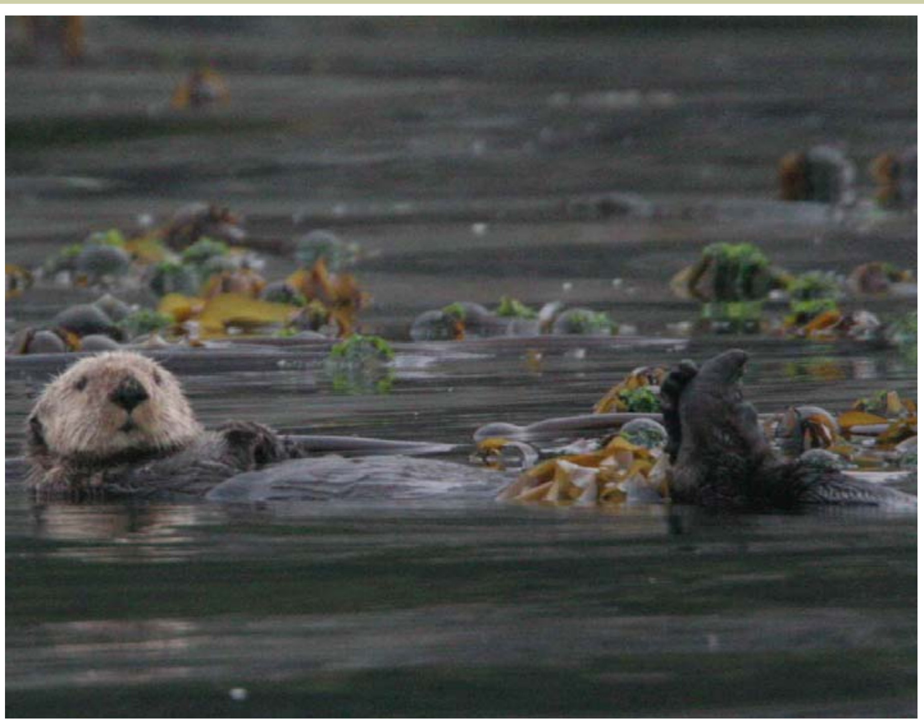
Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Sea Otter (*Enhydra lutris*) in Canada

Sea Otter



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About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/).

Recovery Strategy for the Sea Otter (*Enhydra lutris*) in Canada

December 2007

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Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/)

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DECLARATION

The recovery strategy for the sea otter has been prepared in cooperation with the jurisdictions described in the Preface. Fisheries and Oceans Canada has reviewed and accepts this document as its recovery strategy for the Sea Otter as required under the *Species at Risk Act* (SARA). This recovery strategy also constitutes advice to other jurisdictions and organizations on the recovery goals, approaches and objectives that are recommended to protect and recover the species.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the species and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. Implementation of the strategy by other participating jurisdictions and organizations is subject to their respective policies, appropriations, priorities, and budgetary constraints.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new information. The Minister of Fisheries and Oceans will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister of Fisheries and Oceans will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Fisheries & Oceans Canada
Government of British Columbia
Parks Canada Agency

AUTHORS

The Sea Otter Recovery Team (Section 4) led the preparation of this recovery strategy for Fisheries and Oceans Canada.

ACKNOWLEDGMENTS

The development of the recovery strategy for sea otters was the result of valuable contributions by a number of individuals and organizations. The Sea Otter Recovery Team and Fisheries & Oceans Canada is grateful to the following reviewers for their valuable advice and contributions on the recovery strategy in 2003: James Bodkin, Alaska Science Centre; James Estes, University of California Santa Cruz; Ian Perry, Fisheries & Oceans Canada; Greg Sanders, U.S. Fish and Wildlife Service; and Glenn VanBlaricom, US Geological Survey, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences. The recovery team and Fisheries & Oceans Canada also sincerely thank the many people who provided advice and comments through consultation workshops and written submissions to improve the recovery strategy.

Fisheries & Oceans Canada appreciates the time and dedicated effort contributed by the individuals and their organizations who participate on the Sea Otter Recovery Team and its Oil Spill Response Recovery Implementation Group (Section 4) and all those who are working with the team to achieve the long-term recovery of sea otters.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, the purpose of a Strategic Environmental Assessment (SEA) is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats.

This recovery strategy will result in environmental benefits. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that, while changes to the nearshore ecosystem will result from the restoration of the sea otter to its ecological role, the strategy itself recommends research, population assessment, protection and communication which will benefit the environment and not entail any significant adverse effects. Refer to the following sections of the document in particular: Needs of the sea otter; Approaches Recommended to Achieve Objectives; Recommended Approach for Recovery Implementation.

RESIDENCE

SARA defines residence 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*" **[SARA S2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

Sea otters are a marine species under federal jurisdiction of the Minister of Fisheries and Oceans under the *Fisheries Act* and the *Species at Risk Act* (SARA). SARA (Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. The sea otter was listed as *Threatened* under SARA in June 2003. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently reassessed the sea otter population as *Special Concern* in April 2007. Consideration of a change to the legal listing of sea otters under SARA based on the reassessment will proceed through the regular SARA listing process.

The Province of British Columbia has jurisdiction for fur bearing animals and threatened and endangered species in British Columbia (BC) under the BC *Wildlife Act* and has jurisdiction over the use of seabed and foreshore under the BC *Land Act*. Aquaculture facilities are subject to licensing under the BC *Fisheries Act*. Under the *Canada National Marine Conservation Areas Act*, Parks Canada Agency will have involvement in sea otter management and protection in National Marine Conservation Areas (NMCAs) as sea otters recover in to these areas. The Province of BC and Parks Canada have cooperated in the development of this recovery strategy.

Fisheries & Oceans Canada formed the Sea Otter Recovery Team (Section 4) in 2002 to develop a sea otter recovery strategy. In 2007, the recovery strategy was updated to meet the requirements of SARA (this document).

This recovery strategy meets SARA requirements (Sections 39-41) in terms of content and process, pending a change to the legal listing.

EXECUTIVE SUMMARY

Sea otters ranged once 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 2,000 animals, little more than 1% of the pre-fur trade population, are thought to have remained in 13 remnant populations by 1911. The last verified sea otter in Canada was shot near Kyuquot, British Columbia (BC), 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.

Recent population surveys (2001 to 2004) indicate the Canadian sea otter population includes a minimum of 2,700 animals along the west coast of Vancouver Island and 500 animals on the central BC coast. Sea otters are legally listed as *Threatened* under the *Species at Risk Act* (SARA) but have recently been reassessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as *Special Concern* as they have re-populated 25-33% of their historic range and the population is growing and expanding. However, the population is still considered small (<3500) and their susceptibility to oil and the proximity to major oil tanker routes make them particularly vulnerable to oil spills (COSEWIC 2007).

Oil spills remain the most significant threat because of the population's distribution and the species' inherent vulnerability to oil. The need to protect sea otters and their habitat was identified. However, there is also a 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 is to see that the sea otter population 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.

The population and distribution objectives for at least the next five years to measure progress towards reaching the goal are:

1) to observe that the geographic range of sea otters in coastal BC continues to expand naturally beyond the 2004 continuous range in order to be able to 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; and
2) to observe that the number of sea otters (compared to 2004) correspondingly continues to increase in order for the geographic range to expand.

In addition, a recovery objective was set to identify and, where possible, mitigate threats to sea otters and their habitat to provide for recovery of the population.

To achieve the goal, the recovery strategy adopts a non-intrusive approach 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 to sea otters and their habitat that could impede recovery. Strategies that are recommended to address threats and effect recovery are: research to clarify threats; population

assessment (surveys); protection from oil spills and other threats; and communication to support recovery.

Critical habitat for sea otters has not been identified. Certain wintering habitats may be the most critical to sea otters' survival and recovery. A schedule of studies towards identifying critical habitat has been included.

One or more action plans, which provide the specific details for recovery implementation, will be completed within six years of completion of the recovery strategy.

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1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2000

Common Name: Sea Otter

Scientific Name: *Enhydra lutris*

Assessment Criteria: Not applicable

Status: Threatened

Reason for Designation: The species had been extirpated in British Columbia by the fur trade by the early 1900s, and was re-introduced from 1969-72. It has since repopulated 25-33% of its historic range in British Columbia, but is not yet clearly secure. Numbers are small (<3,500) and require careful monitoring. Their susceptibility to oil and the proximity to major oil tanker routes make them particularly vulnerable to oil spills.

Canadian Occurrence: BC Pacific Ocean

Status History: Designated Endangered in April 1978. Status re-examined and confirmed Endangered in April 1986. Status re-examined and designated Threatened in April 1996 and in May 2000. Status re-examined and designated Special Concern in April 2007.

Sea otters are legally listed as *Threatened* under Schedule I of SARA (June 2003). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently reassessed the sea otter population as *Special Concern* in April 2007. Consideration for a change to the legal listing of sea otters under SARA based on the reassessment will follow the regular SARA listing process.

1.2 Description

Sea otters are the second smallest marine mammal, and the second largest member of the Mustelidae, or weasel, family. 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 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). 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*, which occurs along the California coast and *Enhydra lutris lutris*, which ranges from the Kuril Islands to the Kamchatka Peninsula and the Commander Islands (Wilson *et al.* 1991). Genetic analysis of mitochondrial DNA (mtDNA) variation supports this, although there are some similarities in the frequencies of mtDNA haplotypes between *Enhydra l. lutris* and *Enhydra l. kenyoni* (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 the integrity of 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).

1.3 Populations and Distribution

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 became 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 (Lance *et al.* 2004).

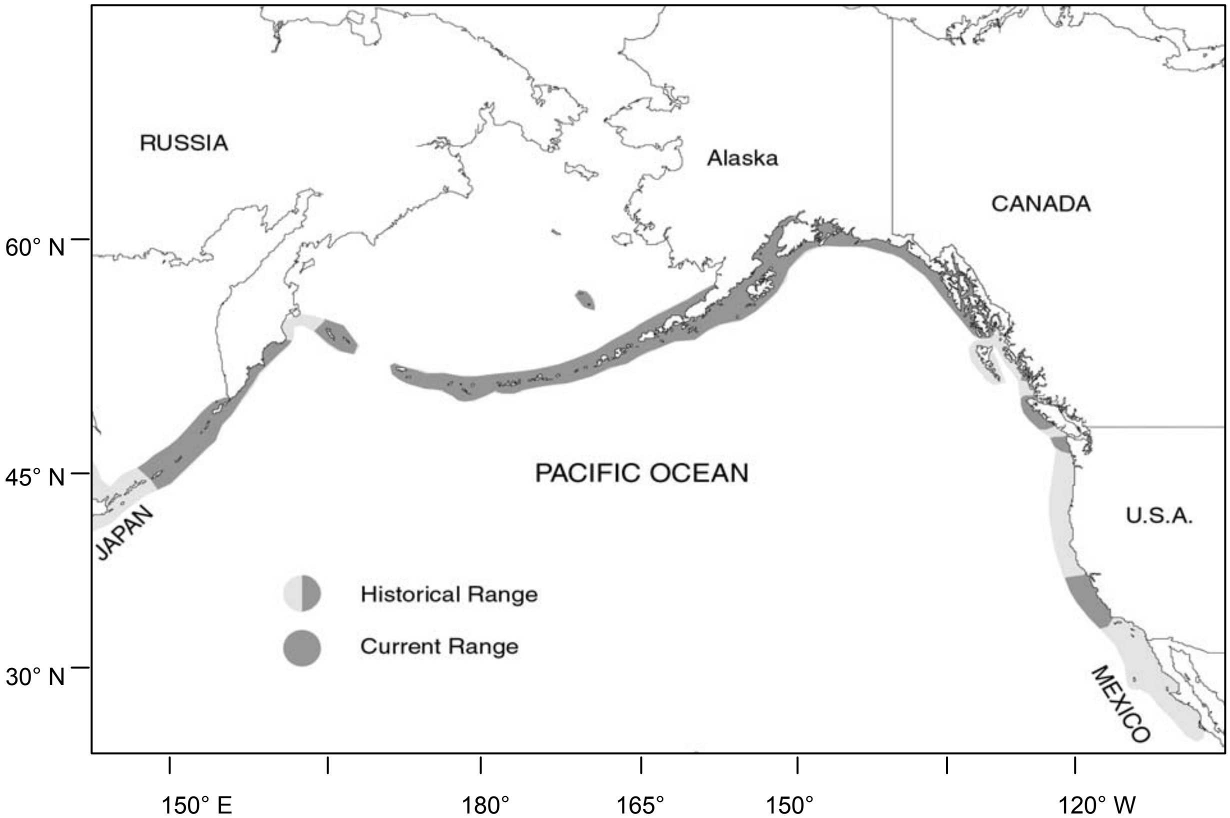

Figure 1 Historical and current global range of all three subspecies of sea otters.

In an effort to re-establish sea otters to BC, 89 sea otters were reintroduced to Checleset Bay, BC, from Alaska (Bigg and MacAskie 1978) (Table 1). Until 1987, sea otters occupied two locations along the west coast of Vancouver Island, Checleset Bay and Bajo Reef off Nootka Island which is 75 km southeast of Checelest Bay. By 1992, the range of the population extended continuously along Vancouver Island from Estevan Point northwest to Quatsino Sound (Watson *et al.* 1997). By 2004, sea otters along Vancouver Island ranged from Vargas Island, in Clayoquot Sound, northward to Cape Scott and eastward to Hope Island in Queen Charlotte Strait (Nichol *et al.* 2005) (Figure 2). In 1989, females with pups were reported near the Goose Islands on the central BC coast indicating establishment of sea otters in the area (BC Parks 1995). By 2004, sea otters on the central BC coast ranged continuously from the southern end of the Goose Group, northward through Queens Sound to Cape Mark at the edge of Milbanke Sound. Single sea otters are periodically reported outside the continuous range.

Table 1. Sex, maturity, and health of 89 sea otters released in Checleset Bay 1969 to 1972. From Bigg and MacAskie (1978.)

			Number released					
			Adult		Immature			
Transplant date	Origin	Total	♂	♀	♂	♀	?	Health
July 31, 1969	Amchitka	29	9	19			1	Fair-good
July 27, 1970	Prince William Sound	14	6	8				Excellent
July 15, 1972	Prince William Sound	46	8	22	7*	9*		Excellent
Total		89	23	49	7	9	1	

* includes 4 male and 2 female pups

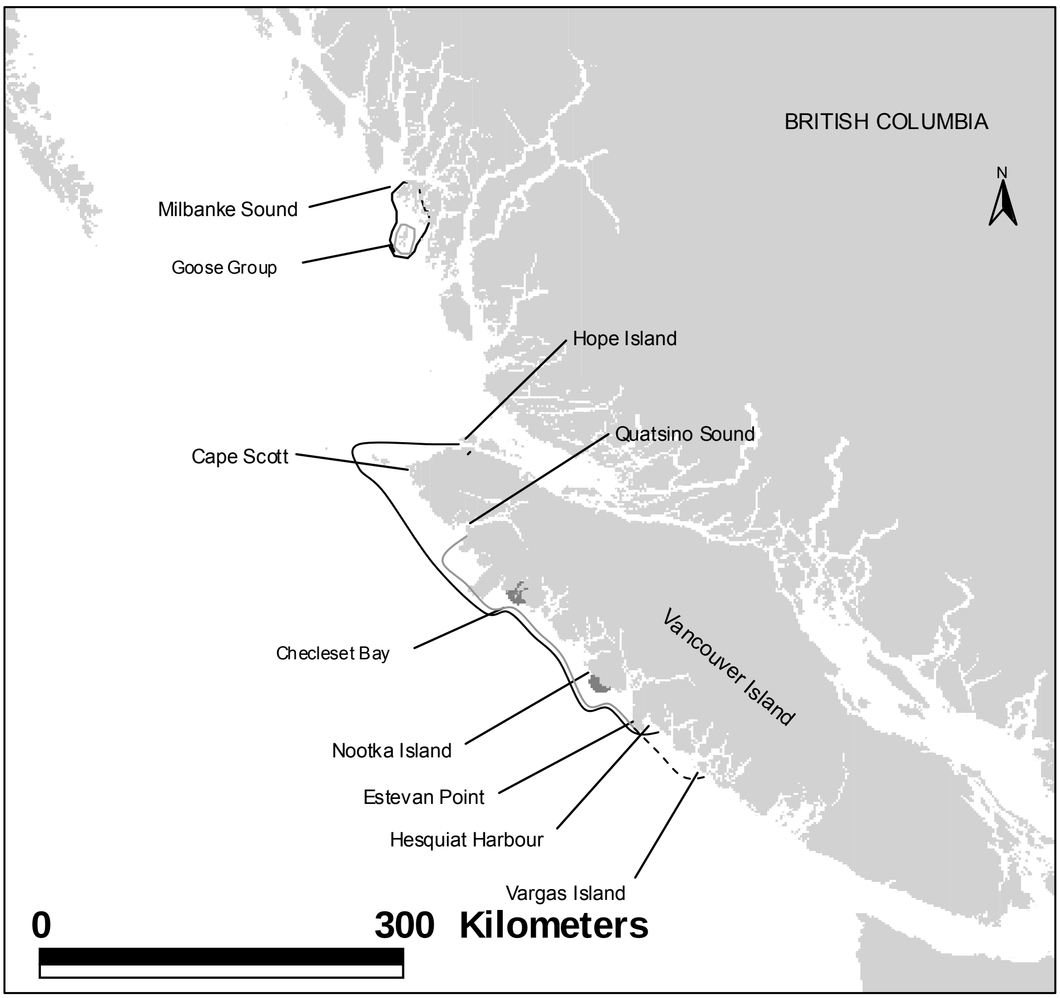

Figure 2 Range of the sea otter in BC and place names mentioned in the text regarding range. Shaded areas on Vancouver Island represent range in 1977. Gray line represents the range by 1995, black line the range by 2001 and the dashed line, range expansion on Vancouver Island in 2004.

Approximately 5 to 10% of the global distribution of sea otters occurs in Canada in the coastal waters of BC. In terms of population size, sea otters represent 3 to 4 % of the global population, however should declines in the sea otter populations of Southwestern Alaska continue, this percentage could increase.

Population Size and Trends

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, and range from 150,000 to 300,000 although some authors suggest the number may have been considerably higher (Kenyon 1969; Johnson 1982). Kenyon (1969) reported a world population in the late 1960s 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.

Although the maritime fur trade was a period of intensive hunting of sea otters, native peoples hunted sea otters prior to the trade. Examination of midden data from some sites in the Aleutian Islands show alternating periods of abundant urchins and sea otter remains that have been interpreted as evidence that humans may have caused periods of local extirpation long before European contact (Simenstad *et al.* 1978). Yet it was over-exploitation by European and American trade with aboriginal peoples during the maritime fur trade that 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 (three miles from shore). This would have afforded some protection. By 1911, however, less than 2000 otters remained scattered amongst 13 remnant populations (Kenyon 1969). Several of these remnant populations declined to extinction (Kenyon 1969).

Until the early 1980s, most of the world population of sea otters (~ 165,000 animals) occurred in the Aleutian Islands (55,100 to 73,700 individuals) (Calkins and Schneider 1985). However, dramatic declines in the Aleutian Islands started in the mid-late 1980s (Estes *et al.* 1998; Doroff *et al.* 2003). Gorbics *et al.* (2000) provides a compilation of population estimates for North America and Russia of about 126,000 otters based on data from the late 1990s. However, dramatic declines in the Aleutian Islands that began in the mid-late 1980s are underway (Estes *et al.*1998; Estes *et al.* 2005; Doroff *et al.* 2003). Precipitous declines in the Aleutian Islands to 8,742 individuals ($CV = 0.215$) by 2000 has meant that sea otters in Western Alaska are now listed as *Threatened* (2005) under the US *Endangered Species Act* (USFW 2006). Table 2 provides a summary of available counts and estimates from North America and Russia, 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. Compilation of available counts and estimates of sea otter populations in the North Pacific.

Region	# of otters	Year of estimate	Source
USA - California	3,026[a]	2007	USGS 2007
USA - Washington	814[a]	2005	Jameson and Jeffries 2005
Canada - BC	3,185[a]	2001, 2004	Nichol *et al.* 2005
USA - Southeast Alaska	12,632[b]	1994, 1995, 1996	USFW 2002c
USA - Southcentral Alaska	16,552[b]	1996, 1999, 2002	USFW 2002b
USA - Southwestern Alaska	41,474[b]	2000, 2001, 2002	USFW 2002a; Doroff *et al.* 2003
Russia - Commander Islands	5,546[a]	2002	A. Burdin pers. comm. 2003
Russia - Kamchatka Peninsula and Kuril Islands	16,910[a]	1997	Gorbics *et al.* 2000
Japan – Cape Nossapu	1[a]	1997	Gorbics *et al.* 2000

a = direct counts, b = estimates corrected for unseen animals

Canada (Pacific) - British Columbia

The size of the population of sea otters in coastal BC prior to commercial exploitation is unknown, but records from the maritime fur trade give an indication of the magnitude of the hunt and the supporting population of sea otters. Sea otter pelt landings in BC between 1785 and 1809 total 55,000. Without a complete record of ship logbooks from which it would possible to ascertain where each trading event occurred, it is difficult to determine the geographic source of these pelts. Some of them could have come from Washington, Oregon or Southeast Alaska, but at least 6,000 of these came from the west coast of Vancouver Island (Fisher 1940; Rickard 1947; Mackie 1997). From surviving 18th century logbooks and voyage accounts between 1787 and 1797, at least 11,000 pelts were obtained in trade in the Queen Charlotte Islands alone. The aggregate landings from the Queen Charlotte Islands of four ships in 1791 alone was at least 3,000 pelts (Dick 2006). By 1850, sea otters in Canada were considered commercially extinct, and they may have been ecologically extinct (and ceased to function as a keystone species, Estes *et al.* 1989) earlier than this (Watson 1993).

Although 89 sea otters were reintroduced to the coast of BC in three translocation efforts (1969 to 1972), many did not survive, and the initial population may have declined to as few as 28 animals (Estes 1990). Seventy sea otters were counted during an aerial survey in 1977 in two locations on the west coast of Vancouver Island. In 1995, 1,522 sea otters were counted, of which 1,423 occurred along the west coast of Vancouver Island and 99 occurred along the central mainland coast in the Goose Islands (Bigg and MacAskie 1978; Watson *et al.* 1997). Surveys in 2001 resulted in a count of 2,673 otters along the Vancouver Island coast and 507 on the central BC coast for a total of 3,180 otters (Nichol *et al*. 2005). Surveys were also made in 2002, 2003 and 2004, but some segments of the range were missed in each year. Using interpolation to estimate numbers of otters in the missed segments (which represented less than 10% of each annual count) resulted in population estimates of 2,369 in 2002, 2,809 in 2003 and 3,185 in 2004 (Nichol *et al.* 2005).

Watson *et al.* (1997) estimated population growth to be 18.6% per year from 1977 to 1995 on Vancouver Island. Since 1995, the growth rate on Vancouver Island appears to have slowed and the average annual growth rate between 1977 and 2004 was 15.6% per year (Nichol *et al*. 2005).

Sea otter populations are density dependent. As the number of sea otters in an area increases and food becomes limiting, otter density is maintained at equilibrium through mortality and emigration (Estes 1990). Rapid initial growth rates of 17-20% per year (~ r_{max} for the species) and a subsequent slowing of growth as parts of the population reach equilibrium are typical of reintroduced sea otter populations (Estes 1990). Such high rates are likely a result of unlimited food and habitat resources following the long absence of sea otters. Some parts of the population near the centre of the range on Vancouver Island have been at equilibrium since the mid-1990s and additional areas are now at or nearing equilibrium, suggesting density-dependence may, in part, explain the reduced population growth rate on Vancouver Island (Watson *et al.* 1997; Nichol *et al*. 2005). Surveys on the central BC coast started in 1990 following a sighting in 1989 of females with pups in the Goose Islands (BC Parks 1995; Watson *et al.* 1997). Nichol *et al.* (2005) estimated population growth between 1990 and 2004 to have been 12.4% per year, however, they noted that this estimate seemed low given the amount of unoccupied habitat available. There may be greater inter-survey variability in this area obscuring the trend and/or unknown sources of mortality.

USA (California, Alaska and Washington)

Following protection from commercial hunting by 1911, sea otter populations began to recover from remnant populations (western and central Alaska and California). However, even by the 1960s, sea otters had not repopulated the area from southeast Alaska to northern California. Re-introductions to southeast Alaska, BC, Washington and Oregon were attempted in the 1960s and 1970s in an effort to re-establish the species in its historic range (Jameson *et al.* 1982). These reintroduction efforts were successful in all cases except in Oregon (Jameson *et al.* 1982). In general, re-introduced populations have exhibited maximum growth rates of 17- 20% per year, whereas remnant population growth has been lower and more variable and has often included periods of decline (Estes 1990; Bodkin *et al.* 1999; Doroff *et al.* 2003). The reasons for these apparent differences are not entirely clear. Whereas the high rates of growth in re-introduced populations have been attributed to unlimited food and habitat resources in the areas of reintroduction, the low and variable rates among remnant populations are at least in part due to continued illegal harvest following protection in 1911, as well as incidental mortality related to fisheries in the later part of the twentieth century (Bodkin *et al.* 1999; Bodkin 2003). Certainly, some of the remnant populations that existed after 1911, such as the remnant population in the Queen Charlotte Islands, declined to extinction after 1911 (Kenyon 1969).

California

Positive growth has ranged from 5 - 7% per year, although there have also been periods of decline (Estes *et al.* 2003; USFWS 2003).). A decline of about 5% per year was detected in the mid-1970s and was attributed to mortality from entanglement in submerged fish nets. The trend reversed following restrictions on net use, and by 1995 surveys indicated a minimum population of 2,377. The southern sea otter population continues to exhibit a high rate of mortality compared to other sea otter populations. Disease, in particular from parasites for which sea otters may not be the natural host, anthropogenic factors including sewage and runoff, as well as entanglement in coastal gill and trammel nets, are considered contributing factors (Estes *et al.* 2003; USFWS 2003). Recent population surveys indicate a minimum population size of 3,026 in 2007 (USGS 2007).

Southcentral Alaska

In Southcentral Alaska, sea otters have recolonized most of their former range. The population in Prince William Sound was, however, significantly affected by the *Exxon Valdez* oil spill in 1989. Since the spill, the sea otter population in Prince William Sound has recovered, but not to the level expected (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, by which time the Southwestern Alaska population accounted for about 80% of the world population which was estimated to be 30,000 animals 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 began to decline precipitously in the late 1980s. By 2000, the population had declined to 8,742 ($CV = 0.215$), at a rate of -17.5 % per year (Doroff *et al.* 2003). Surveys of other parts of Southwestern Alaska suggest the decline may extend eastward to include the Alaska Peninsula and the Kodiak archipelago (Doroff *et al.* 2003). The total population estimate for all of southwestern Alaska as of 2002 is 41,474 animals (USFWS 2002a).

Southeast Alaska

Between 1965 and 1969, 412 sea otters were re-introduced to Southeast Alaska from Southwestern Alaska (Jameson *et al.* 1982). Population growth averaged 18 % per year between 1969 and 1988, but has since slowed to 4.7% per year overall (1988 to 2003), despite ample amounts of unoccupied habitat still available for expansion (Esslinger and Bodkin 2006). The slow growth rate does not appear to be attributable to disease, predation or limiting resources, but sea otters are hunted in Southeast Alaska (Esslinger and Bodkin 2006). The population was estimated to include 12,632 animals (including Yakutat and the north Gulf of Alaska)(USFWS 2002c).

Washington

In 1969 and 1970, 59 sea otters were re-introduced to Washington State from Amchitka Alaska. The population grew rapidly in the early years (~20% per year) but since 1989 the rate has averaged 8.2% per year (Estes 1990; Jameson and Jeffries 2005). In 2005 the Washington sea otter population included 814 animals (Jameson and Jeffries 2005). It has been suggested that the population may be approaching equilibrium density in some rocky habitat along the outer coast (Gerber *et al.* 2004; Jameson and Jeffries 2005).

Russia (Kuril Islands, Kamchatka Peninsula, and Commander Islands)

Gorbics *et al.* (2000) compiled counts from Russia including counts from 1997 of 16,910 sea otters in the Kuril Islands and Kamchatka Peninsula. The results of surveys of the Commander

Islands in 2002 indicate a total of 5,546 animals, and the population there is likely at carrying capacity (Bodkin *et al.* 2000; A. Burdin *pers. comm.* 2003). Sea otters are not considered endangered in Russia, but the population is still considered to be below previous (historic) levels. The population is considered to be threatened by poaching, habitat contamination and fisheries conflicts. Poaching is of particular concern because a black market is believed to exist in Russia to illegally export pelts to China, Korea and Japan (Burdin 2000).

Translocation of sea otters

Translocation as a means of re-establishing sea otter populations ("re-introductions") into parts of their former range was successfully used in the late 1960s and early 1970s in Southeast Alaska, BC, Washington and Oregon (see above). 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 was used in California as a recovery strategy to increase the distribution of the southern sea otter population, thereby reducing 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 group of southern sea otters in California, which would expand the distribution, and increase the population size, thereby reducing 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 to 1990, USFWS translocated 140 southern sea otters from central California to San Nicolas Island, located in the Channel Islands off Santa Barbara, 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 ensure the continued availability of commercially valuable shellfish resources south of Point Conception. Sea otters moving into the *no sea otter zone* were captured 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, sea otters eventually became established in Washington State (Benz 1996). This was also true in BC and Southeast Alaska (see sections above).

In terms of establishing a breeding population, 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.* A final decision regarding options for the translocation program, whether to revise the program or whether to terminate the program, is pending (USFW 2005).

It is not clear why the translocation has had such limited success (Benz 1996). 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 be reduced.

1.4 Needs of the Sea Otter

1.4.1 Habitat and biological needs

Habitat

Sea otters forage primarily on invertebrates, which they obtain by diving to the sea floor. The seaward extent of their habitat is, therefore, limited by their diving ability. Most foraging dives are in depths of less than 40m, thus, sea otters seldom range beyond 1-2 km of shore, unless shallows extend further offshore (Riedman and Estes 1990; Bodkin *et al.* 2004). In coastal BC, sea otters generally occur along stretches of exposed coastline characterized by complex rocky shorelines with small islets and offshore rocky reefs. 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, but not required, 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 quality, and thus the density of otters, seems to be indicated by 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 that support an abundance of clams (J. Bodkin pers. comm. 2003). In general, rocky substrate probably supports a greater variety of invertebrate prey species (Riedman and Estes 1990). Sea otter population growth in BC is not limited by availability of habitat at this time, as there is a considerable amount of habitat as yet unoccupied by sea otters.

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

Foraging

Sea otters forage along the bottom as well as in kelp beds. Most foraging takes place in subtidal areas, although otters forage in the intertidal zone at high tide (Estes 1980; VanBlaricom 1988: J. Watson pers. comm. 2002) and 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 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 three minutes (reviewed in Riedman and Estes 1990). Prey is consumed at the surface. Sea otters will use rocks or other hard objects to open hard-shelled prey and are among only a few animals known to use tools.

Diet

Sea otters eat a wide variety of prey species but diet varies geographically, by duration of residency and by individual. In recently re-occupied rocky habitats where sea urchins are abundant, sea urchins 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 in some areas (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). Within populations, individuals display foraging and prey specialization. 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)).

Social Organization

Sea otters segregate by gender with males and females occupying spatially-distinct areas. However, individual adult males establish and occupy breeding territories in female areas (Garshelis *et al.* 1984; Jameson 1989; Riedman and Estes 1990; Watson 1993). Male rafts occur in the range of established populations and 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).

Movements and Home Range

Sea otters are non-migratory and show great site fidelity, although seasonal movements and occasional long distance movements of individuals may occur (Garshelis 1983; Jameson 1989). Sea otters occupy relatively small overlapping home ranges varying in size from a few to tens of kilometres of coastline (Loughlin 1980; Garshelis *et al.* 1984; Jameson 1989). 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 used over 80 kilometres of coastline (Ribic 1982; Jameson 1989). Population range expansion typically occurs when males move *en masse* from the periphery of the occupied range into previously unoccupied habitat. Females gradually occupy the areas vacated by males (Loughlin 1980; Garshelis *et al.* 1984; Wendell *et al.* 1986; Jameson 1989). In this way population growth and range expansion are linked.

Reproduction and Maternal Care

Female sea otters reach sexual maturity at two to five years (Bodkin *et al.* 1993). Males reproduce between five and six years of age, although sexual maturity in males may be attained earlier (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 is noted in some populations, including coastal BC. Pupping appears to peak in March and April in BC (Watson 1993). Gestation, including a period of delayed implantation, lasts six to eight months (Riedman *et al.* 1994). Sea otters are polygynous; males form pair bonds consecutively with several females throughout the year. Female sea otters produce a single 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; 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 six to eight months after which they are weaned (Payne and Jameson 1984; Jameson and Johnson 1993; Riedman *et al.* 1994). Throughout the period of pup dependency, care is provided entirely by the female. During the first month, the pup depends exclusively on its mother's milk, by four months it feeds almost exclusively on prey provided by the mother, and at five months a pup can dive, capture and break open prey, and groom itself. Pre-weaning mortality can be high; 60 to 78% in areas where populations are nearing equilibrium with resources, but as low as 15% in growing populations (Siniff and Ralls 1991; Bodkin *et al.* 1993; Jameson and Johnson 1993; Monson *et al.* 2000a).

1.4.2 Ecological role

The sea otter is a nearshore species feeding primarily on benthic invertebrates, which it obtains by diving to the sea floor. The sea otter is recognized as a 'keystone species' contributing significantly to the structure and function of nearshore benthic communities and upon the life history of their invertebrate prey (Estes and Palmisano 1974; Estes *et al.* 2005). These interactions are ecologically important, and have significant implications for many invertebrate fisheries.

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, which in turn has important consequences for nearshore community structure (Estes *et al.* 1989).

The extirpation of sea otters from much of their range likely had widespread effects on nearshore community structure (Estes and Duggins 1990). This may have affected ecological processes and had evolutionary effects on many species of otter prey (Estes *et al.* 1989, Watson 2000, Estes *et al.* 2005). Sea otters regulate the abundance and size of their prey. By preying on herbivores such as sea urchins, sea otters reduce grazing pressure and increase algal abundance. Consequently when sea otters are removed from a system, it can become deforested by urchin grazing (Estes and Palmisano 1974). In the absence of sea otter predation, sea otter prey species likely became larger and more abundant because sea otters are energetically constrained to feed on large prey items (Estes *et al.* 1989). Thus, in areas where otters forage, prey species tend to be both less abundant and smaller, and in many cases occur in crevices and under rocks, which offer a physical refuge from foraging otters (Hines and Pearse 1982, Fanshawe *et al.* 2003). Furthermore, in areas with sea otters, herbivorous invertebrates may switch from active grazing to feeding passively on drift algae, which becomes abundant as kelp increases (Harrold and Reed 1985).

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), BC (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 the generality of this interaction. 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 and biological processes that can affect the abundance of kelp and sea urchins (see Foster and Schiel 1988, Konar and Estes 2003). Furthermore the importance of sea otters in regulating community structure must be viewed in a geographical context. For example, in southern California, where alternate predators can control the abundance of sea urchins, sea otters may play a less important role in enhancing kelp abundance (see Steneck *et al.* 2002 for a review). Likewise in the inner waters of Puget Sound and the Strait of Georgia where sea otters may never have been abundant, factors other than urchin grazing may help to regulate kelp abundance (Carter *et al.* 2007).

Sea otter predation also has indirect effects on ecological processes and community structure. Kelp forests enhance nearshore productivity, and enter food webs as detritus from drift algae and dissolved organic material. At islands in the Aleutian chain that are dominated by sea otters, kelp-derived carbon accounted for more than half the carbon in food webs. In these habitats, nearshore productivity, measured as growth of invertebrates, is two to five times higher than in areas where sea otters and kelp are absent (Duggins *et al.* 1989). Kelp also enhances the structure of the water column by creating a complex three-dimensional habitat that supports a large variety of invertebrate and fish (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 processes may all be affected by the presence of kelp (Reed *et al.* 2000, 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 coastal 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 (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 species, although these have not been well studied (Bodkin *et al.* 2001).

1.4.3 Limiting factors

The sea otter is a density-dependent species and population growth is thought to be regulated by resource availability. The abundance of prey affects juvenile survival, whereas female reproductive rates (0.83 to 0.94) remain relatively constant regardless of whether the population is growing or stable and at equilibrium (Siniff and Ralls 1991; Bodkin *et al.* 1993; Jameson and Johnson 1993; Monson *et al.* 2000). As the number of sea otters in an area increases and food becomes limiting, otter density in the area is maintained at equilibrium through mortality and emigration (Estes 1990). Pre-weaning survival ranges from 22- 40% in populations near equilibrium to 85% in growing populations. Survival post weaning to one year of age tends also to be lower in populations near equilibrium (Monson *et al.* 2000a). Otters ≥ two years of age generally have high rates of survival, approaching 90% regardless of population status (Monson *et al.* 2000a).

Predation

Pup carcasses found at eagle nests suggest eagles may be a source of pup mortality in BC (Watson *et al.* 1997). In the Aleutian Islands, sea otter pups comprise five to 20% (by frequency) of the eagle diet during the sea otter pupping season (Anthony *et al.* 1998). Killer whales are not thought to be a significant source of mortality in BC, 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. 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 the southern sea otter population decline (Estes *et al.* 2003). The decline in western Alaska suggests that a better understanding of sources of predation in the Canadian sea otter population may be warranted.

Disease

Various diseases have been documented in sea otters (Thomas and Cole 1996; Reeves 2002; Shrubsole *et al.* 2005; Gill *et al.* 2005), but, generally, disease is not thought to be a significant source of mortality in most sea otter populations, excluding California. In California disease 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).

Genetic Diversity

Genetic diversity can be lost when a population is reduced to a small size and then allowed to increase, a phenomenon known as a bottleneck. The loss of genetic diversity that occurs through inbreeding or because of the limited gene pool in small populations results 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 stochastic events. Sea otters in coastal BC have suffered through at least two genetic bottlenecks, the initial global bottleneck brought about by the species' near extinction as a result of the maritime fur trade of the 18th and 19th centuries, and a second bottleneck caused by re-introducing a small number of animals to BC.

As a result of the fur trade, the total range-wide population of sea otters was reduced by 1911 to less than 2000 animals, approximately one to two percent of its pre-exploitation size (Kenyon 1969). As a result of this bottleneck, genetic diversity among extant sea otter populations is significantly lower than pre-fur trade sea otters, with a loss in modern sea otters of at least 62% of the alleles and 43% of the heterozygosity, compared to the pre-fur trade population (Larson *et al*. 2002a).

Bodkin *et al.* (1999) demonstrated that mitochondrial DNA (mtDNA) haplotype diversity (a measure of genetic 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. Yet with respect to the bottleneck resulting from translocating small numbers of animals, Bodkin *et al* (1999) could not detect a difference in the genetic diversity of remnant (experienced one bottleneck) and translocated (experienced two bottlenecks) populations in coastal BC, Washington and Southeast Alaska (Bodkin *et al.* 1999; Larson *et al.* 2002b). Further loss of genetic diversity has largely been avoided in successfully reintroduced populations that arose from at least 20 to 30 animals, as rapid population growth, aided by a high abundance of food in the reintroduction areas, limited the duration of the bottleneck (Bodkin *et al.* 1999; Larson *et al.* 2002b).

In 1989, females with pups were first reported on the central BC coast, more than 235 km away from the reintroduced population on Vancouver Island (BC Parks 1995). The origin of these otters was unknown (Watson *et al.* 1997), but recent genetic analysis of 18 sea otter samples from the central BC coast in 2003 revealed two mtDNA haplotypes (genetic markers) consistent with otters from Amchitka and Prince William Sound, suggesting otters on the central BC coast are descendents of reintroduced Alaskan otters (DFO unpubl.). Sea otters in Southeast Alaska and Washington State are of the same origin (Bodkin *et al.* 1999; Larson *et al.* 2002b). Present populations of sea otters are less genetically diverse than pre fur-trade populations (Larson *et al.* 2002a). This lowered genetic diversity increases the risk of extinction from stochastic events. If a catastrophic oil spill were to occur, and substantially reduce the sea otter population, it is unlikely that recovery would be as rapid (i.e., as occurred following reintroduction) because degradation of the habitat from the spill and the lower abundance of large prey would likely influence growth and recovery of the population (see Bodkin *et al.* 2002).

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 Kodiak Archipelago 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. Recently, the incidence of myocarditis and dilated cardiomyopathy in southern sea otters, found to be the cause of death in 13% of beach cast carcasses between 1998 and 2001, has been linked to exposure to domoic acid (Kreuder *et al.* 2005; Kreuder *et al.* 2003).

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 the case in the waters around BC (Taylor 1990). Coastal pollution, in particular increased levels of nitrogen and phosphorus abundant in sewage and coastal runoff, is at least partly to blame (Anderson 1994).

1.5 Threats

The following are categories of human-caused mortality, or threats, to sea otters. Disease is included because of the apparent anthropogenic influences emerging in California. See Appendix II for definition of table headings and terms.

1.5.1 Threat classification

Table 3 Threat Classification Table

1	Threat #1 (Environmental Contaminants - Oil Spill)	Threat Information		
Threat Category	Accidental Mortality and Habitat Loss or Degradation	Extent	Localized	
			Local	Range-wide
General Threat	Transport of oil and use of hydrocarbons to fuel vessel	Occurrence	Anticipated	
		Frequency	Recurrent	
Specific Threat	Oil spill	Causal Certainty	High	
		Severity	High	
Stress	High mortality from hypothermia, inhalation of fumes or ingestion of oil from fur causing damage to internal organs. Reduced reproductive success; chronic contamination through exposure to contaminated sediment and prey	Level of Concern	High	
2	Threat #2 (Environmental Contaminants - Persistent Bioaccumulating Toxins)	Threat Information		
Threat Category	Pollution	Extent	Widespread or localized	
			Local	Range-wide
General Threat	Deposition of industrial and agricultural chemicals in marine food webs	Occurrence	Current	
		Frequency	Continuous	
Specific Threat	Bioaccumulating toxins	Causal Certainty	Low	
		Severity	Low-Moderate	
Stress	Reduced reproductive success, reproductive impairment, reduced immune competence, mortality	Level of Concern	Low	
3	Threat #3 (Disease and Parasites)	Threat Information		
Threat Category	Accidental Mortality, Changes to Ecological Dynamics, Pollution	Extent	Localized and Widespread	
			Local	Range-wide
General Threat	Introduction of diseases and parasites	Occurrence	Anticipated	
		Frequency	Unknown	
Specific	Exposure to novel disease	Causal Certainty	High	

Threat		**Severity**	Unknown	
Stress	High mortality, loss of reproductive potential	**Level of Concern**	Low	
4	**Threat #4 Entanglement in fishing gear**	**Threat Information**		
Threat Category	Accidental Mortality	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Entanglement or entrapment	**Occurrence**	Anticipated	
		Frequency	Recurrent	
Specific Threat	Entanglement/entrapment in fishing or aquaculture gear	**Causal Certainty**	High	
		Severity	Low	
Stress	Increased mortality (drowning)	**Level of Concern**	Low	
5	**Threat #5 Collisions with vessels)**	**Threat Information**		
Threat Category	Accidental Mortality (or Injury)	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Vessel traffic	**Occurrence**	Anticipated	
		Frequency	Recurrent	
Specific Threat	Collisions with vessels	**Causal Certainty**	High	
		Severity	Low	
Stress	High mortality, loss of reproductive potential	**Level of Concern**	Low	
6	**Threat #6 Illegal kill**	**Threat Information**		
Threat Category	Killing	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Shooting, trapping	**Occurrence**	Current	
		Frequency	Recurrent	
Specific Threat	Illegal kill	**Causal Certainty**	Moderate	
		Severity	Unknown	
Stress	High mortality	**Level of Concern**	Low-Moderate	
7	**Threat #7 Human Disturbance**	**Threat Information**		
Threat Category	Disturbance and Persecution	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Human activities on the water, vessel traffic, sea otter viewing	**Occurrence**	Current	
		Frequency	Recurrent	
Specific Threat	Behavioural disruption	**Causal Certainty**	Low	
		Severity	Low	

Stress	Reduced reproductive success (possible displacement from preferred habitat)	**Level of Concern**	Low

1.5.2 Description of threats

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 the integrity of 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.

- 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 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 found in single sex aggregations, which can include 100 or more 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 raft of male otters may have less reproductive impact than the loss of a raft of female otters because of the species' polygynous mating system.

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

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 aground in Prince William Sound, spilling 42 million litres of crude oil. Nearly 1000 sea otter carcasses were recovered within six 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 is 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.* 2000b), but the Prince William Sound sea otter population has not yet fully recovered to pre-spill levels.

The risk of oil spills in BC has been of considerable concern for sometime, particularly since the *Nestucca* oil spill, 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. Weathered oil reached as far as the Goose Islands Group on the central coast of BC (Watson 1989). Sea otter surveys made soon after the spill found one oiled sea otter carcass on an offshore islet in Checleset Bay and wolf scats 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 could not be established because wolves and bears quickly scavenge beach-cast carcasses. Boat-based surveys made the following summer found no detectable effect 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 the sea otter population to oil contamination.

Sources of oil spill threats in the marine waters around BC include cargoes of tankers and barges, bilges, fuel tanks of marine vessels, shore-based fuelling stations 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 Pacific Canadian 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 the 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.* 1990). Risk models 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 159,000 litres (1000 barrels) could be expected every 2.5 years;
- spills of any type of petroleum product exceeding 159,000 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 159,000 litres, there are numerous smaller spills. Spills over 1,113 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 1,113 litres (7 barrels) annually (Burger 1992). A recent development proposal to deliver crude oil by tanker from Kitimat, BC, to Asia Pacific and California markets (Enbridge Inc. 2005) and proposals to allow drilling for oil and gas in Hecate Strait and Queen Charlotte Basin (BC Ministry of Energy Mines and Petroleum Resources) pose additional risks and could alter the above predictions about the size and frequency of spill events.

Environmental Contaminants – Persistent Bioaccumulating Toxins

Organochlorine contaminant levels have not been measured in Canadian sea otters. Polychlorinated biphenyls (PCB), organochlorine pesticides including DDT and butyltin have been measured in sea otters from California, Washington and Alaska (Bacon *et al.* 1999; Kannan *et al.* 2004; Lance *et al.* 2004). PCBs concentrations were higher in Alaskan otters from the Aleutian Islands (309µg/kg wet weight) compared to otters from California (185µg/kg wet weight) and southeast Alaska (8µg/kg wet weight) (Bacon *et al.* 1999). Total DDT concentrations were highest in California sea otters (850µg/kg wet weight), compared to the Aleutian Islands (40µg/kg wet weight) and southeast Alaska (1µg/kg wet weight), likely reflecting the greater degree of agricultural activity in California than in Alaska. The levels of PCBs measured in California and Aleutian sea otters is considered to be of concern, since similar levels cause reproductive failure in mink, a closely related species (Risebrough 1984 *in* Riedman and Estes 1990). Although the levels of DDT measured in California sea otters were not considered to be exceptionally high when compared to other marine mammals (Bacon *et al.* 1999), reduced immune competence is a well-documented side-effect of contaminants in marine mammals and is considered a possible factor in the high rate of disease-caused mortality in the southern sea otter population (Thomas and Cole 1996; Reeves 2002; Ross 2002). Among a small sample of beach-cast carcasses retrieved for contaminant analysis in California, those that died from infectious disease contained, on average, higher concentrations of butyltin compounds (components in antifouling paint) and DDTs than animals that had died from trauma and unknown causes (Kannan *et al.* 1998; Nakata *et al.* 1998).

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). 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 for which sea otters are thought not to be 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 and other felids are the terrestrial parasite's definitive host. Runoff from urban and agricultural areas into streams and rivers may be linked to the transport of the parasite to coastal marine waters. (Miller *et al.* 2002;Lafferty and Gerber 2002). *Sarcocystis neurona*, a disease thought also to be terrestrial in origin and typically associated with opossums, is causing mortality among southern sea otters as well (Kreuder *et al.* 2003). Peritonitis induced by acanthocephalan parasites has 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. Reduced immune competence could result from environmental toxins, genetic factors, or habitat degradation leading to nutritional stress (Thomas and Cole 1996; Reeves 2002).

Exposure to a variety of diseases has been documented in sea otters in Alaska, Washington, and BC (Thomas and Cole 1996; Reeves 2002; Lance *et al.* 2004; Gill *et al.* 2005; Shrubsole *et al.* 2005). Since 2000, sea otter beach-cast carcasses have been examined to determine cause of death in Washington State (Lance *et al.* 2004). In 2000, one of six animals examined died from dual infection with *T. gondii* and *S. neurona*. In 2002, one of eight animals examined died from infection with *S. neurona* and six died from infection with *Leptospirosis*. In 2004, two of three animals examined had died from infection with *S. neurona*. One animal died from Canine Distemper Virus (CDV), a member of the genus *Morbillivirus*. This was the first reported case of CDV in sea otters, although 81% of 32 live-captured sea otters in 2000 and 2001 tested seropositive for exposure to morbilliviruses such as CDV (Lance *et al.* 2004).

In BC, beach-cast carcasses are rarely retrieved because of scavenging by eagles, bears and wolves and the remoteness of the sea otter range. However, in 2006 one animal from the west coast of Vancouver Island was examined and found to have died from infection with *S. neurona* (Raverty pers. comm. 2006). Among 42 animals live-captured on the BC coast in 2003 and 2004, eight were seropositive for morbilliviruses and two tested positive for *T. gondii* (Shrubsole *et al.* 2005). CDV has recently been detected in river otters living in the marine environment in BC. Transmission is thought to 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).

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 killed. Incidental drowning in sunken gill nets was a significant cause of mortality 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 a cause of the current decline in southern sea otters (USFWS 2003).

Incidental entanglements in fishing gear have 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 coastal BC is unknown, but not thought to be significant at this time based on the current range of sea otters. 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 Lance *et al.* 2004). Crab traps 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 sea 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).

Illegal kill and Human Disturbance

There are few verified reports of illegal killing of sea otters in BC, although it has long been suspected based on unconfirmed reports. Recently, four skinned carcasses were reported and verified in 2006 and one shot carcass in 2004, confirming that illegal killing occurs (DFO unpubl.). However, the extent of illegal killing within the range is unknown.

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 human-populated areas, and public awareness and interest in watching the BC sea otter population grows.

1.6 Actions Already Completed or Underway

Surveys (1977 – present). Between 1977 and 1987, survey counts were made collaboratively by Fisheries and Oceans Canada, BC Parks, and West Coast Whale Research (see Watson *et al.* 1997). Between 1988 and 2000, most comprehensive counts were led by Dr. Jane Watson as part of her Ph.D. work and then an 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 up to 1995. As part of a Habitat Stewardship Program project, biologists with the Nuu-cha-nulth Tribal Council (NTC) have made annual boat-based counts in parts of their claimed traditional territory since 2002.

Development of standardized survey procedure (2001 to 2004). In 2001, Fisheries and Oceans Canada began work to standardize a survey method suitable for on-going assessment of the sea otter population and has since made aerial and boat-based counts of the population. A population survey procedure has now been developed that provides an index of population abundance and growth trends (Nichol *et al.* 2005). Assessment of trends in abundance and growth are dependent on a time series of survey data and therefore on-going population surveys at regular intervals are important.

Sampling collection and assessment of genetic origin, disease exposure and contaminants in sea otters (2003 - present). In 2003, 18 sea otters were live-captured on the central BC coast and in 2004, 24 sea otters on the west coast of Vancouver Island and blood and skin biopsy samples were collected. Genetic samples were collected to determine the origin of the central coast sea otters (i.e., remnant population or a result of reintroduction) and for further research on genetic structure and diversity in the population. Blood samples were collected to determine disease exposure (what diseases has the population been exposed to) and to identify pathogens of concern and emerging diseases. Additional samples are stored for further study of contaminants and health effects.

Oil spill response (1995 - present). A symposium was held in 1995 at the Vancouver Aquarium 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) (http://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.
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). The (Canadian) Sea Otter Recovery Team formed a sea otter oil spill response Recovery Implementation Group in 2004 and has developed a sea otter oil spill response plan working document, and is working to protect the sea otter population and its habitat from oil contamination. In 2005, the Nuu-chah-nulth Tribal Council and Vancouver Aquarium held oil spill response and wildlife response training as part of their Habitat Stewardship Program projects.

Education / Information Exchange - Nuu-cha-nulth Tribal Council and West Coast Aquatic Management Association, Habitat Stewardship Program project (2002-present). The NTC and West Coast Aquatic Management Association have developed and presented workshops to their community members to inform them of the biology and ecology of the sea otter and conflicting views about sea otters' role in the ecosystem. In addition to annual surveys and the work on oil spill response listed above, community mapping sessions and reporting of incidental sightings is also conducted.

Sea otter viewing guidelines (2004). The West Coast Aquatic Management Association and the Bamfield Marine Sciences Centre also developed guidelines for viewing sea otters as part of their Habitat Stewardship Program project in 2004.

Johnstone Strait Marine Mammal Interpretative Society Museum (2002). In 2002 under their Habitat Stewardship Program project, the Johnstone Strait Marine Mammal Interpretative Society created a museum in Telegraph Cove depicting local marine mammals, including sea otters.

Documentation of subtidal excavations (geoducks and horse clams). The Underwater Harvesters Association count subtidal excavations made by sea otters while carrying out subtidal transect surveys for geoducks and horse clams.

Communication material (2002). The BC Ministry of Water, Land and Air Protection revised and re-issued a booklet on sea otters as part of their Species at Risk series.

Habitat Protection (1981). Checleset Bay Ecological Reserve was established in 1981 by the Province of BC to protect sea otter habitat.

Re-introduction (1969-1972). Between 1969 and 1972 in a series of three translocations, the provincial, state and federal governments of BC, Canada and Alaska re-introduced 89 sea otters from Amchitka Island and Prince William Sound, Alaska, to the Bunsby Islands in Kyuquot Sound on the west coast of Vancouver Island, BC.

1.7 Knowledge Gaps

Critical habitat. 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. Almost nothing is known of seasonal habitat use. Although sea otters are observed using 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. These observations suggest that there may be limited seasonal movement. There is a need to document and describe the characteristics of habitats used during winter and inclement sea-state conditions.

Genetic diversity. Genetic diversity of the Canadian 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. While it is likely that genetic diversity of the BC population is similar to the other translocated populations that Larson *et al.* (2002b) examined, the genetic diversity of the Canadian sea otter population compared to other extant populations, as well as pre-fur trade ancestors, is not known. Insight into the genetic relationship (possibility of gene flow) between BC sea otters and adjacent populations would also help understand the vulnerability of the population.

Sources of mortality. Sources and impacts of natural predation on the sea otter population in coastal BC 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 numbers of sea otters and the hypothesized role of killer whale predation in the decline occurring in western Alaska (see Section 1.3 Populations and Distribution).

Emerging threats. Additional threats that could be significant but are not well understood and for which the level of concern, or potential future threat, 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 (see Section 1.5 Threats).

Interactions with other species. Although there has been considerable research examining the ecological role of sea otters and their influence on nearshore rocky habitats and upon the life history of their prey (see Section 1.4.2 Ecological Role), further research is required to determine northern abalone population parameters in the presence of sea otters to determine objectives for northern abalone recovery. An ecosystem-based approach may be warranted more broadly to evaluate population targets for other listed species in ecosystems that now include sea otters.

Density-independent factors regulating population growth. In Southwestern Alaska, the sea otter is now listed as *Threatened* under the US *Endangered Species Act* because of a precipitous decline since the mid to late 1980s. The current leading hypothesis to explain the decline is that it has occurred as a result of increased predation by killer whales, although the reason for the shift is complex (see Section 1.4.3 Limiting Factors). Maintaining information exchange and/or collaboration with researchers and managers working on populations of sea otters in other jurisdictions will assist in understanding factors that may regulate population growth in BC.

1.8 Socio-Economic Considerations

Sea otters are a keystone species, thereby exerting a profound 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 because of their effects on invertebrate and kelp abundance. Throughout the sea otter range, there is mounting evidence that many invertebrate fisheries cannot co-exist in the presence of an established sea otter population. This conflict presents challenges and opportunities for those concerned with wildlife and ecosystem conservation, and maintaining harvestable invertebrate resources. This section provides a brief summary of the prevailing socio-economic views regarding sea otters and their recovery.

Historically, sea otters were hunted by First Nations people and used for clothing, regalia and gifts. In the 1700 and 1800s the luxuriant fur was highly prized by maritime fur traders (European and American), who hunted and bartered with First Nations for pelts that were then sold in Asia. Along the Pacific coast of North America, this trade began in 1778, following the return of Captain Cook's ship from Vancouver Island with sea otter pelts. Trade with First Nations people specifically for sea otter pelts intensified rapidly and continued through the mid-1800s. By the mid-1800s, sea otters had been so far reduced that trade had largely shifted to focus on other fur-bearing mammals. By 1911 it was recognized that the sea otter was near the brink of extinction. In that year, the species gained some protection through a clause in the International Fur Seal Treaty of 1911, but by then the global population had been reduced to one to two percent of its pre-exploitation size. Since 1911, the sea otter has been protected from commercial harvest throughout much of its range. Under the US *Marine Mammal Protection Act*, only aboriginal people in Alaska 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 some 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 rocky 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 northern 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.

Over the last 100 years commercial and recreational invertebrate fisheries that developed following extirpation of sea otters grew as many invertebrate populations increased in abundance in the absence of their greatest natural predator, the sea otter. As the sea otter population recovers and re-populates its historic range, the size and abundance of many invertebrate species are expected to decline. Commercial fisheries in BC 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. The impact of these losses may be felt particularly in coastal communities where options for economic diversification are limited.

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 1980s (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 Populations and Distribution) (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 BC have declined (reviewed in Watson 2000). 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 costs and social impacts of sea otters are understood, there has been little effort to identify the social and economic benefits of sea otters. Such quantitative analyses are more challenging. Loomis (2006) suggests that with less effort made to quantify benefits accruing from the recovery of species such as sea otters, there tends to be a perception that endangered species recovery often involves an “economy vs. environmental” trade-off. Loomis (2006) presents results of an analysis using techniques often used to quantify recreation benefits and health benefits, to estimate the value of sea otter population expansion in southern California. He concludes the benefits will more than compensate for the estimated loss to commercial fishing.

Studies show that kelp beds support a greater abundance of fish and invertebrates and suggest kelp may contribute significantly to the productivity of offshore habitats (e.g., 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 on the outer coast (Gerber and VanBlaricom 1998). Currently, it seems evident that the marine eco-tourism industry and the herring-spawn-on-kelp fishery should benefit from the recovery of the sea otter population.

Eco-tourism is a valuable industry in BC 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. Coastal tourism in California is recognized as the third largest employer in the state’s economy and in the

1970s tourism generated almost one third of all jobs in the Monterey area (Silva 1982; USFW 2005 cited in Loomis 2006).

The herring-spawn-on-kelp fishery in BC depends on a reliable supply of suitable quality kelp. Kelp abundance and quality can 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).

1.9 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 invertebrate harvesting activities.

In BC, 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 2005 value of shellfish fisheries in BC was $122.1 million in landed value (estimates from "The 2005 British Columbia Seafood Industry Year in Review" published by the BC Ministry of Agriculture, Food and Fisheries, September 2006). 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 of invertebrate 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 (estimated using wholesale values in the 2001 British Columbia Seafood Industry Year in Review report, Michelle James pers. comm. 2003). 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 Nations 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. Industry representatives are also 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 on 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 were some concerns expressed by members of the Haida Nation, based upon the current situation on the west coast of Vancouver Island. Some First Nations groups have expressed concern about the impact of sea otters on the economic value of shellfish to their community, in particular, the manila and littleneck clam fisheries, and aquaculture operations, including geoduck. 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. Despite 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 have the health, "balance" and ecological integrity of all the components 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, resulting from the increases in kelp habitat for spawn and for juvenile fish nurseries. 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 sea otter populations returning after extirpation.

2. RECOVERY

The sea otter recovery strategy recommends a non-intrusive approach to recovery that recognizes sea otters' ability to rebound, but also 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.

2.1 Recovery Goal

The recovery goal for sea otters is to see that the sea otter population in BC 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.

2.2 Recovery Feasibility

Sea otter recovery is feasible. Sea otters have the capacity to rebound from a small founding population, as illustrated by the growth of several translocated populations, including the population in BC, and remnant populations. Food is generally viewed as the main factor that limits population growth. Much of the BC coast remains unoccupied by sea otters and, for this reason, population recovery is unlikely to be limited by food or habitat at least in the near future. Among successfully translocated populations, early growth rates have been very high (between 17 and 20% per year) at a rate near the physiological maximum (r_{max}) of the species (Estes 1990). These high rates are likely attributable to unlimited food and habitat resources in the areas of reintroduction (Bodkin 2003). Growth rates have, however, been more variable and lower (Bodkin *et al.* 1999), including periods of decline, among remnant populations. The reasons for these differences are not clear, although it is likely that continued illegal harvest following protection in 1911, as well as incidental mortality related to fisheries in the later part of the 20th century, were some of the contributing factors (Bodkin 2003).

One of the largest threats to sea otters is an oil spill. Such an event could occur at any time and could cause significant mortality. Furthermore, recovery of sea otter populations in an area contaminated by oil can be slow (Bodkin *et al.* 2002). Concerns about the reduction of socially and economically valuable invertebrate resources by sea otters may also prove to be a challenge to gaining support for sea otter recovery. 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.

2.3 Population and Distribution Objectives

Sea otter distribution and abundance are highly inter-related. Unoccupied habitat is sequentially occupied as the number of otters in an area approaches carrying capacity. Given the relationship between range size and population abundance, coupled with the localized movements of individuals, it follows that increasing the geographic range to reduce the risk from human-induced mortality will also result in an increased abundance of sea otters.

The objectives for at least the next five years that will be used as a measure of progress towards reaching the recovery goal are:

1. To observe that the geographic range of sea otters in coastal BC continues to expand naturally beyond the 2004 continuous range (see Section 1.3 Populations and Distribution) in order to be able to survive events catastrophic to the species, such as an oil spill, and be able to rebound within a relatively short period of time to pre-catastrophe numbers.

2. To observe that the number of sea otters (compared to 2004) correspondingly continues to increase in order for the geographic range to expand.

2.4 Recovery Objective

1. Identify and, where possible, mitigate threats to sea otters and their habitat to provide for recovery of the population.

2.5 Approaches Recommended to Meet Objectives

The following activities are broadly grouped into four approaches that are recommended for recovery: Threat Clarification Research, Population Assessment, Protection, and Communication. The approaches are ordered in relation to the objectives, and within each approach, the activities are ordered from highest to lowest priority. The approaches refer only to the sea otter population in Canada, unless otherwise stated.

2.5.1 Threat Clarification Research

In order to protect sea otters from threats to their survival, research is needed to identify and 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 by modeling 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 spills.
- Identify options to reduce risk to the population from oil spills.
- Assess the genetic diversity of the sea otter population and monitor population measures that are indicative of fitness and of vulnerability to stochastic events.
- Develop a sea otter health-monitoring program. Include assessment of body condition, disease exposure and contaminant burdens in live-captured sea otters and perform necropsies of fresh carcasses when the opportunity arises. Develop a set of standard morphometric measurements.
- 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.
- Assess sources and the significance of natural predation.
- Incorporate relevant research from other jurisdictions (e.g. Washington, Alaska), First Nations and coastal communities.

2.5.2 Population Assessment

Population assessment will involve surveys to assess population distribution, relative abundance and trends in growth to monitor progress towards recovery.

- Undertake regular surveys of the sea otter population, to monitor population size, growth and distribution.

- Develop models to help define a geographic distribution that is better able to withstand catastrophic events, particularly oil spills.

- Develop or refine a sea otter carrying capacity model for the BC coast that could be used to assess recovery compared to a theoretical maximum population size that the habitat could support.

2.5.3 Protection

Approaches to protection should include the following activities. With further research (See Section 2.5.1), additional efforts may be needed.

- Respond to oil spills. Oil spills remain the single biggest threat to sea otters. An oil spill response plan working document specifically for sea otters has been developed (SORT 2004). Greater readiness to implement the response plan in the event of a spill is needed.

- Protect important habitat for sea otters from identified threats. This might be achieved in part by improving habitat protection in existing protected areas and closures from activities that are likely to result in destruction or harm to important habitat. Protection measures may be developed through coastal planning initiatives. 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 input to discussions on oil and gas exploration and drilling in BC marine waters.

- Provide for an adequate level of protection and enforcement of regulations to reduce the threats.

2.5.4 Communication

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 should 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.

- Promote 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 it may require additional considerations.

2.6 Performance Measures

Within five years[1] 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.
The objective-based performance measures that will be used to monitor progress are:

- Did the geographic range of sea otters continue to expand naturally beyond the 2004 continuous range?
- Did the number of sea otters increase (compared to the 2004 estimate) to correspond to the range expansion?
- Were threats better identified or clarified? Were threats to sea otters and their habitat mitigated to provide for continued recovery?

2.7 Critical Habitat

2.7.1 Identification of the species' critical habitat

The seaward extent of sea otter habitat is largely limited by sea otters' ability to dive to the sea floor for food. Most foraging dives occur in depths of 40m or less, although sea otters are capable of diving to 100m. Thus, their habitat is typically within 1 to 2km of shore unless areas of extensive shallows extend further. When present, kelp beds are often used habitually as rafting sites. Kelp beds are also used for foraging and are important, though not essential, habitat components. Sea otters prey upon a wide variety of invertebrate species and both rocky and soft bottom communities provide foraging habitat.

In BC, sea otters occupy exposed coastal areas with extensive rocky reefs and associated shallow depths along the west coast of Vancouver Island and the central BC coast. As the range expands, the characteristics of the habitat used by sea otters are likely to become more diverse. Habitat is not limiting for this population at this time but further study is needed to assess the components that could identify critical habitat as defined by SARA.

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 are 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.

[1] of posting to the SARA Public Registry

2.7.2 Schedule of studies to identify critical habitat

Table 4. Schedule of Studies

Recovery Activity	Outcome/Rationale	Timeline
Identify rafting and foraging areas and seasonal variation in their use • Survey summer rafting and foraging locations • Survey winter raft locations • Compile incidental reports of sightings of rafts of sea otters, especially in winter, from First Nations, fishermen and coastal communities • Use physical attributes of observed winter distribution to characterize habitat use in winter • Model physical attributes of observed winter distribution to predict probable winter habitat in other areas, including areas not occupied by sea otters	Determine the winter distribution of sea otters. Summer rafting areas can be identified in conjunction with population survey work but winter rafting areas are likely different.	2007-2012
Study movement and home range of sea otters (e.g., telemetry)	Determine the size of home ranges and habitat use	2012+

2.8 Existing and Recommended Approaches to Habitat Protection

In Canada, the *Fisheries Act* has provisions to protect sea otter habitat. A list of existing Marine Protected Areas is summarized in Jamieson and Lessard (2000), and includes the Checleset Bay Ecological Reserve established in 1981 for the protection of sea otter habitat. Marine Protected Areas may also be established under the *Oceans Act*.

Under the *Canada National Marine Conservation Areas Act*, Parks Canada is responsible for the creation of National Marine Conservation Areas (NMCAs) which will be managed for sustainable use, and protected from industrial activities such as marine dumping, mining, and oil and gas exploration and development. A NMCA is proposed in the southern Queen Charlotte Islands that would extend 10 km offshore from Gwaii Haanas National Park Reserve. As such, it would encompass habitat to which sea otters may in future be expected to recover. Pacific Rim National Park Reserve (PRNPR) along the west coast of Vancouver Island has special provisions under the *Canada National Parks Act*. The PRNPR encompasses the nearshore waters adjacent to it and the Broken Group Islands. The sea otter population’s range can be expected to extend in to the PRNPR as the population recovers.

Works or developments on, in and under the water that may affect sea otter habitat may be subject to review under the *Navigable Waters Protection Act* and the *Canadian Environmental Assessment Act*.

2.9 Effects on Other Species

See Section 1.4.2 Ecological Role.

2.10 Recommended Approach for Recovery Implementation

The single-species approach for recovery was chosen largely for expediency as it allows a focused 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 strategy could not have been completed within the required timelines. Sea otters are keystone predators and contribute to the structure of nearshore ecosystems (see Section 1.4.2 Ecological Role), with both direct and indirect effects on other species at risk and their associated habitats. For example, sea otters prey on the northern abalone (listed under SARA as *Threatened*), 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 boccacio, designated under COSEWIC as *Threatened*), increases, and species that feed in kelp forests (e.g. the marbled murrelet, listed under SARA as threatened) should benefit. Furthermore, the major threat to sea otters is oil spills, which would also affect 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 many other species.

2.11 Statement on Action Plans

One or more sea otter action plans will be completed within six years of approval of the sea otter recovery strategy. However, in the event sea otters are listed under SARA as a species of special concern based on the reassessment by COSEWIC, a management plan outlining measures for the conservation of the species must be prepared within three years of listing, replacing the recovery strategy and the requirement for the development of one or more action plans.

2.12 Permitted activities under the *Species at Risk Act*

As set out in subsection 83(4) of the *Species at Risk Act*, a person can engage in an otherwise prohibited activity if the activity is permitted by a recovery strategy and the person is authorized under an Act of Parliament to engage in that activity. Presently, there is scientific confidence that a limited harvest of sea otters by Aboriginal groups for food, social and ceremonial purposes will not jeopardize the survival or recovery of sea otters. Accordingly, pursuant to subsection 83(4) of SARA, and in accordance with this recovery strategy, Fisheries and Oceans Canada may, following a request, permit the taking of a limited number of sea otters by aboriginal people for food, social and ceremonial purposes (e.g., for use in ceremonial regalia). The activity of engaging in a First Nation's food, social and ceremonial fishery of the sea otter must be authorized under a communal licence issued by the Minister of Fisheries and Oceans pursuant to the *Aboriginal Communal Fishing Licences Regulations* made under the *Fisheries Act*. The Minister may specify in the communal licence any terms and conditions governing the activity that the Minister considers necessary for protecting the species. Such conditions would be expected to include harvest limits in specified areas and geographic distribution so as to minimize impact to the population and provide for further recovery (i.e. range expansion).

Scientific research and activities beneficial to sea otter recovery or that are incidental to the carrying out of the activity may also be conducted through a permit issued under Section 73 of SARA.

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4. RECOVERY TEAM MEMBERS

Recovery team (2002-3)

Michael Badry	Furbearer Specialist, BC Ministry of Water, Land and Air Protection
John Broadhead	Sierra Club of British Columbia, Marine Committee
Laurie Convey	Resource Management Biologist, Fisheries and Oceans Canada
Christiane Cote	Communications Officer, Fisheries and Oceans Canada
Carole Eros	Species at Risk Recovery Planner, Fisheries and Oceans Canada
John Ford	Marine Mammal Scientist, Fisheries and Oceans Canada
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Ron J. Jameson	USGS Research Wildlife Biologist (retired); Washington Department of Fish and Wildlife
Steven Jeffries	Washington Department of Fish and Wildlife
Marilyn Joyce	Marine Mammal Coordinator, Fisheries and Oceans Canada
Don Lawseth (Chairperson)	Species at Risk Coordinator, Fisheries and Oceans Canada
Lynn Lee (alternate)	Marine Program Director, Pacific Region, World Wildlife Fund Canada
Deanna Lynch	Fish and Wildlife Biologist, U.S. Fish and Wildlife Service

Linda Nichol	Marine Mammal Biologist, Fisheries and Oceans Canada
Michele Patterson	Marine Program Director, Pacific Region, World Wildlife Fund Canada
Cliff Robinson (alternate)	Marine Ecologist, Ecosystem Services, Parks Canada Agency
Pippa Shepherd	Species at Risk Coordinator, Ecosystem Services, Parks Canada Agency
Scott Wallace (alternate)	Sierra Club of BC, Marine Committee
Jane Watson	Marine Ecologist, Malaspina University College

Recovery team (2003-present)

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Sea Otter Oil Spill Response Recovery Implementation Group (2004-present)

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5. GLOSSARY OF TERMS

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

Allele – one member of a pair of genes that occupy a locus (a specific location on a chromosome). One member of each pair of alleles is inherited from the mother, the other from the father.

Benthic – A term that refers to the ocean bottom or seabed. Benthic animals are those that 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 – The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.

Deleterious recessive alleles – An allele is one of a pair of genes for a trait and may be alternate forms of a gene (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 that 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 wildlife species that no longer exists.

Extirpated – A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.

Endangered – A wildlife 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 decreased generally have low genetic diversity. Genetic variability is what ultimately allows individuals to cope with changing environments. Also see deleterious recessive alleles and heterozygosity.

Haplotype: A unique mtDNA sequence. An individual has the same haplotype as its mother, except in rare cases when mutation occurs.

Heterozygosity – When the paired alleles for a trait (gene) are different as opposed to homozygous (the same). In small or inbred populations homozygosity (one type of reduced genetic diversity) is common.

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.

MtDNA – DNA from structures (organelles) in the cell called mitochondria. Unlike nuclear DNA (from the nucleus of cells), individuals inherit mtDNA from their mothers only. For this reason, mtDNA can be used to trace maternal lineages with great accuracy.

Polygynous – Males mate with more than one female.

Precautionary approach – Recognizing that measures to address the reduction or loss of the species should not be postponed for lack of full scientific certainty.

Raft – An aggregation of resting sea otters.

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

Residence – 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 – A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

Stochastic – Patterns or processes resulting from random factors.

Threatened – A wildlife species likely to become endangered if limiting factors are not reversed.

APPENDIX I RECORD OF COOPERATION AND CONSULTATION

Sea otters are an aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada: #200 - 401 Burrard Street, Vancouver, BC V6C 3S4.

Two workshops 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 draft recovery strategy was made available to the public on the internet in advance of the workshops. Proceedings were prepared by Julia Gardner, Dovetail Consulting Inc. and are available at http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/sea-otters/default_e.htm.

The following organizations provided input on the draft recovery strategy 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 Harvesters' 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 recovery 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.

The draft recovery strategy was updated in 2007 (this document) and formatted to meet the requirements of SARA.

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APPENDIX II ANTHROPOGENIC THREAT CLASSIFICATION TABLE DEFINITIONS

The following definitions are taken from the draft Guidelines on Identifying and Mitigating Threats to Species at Risk, February 1, 2007, prepared by Environment Canada.

Threat Definitions

Threat category – Broad category indicating the type of threat. The threat categories are:

- Habitat Loss or Degradation
- Exotic or Invasive Species
- Changes in Ecological Dynamics or Natural Processes
- Pollution
- Accidental Mortality
- Consumptive Use
- Disturbance or Persecution
- Climate and Natural Disasters
- Natural Processes or Activities

General threat – Typically the general activity causing the specific threat. To be determined by status report author or recovery team/planner.

Specific threat – The specific factor or stimulus causing stress to the population. To be determined by status report author or recovery team/planner. Note that not every threat can be specified to all three levels in this classification hierarchy. Thus, in these situations, specify either a general or specific threat.

Stress – Indicated by an impairment of a demographic, physiological, or behavioural attribute of a population in response to an identified or unidentified threat that results in a reduction of its viability. To be determined by status report author or recovery team/planner.

Extent – Indicate whether the threat is widespread, localized, or unknown across the species range.

Occurrence – Indicate whether the threat is historic (contributed to decline but no longer affecting the species), current (affecting the species now), imminent (is expected to affect the species very soon), anticipated (may affect the species in the future), or unknown. If applicable, also indicate whether the occurrence differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Frequency – Indicate whether the threat is a one-time occurrence, seasonal (either because the species is migratory or the threat only occurs at certain times of the year – indicate which season), continuous (on-going), recurrent (reoccurs from time to time but not on an annual or seasonal basis), or unknown. If applicable, also indicate whether the frequency differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Causal certainty – Indicate whether the best available knowledge about the threat and its impact on population viability is high (evidence causally links the threat to stresses on population viability), medium (correlation between the threat and population viability, expert opinion, etc), or low (assumed or plausible threat only). This should be a general reflection of the degree of evidence that is known for the threat, which in turn provides information on the risk that the threat has been misdiagnosed. If applicable, also indicate whether the level of knowledge differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Severity – Indicate whether the severity of the threat is high (very large population-level effect), moderate, low, or unknown. If applicable, also indicate whether the severity differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Level of concern – Indicate whether managing the threat is an overall high, medium, or low concern for recovery of the species, taking into account all of the above factors.

Local – indicates threat information relates to a specific site or narrow portion of the range of the species.

Range-wide – indicates threat information relates to the whole distribution or large portion of the range of the species.