NATIONAL RECOVERY STRATEGY

FOR THE

SEA OTTER

Enhydra lutris

IN

CANADA

DRAFT

September 2004

EXECUTIVE SUMMARY

Sea otters once ranged from Northern Japan to central Baja California, but were hunted almost to extinction during the Maritime fur trade that began in the mid 1700s. As few as 2000 animals, little more than 1% of the pre-fur trade population, are thought to have remained in 13 remnant populations by 1911. In Canada, the last verified sea otter was shot near Kyuquot, British Columbia[1], in 1929. Between 1969 and 1972, 89 sea otters from Amchitka and Prince William Sound, Alaska were translocated to Checleset Bay on the west coast of Vancouver Island, BC. Animals from these translocation efforts established themselves, but there were still less than 100 animals in 1978, when the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the species as *Endangered*. By 1995, the population had increased in size to about 1500 animals and in geographic extent but was still considered relatively small and restricted in distribution and therefore vulnerable to environmental catastrophes such as oil spills. Though no longer considered in imminent danger of extirpation, it was still considered at risk and was thus down-listed by COSEWIC to *Threatened* in 1996. The most recent estimate made in 1998 indicates the population includes a minimum of 2000 animals along the west coast of Vancouver Island and 500 animals on the central British Columbia coast. Oil spills remain a significant threat that could easily decimate the population at any time because of its size and distribution and the species' inherent vulnerability to oil. Sea otters are legally listed as *Threatened* under Schedule I of the *Species At Risk Act*. Protection under the Act prohibits killing, harming, capturing, taking and harassing of individuals. The Act also prohibits the damaging or destroying of their residence and, once identified, their critical habitat.

In June of 2002, Fisheries and Oceans Canada formed a Recovery Team to develop a National Recovery Strategy for sea otters in Canada consistent with the requirements of the *Species At Risk Act*. The team is comprised of scientists, resource managers, conservationists, First Nations and commercial shellfish harvesters. There is representation from: Fisheries and Oceans Canada, Parks Canada Agency, BC Ministry of Water, Land and Air Protection, the U.S. Fish and Wildlife Service, the Washington State Department of Fish and Wildlife, the World Wildlife Fund Canada, the Nuu-cha-nulth Tribal Council, the Underwater Harvesters Association, and Malaspina University-College.

A single-species approach to recovery was adopted to allow focussed consideration of the activities needed to recover sea otters, independently from other species of conservation concern and to be able to achieve completion of the strategy within one year. There are, however, compelling arguments in support of a multi-species approach, but the team recognized that the effort to integrate multiple species conservation issues would have been significant and

[1] In Canada, sea otters occurred only in coastal British Columbia.

development of such a recovery plan could not possibly have been completed in a single year.

The Recovery Team identified a number of knowledge gaps with regard to recovery of sea otters. A current population estimate is needed. A survey method, that is being developed, is needed to be able to monitor population size and distribution with some confidence now and in the future and in the event of an oil spill or some other threat. A lack of knowledge exists about sea otter habitat use by season by age and by sex, although habitat is not considered limiting at this time. Knowledge is lacking about the level of genetic diversity in the BC sea otter population. Sea otter populations throughout the North Pacific experienced a severe bottleneck as a result of the Maritime fur trade. Given this fact, genetic diversity of BC sea otters should be measured to assess the vulnerability of the population to random environmental or biological events.

The following threats were identified as significant or requiring clarification. Oil spills remain the most significant threat to sea otters and the need to protect sea otters and their habitat was identified. However, the team also identified the need to clarify the significance of additional threats such as disease, contaminants, entanglement in fishing gear, and illegal killing as these have been implicated in declines in sea otter populations elsewhere.

The goal for recovery of sea otters in Canada:

Ensure that the sea otter population in British Columbia is sufficiently large and adequately distributed so that threats, including events catastrophic to the species, such as oil spills, would be unlikely to cause extirpation or diminish the population such that recovery to pre-event numbers would be very slow.

To achieve this goal the Recovery Team adopted a relatively non-intrusive approach to recovery that recognizes the sea otter's ability to rebound but at the same time considers that threats could limit or even reverse the current population trend if not addressed. The first objective focuses on identifying and reducing threats to sea otters and their habitat that could impede recovery. With a lack of knowledge regarding the necessary size and distribution of the population to achieve the goal, the recovery team could not at this time, set quantitative measures for these as short-term recovery objectives (for the next 5 years). Instead, the team set objectives to identify a population size target, and to identify a distribution target and then monitor the population to determine when these targets have been reached.

A first draft of the Recovery Strategy was posted to the internet in December 2002 for public comment. The Recovery team sought input through two public consultation meetings held in late January 2003 and through written submissions. In general, there was support for protecting sea otters from becoming endangered but also concern expressed about the impact of sea otters on shellfish resources for First Nation's food, social and ceremonial purposes and for commercial shellfish fisheries. Public input has been incorporated into the document where appropriate.

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I. INTRODUCTION

Hunted during the Maritime fur trade, that commenced in the mid-1700s, sea otters (*Enhydra lutris*) were driven to the brink of extinction by the mid 1800s. Found along the North Pacific Rim, sea otters today occupy roughly half their historic range. In Canada, sea otters are found in coastal British Columbia (BC) and are listed as *Threatened* by the Committee on the Status for Endangered Wildlife in Canada (COSEWIC).

With input from First Nations, stakeholders and those interested in the recovery of sea otters, the Sea Otter Recovery Team under the lead of Fisheries & Oceans Canada have drafted this National Recovery Strategy, which represents a legal requirement under the *Species At Risk Act* (*SARA*) and forms the scientific basis for recovering the sea otter population in Canada.

The purposes of the Act are:

> “to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of a wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened”.

As such, this strategy is being developed from the perspective of benefits to sea otters and activities that lead to recovery of the population. Socio-economic factors are identified in this strategy, and will be further evaluated for costs and the benefits to be derived from implementation in the subsequent Action Plan. Under the Act, the development of an Action Plan will follow the drafting of the Recovery Strategy. The Sea Otter Action Plan will list the measures and estimated costs for 5 years that are to be taken in implementing the Recovery Strategy.

II. BACKGROUND[2]

1. CURRENT STATUS

Table 1. COSEWIC Species Database listing information about sea otters

Common Name: Sea Otter

Scientific Name: *Enhydra lutris*

Assessment Summary: 1996 – threatened, confirmed May 2000

Status: Threatened

Reason for Designation: Formerly endangered. The population is increasing and now occupies two sites off the British Columbia coast and is not in imminent danger of extirpation. However, the species remains at risk due to potential environmental contamination and fisheries conflicts.

Canadian Occurrence: Pacific Coastal Waters

Status History: Designated Endangered in April 1978. Status re-examined and confirmed Endangered in April 1986. Status re-examined and downlisted to Threatened in April 1996. Status re-examined and confirmed Threatened in May 2000. Last assessment based on an existing status report.

From: www.cosewic.gc.ca/eng/sct1/index_e.cfm.

COSEWIC requires a status report every 10 years for species with *Threatened* status. The last status report for sea otters was completed in 1996; the next status report is required and will be prepared in 2006. See Watson *et al.* (1997), COSEWIC's sea otter status report. Sea otters are legally listed as *Threatened* under Schedule I of *SARA*.

1.1 Species Description

Sea otters are the second smallest marine mammals, and the second largest member of the Mustelidae or weasel family. Many consider the South American marine otter or chungungo (*Lutra felina*) to be the smallest marine mammal, although they are not exclusively marine occupying freshwater habitats and denning on land. The giant Amazonian otter (*Pteronura brasiliensis*).is the largest mustelid. Worldwide there are 12 species of otters. All have streamlined bodies, thick fur and amphibious habits, but the sea otter, is the only species that carries out all aspects of its life in the marine environment. Sea otter possess several important adaptations. These include development of hind flippers for aquatic

[2] *SARA* requires that the recovery strategy identify "a description of the species and its needs that is consistent with the information provided by COSEWIC" [*SARA* s.41(1)(a)].

locomotion, flattened premolars and molars for crushing the hard-shelled marine invertebrates and enlarged kidneys to process the large amounts of ingested sea salt (reviewed in Riedman and Estes 1990).

On average, sea otters weigh between 19.5 kg and 29.5 kg (reviewed in Riedman and Estes 1990). Adult male sea otters tend to weigh more than females, and can weigh up to 50 kg and reach lengths of 1.5 m (R. Jameson pers. comm. 2002). Males tend to have a larger head and the neck is more muscular, however the presence of the penile and testicular bulge is the only reliable method for determining sex when observing free-ranging otters. Newborn pups are characterized by a light brown, or yellowish, woolly natal fur that is completely replaced by adult fur by 13 weeks (Payne and Jameson 1984).

Three subspecies of sea otter are recognized, based on detailed skull measurements. *Enhydra lutris kenyoni*, which is thought to have historically ranged from the coast of Oregon to the Aleutian Islands, *Enhydra lutris nereis* occurs along the California coast and *Enhydra lutris lutris*, ranges from the Kuril Islands to the Kamchatka Peninsula and the Commander Islands (Wilson *et al.* 1991). Genetic analysis of mitochondrial DNA variation supports this, although there are some similarities in the frequencies of mtDNA haplotypes between *Enhydra l. lutris* and *Enhydra l. kenyon*, (Cronin *et al.* 1996). Recent genetic analysis also indicates some gene flow occurred between California and Prince William Sound, Alaska prior to the Maritime fur trade (Larson *et al.* 2002a).

Sea otters have little or no body fat. To survive in an aquatic environment, they maintain an exceptionally high metabolic rate and rely on their dense fur for insulation. The fur consists of an outer layer of protective guard hairs below which is an extremely fine dense under fur of approximately 100,000 hairs per cm^2 (Kenyon 1969). Oil from glands in the skin helps to enhance the water repellency of the fur. Sea otters must groom their fur frequently to maintain its insulative quality and water repellency. During grooming, the fur is cleaned, hair shafts are straightened and aligned to maintain loft, oil is distributed and air is blown through the fur where it is trapped as tiny bubbles that enhance the insulative capacity of the fur (reviewed in Riedman and Estes 1990).

The metabolic rate of the sea otter is 2.4 to 3.2 times higher than that of terrestrial mammals of a similar size. To fuel this internal heat production, free-ranging sea otters consume the equivalent of 23 to 33% of their body weight per day (reviewed in Riedman and Estes 1990).

1.2 Distribution

1.2.1 Global Distribution

Sea otters are found in coastal areas throughout the North Pacific (Figure 1). The species once ranged fairly continuously from Northern Japan to central Baja California (Kenyon 1969), but the Maritime fur trade caused near extinction of the species by the mid 1800s. Today, the sea otter occupies about half of its historical range. Small remnant populations in California, the Aleutian Islands and Russia survived and eventually re-established. Yet large areas to the south of the Gulf of Alaska, with the exception of California remain unoccupied except where sea otters were intentionally re-introduced (Southeast Alaska, BC, Washington). Sea otters are found in Washington state and Southeast Alaska, the US jurisdictions bordering BC. In Southeast Alaska, sea otters range into Dixon Entrance (USFWS 2002c). In Washington State, sea otters range along parts of the west coast north to Cape Flattery and eastward into the Strait of Juan de Fuca to Pillar Point (Richardson and Allen 2000).

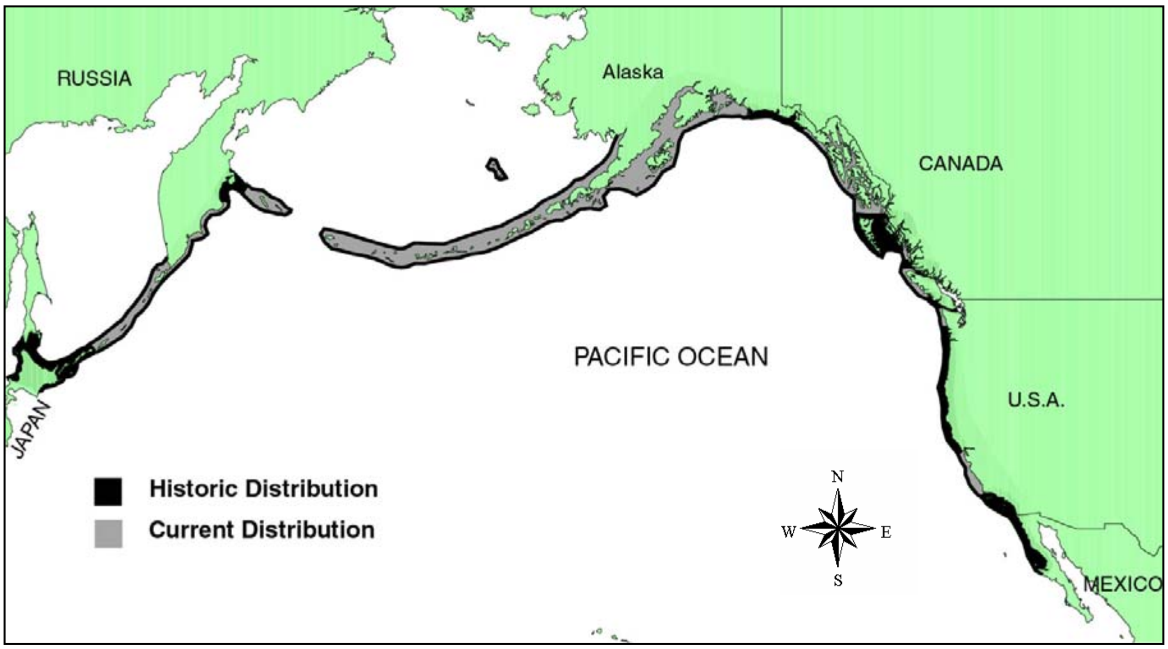

Figure 1. Distribution of historic and current populations of sea otters in the North Pacific.

1.2.2 Canadian Distribution

In British Columbia sea otters most likely occurred historically wherever there was suitable habitat in waters less than 100m. This would have included exposed coast lines, and in the absence of historical records, the possibility that sea otters also occupied more protected areas in large numbers can not be ruled out. Since re-introduction of the sea otter to the British Columbia coast between 1969 and 1972, the population range has expanded beyond Checleset Bay; the site of re-introduction (Figure 2). Sea otters surveys are generally made between May and September and the population range is defined as the area in which sea otters are consistently observed during survey months. For consistency, expansion of the range over time is estimated using the known range during survey months. In 1992, the population ranged from Estevan Point northwest to Quatsino Sound (Watson *et al.* 1997). Based on surveys made in 2001 and 2002, sea otters now range from Hesquiat Harbour northwest to Cape Scott and eastward to Hope

Island (DFO unpublished 2002). In 1989, sea otters were reported in the Goose Group on the central BC coast (Watson *et al.* 1997). The continuous range on the central coast extends from the Goose Islands Group to the edge of Milbanke Sound (DFO unpublished 2002). Sea otters move seasonally within and beyond their continuous range. For example, over the past two winters, a sea otter raft has been observed and reported off of Flores Island, a distance of about 25km southeast of Hesquiat Harbour (DFO sea otter survey 2002; S. Jeffries pers. comm. 2003).

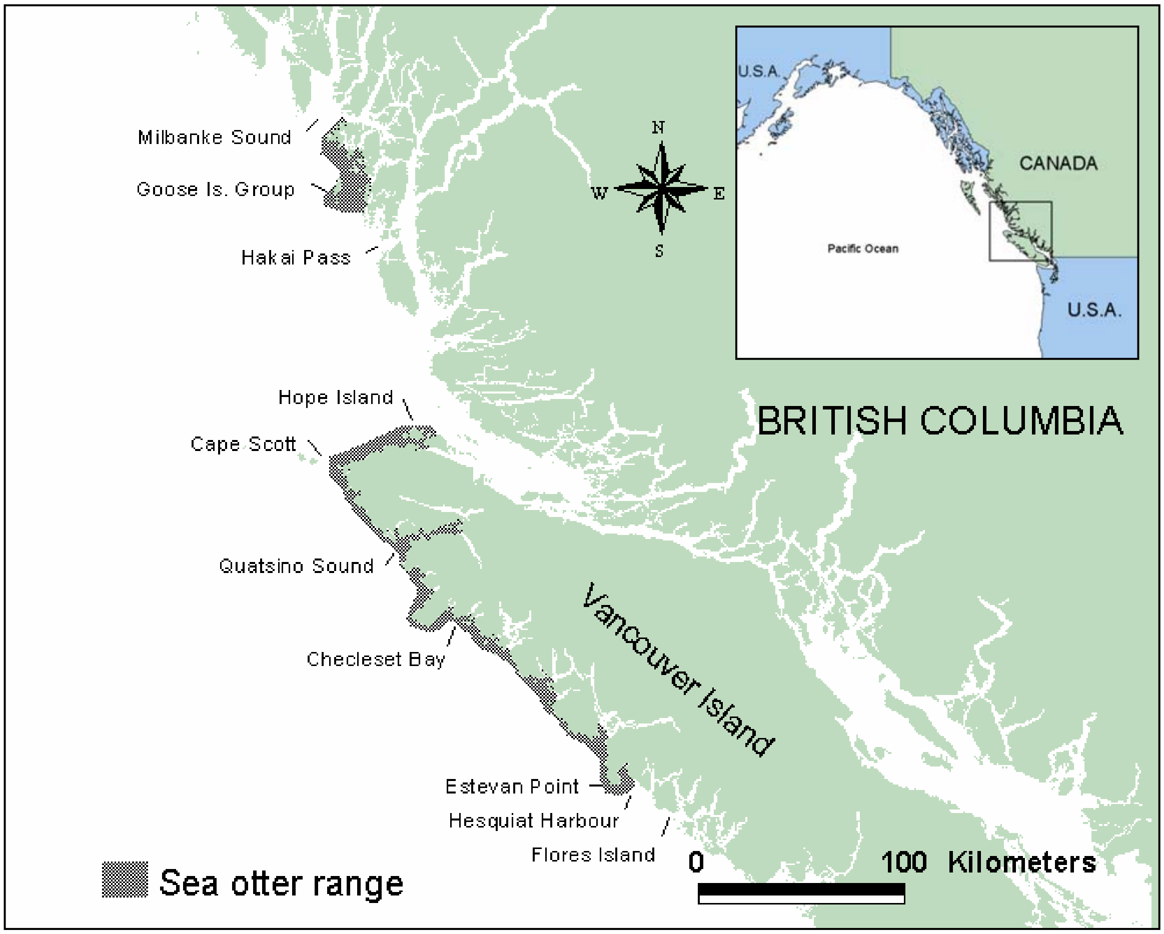

Figure 2. Distribution of sea otters in British Columbia.

1.2.3 Percent of Global Distribution in Canada

Based on inspection of the sea otter distribution map in Watson *et al.* (1997) not more than 5 to 10% of the global distribution of sea otters occurs in Canada. In terms of population size, British Columbia sea otters represent 3 to 4 % of the global population, however should declines in the sea otter populations of Southwestern Alaska and California continue, this percentage could increase. British Columbia is the only jurisdiction in Canada with sea otters.

1.3 Population Size and Trends

1.3.1 Global

Estimates of the historic number of sea otters that occurred throughout the North Pacific prior to the Maritime fur trade are crude and uncertain but range from 150,000 to 300,000 (Kenyon 1969; Johnson 1982). Kenyon (1969) reported a world population in the late 1960's of about 30,000 sea otters, occupying about one fifth their former range. From this he surmised conservatively, that the pre-fur trade population could have been 100,000 to 150,000 animals. Johnson (1982) followed Kenyon's approach but used 60,000 as an estimate of the population in the late 1960s.

Midden remains indicate native people exploited sea otters before the Maritime fur trade, and at least in the Aleutian Islands, may have extirpated local populations (Simenstad *et al.* 1978). Massive over exploitation during the Maritime fur trade drove sea otters to the brink of extinction by the mid 1800s. The International Fur Seal Treaty of 1911, signed by Japan, Russia, the United States and the United Kingdom (for Canada), intended to protect the Northern fur seal, included an article that prohibited non-natives, and anyone hunting for commercial purposes from hunting sea otters in international waters (3 miles from shore). This would have afforded a small degree of protection. By 1911, however, less than 2000 otters remained scattered amongst 13 remnant populations (Kenyon 1969). Several of these remnant populations declined to extinction (Watson *et al.* 1997).

Translocated populations have maximum growth rates of 17- 20% per year, whereas remnant populations grow more slowly, 8 to 13% per year (Estes 1990; Bodkin *et al.* 1999). Habitat quality may account for some of these differences. Translocated populations are typically introduced to areas that have not been inhabited by sea otters for many decades and have a high abundance of food resources. In contrast, remnant populations began expanding soon after protection (after 1911). In addition, illegal harvest from remnant populations is known to have continued and would have slowed recovery (Bodkin *et al.* 1999).

Until recently, the estimated world population was thought to be more than 126,000 animals (Gorbics *et al*. 2000)) but dramatic declines in Southwestern Alaska, have reduced the overall population. Table 1 provides a summary of recent counts and estimates, made using a variety of different survey methods and survey effort. Some are minimum counts while others have been adjusted with correction factors to account for missed animals.

Table 2. Recent counts and estimates of sea otter populations in the North Pacific

Region	# of otters	Year of count/ estimate	Source
USA - California	2,150	2002	USFWS 2003
USA - Washington	551	2002	Jameson and Jeffries 2002
Canada - British Columbia	2,500	1998	Watson 2000
USA - Southeast Alaska	12,632	1994, 1995, 1996	USFWS 2002c
USA - Southcentral Alaska	16,552	1996, 1999, 2002	USFWS 2002b
USA - Southwestern Alaska	41,474	2000, 2001, 2002	USFWS 2002a; Doroff *et al.* 2003
Russia - Commander Islands	5,546	2002	A. Burdin pers. comm. 2003
Russia - Kamchatka Peninsula and Kuril Islands	16,910	1997	see table in Gorbics *et al.* 2000
Japan – Cape Nossapu	1	1997	see table in Gorbics *et al.* 2000
Total estimate	**98,316***		

* The total does not represent an accurate global population estimate as survey methods, survey effort and year of survey vary among regions and some results represent minimum counts while others are estimates derived from counts.

1.3.2 British Columbia

No estimates exist of the number of sea otters that historically inhabited coastal British Columbia although they likely occupied most coastal marine waters. Following the intense fur trade of the 18th and 19th Century, the last verified sea otter was shot near Kyuquot in 1929 (Cowan and Guiguet 1960). There are no confirmed sightings of sea otters until re-introduction. Between 1969 and 1972, 89 sea otters were released in three transplant attempts. Between 1977 and 1995, the BC sea otter population increased at 18.6% per year from 70 animals in 1977 to 1,522 in 1995 (Watson *et al.* 1997). In areas near the site of re-introduction, (Checleset Bay and Kyuquot) the population appears to be at equilibrium (Watson *et al.* 1997) and the overall population growth rate is likely now less than 18.6% per year. The most recent population estimate was made in 1998, and at that time the population was estimated to include 2000 animals along the west coast of Vancouver Island and an additional 500 animals off the central coast of British Columbia (Watson 2000).

1.3.3 Population trends in other jurisdictions

The North Pacific sea otter populations include several remnant populations that have rebounded (California, Southcentral Alaska, Southwestern Alaska, and Russia) and several re-introduced populations (Washington, British Columbia, and Southeast Alaska) founded with animals translocated from Southwestern Alaska between 1965 and 1972. Sea otters were also translocated to Oregon during the same period, but that re-introduction was unsuccessful. The following section summarizes current trends in each jurisdiction, except British Columbia, which is summarized above.

California
The southern sea otter population has a naturally high rate of mortality compared to other populations, so that even during periods of positive growth, the population growth rate, 5 to 7%, is notably lower than other populations (Estes *et al.* 2003). Periods of population decline have been documented in this population. A decline of about 5% per year was detected in the mid 1970s when the population numbered 1789 individuals and was attributed to mortality from entanglement in submerged fish nets. The trend reversed following restrictions on net use (USFWS 2003). In 1995 the population numbered 2377 but may again be in decline. Several factors including disease and entanglement in fishing gear are currently of concern (USFWS 2003). Although disease is not thought to be the cause of the current decline many infections documented in southern sea otters are from parasites and microbes for which sea otters are not the natural host, and this is of concern (USFWS 2003). Incidental losses in coastal gill and trammel nets appear to have increased and are considered a possible cause (USFWS 2003).

Southcentral Alaska
In Southcentral Alaska sea otters have recolonized most of their former range; however, the population was significantly affected by the *Exxon Valdez* oil spill in 1989. Since the spill, the population in Prince William Sound has recovered but not to the level expected and large numbers of sea otter carcasses still wash ashore periodically (USFWS 2002b). An estimated 16,552 sea otters occur in Southcentral Alaska (USFWS 2002b).

Southwestern Alaska
In Southwestern Alaska sea otters re-established to a large population size as early as the late 1950s and the Southwestern Alaska population accounted for about 80% of the world population, estimated to be 30,000 in the late 1960s (Kenyon 1969). By the 1980s the Aleutian Island sea otter population alone numbered between 55,100 and 73,700 (Calkins and Schneider 1985), but declined precipitously during the 1990s (Doroff *et al.* 2003). A comparison of survey results from 2000 with those made in 1965 and 1992 indicates the population has decreased by 75% since 1965. Since the mid 1980s, the decline has been at an annual rate of 17.5 % per year (Doroff *et al.* 2003). Surveys of other parts of Southwestern Alaska indicate declines extend eastward to include the Alaska Peninsula and the Kodiak archipelago (Doroff *et al.* 2003). The population is estimated to include 41,474 animals (USFWS 2002a).

Russia (Kuril Islands, Kamchatka Peninsula, and Commander Islands)
Westward of the Aleutian Islands are the Commander Islands, Kamchatka Peninsula, and the Kuril Islands. Gorbics *et al.* (2000) compiled counts and estimates of all areas in the North Pacific. The data they compiled indicate an estimated 16,910 sea otters in the Kuril Islands and Kamchatka Peninsula in 1997. The results of surveys of the Commander Islands in 2002 indicate a total of 5,546 (A. Burdin pers. comm. 2003), for a total of 22,456 sea otters. Sea otters

are not considered endangered in Russia, but the population is still considered to be below historic levels (Burdin 2000).

<u>Washington</u>
In 1969 and 1970, 59 sea otters were re-introduced to Washington State from Amchitka Alaska. The Washington sea otter population currently includes 551 animals and since 1989 has grown at 8.2% per year (Jameson and Jeffries 2002). The overall growth rate has continued to decline, although the overall trend is still positive, but the population may be approaching equillibrium density in some rocky habitat along the outer coast (Jameson and Jeffries 2002).

<u>Southeast Alaska</u>
Between 1965 and 1969, 467 sea otters re-introduced to Southeast Alaska from western Alaska (Jameson *et al.* 1982). The population is estimated to include 12,632 animals (USFWS 2002c).

1.3.4 Translocation of sea otters

Translocation as a means of re-establishing sea otter populations into parts of their former range were successfully used in the late 1960s and early 1970s in Southeast Alaska, British Columbia, Washington and Oregon (see above section). Although sea otters reproduced and remained in Oregon for several years they eventually disappeared. The reason for the failure in Oregon is unclear (R. Jameson pers. comm. 2003). Early translocations in the 1950s to a variety of Aleutian Islands (Kenyon and Spencer 1960) and a translocation in 1966 of 55 sea otters to the Pribilof Islands were likewise considered unsuccessful (Jameson *et al.* 1982). At present there are less than 50 sea otters in the Pribilof Islands, and there is some question as to whether these are descendants of the re-introduced animals, or animals that have dispersed from the Alaska peninsula (R. Jameson pers. comm. 2003). Many of these early translocations were conducted to determine if sea otters could be successfully relocated, and to assess capture and transport techniques. A summary of all these early sea otter translocations can be found in Jameson *et al.* (1982).

More recently, translocation has been used in California as a recovery strategy to increase the distribution of the southern sea otter population and thereby reduce the impact of an oil spill and to establish another breeding population (Benz 1996). The following summarizes the results to date of this approach to achieving recovery of southern sea otter.

In 1982, the Southern Sea Otter Recovery Plan (1982) called for the United States Fish and Wildlife Service (USFWS) to establish a second breeding colony of southern sea otters in California, that would expand the distribution, increase the population size and thereby reduce the threat of a catastrophic oil spill (Riedman 1990). At that time, the southern sea otter population had not grown significantly since 1973, and oil spills were considered a major threat in California (VanBlaricom and Jameson 1982).

From 1987 – 1990 USFWS translocated 140 southern sea otters from central California to San Nicolas Island, located in the Channel Islands off Santa Barbara a distance of more than 200 km southeast of the mainland population and about 100km west of the coast. In addition to reducing the effects of a catastrophic oil spill on the southern sea otter population, scientists further hoped to refine the techniques used to capture, hold and relocate sea otters, gather data on population dynamics and ecological relationships, and determine if removing sea otters affected the source population (Benz 1996).

The decision to translocate sea otters was extremely controversial. As part of the translocation the USFWS was legally obliged to restrict the "experimental population" of sea otters to the translocation site at San Nicolas Island, and to ensure that the existing sea otter population did not extend south of Point Conception. This "zonal management " strategy was instituted because shellfish fishers demanded that a *no sea otter zone* be created to insure the continued availability of commercially valuable shellfish resources south of Point Conception. Sea otters moving into the *no sea otter zone* were captured (non lethally) and relocated back to the approved sea otter zone (Benz 1996).

By the end of the first year of translocation more sea otters had dispersed from San Nicolas Island than was expected and the translocation strategy changed several times to try and address this problem.The last otters were released in 1990. Of the 140 sea otters moved to San Nicolas, 36 returned to their capture location on the mainland. Eleven were captured in the *no sea otter zone* and returned to the mainland. Seven were found dead in the *no sea otter zone.* Three were found dead at San Nicolas Island, and at least 13 are believed to have established at San Nicolas Island. The fate of the remaining 70 translocated animals is unknown, although they are suspected of having returned to the mainland or to the *no sea otter zone* and died (USFWS 2003). However, the results of the earlier translocations to Washington State, suggested that high mortality and dispersal following translocation was normal, and even with a very small founder population, the sea otter eventually became established in Washington State (Benz 1996). This was also true in British Columbia and Southeast Alaska (see sections above).

In terms of establishment of a breeding colony, the translocation project, has been less successful than hoped. The number of otters at San Nicolas Island has increased slowly since 1993 with 27 animals in the population as of 2002 and at least 73 pups known to have been born since re-introduction (USFWS 2003). In terms of containing the population, the project failed. Zonal management has proven ineffective, costly, and potentially detrimental to the parent population. In July 2000 the USFWS decided, that the containment of sea otters by attempting to maintain the *no sea otter zone* was jeopardizing recovery of the southern sea otter population, and stopped removing sea otters from the exclusion zone (Federal Register January 22, 2002, Volume 66:14:6649-6652). The decision to stop capturing sea otters was contested by commercial fishers who filed a lawsuit against the USFWS. The courts however found in favour of the USFWS and sea otters have been allowed to expand into the *no sea otter zone,* although a final decision on the translocation and containment program has not been made pending a revised Environmental Impact Statement to be released in 2003 (USFWS 2003).

It is not clear why the translocation has had such limited success (Benz 1996). Perhaps the greatest problem was that the sea otters did not recognize the lines that scientists had drawn and at least one third of the adult sea otters dispersed from San Nicolas, often returning to where they were captured and to other areas beyond San Nicolas Island. The requirement to capture and relocate otters dispersing from the translocation zone, and especially to limit the range of the existing population was extremely expensive and difficult to monitor, and possibly detrimental to the original sea otter population. Had the *no sea otter zone* not been in effect and the relocated population been left alone, the effort to establish a new breeding population beyond the current range in California might have been more successful than currently thought (R. Jameson pers. comm. 2003).

The *Exxon Valdez* oil spill in 1989 illustrated that a spill of a similar magnitude in California would have affected both the existing population and the experimental population at San Nicolas Island. As such the translocation could not reduce the threat from such a large spill, although the threat posed by smaller spills might still be reduced.

1.4 Legislation protecting sea otters and their habitat

The *Fisheries Act* provides a legislative framework for the conservation and protection of sea otters in Canada. Currently, all harvest of sea otters is prohibited. The *Fisheries Act* also prohibits the disturbance of sea otters and has provisions to protect sea otter habitat. The *British Columbia Wildlife Act* and Regulations also provide a framework to protect sea otters from being hunted, trapped or killed. Sea otters are legally listed as *Threatened* under the *Species at Risk Act* (*SARA*). Section 32 of *SARA* prohibits the killing, harming, harassing capturing, and taking of a threatened or endangered species, Section 33 prohibits the damaging or destroying of their residences, and Section 58 prohibits the destruction of critical habitat once identified.

Currently, there is one area explicitly designated for sea otters, the Checleset Bay Ecological Reserve established in 1981. It is a provincially protected area that includes 33,321 ha of marine habitat (Jamieson and Lessard 2000). Federal fisheries for geoducks, red urchins, green urchins, octopus, horseclams and sea cucumbers are closed in the ecological reserve. There are no other areas explicitly designated for the protection of sea otters or their habitat. There are several protected areas where sea otters occur or may expand to, although these areas are not automatically closed to federal fisheries. These include, Hakai Recreation Area, on the central coast, where sea otters occur, and Pacific Rim

National Park Reserve and the proposed, Gwaii Haanas National Marine Conservation Area where sea otter are anticipated in the future.

2. FACTORS AFFECTING VULNERABILITY AND CONTRIBUTING TO THREATENED STATUS

2.1 Habitat Requirements

The following is a broad description of sea otter habitat as observed in BC and elsewhere. It is not known at this time, however, what habitat features are critical to survival of the species or how these might vary by season or by age and sex of animals. Foraging behaviour, diet, social organization, reproduction and maternal care are influenced by and have influence on habitat use and requirements and for this reason are summarized here.

Critical Habitat - see Knowledge Gaps Section 2.6.4.

2.1.1 Habitat

In British Columbia, sea otters generally occur along stretches of exposed coastline characterized by complex rocky shorelines with small islets and offshore rocky reefs. Throughout their range in the North Pacific, sea otters occur in shallow coastal waters not generally deeper than 40 m and seldom range beyond 1-2 km of shore, although in areas where shallows extend well offshore they have been found well beyond 2 km (Riedman and Estes 1990). Specific kelp beds are often used habitually as rafting sites by groups of otters, as well as by individuals (Loughlin 1977; Jameson 1989). Kelp beds are also used for foraging and are important habitat components. Soft-bottom communities that support clam species are also very important foraging habitat for otters (Kvitek *et al.* 1992; Kvitek *et al.* 1993). Habitat is not thought to be limiting in BC, as much of the coast remains unoccupied by sea otters.

Sea otter density in an area may be related to substrate characteristics; areas with irregular rocky substrate appear to support more otters than areas with little relief. Certainly this is true in California (Riedman and Estes 1990; Laidre *et al.* 2001), although in parts of Prince William Sound sea otter densities are high in some soft sediment habitats (J. Bodkin pers. comm. 2003). Rocky substrate probably supports a greater variety of invertebrate prey species (Riedman and Estes 1990).

Weather and sea conditions may influence use of habitat, but these are little more than anecdotal observations in BC. During periods of calm weather, sea otters tend to occur near offshore reefs but during inclement weather, they may aggregate inshore (Morris *et al.* 1981; Watson 1993).

2.1.2 Foraging

Sea otters forage along the bottom as well as in kelp beds. Most foraging takes place in subtidal areas, although otters, particularly young otters also forage in intertidal areas at high tide (Estes 1980; VanBlaricom 1988: J. Watson pers. comm. 2002) and on rare occasions actually leave the water to feed on mussels exposed at low tide (Harrold and Hardin 1986). The depth at which sea otters forage may vary geographically and depends on prey availability. In California, sea otters typically forage in depths of less than 25 m and rarely exceed 40 m whereas in parts of Alaska, sea otters may forage in deeper waters (Riedman and Estes 1990).

Sea otters capture their prey with their forelimbs, often storing prey in the loose flaps of skin under the forelimb. Dives to obtain prey can range from 50 seconds to more than 3 minutes (reviewed in Riedman and Estes 1990). Prey is consumed at the surface. Where hard shelled prey are not readily crushed or pried open, sea otters will use rocks or other hard objects to break prey open. They are among only a few animals known to use tools.

2.1.3 Diet

Sea otters eat a wide variety of prey species and diet varies geographically, by duration of residency and by individual. In recently re-occupied rocky habitats where sea urchins are abundant these are consumed preferentially probably because of ease of capture. As the abundance of preferred prey is reduced, the diet of the sea otter population in an area diversifies to include a larger array of invertebrates including various bivalves, snails, chitons, crabs, sea stars and even fish (Estes *et al.* 1981). In soft sediment habitats, where clams occur, sea otters excavate their prey. Clams are an important part of the sea otter diet in southeast Alaska and in BC (Kvitek *et al.* 1992). Evidence of sea otters excavating butter clams, horse clams and geoducks in BC (Keple 2000; J. Osborne pers. comm.2003; L. Nichol pers. comm. 2002; UHA geoduck surveys 2002) suggests that these species are an important part of the diet. Fish are important prey in some parts of the Aleutian, Commander and Kuril Islands (Estes and VanBlaricom 1985; Watt *et al.* 2000). Even within a population, sea otters display a great deal of individual prey preference. These preferences can persist for long periods of time and appear to be transmitted from mother to offspring through learning during the period of mother-young association (Estes *et al.* 1981; Estes *et al.* 2003)).

2.1.4 Social Organization

Sea otters segregate by gender with males and females occupying spatially distinct areas. However individual adult males establish and occupy breeding territories that overlap female areas (Garshelis et al 1984; Jameson 1989; Riedman and Estes 1990; Watson 1993). Male rafts occur in the range of established populations but occur at the periphery of the range of expanding populations (Jameson 1989; Watson 1993). During the peak breeding season, male rafts are composed largely of sub-adult males because adult males have established territories closer to female raft areas. Territorial males re-join the male rafts, although some males maintain territories year-round (Garshelis *et al.* 1984; Jameson 1989). Males generally expand into new areas first (Loughlin 1980; Garshelis *et al.* 1984; Wendell *et al.* 1986) while females use areas which have been occupied by sea otters for longer periods and expand into areas vacated by male groups (Garshelis *et al*. 1984).

2.1.5 Movements and Home Range

Individual otters typically remain within an area known as a home range, which varies in size depending on season, reproductive status, sex and age. In California, adult male territories average 40 ha. Female home ranges are larger but on an annual basis adult males may use a much larger area (Jameson 1989). In California adult males on an annual basis utilized over 80 kilometres of coastline (Ribic 1982; Jameson 1989). Home ranges of males may be comprised of several heavily used areas interconnected by travel routes (Ribic 1982; Garshelis and Garshelis 1984; Jameson 1989). In Prince William Sound, sea otters were reported to travel as much as 100 km over several days (Garshelis and Garshelis 1984) and in California 127 km (Jameson 1989), while one male moved 75 km in less than 23 hours (Jameson 1989).

2.1.6 Reproduction and Maternal Care

Female sea otters reach sexual maturity at three to five years (Bodkin *et al.* 1993) and males between five and six years of age (Riedman and Estes 1990). By five years of age all females have given birth (Bodkin *et al.* 1993; Jameson and Johnson 1993). Sea otters remain reproductive until death. Females have a higher survival rate than males (Siniff and Ralls 1991) and live 15 to 20 years, whereas males live only 10 to 15 years (Riedman and Estes 1990).

Mating occurs year-round, although peak pupping in BC occurs in March and April (Watson 1993). Gestation, including a period of delayed implantation, lasts 6 to 8 months (Riedman *et al.* 1994), which places peak mating in BC in the fall. Sea otters are polygynous, males form pair bonds consecutively with several females throughout the year. Female sea otters produce .90 pup per year (Siniff and Ralls 1991; Bodkin *et al.* 1993; Riedman *et al.* 1994). Gestation is followed by birth in the water or on land of a single pup, twins are rare (Kenyon 1969; Jameson 1983; Jameson and Bodkin 1986; Jameson and Johnson 1993; Riedman *et al.* 1994).

At birth a sea otter pup weighs 1.4 to 2.3 kg (Riedman and Estes 1990). Pups remain dependent on their mothers for the first 6 months after which they are weaned (Payne and Jameson 1984; Jameson and Johnson 1993; Riedman *et al.* 1994). Throughout the 6 months of pup dependency, care is provided entirely by the female. During the first month the pup depends exclusively on its mother's milk, by 4 months it feeds almost exclusively on prey provided by the mother, and by 5 months a pup can dive, capture and break open prey, and groom itself. Pre-weaning mortality, can be high and has been found to be at least 40% among southern sea otters (Siniff and Ralls 1991; Riedman *et al.* 1994), although only 15 to 25% among sea otters in Alaska (Riedman *et al.* 1994).

2.2 Biological Limiting Factors

It is thought that sea otter populations are limited by prey abundance that influence mortality rates (Riedman and Estes 1990). Other sources of natural mortality are predation and disease. Pup carcasses found at eagle nests suggest this may be a significant source of pup mortality in British Columbia (Watson *et al.* 1997). In the Aleutian Islands sea otter pups comprise 5 to 20% of the eagle diet during the sea otter breeding season (Anthony *et al.* 1998). Killer whales are not thought to be a significant source of mortality in British Columbia, although there is one anecdotal account of killer whales pursuing sea otters in Kyuquot Sound (Watson *et al.* 1997). In contrast, killer whale predation may be significant in western Alaska, where dramatic declines in the sea otter population are underway. Estes *et al.* (1998) hypothesize that because of dramatic declines in seal and sea lion populations in response to a large-scale ecosystem shift, mammal eating killer whales have switched to preying on sea otters and are the cause of the observed decline in the sea otter population. The decline in western Alaska suggests that a better understanding of sources of predation in the BC sea otter population may be warranted. White shark predation is a significant cause of mortality in the southern sea otter population and has increased through time, particularly during the current and recent period of population decline (Estes *et al.* 2003).

Various diseases have been documented in sea otters (Thomas and Cole 1996; Reeves 2002), but generally, disease is not thought to be a significant source of mortality in most sea otter populations. In California, however disease may be a major source of mortality and explains 40% of beach cast carcasses and contributes to the low rate of population growth compared with other sea otter populations ((Thomas and Cole 1996; Estes *et al.* 2003). No research has as yet been directed at assessing disease in BC sea otters.

2.3 Threats[3]

2.3.1 Oil Spills

Oil contamination has both immediate and long-term effects on sea otters and the recovery of their populations. The following five points summarize sea otter vulnerability to oil contamination.

- Sea otters depend upon their fur for insulation. Oil destroys the water-repellent nature of the fur. As it penetrates the pelage it eliminates the air layer and reduces insulation by 70% (Williams *et al.* 1988). This usually results in hypothermia.

[3] *SARA* requires that the recovery strategy identify "threats to the survival of the species that is consistent with information provided by COSEWIC." [*SARA* s.41(1)(*b*)].

- Once the fur is fouled, sea otters ingest oil as they groom themselves. Ingested oil damages internal organs, which in turn has chronic and acute effects on sea otter health and survival.

- Sea otters feed on benthic invertebrates, which can accumulate and store toxic hydrocarbons, during and after an oil spill.

- Sea otters are nearshore animals with strong site fidelity, and will remain in or return to oiled areas, additionally, they often rest in kelp beds, which collect and retain oil.

- Sea otters are often found in single sex aggregations, which can include hundreds of animals. Thus large numbers of sea otters, (representing a substantial portion of the reproductive potential of a population) can become simultaneously fouled by oil. The loss of a male raft may have less of a reproductive impact than the loss of a female raft because of the species polygynous mating system.

The status of the sea otter population in Prince William Sound illustrates both short-term and long-term impacts of oil contamination. In the spring of 1989, the oil tanker *Exxon Valdez* ran a ground in Prince William Sound spilling 42 million litres of crude oil. Nearly 1000 sea otter carcasses were recovered within 6 months but total mortality estimates ranged from 2,650 (Garrott *et al.* 1993) to 3,905 (DeGange *et al.* 1994). Presently, sea otters in parts of the Sound that were most heavily oiled continue to have significantly higher levels of cytochrome P4501A, a biomarker for hydrocarbons, than otters in less heavily oiled areas. This suggests continued exposure to residual oil in prey and habitat. Population growth is significantly lower in the heavily oiled area as well and it is thought that recovery maybe constrained by residual oil effects, despite an adequate food supply and by emigration (Bodkin *et al.* 2002). Population modelling using data from 1976 to 1998 shows that sea otters in Prince William Sound had decreased survival rates in all age-classes in the nine years following the spill. The effects of the spill on survival appear to have dissipated mostly as those animals alive at the time of the spill have died (Monson *et al.* 2000), but the Prince William Sound sea otter population has not yet recovered to pre spill levels and it is clear that the effects of hydrocarbon contamination are still pervasive throughout the marine ecosystem of Prince William Sound (Peterson *et al.* 2003).

The risk of oil spills in British Columbia has been of considerable concern for sometime, particularly since the *Nestucca* oil spill of December 22, 1988 (Waldichuk 1989) and the *Exxon Valdez* spill that occurred less than six months later (Loughlin 1994). The *Nestucca* spill released 875,000 litres of Bunker C oil off Grays Harbour, Washington. The current, combined with onshore winds, carried the oil slick northward fouling the shoreline of western Washington and the west coast of Vancouver Island. The slick reached as far as the Goose

Islands Group on the central BC coast (Watson 1989). Sea otter surveys made soon after the spill found one oiled sea otter carcass on an offshore islet in Checleset Bay, and a wolf scat containing oiled sea otter fur on Vancouver Island in the affected area. While there is little doubt sea otters did die from oil contamination, the exact number cannot be established because wolves and bears quickly scavenge beach cast carcasses. Boat-based surveys made the following summer found no detectable affect on the population (Watson 1989), although variation among sea otter counts can be quite high making trends often difficult to ascertain. Although the impact of the spill appears to have been minimal, the event, nonetheless, demonstrated the vulnerability of BC's sea otter population to oil contamination.

Sources of oil spill threat in BC marine waters include cargoes of tankers and barges, bilges, fuel tanks of marine vessels, shore-based fuelling station and even shore-based industries such as pulp mills (Shaffer *et al.*1990). In the early 1990s more than 7000 transits were made annually by freighters and tankers in BCs waters, including at least 1500 tanker trips to or from Alaska, and more than 350 loaded tankers entered the Strait of Juan de Fuca (Burger 1992). The greatest volume of petroleum and risk comes from shipments of crude oil and refined petroleum products. Based on data from 1988 and 1989, over 26 million cubic metres of crude oil were transported annually into and out of Strait of Juan de Fuca, mostly carried by tankers and an additional 15 million cubic metres of refined petroleum products, carried mostly by barges (Shaffer *et al.*1990). About 15% of these loads were delivered to coastal depots along the west coast of Vancouver Island (Shaffer *et al.*1990).

It is unlikely that the volume of petroleum transported has declined since the late 1980s, in fact it is more likely to have increased with the growing human population (Schaffer *et al.* 990). Risk models for southern BC and Washington State developed at that time, predicted the following oil spill frequencies for the marine waters of southern BC and northern Washington:

- spills of crude oil or bunker fuel exceeding 254,000 litres (1000 barrels) could be expected every 2.5 years;

- spills of any type of petroleum product exceeding 254,000 litres (1000 barrels) could be expected every 1.3 years (Cohen and Aylesworth 1990).

The actual frequency of large spills affecting BC between 1974 and 1991 was fairly close to the predicted frequency (see table in Burger 1992). In addition to spills of at least 254,000 litres, there are numerous smaller spills. Spills over 1,778 litres (7 barrels) are considered significant by Environment Canada and are tracked. Along the west coast of Vancouver Island, there are at least 15 reportable spills of more than 1,778 litres (7 barrels) annually (Burger 1992). Recent plans by the BC Provincial government, to begin oil and gas exploration and drilling in Hecate Strait and Queen Charlotte Sound by 2010 pose additional risks that could alter the above predictions about the size and frequency of spill events.

2.3.2 Disease and Parasites

In general, disease is not thought to be a major cause of mortality among most sea otter populations (Riedman and Estes 1990), however little effort has been made to assess disease in sea otter populations, except in California. The southern sea otter population has a much lower rate of growth than other populations and a higher rate of mortality, of which 40% is disease-caused (Thomas and Cole 1996). This is true even during periods of population increase (Estes *et al.* 2003). Although high rates of disease-caused mortality have been noted in the southern sea otter population for several decades, of recent concern is the emergence of infections arising from parasites and microbes for which sea otters are not the normal host. In addition, diseases seem to be affecting high numbers of prime age animals (Thomas and Cole 1996; Estes *et al.* 2003) A large number of recent mortalities have been the result of protozoal encephalitis caused by *Toxoplasma gondii.* Cats are this terrestrial parasite's definitive host not sea otters. Runoff from urban and agricultural areas into streams and rivers is thought to transport the parasite to coastal marine waters. (Miller *et al.* 2002). Filter-feeding invertebrates are suspected of accumulating the parasite (Lafferty and Gerber 2002; Miller *et al.* 2002). *Sarcocystis neurona*, a disease spread by opossums, is also causing disease and death among southern sea otter (Kreuder *et al.* in press). Peritonitis induced by acanthocephalan parasites has also increased in recent years (Thomas and Cole 1996). The observed prevalence of disease and variety of diseases are of concern and it is speculated that decreased immune function may be a factor. Reduce immune competence could result from environmental toxins, genetic factors, or habitat degradation leading to nutritional stress (Thomas and Cole 1996; Reeves 2002).

Disease caused mortality in the Washington state sea otter population is currently under investigation. Protozoal encephalitis was the cause of death in one of seven dead sea otters tested in 2000 and one of nine dead sea otters tested in 2002 (D. Lynch pers. comm. 2002). Leptosporosis, a bacterial infection common in sea lions as well as other marine and land mammals, was confirmed as the cause of death of six of the nine animals tested in 2002. An additional 18 carcasses were found in 2002, but were not tested (D. Lynch pers. comm. 2002). Of 16 sea otters live-captured in 2001, 14 tested positive for exposure to *Morbillivirus*, however, no animals appear to have died from a *Morbillivirus* disease in 2002 (D. Lynch pers. comm. 2002).

Canine Distemper Virus (CDV), a member of the genus *Morbillivirus*, has recently been detected in river otters living in the marine environment in British Columbia. Transmission is thought occur via terrestrial hosts (Mos *et al.* 2002). The disease can cause mortality in populations that have not previously been exposed. Persistent organic pollutants that suppress immune function appear to exacerbate morbillivirus-related outbreaks in other marine mammals (Ross 2002).

2.3.3 Genetic Diversity

Genetic diversity is of concern to conservation of species that have been reduced to a small size and then allowed to increase; a phenomenon called a bottleneck. The loss of genetic diversity through inbreeding in small populations will reveal deleterious recessive alleles, resulting in lower fecundity, higher rates of juvenile mortality and an overall reduction in population growth rate. Furthermore loss of diversity reduces a population's ability to respond to unexpected environmental or biological events.

A recent genetic study shows that current sea otter populations have significantly less genetic variation than did their pre-fur trade ancestors (Larson *et al.* 2002b). This is attributed to the severe population bottleneck that resulted from the fur trade (Kenyon 1969; Riedman and Estes 1990). Among current populations there are no significant differences in genetic variation between remnant and translocated populations, even though translocated populations experienced two bottlenecks (Larson *et al.* 2002a). Bodkin *et al.* (1999), however, found that among current populations, mitochondrial DNA haplotype diversity was inversely correlated with the amount of time remnant and translocated populations spent at their small founding population sizes, and that haplotype diversity was positively correlated with the size of the founding population. Several other studies have also assessed genetic diversity and stock delineation of sea otters (Cronin *et al.* 1996; Schribner *et al.* 1997).

That reduced genetic diversity is apparent in extant populations compared to pre-fur trade ancestors (Larson *et al.* 2002b) indicates genetic diversity should remain of concern in the long-term as it increases the risk of extinction from random events.

2.3.4 Marine Biotoxins

The toxin responsible for Paralytic Shellfish Poisoning (PSP), produced by certain dinoflagellate species, can accumulate to toxic levels in filter-feeding bivalves. Butter clams, which tend to accumulate the biotoxin PSP, form an important component of the sea otter diet. A large die-off of sea otters in the Aleutian Islands in the summer of 1987 was in part attributed to PSP poisoning (DeGange and Vacca 1989). One study has shown that sea otters may be able to detect PSP and avoid clams with lethal concentrations (Kvitek *et al.* 1991).

Domoic acid, a biotoxin produced by certain diatom species and some marine algae can accumulate in filter feeding shellfish and be passed through the food chain thereby affecting not only species that prey on invertebrates but fish-eating species as well. First detected on the west coast of North America in 1991, domoic acid has been identified as the cause of several large die-offs of sea birds and sea lions in California. So far only one case has been confirmed of a sea otter in California dying from domoic acid poisoning.

Although the occurrence of toxic phytoplankton is a natural phenomenon, the problem of harmful algae blooms appears to have increased over the past two decades and this is certainly true in BC. Coastal pollution, in particular increased levels of nitrogen and phosphorus abundant in sewage and coastal runoff are at least partly to blame (Anderson 1994).

2.3.5 Contaminants

Contaminant levels of British Columbia sea otters have not been assessed. Organochlorine contamination has been assessed in sea otters from California, Southeast Alaska and the Aleutian Islands (Jarman *et al.* 1996). Total polychlorinated biphenyls (PCB) were found to be highest in sea otters from the Aleutian Islands (310μg/kg), followed by California (170μg/kg) and negligible in Southeast Alaska. DDT was high in California (850μg/kg), but negligible in Alaska. There is concern that contaminants may affect sea otter populations in California and in the Aleutian Islands (Estes *et al.*1997). Immune suppression resulting from contaminants is a potential contributor to the incidence of disease now documented in the southern sea otter, but there may be other factors as well (Thomas and Cole 1996; Reeves 2002).

2.3.6 Entanglement in fishing gear and collisions with vessels

Mortality from entanglement in fishing gear can have a substantial impact to a population, particularly where prime age animals are taken. Incidental drowning in sunken gill nets was a significant threat in California during the late 1970s and early 1980s and contributed to a population decline (UFWS 2003). As a result, restrictions in the use of gill and trammel nets in waters less than 65 metres were implemented (Riedman and Estes 1990) and the population decline reversed. Increased mortality in fishing gear is again under consideration along with disease as causes of the current decline in southern sea otters (USFWS 2003).

Incidental entanglements in fishing gear has been reported in Alaska (USFWS 1994) and Washington. There have been accidental takes in the Makah tribal set-net fishery for salmon (Gearin *et al.* 1996; Gerber and VanBlaricom 1998). The extent of accidental drowning of sea otters in fishing gear in British Columbia is unknown, but not thought to be significant at this time. However, as the sea otter population expands into areas of gill-net fisheries, there may be local effects and entanglement may emerge as a threat of concern in the future (Watson *et al.* 1997). Sea otters die from drowning in various crab and fish trap fisheries in California and Alaska (reviewed in Richardson and Allen 2000). Crab pots may present a threat to sea otters, particularly since they are set in shallow waters within the species diving depth range. Collisions with vessels are not well documented. In BC one otter carcass recovered from Kyuquot Sound had injuries that could have been caused by a boat propeller, but the occurrence of collisions is probably minor and localized at this time (Watson *et al.* 1997).

2.3.7 Illegal kill and Human Disturbance

There are no statistics on illegal kill of sea otters in British Columbia, although it is suspected in some areas. The extent of disturbance of resting and foraging otters from boat traffic is largely unknown but unlikely to be significant at this time. Disturbance may become a more significant local effect in the future as the sea otter population expands its range into more populated areas, and public awareness and interest in the British Columbia sea otter population grows.

2.4 Ecological Role

The keystone species concept was presented by Paine (1969) to describe the role sea stars, *Pisaster ochraceous*, play in structuring rocky intertidal communities. A keystone species is one that has an effect on community structure that is greater than would be expected based on its abundance (Power *et al.* 1996). The sea otter is a prime example of such a species. Research over the past several decades has demonstrated the sea otter's keystone role, particularly in rocky subtidal habitats (Estes and Palmisano 1974; Estes and Duggins 1995) and the effect in soft sediment habitats as well (Kvitek and Oliver 1992).

Sea otter predation reduces the abundance and size of invertebrate prey species as well as their distribution. This in turn has important consequences for the structure of nearshore benthic communities. Where sea otters are absent, sea urchins dominate much of the rocky nearshore habitat and survive by actively grazing on kelps and by so doing, restrict their growth. Abalone, another herbivorous invertebrate, also survive by grazing and in the absence of sea otter predation occur in open habitat where they grow to large sizes (Wendell 1994). When sea otters establish in an area, they reduce the abundance of sea urchins and by doing so, release fleshy algae, particularly kelp, from intense grazing pressure. Over time, areas with sea otters shift from habitats dominated by sea urchins to habitats dominated by kelp. While sea urchins still occur in these habitats, they are rare in the open, but persist in deep crevices and under boulders that are inaccessible to sea otters (Breen *et al.* 1982; Watson 1993; Estes and Duggins 1995). In these refugial habitats, sea urchins switch from active grazing to passive feeding on the abundant drift algae associated with kelp forests (Lowry and Pearse 1973). Abalone behave similarly, refugial habitats can support stable populations of abalone, although at low densities (Lowry and Pearse 1973; Fanshawe *et al.* 2003;). The relationship between sea otters, sea urchins and kelp was first described in the Aleutian Islands (Estes and Palmisano 1974). Since then studies in Southeast Alaska (Estes and Duggins 1995), British Columbia (Morris *et al.* 1981; Breen *et al.* 1982; Watson 1993), Washington State (Kvitek *et al.* 1989; Kvitek 1998) and California (Laur *et al.* 1988) have provided supporting evidence for this theory. However, there is some question as to the generality of this paradigm (Foster and Schiel 1988). Although there is little dispute that sea otters have a great impact on invertebrates and that this leads to changes in the abundance of kelp, there are other physical processes that can also greatly affect the abundance of kelp and sea urchins (Foster and Schiel 1988). The physical motion and abrasion caused by seaweed fronds at the edges of kelp beds may act as a physical deterrent to sea urchins that might otherwise graze through a kelp bed (Konar and Estes 2003). In the Aleutain Islands ecosystem there may be a threshold density of sea otters required to cause a dramatic shift from urchin dominated habitat to a kelp bed community (Konar 2000).

Sea otter predation has a cascading effect. While the effects are direct on sea otter prey species and kelp, there are also important indirect effects. The physical structure and the biological productivity of kelp have significant consequences for coastal food webs. Kelp forests enhance nearshore productivity, becoming a significant source of food particularly in the form of detritus from drift algae. As described above, drift algae becomes the primary food source for sea urchins, abalone and other herbivorous invertebrates in these habitats. Where sea otters and kelp forests occur, kelp-derived carbon accounts for more than half the carbon in food webs. In these habitats nearshore productivity, measured as growth of invertebrates, is 2 to 5 times higher than in areas where sea otters and kelp are absent (Duggins *et al.* 1989). Kelp enhances the structure of the water column by creating a complex three-dimensional habitat that supports a large variety of invertebrate and fish species (Bodkin 1988; Ebeling and Laur 1988; Laur *et al.* 1988; Duggins *et al.* 1990; Carr 1991). Nearshore fish have been shown to be more abundant in areas with kelp beds than in urchin barrens or in areas without kelp. Furthermore stands of kelp dampen tidal currents and wave height and influence dispersal, settlement rates and recruitment of benthic invertebrates and rockfish that live within them (Duggins *et al.* 1990; Carr 1991). Fertilization, larval settlement and recruitment success may in fact be greater among abalone that occur in kelp forests compared to those in open habitat. In the open, currents may disperse gametes and larvae widely and into unsuitable habitat, thereby reducing the likelihood of fertilization and successful settlement and survival of larvae (reviewed in Watson 2000).

Sea otters also exert ecological effects on soft bottom communities although their role in these communities is less well understood. Sea otter predation on clams can reduce the abundance and size of these species. Clams probably form an important part of the sea otter diet in BC. In Southeast Alaska, clams are the major food resource of sea otters (Kvitek and Oliver 1992). As well as influencing these species through direct predation, sea otters may exert secondary community level effects, although perhaps not to the same extent as in rocky habitats where food webs are strongly linked (Kvitek *et al.* 1992). Nonetheless, by disturbing the sea floor and adding shell litter (hard substrate) sea otter predation may support settlement and recruitment of various species that require hard substrate (Kvitek *et al.* 1992; Kvitek *et al.* 1993).

Sea otters feed on both clams and mussels in the intertidal zone. Predation on mussels creates gaps in mussel beds that allow other species to attach (VanBlaricom 1988). Clam predation in intertidal areas may also have secondary consequences for birds and other mammals that feed on intertidal clams, although these have not been studied (Bodkin *et al.* 2001).

2.5 Socio-Economic Considerations

Sea otters are a keystone species, thereby exerting a profound cascading effect on the structure and function of the nearshore benthic communities in which they live. These consequences are ecological, but have significant social and economic ramifications through the effect on shellfish and kelp forest abundance. Throughout their range, there is mounting evidence that many shellfish fisheries can not co-exist in the presence of an established sea otter population. These consequences present challenges and opportunities for our society concerned with both the conservation of wildlife, and the sustainability of harvestable shellfish resources. This section provides a brief summary of the prevailing socio-economic views regarding sea otters and their recovery.

Historically the sea otter was hunted by First Nation's people and used for clothing, regalia and gifts. In the 1700 and 1800s the luxuriant fur was highly prized by Maritime fur traders, who hunted and bartered with First Nations for pelts that were them sold in Asia. This trade resulted in an intensive commercial fur trade that led to the near extinction of the species. In 1911 when sea otters were protected under the International Fur Seal Treaty, the total North Pacific population was little more than 1% of pre-exploitation size. Since 1911, the sea otter has been protected from commercial harvest throughout much of its range. Under the United States Marine Mammal Protection Act, only aboriginal people in Alaska, where sea otter populations are not considered to be at risk, may harvest sea otters for subsistence purposes and for creating handicraft and traditional clothing for sale and trade (USFWS 1994; Lianna Jack pers. comm. 2002).

For many people the re-introduction of the sea otter represents a return to the pristine natural order of the marine ecosystem (Gerber and VanBlaricom 1998). This view, based on studies of the community ecology of sea otters, recognizes the ecologically important role of sea otters. Collectively, these studies demonstrate that the presence of sea otters results in increased diversity and productivity of nearshore marine ecosystems. For some, the presence of sea otters also underlines the fragility of the marine ecosystem and the need for greater protection of this environment (Watson and Root 1996), particularly from oil spills. For other people, the re-introduction of the sea otter is viewed as a threat to socially and economically valuable invertebrate resources, such as sea urchins, Dungeness crab, intertidal clams, geoducks and abalone. This view is of particular concern to the commercial shellfish industry, to the First Nations along the west coast of Vancouver Island, to recreational harvesters and, potentially in the future, to the shellfish aquaculture industry.

Commercial and recreational invertebrate fisheries have developed and grown over the past 100 years, as many invertebrate populations flourished in the absence of sea otter predation. As the sea otter population recovers and re-populates its historic range, declines in the abundance of many invertebrates are expected. Commercial fisheries in British Columbia for invertebrate species such as sea urchins, intertidal clams and sea cucumbers will not be possible in areas with sea otters and other shellfish fisheries will be curtailed because of declines in abundance due to sea otter predation.

Declines in the abundance of abalone, sea urchins and pismo clams were documented in California with the expansion of sea otters in the 1970s and 1980's (Estes and VanBlaricom 1985; Wendell *et al.* 1986; Wendell 1994). In California efforts to maintain sea otter free zones by live capture and release of sea otters has been ineffective and impractical (see section 1.3.4) (USFWS 2003). Reviews of the potential impacts of sea otters on various shellfish fisheries in BC and Southeast Alaska have been made (Pitcher 1989; Watson and Smith 1996).

Although it is evident sea otters can and have reduced the abundance of many invertebrate populations (Estes and Palmisano 1974; Morris *et al.* 1981; Breen *et al.* 1982; Watson 1993; Watson and Smith 1996), invertebrate stocks can and do decline in the absence of sea otters. For example, in the absence of sea otters, abalone populations in California and in British Columbia have declined (reviewed in Watson 2000). These examples may serve as cautionary reminders that ecosystems are complex. Estes and VanBlaricom (1985) point out that in addition to understanding how sea otters affect invertebrate abundance, it is also important to understand other factors that can strongly affect invertebrate populations.

Although the economic and social impacts of sea otters are understood, there has been little effort made to identify the social and economic benefits of sea otters. Studies show that kelp beds support a greater abundance of fish and invertebrates and one study suggests kelp may contribute significantly to the productivity of offshore habitats (Harrold *et al.* 1998). In Washington State it has been suggested that sea otters may benefit recreational and commercial fisheries for rockfish and lingcod by increasing kelp bed habitat (Gerber and VanBlaricom 1998). Currently it seems evident that both marine eco-tourism and the herring-spawn-on-kelp fishery should benefit from the recovery of the sea otter population.

Eco-tourism is a valuable industry in British Columbia and one that continues to grow. Sea otter viewing is included in the itinerary of eco-tour operators on the west and northeast coasts of Vancouver Island. In California sea otters are a major tourist attraction in Monterey and Santa Cruz. Tourism generated almost 1/3 of all jobs in the area during the late 1970s (Silva 1982).

The herring-spawn-on-kelp fishery depends on a reliable supply of suitable quality kelp. Kelp abundance and quality can in fact limit the value of this fishery (Shields *et al.* 1985). An increase in the abundance of giant kelp (*Macrocystis integrifolia*) could benefit this industry and provide increased opportunities to export kelp for this and other purposes (Watson and Smith 1996).

2.5.1 Preliminary Public Consultations

Two public consultation workshops were held in January 2003 (one in Port Alberni and one in Queen Charlotte City) to gather preliminary information on the potential socio-economic impacts, both positive and negative, of the draft Sea Otter Recovery Strategy on local communities. This information will be followed up and supplemented with further study during the Action Planning phase of sea otter recovery, however a brief summary is presented here of the opinions expressed during the public consultations and from written submissions received during the consultation period.

Much of the local input focused on economic concerns and First Nations concerns about their right to harvest for food, social, ceremonial purposes, although generally, there was support from all sectors for the recovery of sea otters in BC. However, some sectors also expressed concerns about the current and potential negative impacts of sea otter recovery on their shellfish harvesting activities.

In British Columbia, members of the commercial shellfish industry have expressed concern about declines in the abundance of economically important invertebrate resources in areas occupied by sea otters and about declines anticipated in areas not yet inhabited by sea otters. The 2001 value of shellfish fisheries in BC was $105 million in landed value and $155.1 million wholesale value (estimates from "The 2001 British Columbia Seafood Industry Year in Review" published by the BC Ministry of Agriculture, Food and Fisheries, June 2002). This includes red sea urchin, green sea urchin, sea cucumber, geoduck, clams, and crab. While it is difficult to accurately estimate the exact cost associated with reductions in shellfish harvest due to sea otters, the industry estimates it will be in the range of $30 to $50 million wholesale value per year in the long term if sea otter populations expand significantly. The shellfish industry does not believe this value can be offset by sea otter related eco-tourism dollars. They note the importance of having sea otters, but also the importance of having commercial fisheries, sport fisheries and First Nation’s food fisheries, and would like to find a way for both sea otters and fishermen to co-exist. The shellfish industry, in general, supports a balanced approach to protecting sea otters from becoming endangered that includes protection for valuable commercial shellfish fisheries. In addition, the industry expressed the view that sea otter populations have recovered sufficiently to no longer be considered threatened or listed as threatened. It was also noted by the seafood industry that the recovery goals for abalone will be impossible to achieve in the presence of sea otters. Industry representatives are completely opposed to any further translocations of sea otters.

First Nations concerns related primarily to the effects of sea otter recovery on subsistence shellfish food fisheries, commercial shellfish fisheries, and ceremonial/social uses. First Nations of the west coast of Vancouver Island are concerned with the impact sea otters are having on invertebrate food resources formerly available to their communities for health, dietary and medicinal purposes. In Kyuquot Sound / Checleset Bay on the west coast of Vancouver Island, where sea otters were first transplanted, changes (refer to Section 2.4 Ecological Role) have occurred to the intertidal and subtidal communities, and observations of the effects of sea otters are being reported from other areas. In the Queen Charlotte Islands, there was some concerns expressed by members of the Haida Nation, based upon the current situation on the west coast of Vancouver Island. Some First Nation's groups have expressed concern about the impact of sea otters on the economic value of shellfish to their community. In particular, they have expressed concerns for the economic value of the manila and littleneck clams fishery and aquaculture operations, such as geoduck aquaculture. Some hold the view that sea otter numbers have rebounded sufficiently in some areas, and that sea otters should be managed to control their numbers in those areas. Some would also like to exercise their rights to harvest sea otters for cultural and ceremonial uses, once the numbers of otters have rebounded sufficiently to support a harvest. Notwithstanding the concerns outlined above, the opinion was also expressed that First Nations are stewards of the land and waters and would like to see sea otters recover and the balance of the ecosystem restored.

Many workshop participants identified socio-economic benefits of sea otter recovery. Tourism industry representatives identified likely increases in economic benefits to their industry with the increased opportunities for sea otter viewing that recovered populations would provide. This would include tour operators and all of the other businesses that benefit economically from increased tourist traffic to the area. Some participants identified potential economic benefits to finfish fisheries (such as rockfish, herring, and salmon) of the increases in kelp habitat (for spawn and for juvenile fish nurseries) that might result from sea otter recovery. Increased biodiversity might provide a basis for sustainable fisheries in the future. Environmental groups and members of the public also supported sea otter recovery as a means of restoring a natural ecological balance and recognized the pleasure that many people experience from viewing sea otter populations returning after extirpation.

2.6 Knowledge Gaps[4]

The following describes key knowledge gaps regarding population, biology and ecology of sea otters in British Columbia.

2.6.1 Population Surveys

Lack of a current population estimate is a significant knowledge gap for recovery of the sea otter. The most recent complete population count was made in 1995. The most recent population estimate was made in 1998, by applying the estimated population growth rate to the 1995 count. Sea otters are challenging to count because of their small size, sensitivity to disturbance, and the rugged exposed coastal habitats in which they occur. A method that produces estimates that are comparable from year to year allowing assessment of population growth trends and that can provide minimum population estimates with some confidence is required. High variability among survey results is inherent to sea otter surveys. The sea otter population decline in Western Alaska took several years to detect for these very reasons (see Estes *et al.* 1998). Counts in BC are made by boat and by helicopter. The development of a methodology, that builds on techniques developed in Alaska (eg. Bodkin and Udevitz 1999), is underway. There may also be a need in the future to use results from surveys made by other organizations and local communities interested in monitoring sea otter population size. The ability to detect changes in population size and distribution reliably are needed to assess recovery of the population and to monitor the impact of oil spills or other threats to the population should these occur.

Although the BC otter population appears to be isolated from the Washington State and the Southeast Alaska populations at this time, surveys are needed to detect evidence of population interchange in the future. Should there be evidence of movement and interchange between BC and Washington and BC and Southeast Alaska this might reduce concern for the genetic isolation of the BC sea otter population and might influence our understanding of the distribution of the species in BC with respect to vulnerability to threats.

2.6.2 Biological/Ecological Research

Significant knowledge gaps exist with regard to understanding habitat use. It is not possible, at this time, to describe the sea otter's *critical habitat* as defined by *SARA*. Nothing is known of seasonal habitat use, although sea otters are observed to use exposed rocky coastal areas during spring and summer under good weather conditions, anecdotal observations have been made of sea otters in inlets and protected areas during winter and severe storms. This suggests that there may be some seasonal movement. There is a need to document and describe the characteristics of habitats used during winter and inclement conditions.

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[4] *SARA* requires that the recovery strategy identify "a statement about whether additional information is required about the species" [*SARA* s.41(1)(*f*)'].

Genetic diversity of the British Columbia sea otter population is unknown, although Larson *et al.* (2002b) show that other sea otter populations have significantly less genetic diversity compared to their pre-fur trade ancestors. Lack of genetic diversity is of conservation concern and can affect the anticipated recovery of a population, by increasing susceptibility of the population to random environmental or biological events, and/or reducing population growth rates. An assessment of the genetic diversity of BC sea otters, including comparing west coast Vancouver Island sea otters and central BC coast sea otters and comparing these with other remnant and translocated populations should be done to determine whether genetic diversity among BC sea otters is cause for concern.

Sources and impacts of natural predation on the BC sea otter population are not well documented. Although natural predation is thought to be relatively low (Watson *et al.* 1997), a greater consideration of this limiting factor may be warranted given the relatively small size of the population and the decline occurring in western Alaska and the hypothesized role of killer whale predation (see section 2.2).

2.6.3 Threat Clarification Research

Oil spills are the single biggest threat to sea otter populations. While the effect of oil spills to sea otters is well documented (e.g. *Nestucca* and *Exxon Valdez*) (Waldichuk 1989; Loughlin 1994) and the risk of an oil spill and sources of oil in BC are documented (see section 2.3) research is needed to assess options for protecting the population and its habitat from oil contamination. Translocation is an important tool that should be investigated.

Additional threats that may be significant but are not well understood and should be clarified include, disease, contaminant levels, entanglement in fishing gear, illegal kills and human disturbance. Interactions with human-related activities can be expected to increase as the sea otter population expands into areas previously unoccupied. These are threats that have been identified and found to be significant in other sea otter populations. For example, entanglement in fishing gear in California in the 1970's caused a population decline. Presently, the southern sea otter population is declining again, drowning is fishing gear is a suspected cause, however there is also concern about disease exposure (Miller *et al.* 2002;USFWS 2003).

Finally, while sea otter populations can and do rebound from historic declines, the species can also decline rapidly. In Southwestern Alaska, for example, there are now calls to list the sea otter as *Endangered* because of a precipitous decline over the past decade. It is thought that increased predation by killer whales has caused the decline, although the reason for the shift is complex. It is hypothesized that increased killer whale predation is an end result of the major ecosystem change occurring in southwestern Alaska that has led to a decline in seals and sea lions, killer whales preferred prey. Given the sea otters small size and the nutritional needs of killer whales, killer whale predation is theorized to have a significant impact. There is a need to support research on threats and limiting factors and to maintain information exchange and/or collaboration with researchers and managers working on populations of sea otters in other jurisdictions.

2.6.4 Critical habitat identification

"Critical habitat" is defined under *SARA* as "*the habitat that is necessary for the survival or recovery of a listed wildlife species that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*"[5]. Under *SARA*, defining critical habitat for sea otters to the extent possible is a legal requirement[6]. Although the general types of habitat in which sea otters are found (Section 2.1.1 to 2.1.6) is known, specific habitat features that are critical or important to the survival of sea otters in BC, or how these vary by season, age, or gender of animals, are unknown.

Studies of sea otter critical habitat should attempt to identify important rafting and foraging areas and seasonal variations as well as assess movements and home range patterns. Winter is thought to be the season of highest natural mortality for sea otters and is also the time when oil spills are most likely to occur and most difficult to respond to because of sea conditions. The spatial and temporal distribution of the sea otter population in winter may indicate the areas most critical to its survival and recovery.

[5] SARA s.2(1).

[6] *SARA* s.41(1)(*c*). *SARA* prohibits the destruction of critical habitat [SARA s.58(1)]. Until critical habitat is defined, "examples of the activities likely to result in its destruction" (*SARA* 49(1)(*a*)), "measures that are proposed to be taken to protect critical habitat" [*SARA* 49(1)(*b*)] and "an identification of any portions of the species' critical habitat that have not been protected" [*SARA* 49(1)(*c*)] can not be identified.

III. RECOVERY

The BC sea otter population has grown without intervention since the time of re-introduction to BC between 1969 and 1972. In 1978, COSEWIC listed the sea otter as *Endangered* due to an extremely small population size, less than 100 individuals and a very limited distribution. By 1995, the population had increased in size to about 1500 animals and had increased in geographic extent but was still considered relatively small and restricted in distribution and therefore vulnerable to environmental catastrophes such as oil spills. Though no longer considered in imminent danger of extirpation, it was still considered at risk and was thus downlisted to *Threatened* in 1996. The population is still relatively small and limited in distribution on the BC coast such that threats continue to pose significant risks to recovery. The Sea Otter Recovery Team has taken a relatively non-intrusive approach to recovery that recognizes the sea otter's ability to rebound but at the same time considers that threats could limit or even reverse the current population trend if not addressed. The approach focuses on identifying and reducing threats that might impede continued recovery and on identifying population size and distribution recovery targets that should be achieved so that by virtue of size and distribution, the population will no longer be *Threatened*.

1. RECOVERY GOAL

Ensure that the sea otter population in British Columbia is sufficiently large and adequately distributed so that threats, including events catastrophic to the species, such as oil spills, would be unlikely to cause extirpation or diminish the population such that recovery to pre-event numbers would be very slow.

2. SHORT-TERM RECOVERY OBJECTIVES (~ 5years)[7]

The following recovery objectives are aimed at obtaining the information necessary to protect and recover the BC sea otter population. While Objective 1 aims to reach the recovery goal, at present there is lack of knowledge regarding the necessary size and distribution of the population to achieve the goal. Consequently the recovery team was not able to set quantitative population size and distribution targets as measurable short-term recovery objectives (for the next 5 years) at this time. Instead it became clear, that there was a need to set objectives to identify these recovery targets and then monitor the population to determine when these targets have been reached. The Sea Otter Recovery Strategy will be updated and revised as new information becomes available with specific measurable objectives as well as new strategies with which to achieve them.

[7] *SARA* requires that the recovery strategy identify "a statement of the population and distribution objectives that will assist the survival and recovery of the species" [*SARA* s.41(1)(*d*)].

Objective 1: Identify and, where possible, mitigate threats to sea otters and their habitat to ensure recovery of the population.

Objective 2: Identify the adequate geographic distribution that is needed to ensure the population would survive events catastrophic to the species, such as oil spills, and be able to rebound demographically within a relatively short period of time to pre-catastrophe numbers.

Objective 3: Specify a minimum population size that would correspond to a viable, sufficiently large population no longer at risk.

3. APPROACHES TO ACHIEVE RECOVERY[8]

The following activities to reach the recovery goal are broadly grouped into five categories and are the approaches needed to meet the objectives: Threat Clarification Research, Population Assessment, Protection, Communication and Identification of Critical Habitat. Within each category, the approaches are ordered from highest to lowest priority, while the broad categories themselves are ordered in relation to the above objectives.

3.1 Threat Clarification Research

In order to protect sea otters from threats to their survival, research is needed to identify or clarify the significance of threats and factors that may limit sea otter population growth and range expansion. These include threats not only to sea otters but also to their habitat.

- Assess the potential for oil spills to impact sea otters in BC by modelling oil spill trajectories and sea otter habitat, using sea otter distribution, rafting and foraging area data and identify areas where sea otters are most susceptible to oil from spills.
- Identify options to reduce risk to the population from an oil spill(s). Assess the feasibility of pre-emptive translocation of sea otters in the event of an oil spill.
- Assess the genetic diversity of the British Columbia sea otter population and monitor population measures that are indicative of fitness and of vulnerability to random environmental events.
- Develop a BC sea otter health-monitoring program. Include assessment of body condition, disease, exposure and contaminant burdens in live-captured sea otters and perform necropsy of fresh carcasses when the opportunity arises. Develop a set of standard morphometric measurements.

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[8] *SARA* requires that the recovery strategy identify "a description of the broad strategy to address those threats" [SARA s.41(1)(*b*)] and "a general description of the research and management activities needed to meet those objectives" [*SARA* s.41(1)(*d*)].

- Assess the occurrence and significance of sea otter entanglement in fishing gear and collisions with vessels.
- Assess the occurrence and significance of illegal killing and disturbance of sea otters in BC.
- Develop a method and then assess and identify critical habitat for sea otters (as defined under the Species At Risk Act). Prey abundance is though to be the main factor limiting growth in most sea otter populations. Identify important rafting and foraging areas and seasonal variations in these as part of identifying and delineating critical habitat. Carry out research on the movements and home range patterns of sea otters in BC.
- Assess sources and the significance of natural predation in the BC sea otter population.
- Incorporate relevant research from other jurisdictions (e.g. Washington, Alaska), First Nations and coastal communities.

3.2 Population Assessment

Population assessment will involve surveys and modelling to specify population targets and surveys to monitor recovery progress relative to the population targets.

Monitor Status

- Develop a census method suitable for the BC coast so that sea otter counts are comparable among years.
- Using the appropriate census method, undertake regular surveys of the BC sea otter population, to monitor population size, growth rate and distribution.

Specify population size and distribution targets

- Use population survey data as a key input to defining a minimum population size and distribution as identified in Objectives 2 and 3.
- Develop a model to determine an adequate geographic distribution of the sea otter population in British Columbia.
- Develop a sea otter carrying capacity model for the British Columbia coast as an input to estimating a minimum population size.
- Assess the feasibility of translocating sea otters in BC as a means of achieving the target distribution.

3.3 Protection

Once threats are identified or clarified, greater efforts are needed to protect sea otters and their habitat from acute and chronic threats to achieve recovery of the population. Approaches to protection should include, but are not limited to the following:

- Respond to oil spills. Oil spills remain the single biggest threat to sea otters. An oil spill response plan specifically for sea otters should include several response options depending on the severity of the oil spill. A readiness of sufficient funds, equipment, facilities and personnel would also be required.

- Protect critical habitat for sea otters from identified threats. This might be achieved in part by improving habitat protection in existing protected areas and closures. It may also require investigating options for moving oil transport corridors, an approach that has been used in Washington and California. It may also require consultation with the BC provincial government agencies leading the plan to initiate oil and gas exploration and drilling in BC marine waters.

- As threats are identified, ensure an adequate level of protection and enforcement of regulations to reduce the threat.

3.4 Communications

Communication to the public and others is important to garner support and understanding for the need to protect sea otters and their habitat. Sea otters were absent from Canada's fauna for almost a hundred years. With their return, there is a need to raise the level of understanding of the role of sea otters in structuring nearshore ecosystems and of the threats to sea otters and their habitat. This approach could include, but is not limited to the following:

- Establish and maintain collaboration and information exchange with First Nations (traditional knowledge), coastal communities and others about protection of sea otters and their habitat.

- Produce public communications materials such as, school curricula, booklets, brochures, films, local newsletters, and websites to inform the public of the status of sea otters, and threats to their recovery.

- Develop sea otter watching guidelines for eco-tour operators and the general public. Human disturbance of sea otters from vessels and people are not yet considered to be significant threats, but as the sea otter population expands, this threat may become significant.

3.5 Critical Habitat Identification

The following studies will provide information needed to identify critical habitat for sea otters in BC. A schedule of these studies[9] is included in Appendix I.

Identify important rafting and foraging areas and seasonal variations.

- Determine the winter distribution of sea otters by observation and by compiling incidental reports of sea otter raft locations in winter. Summer rafting areas can be identified from population survey work but winter rafting areas are likely quite different.
- Develop a reporting protocol for fishermen, First Nations, local communities and the public to report sightings of rafts of sea otters, especially in winter.
- Use physical attributes of observed winter distribution to characterise habitat use in winter. Then use this model to predict probable winter habitat in other areas, including areas not yet occupied by sea otters.

Research movements and home range patterns of sea otters.

- Assess movements and home range patterns of sea otters using telemetry (i.e. implanting radio transmitters into sea otters followed by intensive aerial and/or boat-based tracking). Such studies have been carried out and are underway in Alaska, California, and Washington. Local community involvement in radio tracking tagged individuals may be possible and could be investigated.

4. CONSIDERATIONS FOR RECOVERY

4.1 Recovery Feasibility[10]

Ecological and technical feasibility of species recovery
Sea otter recovery is ecologically feasible. The sea otter has a strong inherent capacity to rebound demographically from a small founding population, as illustrated by the growth of several translocated populations including the population in British Columbia (refer to Section 1.3.2). Food is generally viewed as the main factor that limits population growth. Much of the British Columbia coast remains unoccupied by sea otters and for this reason population recovery is unlikely to be limited by food. One of the largest threats to sea otters, however, is an oil spill. Such an event could occur at anytime and could cause significant mortality. Furthermore, recovery of sea otter populations in an area contaminated

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[9] *SARA* requires that the recovery strategy identify "a schedule of studies to identify critical habitat, where available information is inadequate" [*SARA* s.41(1)(*c.1*)].
[10] *SARA* requires that "the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. The determination must be based on the best available information, including information provided by COSEWIC" [*SARA* s.40].

by oil can be slow (Bodkin *et al.* 2002). Finally, sea otter population growth can reverse dramatically and rapidly. Entanglement in fishing gear, disease, large scale ecosystem shifts and oil spills have been demonstrated to cause or contribute to declines in California, Southwestern Alaska and Prince William Sound Alaska.

4.2 Recommended Approach/ Scale of Recovery

The single-species approach for recovery was chosen largely for expediency as it allowed a focussed consideration of the approaches needed to recover sea otters, independently from other species of conservation concern. There are, however, compelling arguments in support of a multi-species approach for species such as the sea otter, but the effort to integrate multiple species conservation issues would have been significant and development of such a recovery plan could not possibly have been completed in one year. Sea otters are keystone predators, and contribute to the structure of nearshore ecosystems (see ecology section), with both direct and indirect effects on other species at risk and their associated habitats. For example, sea otters prey on the threatened northern abalone, and will reduce abalone abundance and size significantly from present levels. However, by preying on sea urchins sea otters enhance kelp growth. As kelp increases there is ample evidence that fish abundance, including juvenile rockfish (e.g. the threatened boccacio) increases, thus species that feed in kelp forests (e.g. the threatened marbled murrelet) will benefit. Furthermore, the major threat to sea otters is an oil spill, an event that would also affect *at risk* cetaceans, sea birds, fish and invertebrates. Efforts to reduce the threat of chronic or catastrophic oil spills will effectively lessen the threat of oil to these other species groups.

4.3 Anticipated Conflicts or Challenges

Reducing threats to sea otters is a major focus of the sea otter recovery strategy. Yet in some cases, for example, oil spills and contaminants in the food chain, these may be difficult to address. Such threats may be attributed to activities beyond Canada's borders or from a multitude of non-point sources, so that reducing some threats may not be possible.

Sea otters are a keystone predator exerting strong cascading effects on the structure and function of nearshore benthic communities. These ecological consequences have significant ramifications for resource management and will continue to present a challenge once sea otters are recovered.

There remains a challenge to engage First Nations, local communities, and commercial harvesters in activities related to sea otter recovery, while at the same time addressing their concerns for socio-economic impacts on shellfish resources. Many people, from all backgrounds, have emphasized the need to resolve conflicts and work together towards solutions.

5. ACTIONS ALREADY COMPLETED AND/OR UNDERWAY

Surveys
Surveys have been made by a variety of agencies and individuals (summarized in Watson *et al.* 1997)

Sea otter counts have been made since 1977. Between 1977 and 1987 counts were made collaboratively by Fisheries and Oceans Canada, BC Parks, West Coast Whale Research (see Watson *et al.* 1997). Between 1988 and 2000, most comprehensive counts were made by Dr. Jane Watson as part of her Ph.D. work and on-going study of the effects of sea otters on nearshore communities, see Watson *et al.* (1997) for a summary of survey effort and results upto 1995. In 2001 and 2002, Fisheries and Oceans Canada began work to develop a survey method suitable for on-going assessment of the sea otter population in BC and has made aerial and boat-based counts throughout the range of the sea otter population. As part of a Habitat Stewardship project in 2002, biologists with the Nuu-cha-nulth Tribal Council (NTC) have made boat-based counts in parts of their territory in 2002.

Oil spill response for protection of sea otters
A symposium was held in 1995 at the Vancouver Aquarium Marine Science Centre, to discuss procedures necessary in the event of a spill to effectively protect the population (Watson 1995). There are oil spill response plans in place, although they are not specific to conservation of wildlife, or sea otters in particular. The Canada - U.S. Joint Marine Pollution Contingency Plan, includes a plan for transboundary waters in southern BC (CANUSPAC) and a plan for the transboundary waters to the north in Dixon Entrance (CANUSDIX) (www.pacific.ccg-gcc.gc.ca/er/index_e.htm). So far, only CANUSDIX includes a section regarding response procedures for wildlife in the event of a pollution incident.

Education / Information Exchange
Nuu-cha-nulth Tribal Council, Habitat Stewardship project in 2002, developed and presented workshops to their community members to inform them of the biology and ecology of the sea otter and conflicting views about their role in the ecosystem.

Johnstone Strait Marine Mammal Interpretative Society, Habitat Stewardship project in 2002 created a museum in Telegraph Cove depicting local marine mammals, including sea otters.

Underwater Harvesters Association count subtidal excavations made by sea otters while carrying out subtidal transect surveys for geoducks and horseclams.

The BC Ministry of Water, Land and Air Protection prepared a booklet on sea otters as part of their Species at Risk series.

Habitat Protection
Checleset Bay Ecological Reserve was established in 1981 to protect sea otter habitat (see Section 1.4)

Sea Otter Recovery Team
Formed in June 2002, the team includes representatives from Fisheries and Oceans Canada, Parks Canada Agency, BC Ministry of Water, Land and Air Protection, the U.S. Fish and Wildlife Service, the Washington State Department of Fish and Wildlife (WDFW), an expert (retired) from the U.S. Geological Survey and currently employed by WDFW, the Sierra Club of British Columbia, World Wildlife Fund Canada, Nuu-cha-nulth Tribal Council, the Underwater Harvesters Association, and Malaspina University College (see VI Additional Information).

6. STATEMENT OF WHEN ONE OR MORE ACTION PLANS IN RELATION TO THE RECOVERY STRATEGY WILL BE COMPLETED[11]

A Sea Otter Recovery Action Plan that outlines specific programs, costs and timelines will be completed within 2 years of approval of the sea otter recovery strategy.

7. EVALUATION

Within five years[12] and in every subsequent five-year period until the objectives have been achieved or the species recovery is no longer feasible, a report on the implementation of the recovery strategy and the progress towards meeting its objectives will be undertaken.

Approach	Assessment of progress
Threat Clarification Research	Was research undertaken to assess the significance of threats identified in the recovery plan and to clarify other threats or limiting factors? Which threats were adequately assessed, which were not? Is there a better understanding of the threats; what are they? Was research undertaken to assess habitat use and to develop a method to identify and assess critical habitat? Was critical habitat for sea otters identified? Has information exchange been established or maintained regarding threats and other conservation concerns with other jurisdictions?

[11] *SARA* requires that the recovery strategy include "a statement of when one or more action plans in relation to the recovery strategy will be completed" [*SARA* s.41(1)(*g*)].
[12] Of posting to the public registry.

Approach	Assessment of progress
Population Assessment	Was research undertaken that contributes to developing population size distribution targets indicative of recovery? Were population size and distribution targets defined? Was a population survey method developed and is a recent population estimate available?
Protection	Was an oil spill response plan developed with sufficient funds, equipment and personnel made ready? Did oil spill prevention activities take place? Are efforts being made to protect sea otter habitat? Has critical habitat been protected? Have areas where sea otters are most vulnerable to oil spills been protected? Are levels of protection and enforcement of regulations sufficient to address the threats?
Communication	Have activities been undertaken to enhance public education and understanding of sea otters their habitat? Has the understanding of sea otters been improved? Have the results of the education programs been assessed (e.g. interactive web site)? Have threats to sea otters and their habitat been reduced through communication? Have collaborations or information exchange been established or maintained with various groups, stakeholders and researchers responsible for sea otter populations in adjacent jurisdictions?

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V. GLOSSARY OF TERMS

Acute effect – An adverse effect resulting from a single exposure to a substance.

Benthic – A term that refers to the ocean bottom or seabed. Benthic animals are those which live on or in the seafloor.

Carrying capacity – This is the maximum population size that can be supported by an area or environment. This is a theoretical concept. In reality carrying capacity changes as conditions change. This is also known as “K”. Also see equilibrium density.

Chronic effect - An adverse effect resulting from long-term exposure to a substance.

COSEWIC – Committee on the Status of Endangered Wildlife in Canada.

Critical habitat – defined under the *Species At Risk Act* (*SARA*) as habitat necessary for the survival or recovery of a species and identified as critical habitat in a recovery strategy or an action plan. Under *SARA*, the destruction of critical habitat is prohibited.

Deleterious recessive alleles – Alleles are alternate forms of genes (brown, blond, red and black hair represent different alleles of the same gene). The effect of a single recessive allele is masked by a dominant allele, however when an individual inherits two recessive alleles it is potentially harmful. This often occurs due to inbreeding in small populations. Also see genetic diversity.

Demography – A term that refers to the characteristics of a population. Usually processes which affect the size of the population, birth rates, death rates, immigration, and emigration.

Dinoflagellate – A microscopic organism that drifts in the water. Some species cause red tide.
Equilibrium density – The density of a population at carrying capacity. This is the state at which the population size remains almost steady with birth and immigration rate equal to the death and emigration rate.

Extant population – A population in existence.

Extinct – A species that no longer exists.

Extirpated – A species that no longer exists in the wild in part of its range but exists elsewhere in the wild. COSEWIC defined this as a species that no longer exists in the wild in Canada but occurs elsewhere.

Endangered – COSEWIC defines this as a species facing imminent extirpation or extinction.

Fecundity – The number of offspring produced by an individual during some period of time

Genetic diversity – This is a measure of the number of alternate forms (alleles) of genes in a population. Populations that have become small generally have low genetic diversity. Genetic variability is what ultimately allows individuals to cope with changing environments. Also see deleterious recessive alleles

Hypothermia – a condition in which the body core temperature drops to a dangerously low level.

Immune suppression – The ability of the immune system to fight off infection or disease is reduced. Contaminants such as PCBs, lead and mercury may cause immune suppression in many animals.

Invertebrates – Animals without backbones; those that are edible, are commonly referred to as shellfish.

Metabolic rate – The rate at which an animal uses energy to maintain body temperature and activity. Sea otters, which must consume 25-33% per day of their body weight in food to maintain their elevated body temperature and activity level, have high metabolic rates.

Polygynous – males mate with more than one female.

Precautionary approach – An approach to management that says we must be very cautious when making decisions about systems we do not fully understand.

Raft – An aggregation of resting sea otters

Recruitment – Increases to a population caused by the addition of young animals to the adult population.

Residence – Defined in the *Species at Risk Act* (*SARA*) as "…a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating".

Soft-bottomed communities – The animals (often invertebrates) and plants that live in and on gravel, mud and sand bottoms. Organisms such as clams, worms and sea pens are members of soft-bottomed communities

Special Concern – COSEWIC defines this as a species of concern because of characteristics that make it particularly sensitive to human activities or natural events.

Threatened – COSEWIC defines this as a species that is likely to become endangered if limiting factors are not reversed.

VII. APPENDIX I SCHEDULE OF STUDIES[13]

SARA allows for a schedule of studies to be developed to identify critical habitat where available information is inadequate [*SARA* s.41(1)(*c.1*)]. Further research is needed before critical habitat for sea otters in B.C. can be identified. The following schedule outlines the activities required over the next 5 years (2003-2008) for critical habitat identification. The activities outlined in this schedule are recommendations that are subject to priorities and budgetary constraints of the participating jurisdictions and organizations.

Critical Habitat Identification Studies	Date
1) Identify rafting & foraging areas & seasonal variations	2004 - 2008
2) Movements and home range patterns	2004 - 2008

VI. ADDITIONAL INFORMATION

Prepared by: Sea Otter Recovery Team

Date Completed: June 2003

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Lead Jurisdiction / Other Responsible Jurisdictions / Wildlife Management Boards with authority for the species under a settled land claims agreement / Key Contacts: The lead jurisdiction for the protection of sea otters and their habitat is Fisheries and Oceans Canada, under the *Canada Fisheries Act*. The Province of British Columbia has jurisdiction over the use of seabed and foreshore under the *BC Land Act*. Parks Canada Agency will have involvement in management and protection in Marine Conservation Areas.

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[13] *SARA* s.41(1)(*c*).

Recovery Team

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Scott Wallace (alternate)	Sierra Club of British Columbia, Marine Committee
Jane Watson	Marine Ecologist, Malaspina University College

External Reviewers

James Bodkin	US Geological Survey, Alaska Science Center
James Estes	Adjunct Professor of Biology, University of California Santa Cruz
Ian Perry	Fisheries and Oceans Canada, Stock Assessment Division

Greg Sanders	U.S. Fish and Wildlife Service
Glenn VanBlaricom	US Geological Survey, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, University of Washington

Record of Cooperation & Consultation[14]: Sea otters are an aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada: #200 - 401 Burrard Street, Vancouver, BC V6C 3S4.

Fisheries and Oceans Canada engaged a Sea Otter Recovery Team in June 2002 to work cooperatively in the development of this recovery strategy (draft completed June 2003). The Recovery Team membership is provided in Section VI. Representatives to the Nuu-chah-nulth Tribal Council who sit on the Sea Otter Recovery Team also ensure there is information exchange on sea otter recovery, planning and activities with the West Coast Vancouver Island Wildlife Advisory Committee, established as a Nuu-chah-nulth Treaty Related Measure.

Two workshops organized by Fisheries and Oceans Canada and the Recovery Team and also open to the public were held January 21, 2003 in Queen Charlotte City and January 25, 2003 in Port Alberni, BC. The purpose was to bring together a diverse group of interests to provide input on the draft Sea Otter Recovery Strategy and to share information. Over 400 invitations and 13 public announcements were made. The sea otter recovery strategy was made available to the public on the world wide web in advance of the workshops. Proceedings were prepared by Julia Gardner, Dovetail Consulting Inc. and are available at www-comm.pac.dfo-mpo.gc.ca/pages/consultations/sea-otters/default_e.htm.

The following organizations provided input on the draft at the workshops. Representation came from: Ahousaht Nation, Ahousaht Fishing Corporation, Bamfield Marine Sciences Centre, Batstar Adventure Tours, BC Ministry of Agriculture Food and Fisheries, BC Ministry of Water, Land, and Air Protection, Broken Island Adventures, Camosun environmental technology, Chief Chee Xial Taaiixou, Due West Charters, Ehattisaht Band, Fisheries & Oceans Canada Pacific Biological Station, Gwaii Haanas National Park Reserve / Haida Heritage Site, Haida Fisheries Program, Ha-Shilth-Sa newspaper, Hesquiaht First Nation, Hesquiaht Fisheries, Kyuquot, Laskeek Bay Conservation Society, Living and Learning School, Malaspina University-College, Nuu-cha-nalth Tribal Council, Nuu-cha-nulth Tribal Council Education Outreach Habitat Stewardship Program (from WCVI Community Workshops held in Tofino, Kyuquot and Oclucje), Pacific Northwest Expeditions, Pacific Urchin Harvesters Association, Parks Canada Agency, Sea Breeze Kayaking, Sea Kayak Guides Alliance of BC, Sierra Club of BC, Subtidal Adventures, Straitwatch, Ucluelet, Underwater Harvester's

[14] *SARA* s.39.

Association, Vancouver Aquarium, VI Trappers, WCVI Aquatic Management Board, interested biologists and interested public.

Fifteen written submissions were also received. These were from: Ahousaht Fishing Corporation, Bamfield Marine Sciences Centre BC Youth Forum, BC Seafood Alliance, Grand Hale Marine Products, Gulf Crab Fishery Association, Hi-To Fisheries Ltd., Manatee Holdings Ltd., Pacific Sea Cucumber Harvesters Association, Pacific Urchin Harvesters Association, Prince Rupert, Underwater Harvesters Association, and West Coast Crab Association.

Input from the public workshops and written submissions were adopted wherever possible, including 53 specific comments. Input was used to re-draft the 'Socio-economic Considerations' section of the Strategy, and the sections related to activities to assist recovery planning, including (but not limited to) the implications of recovery, recovery targets, international aspects, managing of sea otter populations, re-introduction, area management, community involvement, multi-species management, and ecological significance.