelp biomass (*Nereocystis* and *Macrocystis*) are off the northern mainland coast, the Queen Charlottes, and the Nootka Island area (Fisheries Area 25) off the west coast of Vancouver Island (Fralick and Tillapaugh, 1979). Exposure to high winds and corresponding risk to the operation may foreclose the west coast of the Queen Charlottes as an option. While it is apparent that sea otters may enhance this potential industry by increasing the kelp abundance, it is unclear what effects the industry may have on the sea otters. The sea otters studied in BC. use kelp beds as rafting areas and the presence of a few kelp beds as refuge areas may be of great importance during storms. Sea otters could also be stressed by the disturbance of the actual operation, as well as by the loss of some of their refuge habitat. Kelp in B.C. is likely to be harvested with large, motorized barges that have a cutting mechanism similar to that of a wheat combine (Fralick and Tillapaugh 1979).

Increased kelp abundance could also benefit commercial fisheries. Many fish species, such as the commercial ling cod, use kelp beds but research in this area has only just begun. Herring deposit their roe on kelp plants; it is for this reason that kelp is presently being harvested east of the Queen Charlottes. Herring may also use kelp beds to evade predators; the same may be true for the young of many commercial fish species.

Based on the feeding habits of sea otters in Alaska, competition between sea otters and fishermen over commercial kelp fish is unlikely to occur. At Amchitka sea otters fed mainly on slow-moving, non-commercial species such as globefish (Cyclopterichthys glaber) and Red Irish Lord (Hemilepidotus hemilepidotus) (Kenyon 1969). Sea otters may thus enhance both kelp and fishery industries. However, our lack of understanding of the ecological complexity of kelp communities could generate unforeseen problems, so these potential opportunities must be viewed cautiously.

Controlled harvesting of sea otter pelts is also a possibility, if sea otters become very numerous and widespread in British Columbia. It occurred in Alaska from 1962 to 1972. At a Seattle auction in 1968, the highest quality pelts sold at $2300 each.

There are other, less tangible, benefits to be gained. These include the enriched diversity to which every species in our ecosystem contributes, and the satisfaction of knowing that the sea otter is back at a time when much of our natural habitat and many species are threatened with extinction. The sea otter is a refreshing global success story; with careful management it could be a success story in British Columbia as well.

Management Recommendations

1. Checleset Bay should be given Ecological Reserve Status. The process is already underway but should be hastened. Such status should eliminate commercial fishing for sea urchins and shellfish in the area as well as unnecessary boat traffic or sources of disturbance to the animals. It should also guard against potential dangers such as offshore drilling. Adoption of a volunteer warden system by the Ecological Rserves Branch should enable the Checleset Bay Reserve to be manned and the regulations enforced.

2. More research must be conducted on the biology of sea otters in B.C.

Specifically, we need more information on sea otter feeding behaviour and its effect on our benthic communities, habitat requirements of sea otters in winter, and population dispersal. Population censuses should be done on a regular basis.

3. Subsequent to further research another major colony should be established in B.C.

Presently, an oil slick washing into Checleset Bay would all but eliminate the species in this province. The proposed colony site at Hippa Island Ecological Reserve off the west coast of Graham Island (Fig. 3) is a good choice for several reasons:

a. the site is already legally protected

b. commercial fishing for shellfish does not occur off the west coast of the Queen Charlottes so sea otter range expansion along this coast should not cause conflicts.

c. the site is remote and human disturbance would be minimal.

d. it is far enough away from Checleset Bay that an oil disaster affecting one population should not affect the other.

If further censuses indicate the Checleset Bay and Bajo Reef colonies are not increasing, it may also be desirable to release another transplant into Checleset Bay. Figure 2 suggests that the probability of transplant success increases with an increase in number of transplanted animals. If lack of funding necessitated a choice between a northern re-introduction or a southern "reinforcement" the latter might prove more beneficial to the establishment of the species in B.C. However, the establishment of at least two major colonies should be the primary objective.

4. There should be a limit to the number or size of sea urchins that sports fishermen can take.

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Figure Captions

Figure 1. Temporal trends in numbers of natural sea otter populations (• = count; ∘ = estimate; ↕ = range of estimate). Sources: a) 1 = Kenyon (1969), 2 = Kenyon (1978), 3 = Bailey (1979); b) 1 = Kenyon (1969), 2 = Kenyon (1978), 3 = Bailey (1979), 4 = MacAskie (1971); c) 1 = Kenyon (1969), 2 = Bailey (1979), 3 = Boolotian (1961 in Kenyon 1969), 4 = Carlisle (1966), 5 = Kenyon (1978); d) Kenyon (1969).

Figure 2. Temporal trends in numbers of transplanted sea otter populations. (• = count, ↕ = range of estimate, step-like portion of figures represents individual transplants). Sources: a) 1 = Alaska Dept. Fish and Game (1973), 2 = Johnson (pers. comm.), b) 1 = Kenyon (1978), 2 = Estes et al. (1978); c) Kenyon (1978); d) 1 = Big and MacAskie (1978), 2 = Morris et al. (1979).

Figure 3. Distribution of sea otter colonies and sightings in British Columbia (• = sea otter colony; ➔ = proposed colony; ▲ = sightings as adapted from Bigg and MacAskie 1978).

Figure 4. Distribution of 95% or more of the 1978 harvest of abalone and butter clam; boundaries are those of Fisheries Statistical Areas. Source: Government of Canada, Annual Summaries of B.C. Catch Statistics).

Figure 5. Historical harvests of shellfish in British Columbia. (Source: Government of Canada, Annual Summaries of B.C. Catch Statistics.)