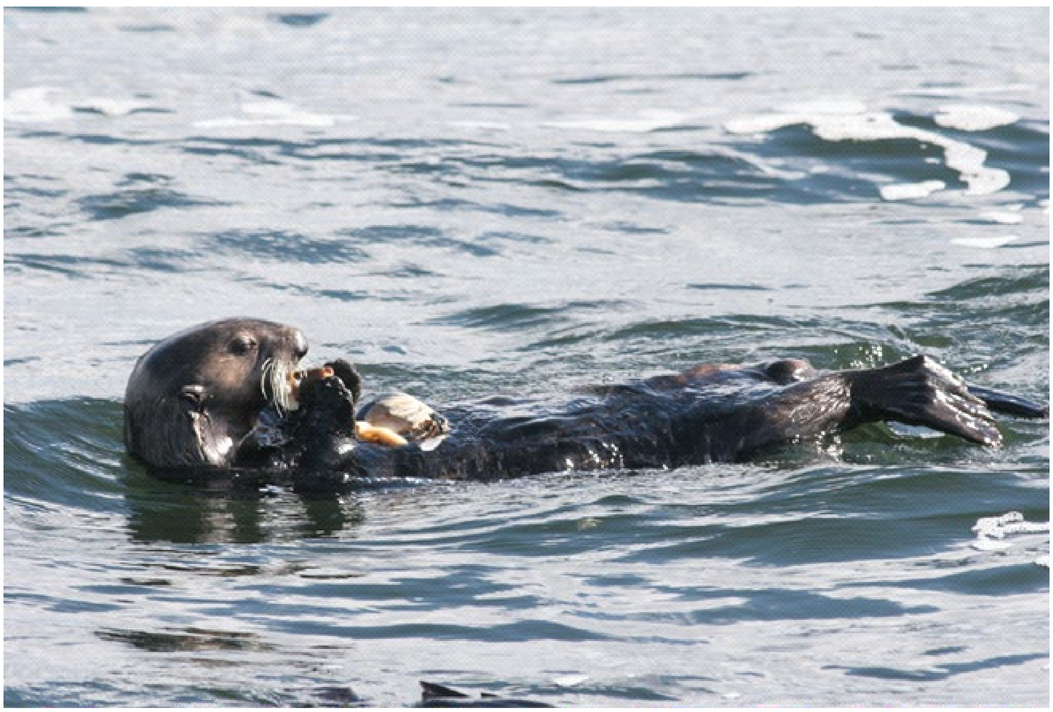
COSEWIC
Assessment and Status Report

on the

Sea Otter
Enhydra lutris

in Canada



SPECIAL CONCERN
2022

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

COSEWIC 2007. COSEWIC assessment and update status report on the sea otter *Enhydra lutris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 36 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

COSEPAC 2000. COSEWIC assessment and update status report on the sea otter *Enhydra lutris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-18 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Watson, J.C., G.M. Ellis, T.G. Smith and J.K.B. Ford. 1996. COSEWIC update status report on the sea otter *Enhydra lutris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-18 pp.

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COSEWIC
Assessment Summary

Assessment Summary – May 2022

Common name
Sea Otter

Scientific name
Enhydra lutris

Status
Special Concern

Reason for designation
This marine mammal was extirpated from British Columbia in the Pacific maritime fur trade by the early 1900s. It was reintroduced to British Columbia during 1969 to 1972. The population has since grown to about 4000 mature individuals, which is 15% of the estimated historical number. The species occupies 33-50% of its historical range in British Columbia but is not yet clearly secure in Canada. It is particularly susceptible to the effects of its main threat, oil contamination, because it depends on its fur for insulation and segregates by sex in large groups. There are several potential sources of oil but the greatest risk is from shipping, which is expected to continue to increase into the foreseeable future. A major oil spill could affect very large portions of the current range, making the species especially vulnerable. Other threats include contaminants, entanglement in fishing gear, persecution, climate change, and strikes from vessels. Pathogens and human disturbance may also pose a risk. Thus, the species may become Threatened if these threats are not effectively mitigated or managed.

Occurrence
British Columbia, 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. Status re-examined and confirmed in May 2022.

COSEWIC
Executive Summary

Sea Otter
Enhydra lutris

Wildlife Species Description and Significance

The Sea Otter, *Enhydra lutris*, is the smallest marine mammal and only member of the weasel family to carry out all of its life processes in the ocean. Sea Otters are unique among marine mammals in that they rely on air trapped in dense fur and a high metabolic rate to stay warm. Their hind limbs are flipper-shaped for swimming and their forelimbs are used for grasping prey. By eating herbivorous invertebrates such as sea urchins, Sea Otters reduce grazing pressure and promote the growth of kelp. Because of this effect on community structure, Sea Otters are considered a keystone species. Sea Otters are culturally important to Indigenous peoples and, although a conservation success story, they are also controversial because by limiting the abundance and size of their prey, they compete with people for resources.

Distribution

Sea Otters occurred in coastal areas from northern Japan, through the Aleutian Islands, along western North America to central Baja California, Mexico. They were extirpated from most of their range, including British Columbia (BC), in the Pacific maritime fur trade from the late 1700s until 1911. Sea Otters were reintroduced to BC from 1969-1972, when 89 Sea Otters, captured from two areas in Alaska (AK), were relocated to the west coast of Vancouver Island. Historically, Sea Otters likely occupied outer coastal areas of BC and the present population occupies 33-50% of this range.

Habitat

Sea Otter habitat is defined by their ability to dive to the sea floor for food with most foraging occurring in water depths less than 40 m. In BC, Sea Otters are most abundant in exposed rocky areas but also depend heavily on areas with soft sediment.

Biology

Females reach sexual maturity from 3 to 5 years of age whereas males reproduce at 5 to 6 years when they become socially mature, although they may be sexually mature earlier. Females live about 20 years, and males live about 15 years. Single pups are born at approximately 1-year intervals and remain dependent on their mothers for 6 to 8 months. In BC, Sea Otters prey on invertebrates, including bivalves, snails, urchins, worms, and crabs, foraging in small home ranges which they occupy for their entire life.

Population Sizes and Trends

In BC, Sea Otter population growth trends are calculated from direct counts. Counts are supplemented by estimates when small areas (<10% of total area) cannot be counted. The 2007 status assessment was based on an estimated population size of 3,185 Sea Otters in 2004. Based on recent counts there were at least 4,712 animals in 2008, 6,754 in 2013 and 8,110 Sea Otters in 2017. Fifty percent of these animals are assumed to be mature. From 1977 to 1995, the population grew at an average of +20.1% per year, but slowed to +8.7% per year during 1995-2017. The historical abundance of Sea Otters in BC, based on a modelled estimate of carrying capacity, may have been as many as 52,000 individuals. Thus, in 2017 Sea Otters in Canada may have been at about 14-17% of their historical abundance. Density-dependent factors (those determined by Sea Otter density) such as prey availability usually regulate population growth. In long-occupied areas, where prey is limiting, otter numbers remain stable or grow slowly whereas in newly occupied areas where prey is not limiting, growth may be exponential.

Threats and Limiting Factors

The greatest single threat to Sea Otters is contamination from oil. Oil destroys the water-repellency of the fur, causing hypothermia and often death. Sea Otters ingest oil when they groom and eat contaminated prey, which can cause organ failure and mortality. Ongoing and proposed port expansions in Vancouver and Prince Rupert, BC, and in Washington State (WA) over the next 15 years are expected to significantly increase vessel traffic (e.g., tankers, bulk carriers, and container ships). Tanker traffic alone is expected to double compared to 2012 volumes. As shipping increases so too does the threat of an oil spill. A major oil spill has the potential to affect the entire current range of Sea Otters in BC. Additional threats include persistent organic contaminants, entanglement in fishing gear, illegal killing, strikes from vessels, climate change and possibly behavioural disturbance from human activities.

Factors that can limit the growth of Sea Otter populations include pathogens and biotoxins from algal blooms. In California (CA), infection caused by *Toxoplasma gondii* and *Sarcocystis neurona,* (parasites of felids and opposums, respectively) is a major mortality source, especially in areas where Sea Otters are resource limited. Although these pathogens have been detected among Sea Otters in BC, their role in limiting populations is unknown.

Protection, Status and Ranks

COSEWIC designated Sea Otters as Endangered in 1978 and in 1986, then Threatened in 1996 and again in 2000. The most recent COSEWIC reassessment in May 2022 resulted in a status of Special Concern. The 2000 COSEWIC status led to a legal listing as Threatened in 2003 under the newly proclaimed *Species at Risk Act* (SARA). Sea Otters were reassessed as Special Concern by COSEWIC in 2007 and reclassified as Special Concern on Schedule 1 under SARA in 2009. Federally, the *Fisheries Act* and *Marine Mammal Regulations* protect Sea Otters from disturbance and harassment, whereas provincially Sea Otters are protected under the *British Columbia Wildlife Act*. NatureServe ranks the Sea Otter as globally secure but in BC the Sea Otter is Blue Listed (Special Concern). The International Union for Conservation of Nature (IUCN) lists Sea Otters as Endangered due to sharp declines in Southwest Alaska and Russia.

TECHNICAL SUMMARY

Enhydra lutris

Sea Otter

Loutre de mer

Range of occurrence in Canada: British Columbia, Pacific Ocean

Demographic Information

Generation time (usually average age of parents in the population). A range of generation times was calculated using the formula: Gen. time = (Age at First Birth + (z)(Longevity$_{(min\ or\ max)}$ - Age at First Birth). Where: z is a constant determined by survivorship and relative fecundity of young vs. old individuals; Age at First Birth in Sea Otters = 3y; Longevity range 15-20y; z set at 0.33 Gen Time range = (3 +0.33(15-3)) to (3 + 0.33(20-3)) See section on Life Cycle and Reproduction	7 to 9 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	No decline over the last 14-18 years
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. Change in number of all individuals (8,110 in 2017). Abundance 3-generations prior to 2017 was 668 in 1990 (assuming 9 yrs/generation) and 1,527 in 1996 (assuming 7 yrs/generation, using closest survey year of 1995)	Observed increase over last 3 generations: 12 fold since 1990, 5 fold since 1996 (or +8.7% to +9.7% per year (total population))
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. Projected change in number of all individuals – population growth since 1995 has not exceeded 8.7% and there is no evidence that it will change.	Projected increase over 3 generations is about +9% per year.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. Estimated change in number of all individuals 10 years into the future and past.	Estimated increase in the total number of mature individuals over 3 generations including the past, present, and future is expected to remain at about +9% per year.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	There is no decline a. b. c.

Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO) Coastal waters of west and north coast of Vancouver Island and central coast of BC where Sea Otter occupation has been confirmed from dedicated surveys and ATK. It does not include sightings of single animals outside of this continuously occupied range. There was an error in the EOO in COSEWIC (2007).	36,980 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value). A 1x1 grid was also applied because of the resolution of range data	2x2 grid; 8,320 km^2 1x1 grid; 7,055 km^2
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate).	A major oil spill has the potential to affect animals over entire range
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Possibly. Increased marine traffic in portions of range could affect habitat.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN for more information on this term.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**There are no subpopulations in Canada**
Total The proportion of mature individuals in the Canadian Sea Otter population is assumed to be 50% of the total number of Sea Otters counted in 2017 (n=8,110) (see text).	4,055

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations whichever is longer up to a maximum of 100 years, or 10% within 100 years]?	No quantitative assessments exist

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes

Overall threat impact assigned: Very High – Medium, primarily due to potential effects of a large-scale catastrophic oil spill, which has a very low probability of occurrence.

i. Contamination from oil spills (petroleum) (IUCN 9.0: High-Medium)
ii. Entanglement in fishing gear (Dungeness Crab fishery) (IUCN 5.4: Medium-Low) and illegal killing (IUCN 5.4: Medium-Low)
iii. Effects of global warming on prey (IUCN 11.1: Medium-Low)

What additional limiting factors are relevant?

i. Availability of prey and habitat
ii. Predation, pathogens and biotoxins

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Southeast Alaska: not listed federally Washington State: not listed federally; Endangered under the State Special Species Policy
Is immigration known or possible?	Yes, wandering males
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source (i.e., outside) population deteriorating?	No
Is the Canadian population considered to be a sink?[+]	No

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Is rescue from outside populations likely?	No. Rescue is unlikely because Sea Otters exhibit high site fidelity and occupy relatively small overlapping home ranges. Furthermore, catastrophic events are likely to affect adjoining populations

Data Sensitive Species

Is this a data sensitive species?	No, but specific raft location data are not publicly available due to risk of illegal killing.

Status History

COSEWIC: 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. Status re-examined and confirmed in May 2022.

Status and Reasons for Designation

Status: Special Concern (b)	**Alpha-numeric codes:** Not applicable

Reason for Designation:
This marine mammal was extirpated from British Columbia in the Pacific maritime fur trade by the early 1900s. It was reintroduced to British Columbia during 1969 to 1972. The population has since grown to about 4000 mature individuals, which is 15% of the estimated historical number. The species occupies 33-50% of its historical range in British Columbia but is not yet clearly secure in Canada. It is particularly susceptible to the effects of its main threat, oil contamination, because it depends on its fur for insulation and segregates by sex in large groups. There are several potential sources of oil but the greatest risk is from shipping, which is expected to continue to increase into the foreseeable future. A major oil spill could affect very large portions of the current range, making the species especially vulnerable. Other threats include contaminants, entanglement in fishing gear, persecution, climate change, and strikes from vessels. Pathogens and human disturbance may also pose a risk. Thus, the species may become Threatened if these threats are not effectively mitigated or managed.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals):
Not applicable. The Canadian population has been increasing since the 1980s following re-introduction in 1969-1972.

Criterion B (Small Distribution Range and Decline or Fluctuation):
Not applicable. EOO of 36,980 km^2 and IAO of 7,055 km^2 both exceed threshold levels.

Criterion C (Small and Declining Number of Mature Individuals):
Not applicable. Canadian population estimate of 4,055 mature individuals is below threshold for Threatened, but there is no decline in numbers.

Criterion D (Very Small or Restricted Population):
Not applicable. Population abundance is above thresholds. Near to qualifying for Threatened D2 based on exposure to threats.

Criterion E (Quantitative Analysis):
Not applicable. Analysis not conducted.

PREFACE

Since the 2007 COSEWIC Sea Otter status assessment report there have been significant advances in knowledge of Sea Otters.

In Canada, Sea Otters have continued to grow and expand their geographic range. Sea Otters in Canada are now at carrying capacity (*K*) in some areas, which will affect growth rates, demographic structure, and mortality rates in the future. Having Sea Otters in densities near carrying capacity may be important because their ecologically effective population size (i.e., sufficient to alter community structure) can occur near *K* (Soulé *et al.* 2005).

Recent studies in California (CA) found that depletion of energy reserves in females with pups resulted in numerous maternal deaths, a condition known as end-lactation syndrome (ELS). ELS is generally associated with females in resource-limited areas, where Sea Otter density is high or near carrying capacity (Chinn *et al*. 2016). The high cost of reproduction may make females more vulnerable to other limiting factors or threats and may slow the population growth rate. Furthermore, Sea Otters in areas that are resource limited are more vulnerable to changes in prey abundance caused by environmental factors or disease (Davis *et al.* 2019).

The extirpation of Sea Otters from much of their range, and their subsequent reintroduction to portions of their historical range, resulted in a significant loss of genetic diversity. Recent studies found twice the genetic diversity in pre-fur trade populations of Sea Otters, compared to present-day populations in AK, WA, and CA (Larson *et al.* 2012).

Threats that limit Sea Otters are better understood. Oil spills, both acute and chronic, are the greatest threat to Sea Otters, but are associated with a high uncertainty of occurrence. Shipping traffic along the BC coast is expected to double over the next 10-15 years (Nuka Research 2013, 2020), substantially increasing the probability of a major oil spill. The probability of a rescue effect in the event of a major oil spill is very unlikely. Climate change also poses potential chronic and acute threats both though acidification (carbonate chemistry changes) on species that are known Sea Otter prey (e.g., Gaylord *et al.* 2015; Sunday *et al.* 2016) and by causing direct mortality through temperature extremes on intertidal species used as prey by Sea Otters (Seuront *et al*. 2019).

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2022)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

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2022

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Sea Otter, *Enhydra lutris*, is the smallest marine mammal (by mass) and only member of the family Mustelidae to carry out all of its life history processes in the ocean. It is the sole member of the genus *Enhydra*. Three subspecies are recognized based on skull measurements and mitochondrial DNA (Wilson *et al.* 1991; Cronin *et al.* 1996).

Class: Mammalia

Order: Carnivora

Family: Mustelidae

Scientific name: *Enhydra lutris*

Subspecies: *Enhydra lutris lutris* (Kuril Islands/Kamchatka/Commander Islands)

Enhydra lutris kenyoni (Aleutian Islands to Central AK/ reintroduced in Southeast Alaska (SEAK), BC, WA)

Enhydra lutris nereis (CA)

Common names:

Aleut: Chngatux

Chinook trade jargon: e-lak'-ha

English: Sea Otter

French: Loutre de Mer

Gitga'at ptoon

Gitx'aala p'ton

Haida: K̲uu (Skidegate)

K̲u (Northern Haida)

Heiltsuk: q\asá

Kwak̓wala: Kasa

Nuu-chah-nulth: Kʷakʷatl

Nuxalk nukwi

Nisga'a plo'on

Spanish: Nutria del Kamchatka, Nutria Marina

Morphological Description

Sea Otters are sexually dimorphic. Adult males can reach a mass of 46 kg and total length of 148 cm, whereas adult females can grow to 36 kg and length of 140 cm (Kenyon 1969). At birth, pups weigh 1.7-2.3 kg and are up to 60 cm in total length (Bodkin 2003). Sea Otters in recently occupied habitat, where food is not limiting, are heavier (up to 28% for males and 16% for females) than animals in populations at or near carrying capacity, where food is limiting (Bodkin 2003; NTC 2019).

Sea Otters have flattened, flipper-like hindfeet with elongated digits. They swim efficiently while foraging underwater or lying on their back on the surface but are awkward on land (Estes 1980). Their powerful forelimbs are well-adapted for grooming and obtaining invertebrate prey but are not used for swimming (Kenyon 1969). Sea Otters use their sensitive paws and vibrissae (whiskers) to locate prey (McKay Strobel *et al.* 2018) and often use a loose pouch of skin at the axilla (armpit) of each forelimb to carry prey to the surface where it is eaten (Estes 1980). Sea Otters have rounded (bunodont) molars adapted for crushing hard-shelled prey rather than the shearing (carnassial) teeth typical of most carnivores (Riedman and Estes 1990).

Sea Otters have little body fat for insulation. Instead, they maintain an exceptionally high metabolic rate and rely on a layer of air trapped in their dense fur to maintain body temperature. The fur consists of an outer layer of guard hairs and a fine dense under fur of approximately 100,000 hairs per cm^2 (Kenyon 1969).

In coastal areas, River Otters (*Lontra canadensis*) are often misidentified as Sea Otters by inexperienced observers. River Otters are semi-aquatic, occur in both fresh and saltwater and weigh less than Sea Otters at 5-14 kg. River Otters have webbed, rather than flipper-shaped hind feet and are agile on land, where they den and give birth to up to 6 (usually 2-3) offspring (Ceballos-G 1999).

Population Spatial Structure and Variability

Sea Otter populations in CA and parts of AK differ from each other genetically whereas translocated Sea Otter populations share genetic structure with their source populations (Bodkin 1999; Larson *et al.* 2012). The unique genetic structure of CA Sea Otters may be a result of extreme post-fur trade isolation (S. Larson, pers. comm. 2020). Fine-scale genetic sampling has not been conducted for extant populations, but may reveal that Sea Otters exhibit clinal and subtle population structure throughout their range (D. Monson, pers. comm. 2020). The genetic structure of ancient otter populations was investigated using bones from Indigenous shell-middens pre-dating the fur trade and then compared to extant Sea Otter populations (Larson *et al.* 2012).

Estimates of F_{ST} (fixation index, a measure of genetic population differentiation) were low to moderate among pre-fur trade populations (range: 0.031-0.274) and among modern (extant) Sea Otters (range: 0.170-0.295). In ancestral populations, these F_{ST} values suggest a continuous distribution of Sea Otters across their range, with genetic mixing (Larson *et al.* 2012), although such values could also reflect Indigenous trading practices. In modern Sea Otter populations, such low F_{ST} values could indicate genetic mixing, but are primarily driven by similarities of translocated populations to their Alaskan source populations (Larson *et al.* 2012).

By 1911, the maritime fur trade had reduced the global population of Sea Otters to fewer than 2,000 animals, or approximately 1-2% of its pre-exploitation size (Kenyon 1969). As a result of this bottleneck, genetic diversity among extant Sea Otter populations in CA, WA, and AK, is significantly lower than pre-fur trade Sea Otters (based on archaeological samples), with a loss in modern Sea Otters of at least 62% of the alleles and 43% of heterozygosity, compared to the pre-fur trade population (Larson *et al.* 2002a; Larson *et al.* 2012).

Sea Otters in BC have undergone at least two genetic bottlenecks: a range-wide bottleneck brought about by the near extinction of Sea Otters in the fur trade, and a regional-scale bottleneck caused by re-introducing a small number of animals (n=89). Because Sea Otters in BC were founded by translocated animals from two source populations in AK, they have higher haplotype diversity (mtDNA) than either of the two AK source populations (Bodkin *et al.* 1999).

Sea Otters were likely extirpated from BC by 1929 (Cowan and Guiguet 1960). The Sea Otters reintroduced to BC (from 1969 to 1972) were captured at Amchitka Island (n=29) and Prince William Sound (n=60), AK (Bigg and MacAskie 1978). Similar reintroductions to SEAK, WA and Oregon (OR) occurred during the same period. All the reintroductions were successful except in OR (Jameson *et al.* 1982). Genetic studies suggest there is no significant loss in the mtDNA haplotype diversity between remnant populations (one bottleneck) and reintroduced populations (two bottlenecks) (Bodkin *et al.* 1999; Larson *et al.* 2002b). However, loss of genetic diversity in reintroduced populations may have been largely avoided (at least in populations that arose from 20 to 30 animals or more) because the bottleneck lasted for a relatively short time and there was rapid population growth (Bodkin *et al.* 1999; Larson *et al.* 2002b; Gagne *et al.* 2018).

In 1989, females with pups were first reported on the BC central coast more than 235 km distant from the reintroduced population on Vancouver Island (British Columbia Parks 1995). The origin of these otters was unknown at the time (Watson *et al.* 1997), but genetic analysis of 18 Sea Otter samples from the BC central coast revealed two mtDNA haplotypes consistent with otters from Amchitka and Prince William Sound, suggesting Sea Otters on the BC central coast are likely descendants of reintroduced Alaskan otters, and not remnants of the original BC population that was extirpated (L. Barrett-Lennard pers. comm. 2004).

In terms of population structure, Sea Otters have small, year-round home ranges, which creates demographic structure at spatial scales of less than several hundred km^2 (Bodkin 2015; Nichol *et al.* 2015, 2020).

Designatable Units

There is no evidence of genetic or morphological distinctiveness, evolutionarily significant disjunctions, or eco-geographic variations among Canadian Sea Otters and only one population or designatable unit of Sea Otters is recognized in Canada.

Special Significance

Sea Otters have been culturally important to Indigenous peoples for thousands of years (e.g., Uu-a-thl-uk 2011; Salomon *et al.* 2015). Traditionally, Sea Otters were highly valued for their thick and warm fur and their meat (e.g., Arima 1983; Arima and Hoover 2011). Sea Otter pelts were used by high-ranking members of coastal First Nations as ceremonial robes and regalia, as dowries, as bedding, and as insulation in canoes (e.g., Uu-a-thluk 2011; Salomon *et al.* 2015; Sea Otter Recovery n.d.). Pelts were traded widely among coastal First Nations long before the arrival of Europeans and the maritime fur trade (McMillan 1999; Uu-a-thluk 2011).

Once on the verge of extinction following the maritime fur trade, Sea Otters have made a remarkable recovery, largely because of protective legislation, an abundance of suitable unoccupied habitat, and successful reintroductions (Mason and MacDonald 1990). Although Sea Otter populations have demonstrated a capacity to recover, sharp declines in Southwest AK and Russia illustrate that populations can decline rapidly and unexpectedly (Bodkin and Monson 2003; IUCN 2015).

Sea Otters are considered a keystone species because they exert significant ecological effects on nearshore community structure (Estes and Palmisano 1974; Hughes *et al.* 2013, 2016; Singh *et al.* 2013) and are a strong selective force in the life history characteristics of their prey (Watson 2000; Estes *et al.* 2005; Lee *et al.* 2016). By preying on herbivorous invertebrates such as sea urchins, Sea Otters reduce grazing pressure. This allows kelp to grow and causes community structure to change from that dominated by grazers and sparse kelp to one with kelp (Breen *et al.* 1982; Watson 1993; Estes and Duggins 1995; Watson and Estes 2011). In areas with Sea Otters, grazing invertebrates are generally smaller and occur in crevice habitat where they avoid otter predation and act as detritivores, feeding on drift kelp (Watson 2000; Lee *et al.* 2016; NTC 2019).

In the Aleutian Islands, communities with Sea Otters were found to be two to three times more productive than systems without Sea Otters because of the kelp-derived carbon (Duggins *et al.* 1989). These kelp communities support a greater abundance and diversity of fish species (Reisewitz *et al*. 2006), enhance fish recruitment (Markel and Shurin 2015), and provide important ecosystem services such as sequestering carbon dioxide and increasing nearshore production (Gregr 2016; Gregr *et al.* 2020). The “kelp highway hypothesis” further suggests that the productive kelp forests of the Pacific Rim, facilitated by Sea Otter foraging, may have enabled the coastal migration of sea-going people into the Americas (Erlandson *et al*. 2007). Finally, Hughes *et al.* (2013) found that Sea Otter foraging in Elkhorn Slough, along the central Californian coast, resulted in a trophic cascade, which helped mitigate the negative effects of agricultural runoff on seagrass communities.

Sea Otters can limit the abundance, distribution and size of their prey (Morris *et al.* 1979; 1981; Breen *et al.* 1982; Watson 1993; Watson and Smith 1996; Watson 2000; Watson and Estes 2011; Larson *et al.* 2013; Reidy and Cox 2013; Lee *et al.* 2016; Rechsteiner *et al.* 2019; Pinkerton *et al.* 2019) and have been a strong selective force in the evolution of the life history characteristics of their invertebrate prey (Watson 2000; Estes *et al.* 2005; Lee *et al.* 2016). In the presence of Sea Otters, invertebrate prey species are unlikely to reach commercially harvestable densities or sizes. In BC, commercial fisheries for many subtidal and intertidal invertebrates were likely made possible by the extirpation of Sea Otters (Watson and Smith 1996; Watson 2000; Reidy and Cox 2013; Lee *et al.* 2016; 2019). Sea Otters affect the abundance and size of clam species (Kvitek *et al.* 1992) and can affect the availability of clams to all harvesters (Pinkerton *et al.* 2019). As the range of Sea Otters expands, concerns about the declining availability of invertebrate resources to commercial, Indigenous, and recreational harvesters have been expressed, making continued growth and range expansion of Sea Otters highly contentious (Carswell *et al.* 2015; Pinkerton *et al.* 2019; Burt 2019). In many areas, real or perceived competition for resources with Sea Otters has led invertebrate harvesters to demand that Sea Otter range expansion and population growth be restricted or limited (Carswell *et al.* 2015; Reidy 2019). Such sentiments may also result in Sea Otters being illegally killed (see **Threats – Directed Killing** section).

The Sea Otter’s brush with extinction, its role in structuring nearshore communities, historical importance, and vulnerability to oil spills have made the species a conservation icon. Sea Otters are of increasing interest to the wildlife-viewing tourism industry in Canada and elsewhere as people have become more aware of their presence (Loomis 2006; Poirier 2006; Martone *et al.* 2020; Gregr *et al.* 2020). Sea Otters do well in captivity and are popular in zoos and aquaria. They are one of the few mammals other than primates to use tools, which they employ to break open hard-shelled invertebrate prey (Hall and Schaller 1964). Tool use in Sea Otters may be an innate behaviour (Tinker *et al.* 2008a; Staedler 2011) that is most common in Sea Otter populations feeding on thick-shelled clams and snails (Fujii *et al.* 2015; 2017).

DISTRIBUTION

Global Range

Sea Otters occur in shallow coastal areas in the North Pacific and prior to the maritime fur trade, they ranged from northern Japan to central Baja California, Mexico (Kenyon 1969; Figure 1). Commercial exploitation and trade, starting in the 1740s, led to near extinction of the species throughout its range (Kenyon 1969). Over the last 200 years, remnant populations of Sea Otters have naturally re-established in some areas and now extend intermittently from the Gulf of Alaska westward through the Aleutian Archipelago to the Kamchatka Peninsula and the Kuril Archipelago and along the CA coast. Reintroduced Sea Otter populations extend through SEAK, BC and WA (Jameson *et al.* 1982; Estes 1990). By 2015 reintroduced populations accounted for approximately 30% of the nearly 150,000 extant Sea Otters and occupied more than 50% of the Sea Otter's historical range (Bodkin, 2015). About 5-10% of the global range of Sea Otters occurs in Canada (calculated using values in IUCN 2015).

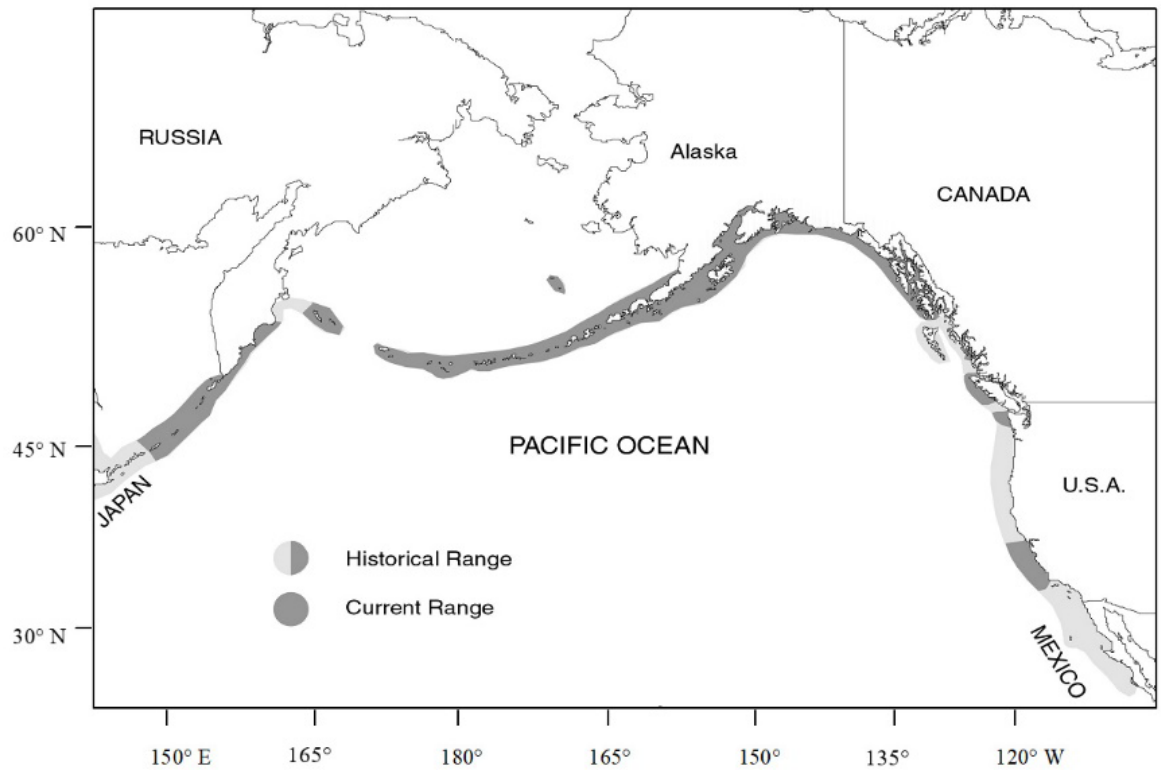

Figure 1. The global range of all three subspecies of Sea Otters: historical (grey and black combined) and current (black).

Canadian Range

In an effort to reintroduce Sea Otters in British Columbia, a total of 89 Sea Otters were translocated and released in Checleset Bay, on the west coast of Vancouver Island: 29 from Amchitka Island in 1969, 14 from Prince William Sound in 1970, and 46 from Prince William Sound in 1972. Until 1987, Sea Otters were known in two areas along the west coast of Vancouver Island: Checleset Bay and Bajo Reef off Nootka Island, 75 km southeast of Checleset Bay (Figure 2). By 1992, the range of the population extended continuously along Vancouver Island from Estevan Point 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). Since the last assessment (COSEWIC 2007), the Sea Otter population has extended its range along the west and northeast coast of Vancouver Island (Nichol *et al.* 2009, 2015, 2020; Figure 2).

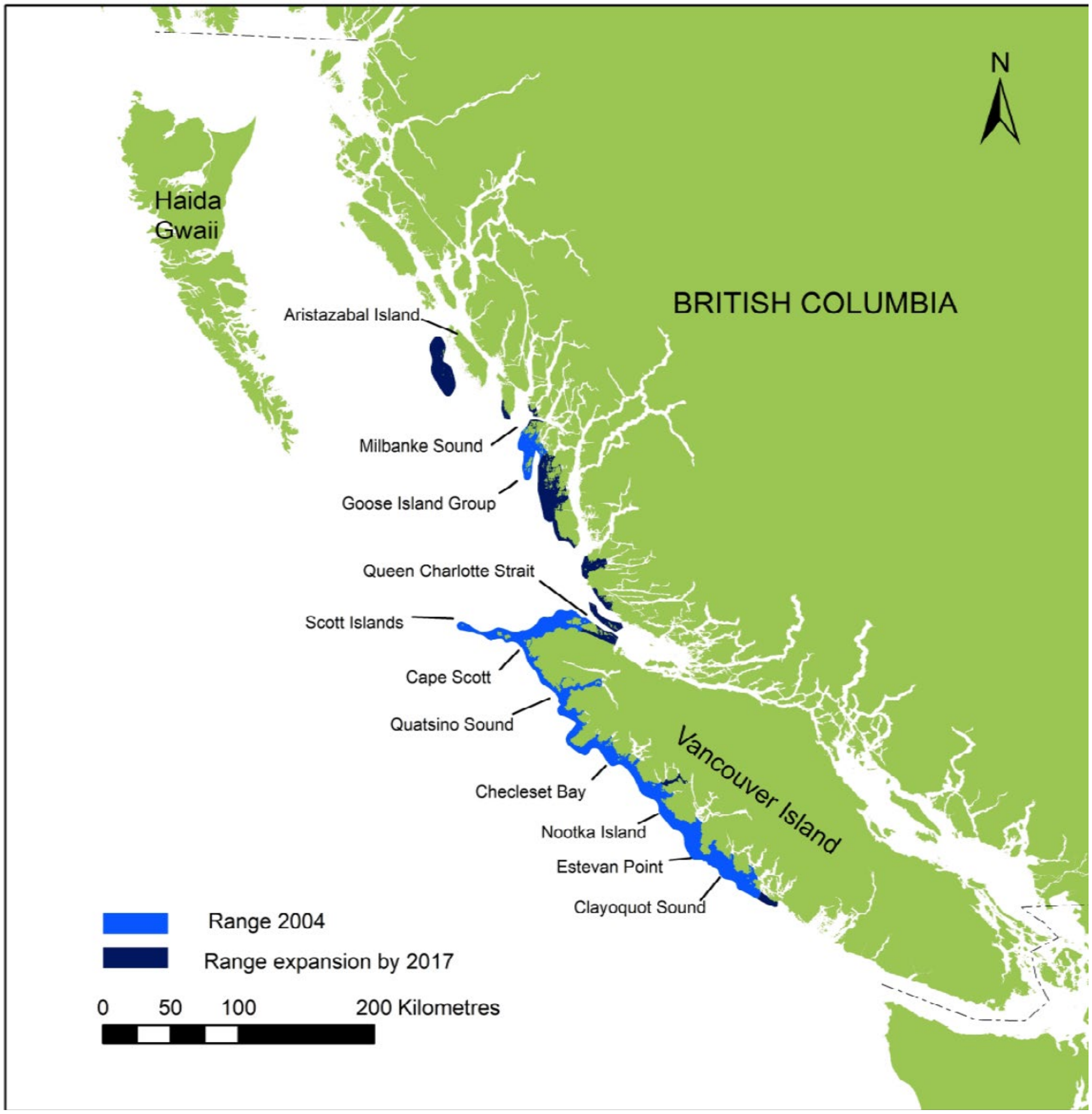

Figure 2. British Columbia range distribution of Sea Otters in 2004 and 2017, including place names mentioned in text.

In 1989, females with pups were reported near the Goose Islands on the BC central coast (Figure 2), indicating that Sea Otters were well established in the area (British Columbia Parks 1995). By 2004, Sea Otters on the central coast ranged continuously from the southern end of the Goose Group, northward through Queens Sound to Cape Mark at the edge of Milbanke Sound (Figure 2; Nichol *et al.* 2005). Since the 2007 status report (COSEWIC 2007), Sea Otters have also spread north and south along the BC mainland coast (Nichol *et al.* 2009, 2015, 2020; Figure 2).

The extent of the BC Sea Otter range is not continuously occupied. Rafts (or groups) of male Sea Otters, which move into unoccupied habitat as resources become limiting, often pass over suitable habitat leaving it temporarily unoccupied (Lubina and Levin 1988; Krkosek *et al.* 2007; Lafferty and Tinker 2014). Females, likely younger animals without home ranges (D. Monson pers. comm. 2020), gradually occupy the areas vacated or passed over by males (Loughlin 1980; Garshelis *et al.* 1984; Wendell *et al.* 1986; Jameson 1989). In BC, single otters are periodically reported outside of the established range, but these extra-limital sightings are not included in calculations of range extent, which is based on the distribution of Sea Otter rafts during directed surveys (see Ford 2014 for map of extra-limital sightings). For example, in 2019, surveys of southern Haida Gwaii located a few scattered Sea Otters, including a mother and pup. These otters were in addition to a mother and pup reported in the same area in 2017. Although not included in the estimate of Sea Otters in BC, these observations confirm that Sea Otters are expanding their range westward (Parks Canada, Council of the Haida Nation and DFO unpubl. data; L. Lee pers. comm. 2019) and will inform future surveys.

Based on the types of habitat currently occupied by Sea Otters in BC, WA and AK, most of the BC coast was likely occupied by Sea Otters historically, although Sea Otters may have been rare in the numerous, deep, coastal fjords common along the coast (see Gregr *et al*. 2008). The current Sea Otter population occupies 33-50% of its historic range in Canada.

Extent of Occurrence and Area of Occupancy

Occupancy calculations for Sea Otters are based on the distribution of otters from directed surveys and Aboriginal Traditional Knowledge (ATK). Calculations do not include sightings of single animals outside this range. Our understanding of the species' distribution and the small home range of individuals, their limited movement, and depths to which Sea Otters forage may make a 1X1 km grid more appropriate for assessing index of area of occupancy (IAO).

Using 2017 survey data, the extent of occurrence (EOO) based on a minimum convex polygon encompassing the current range is 36,980 km^2. The IAO based on a 2X2 km grid is 8320 km^2. Using a 1X1 km grid to remove land areas within the 2x2 km grid, the IAO is 7,055 km^2. The previous range occupancy estimate provided in COSEWIC (2007) was based on the range extent up to 2004, but there was an error in the calculation of area of occupancy (km^2). The defined region, presented in a map figure in the 2007 report, was correct but the calculation of its area was not.

Search Effort

The first directed census to determine the size and range of Sea Otters in BC was undertaken in 1977 (Bigg and MacAskie 1978). From 1977 to 1987, surveys were conducted from fixed-wing aircraft or boats in and around the original Sea Otter reintroduction site (Bigg and MacAskie 1978; Morris *et al.* 1981; MacAskie 1987; Watson *et al.* 1997). Most of the Sea Otter range, which was relatively small and easy to census, was surveyed annually from 1988 to 2001 by boat or helicopter, although there were gaps in survey coverage from 1996 to 2000 (Watson 1993; Watson *et al.* 1997; Nichol *et al.* 2005). From 2001 onwards, Fisheries and Oceans Canada assumed the lead role in conducting Sea Otter surveys in collaboration with First Nations and other biologists, with some areas along the west coast of Vancouver Island being surveyed by biologists from the Nuu-chah-nulth Tribal Council Uu-a-thluk Fisheries Department (Dunlop *et al.* 2003; Nichol *et al.* 2005, 2009, 2015, 2020; NTC 2019). Range-wide surveys are conducted at approximately five-year intervals. Since the 2007 COSEWIC assessment, complete surveys of the total Canadian Sea Otter population range were conducted in 2008, 2013, and 2017 (see Nichol *et al.* 2009, 2015, 2020; DFO unpubl. data; Table 1).

To ensure that range expansion is detected, regions at the edge of the continuous geographic distribution of Sea Otters are searched during directed Sea Otter surveys and in intervening years. It is unlikely that the Sea Otter range in Canada has ever been significantly underestimated. Sea Otters expand their range when large groups of males relocate to unoccupied areas adjacent to the continuous Sea Otter habitat (Lubina and Levin 1988; Krkosek *et al.* 2007; Lafferty and Tinker 2014).

Table 1. Recent population summary estimates and range of growth rate estimates reported by region. The range of annual growth rate values is reported over the entire time population size has been surveyed or estimated for each region.

Region (areas in region)	Regional Population Size	Year of Population Estimate	Status	Growth rates	Sources
California	3,128	2018	Remnant	-5% to 7%	Estes 1990, USFWS 2017; Tinker and Hatfield 2017; Hatfield *et al*. 2018
Washington	1,753, 2,058	2017	Re-introduced	8.2% to 20.6%	Estes 1990; Jeffries *et al.* 2016; 2017; USFWS 2018; 3-year running mean Jeffries *et al.* 2017
British Columbia	8,110	2017	Re-introduced	8% to 20.1%	Watson *et al*. 1997; Nichol *et al*. 2005; 2015; DFO unpublished 2017

Region (areas in region)	Regional Population Size	Year of Population Estimate	Status	Growth rates	Sources
Southeast Alaska (Southeast Alaska) (Yakutat Bay) (N. Gulf of Alaska)	25,712	2014	Re-introduced	~ 8.6% to 17.6%	Estes 1990; USFW 2014a; Tinker *et al.* 2019a
Southcentral Alaska (N. Gulf of Alaska) (Prince William Sound) (Kachemak Bay) (Cook Inlet/Kenai Fjords)	18,297	2014	Remnant	Stable to increasing	USFW 2002a; USFW 2014b
Southwest Alaska (Aleutian Islands) (N. Alaska Peninsula) (S. Alaska Peninsula, offshore and shoreline) (S. Alaska Peninsula, Islands) (Unimak Island) (Kodiak Archipelago) (Kamishak Bay)	54,771	2014	Remnant	-50% to increasing	USFW 2002b; Doroff *et al*. 2003; USFWS 2014c
Russia (Commander Islands) (Kamchatka Pen.) (Kuril Islands)	13,900	2015 2017 2012	Remnant	Decreasing	Burdin cited in Bodkin 2015; Kormev 2007; 2010; Zavadkskaya *et al*. 2017; Ovsyanikova *et al.* 2020

HABITAT

Habitat Requirements

In BC, Sea Otters occupy exposed shallow coastal areas with extensive rocky reefs and areas of associated soft sediment. Habitat quality affects Sea Otter density and differences in factors such as habitat complexity and invertebrate productivity may explain differences in carrying capacity between areas (Laidre *et al.* 2001, 2002; Gregr *et al*. 2008; Nichol *et al.* 2015; Tinker *et al.* 2019a). The extent of Sea Otter habitat is defined by their ability to dive to the sea floor for food, thus in much of their range, Sea Otters are restricted to shallow nearshore regions usually within 1-2 km of shore (Riedman and Estes 1990). Most foraging occurs in depths of 40 m or less, although otters are capable of foraging to depths of ~100 m (Estes 1980; Riedman and Estes 1990; Bodkin *et al.* 2004). Habitat use varies with sex, reproductive status, and the length of time an area has been occupied by Sea Otters (Hale *et al.* 2019; Rechsteiner *et al.* 2019). In WA, female Sea Otters usually rest and forage <1,000 m from shore in shallow water 0-10 m deep. In contrast, male Sea Otters rest and forage further from shore, generally in depths of 10-30 m (Laidre *et al.* 2009). Similar patterns have been observed in BC (Rechsteiner *et al.* 2019).

When present, kelp beds are often used as rafting and foraging sites (Loughlin 1980; Jameson 1989) and are thus important habitat. In non-estuarine areas in CA, females with pups avoid areas without kelp (Nicholson *et al.* 2018), which may affect range expansion. Current Sea Otter expansion rates at the range edges in CA appear to be constrained by gaps in kelp cover, which provides shelter from shark attack (Tinker *et al.* 2016). Thus, in CA, the absence of kelp can increase density-independent mortality through increased risk of shark bites and further limit the dispersal of females, which use kelp canopies as nurseries (Tinker *et al.* 2016; Nicholson *et al.* 2018). In addition to kelp beds, soft-bottom and seagrass communities, which support clams and other infaunal prey, are also important habitat and can sustain high densities of otters (Kvitek *et al.* 1992, 1993; Wolt *et al.* 2012; Hughes *et al.* 2013 2016; Hessing-Lewis *et al.* 2018; Rechsteiner *et al.* 2019).

In long-occupied habitat, density-dependent factors generally regulate Sea Otter population growth. Food becomes limiting as Sea Otters approach carrying capacity and density is maintained through mortality and emigration (Estes 1990; Monson *et al.* 2000a; Lafferty and Tinker 2014; Coletti *et al.* 2016). This means that recently occupied habitat, with abundant food resources, may initially support high densities of Sea Otters regulated by density-independent factors such predation or environmental stressors (Lafferty and Tinker 2014; Nicholson *et al.* 2018).

Weather and sea conditions can influence habitat use. In BC, Sea Otters tend to occur in exposed areas during periods of calm weather, but may aggregate inshore during inclement weather (Morris *et al.* 1981; Watson 1993; Rechsteiner *et al.* 2019) and sightings of otters in inlets and sheltered areas that may offer protection from storms tend to be more common in winter than in spring and summer (Dunlop *et al.* 2003; NTC 2019).

Critical Habitat for Sea Otters was not identified in the Canadian Recovery Strategy before the species was reclassified as Special Concern, a status that does not require Critical Habitat to be identified under the *Species at Risk Act* (SARA) (Sea Otter Recovery Team 2007).

Habitat Trends

Trends in habitat quality are not known. However, since Sea Otters in BC occupy 33-50% of their historical range, and much unoccupied former habitat is in remote areas with good ecological integrity, it is unlikely that habitat is currently limiting (see section **Fluctuations and Trends – *Canada***).

BIOLOGY

Sea Otters have been studied throughout their geographic range, particularly in CA and AK. Consequently, much of what is known about Sea Otters in Canada is inferred from studies conducted in other regions.

Life Cycle and Reproduction

Female Sea Otters reach sexual maturity at 3-5 years (Bodkin *et al.* 1993; Jameson and Johnson 1993) with all females reproducing by age five (Monson *et al.* 2000a); however, age at first reproduction may vary depending on resource limitation (von Biela *et al.* 2009). Males reproduce at 5-6 years of age, although they may be sexually mature earlier (Riedman and Estes 1990; Bodkin *et al.* 1993). Adult females have a higher survival rate than adult males (Siniff and Ralls 1991; Bodkin *et al.* 2000) and live 15-20 years, whereas males live 10-15 years (Riedman and Estes 1990).

These life history parameters result in a calculated generation time of 7-9 years using the equation in the IUCN Red List Guidelines (IUCN 2019) with $z = 0.33$ (where z is some measure of relative survivorship and fecundity of young versus old in the population). However, estimates of generation time vary among authors. In the December 2019 updates to the IUCN Species Status, the Sea Otter generation time was set to 7.9 years (down from 15 years) based on Gagne *et al.* (2018) (A. Doroff pers. comm. 2019), whereas Pacifici *et al.* (2013) calculated a generation time of 11 years. These varied values reflect differences in estimates of life history parameters. Such results are not surprising because demographic parameters vary among and across Sea Otter populations depending upon habitat and how close the population is to carrying capacity (Nichol *et al.* 2015; 2020; see section **Fluctuations and Trends**).

Sea Otters exhibit delayed implantation (Riedman and Estes 1990). Thus, although mating and pupping occur year-round, distinct peaks in pupping in the spring occur in some areas, including BC (Watson 1993; Bodkin 2003). These peaks are thought to occur in populations living with limited resources (Monson *et al.* 2000a; Monson and Bowen 2015), especially in areas where seasonally inclement weather can affect pup survival (Monson and Bowen 2015).

Sea Otters are polygynous with males forming short-lived pair bonds consecutively with several females (Kenyon 1969). Sea Otters segregate by sex, with territorial males seasonally co-occurring with mothers and pups, and non-territorial males (which are seasonally joined by territorial males) occurring in male groups (Lafferty and Tinker 2014; Riedman and Estes 1990). In CA, WA, and AK, breeding-age males leave male areas to establish exclusive breeding territories in female areas during the summer and fall, after which most animals rejoin male rafts (Garshelis and Garshelis 1984; Jameson 1989). Females produce a single pup at approximately 1-year intervals (Siniff and Ralls 1991; Bodkin *et al.* 1993). Birth occurs in the water (Kenyon 1969; Jameson and Bodkin 1986; Jameson and Johnson 1993). Annual estimates of birth rates (pups/adult) in BC range from 0.12-0.33 (Watson 1993) and are similar to AK (0.30 pups/adult; Estes 1980; Riedman and Estes 1990) and CA (0.20 pups/adult; Estes 1980; Riedman and Estes 1990).

Pups remain dependent on their mothers for 6-8 months after which they are weaned (Payne and Jameson 1984; Jameson and Johnson 1993). Pre-weaning mortality is about 40% in CA and 15-25% in AK (Siniff and Ralls 1991; Riedman *et al.* 1994) and is higher in populations nearing carrying capacity than in growing populations. Pre-weaning mortality and factors that affect the survival of Sea Otters early in life are the main demographic mechanism of population regulation in Sea Otters (Monson *et al.* 2000a).

Physiology and Adaptability

Sea Otters have little body fat and rely on a layer of air trapped in their dense fur and metabolic heat to stay warm. They groom frequently to maintain the integrity of their fur and its ability to trap the air needed for insulation (reviewed in Riedman and Estes 1990). The metabolic rate of a Sea Otter is 2.4 to 3.2 times higher than that of a similar-sized terrestrial carnivore (Costa 1978; Costa and Kooyman 1982), with the greatest daily energy being spent on foraging dives (Yeates *et al.* 2007). To fuel this high metabolic rate, free-ranging Sea Otters consume the equivalent of more than 20% of their body mass in prey per day (Costa 1978, 1982). A Sea Otter may dive from 50 seconds to more than 3 minutes (reviewed in Riedman and Estes 1990) to obtain prey.

Female Sea Otters have the additional energetic cost of reproduction, which affects their physiology (Thometz *et al.* 2016). Females may increase nutritional uptake during delayed implantation and gestation (Esslinger *et al.* 2014; Chinn *et al.* 2016). Female metabolism increases during lactation, peaks 3-4 months after the pup is born, and remains high until weaning. During the final 3 months of lactating, female otters require 85-110% more energy than when not reproductive. These costs require adaptive physiological strategies (Thometz *et al*. 2016). Females can adjust the energetic costs of reproduction through fetal loss, abandoning a pup, or early weaning (Chinn *et al.* 2016). In CA, severe depletion of energy reserves results in numerous maternal deaths, a condition known as end-lactation syndrome (ELS). Although ELS is generally associated with resource limitation in areas where Sea Otter density is high (Chinn *et al*. 2016), the high cost of reproduction may make females more susceptible to other limiting factors.

Sea Otters in BC are typically wary of humans; rafts of Sea Otters are difficult to approach and are easily disturbed by boat traffic. Females with pups are most sensitive to disturbance. However, where Sea Otters are routinely exposed to boats or occur adjacent to populated areas they seem to habituate to disturbance (e.g., Woolfenden 1995).

Sea Otters demonstrate a range of techniques for obtaining and feeding on the wide variety of species available within their physiological dive depth limit (reviewed in Riedman and Estes 1990). One adaptation to resource limitation may be inter-individual variation in diet, with intraspecific competition for food driving prey specialization among individuals (Estes *et al.* 2003a; Tinker *et al.* 2008a; 2012). Prey species preference, at least in female otters, appears to be learned and transmitted maternally (Estes *et al*. 2003a; Elliot Smith *et al.* 2015). Dietary specialization by individuals is most common at long-established or high-density sites where food is limited, and is less common at sites where otter density is low and prey are abundant (Tinker *et al.* 2008a, 2012; Newsome *et al.* 2009). In an isotopic, range-wide study of dietary specialization, Newsome *et al.* (2015) found that prey specialization may also depend on habitat characteristics, with rocky substrate promoting specialization more than soft substrate.

Sea Otters are adapted to a wide range of water temperatures. The northern range limit of otters appears to be the southern extent of pack ice, as the ice excludes otters from foraging areas. The southern range limits are poorly understood, but appear to be associated with the southern extent of coastal upwelling and the 20-22°C isotherm (Estes 1980; Bodkin 2003). Changes in water temperature may thus affect the future global range of Sea Otters (IUCN 2015).

Dispersal and Migration

Sea Otters are non-migratory and show great site fidelity, occupying relatively small overlapping home ranges that vary in size from a few to tens of kilometres of coastline (Loughlin 1980; Garshelis *et al.* 1984; Jameson 1989; Tarjan and Tinker 2016). Sea Otters undergo some seasonal and occasional long-distance movements (up to ~100 km) (Garshelis and Garshelis 1984; Jameson 1989; Laidre *et al.* 2009; Larson *et al.* 2015). For example, in CA some males move to the range edge during winter and early spring but return to the range centre during the breeding season (Jameson 1989; Ralls *et al.* 1992; Tinker *et al.* 2008b).

Range expansion in Sea Otters is usually episodic (Lubina and Levin 1988; Kroesek *et al.* 2007; Lafferty and Tinker 2014). In CA, range expansion has been shown to depend upon population growth rate, with relatively small differences in adult survival having a large effect on the spread rate of Sea Otters (Tinker *et al.* 2008b; Smith *et al.* 2009). Tinker and Lafferty (2014) further suggest that, in CA, the rate of range expansion may be affected by social dynamics, with the social nature of otters slowing the dispersal of individuals away from groups.

Interspecific Interactions

Sea Otters feed on a wide variety of benthic invertebrates (Kenyon 1969). In recently occupied habitats, large and easily accessible prey, such as sea urchins and large clams, are consumed first (Laidre and Jameson 2006; Rechsteiner *et al.* 2019). By preying on grazers such as sea urchins, Sea Otters are known to reduce grazing and promote the growth of kelp (Estes and Palmisano 1974, Estes and Duggins 1985, Estes and Watson 2011). As the abundance of easily accessible prey is reduced, the diet of the Sea Otter population diversifies to include a larger array of less profitable invertebrate species including various species of bivalves, snails, chitons, crabs, sea stars, and, in some areas, even fish (Estes *et al.* 1981; Tinker *et al.* 2008a; Hale *et al.* 2019; Rechsteiner *et al.* 2019). Demersal fish are important prey in some parts of the Aleutian, Commander, and Kuril islands (Estes and VanBlaricom 1985; Watt *et al.* 2000).

In BC, Butter Clams, *Saxidomus gigantea*, and other bivalve species form an important component of Sea Otter diet (Rechsteiner *et al.* 2019) and can accumulate the biotoxin responsible for Paralytic Shellfish Poisoning (PSP) (Anderson 1994). A die-off of Sea Otters at Kodiak Island in 1987 was partly attributed to PSP (DeGange and Vacca 1989), suggesting PSP represents a source of mortality in Sea Otter populations. Sea Otters appear able to detect toxic levels of PSP and may avoid feeding on prey with toxic levels (Kvitek and Bretz 2004). Domoic acid, a biotoxin produced by some species of diatoms and marine algae, can accumulate in filter-feeding invertebrates and fish. Domoic acid has been identified as the cause of several large die-offs of sea birds and California Sea Lions, *Zalophus californianus*, in CA as well as mortality in Californian Sea Otters (Kreuder *et al.* 2003). The frequency of PSP and domoic acid events in BC is monitored to the extent that it ensures bivalves from Indigenous and commercial fisheries and shellfish aquaculture are safe to consume (also see **Threats and Limiting Factors** section).

Aside from humans, predators and scavengers on Sea Otters include Bald Eagles, *Haliaeetus leucocephalus*, (Sherrod *et al.* 1975; Anthony *et al.* 2008; Rechsteiner *et al.* 2018), Grey Wolves, *Canis lupus* (Watts *et al.* 2010; C. Neufeld pers. comm. 2018; NTC 2019), Killer Whales, *Orcinus orca* (Riedman and Estes 1990; Hatfield *et al.* 1998; Estes *et al.* 1998; NTC 2019), Brown Bears, *Ursus arctos* (Monson 2021), and sharks (Ames and Morejohn 1980; Kuker and Barrett-Lennard 2010; Tinker *et al.* 2016).

Eagles scavenge adult carcasses and prey on live Sea Otter pups. In the Aleutian Islands, Sea Otter pups comprise 5-20% (by frequency) of Bald Eagle diet during the pupping season (Anthony *et al.* 1999; 2008). Sources of mortality have not been studied in BC, but pup carcasses found at eagle nests suggest that eagle predation may be a significant source of pup mortality (Watson *et al.* 1997; Rechsteiner *et al.* 2018). In AK, females with newborn pups (<3 weeks) are known to switch to nocturnal foraging possibly to reduce eagle predation on vulnerable neonates (Gelatt *et al*. 2002; Esslinger *et al.* 2014).

Sea Otter mortality from shark bites has not been reported in BC, but in CA incidental attacks by White Sharks, *Carcharodon carcharias*, hunting for seals and sea lions may be limiting range expansion in the CA Sea Otter population (Tinker *et al.* 2016; Nicholson *et al.* 2018) which, despite population growth, has not expanded its range in two decades (Nicholson *et al.* 2018). In CA, evidence from beach-cast carcasses indicates that the incidence of mortality due to shark bites has increased markedly since 2003 and accounts for the cause of mortality in >50% of beach-cast carcasses, particularly at the range ends (Tinker *et al.* 2016). Furthermore, Kuker and Barrett-Lennard (2010), who examined reasons for the sudden decline of otters in Southwest AK, suggested that the role of shark predation should be considered given the population-level increases in Pacific Sleeper, *Somniosus pacificus*, and Salmon Sharks, *Lamna ditropis*, that occurred concurrently with the decline of Sea Otters in the Aleutian Islands.

Although there are anecdotal accounts of Killer Whales chasing Sea Otters in BC (n=3, J. Watson pers. comm. 2019) there is no evidence that Killer Whale predation is a significant source of mortality (Watson *et al.* 1997). In BC, pinnipeds, the primary prey of mammal-feeding Killer Whales, are abundant (Olesiuk 2010; 2018). This is in stark contrast to Southwest AK where, after pinnipeds declined dramatically, Killer Whales were proposed to have switched to preying on Sea Otters as an alternative prey (Estes *et al.* 1998; Williams *et al.* 2004; also see section on **Abundance** – ***Global*** below for further discussion of this). Given the abundance of more profitable pinniped prey in BC, a Sea Otter population decline caused by Killer Whale predation seems unlikely.

Fisher *et al.* (2014) suggested that BC Sea Otters may avoid areas where pinnipeds are present to escape predation or harassment by Killer Whales. However, in BC rafts of Sea Otters are regularly observed in close proximity to large pinniped haul-outs (J. Watson, pers. comm. 2020), so it is not clear how important this supposed behaviour may be.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In Canada, Sea Otter surveys are direct counts that provide a measure of relative abundance that is used to calculate trends in population growth. To facilitate surveys, the Canadian Sea Otter range is divided into segments that can be surveyed by boat in a day or less. New survey segments are added as the Sea Otter range expands. Within each segment, Sea Otters are counted along an established survey route. A new segment is considered occupied, and thus part of the census, when a raft of Sea Otters is observed in the segment during a directed summer survey (Nichol *et al.* 2005). This criterion is used because single Sea Otters are reported outside the continuously occupied Canadian range (see Ford 2014 for extra-limital sightings) and during winter, rafts of Sea Otters may move to avoid inclement weather (Rechsteiner *et al.* 2019). When segments of the range are missed, interpolation is used to estimate numbers of otters in the missed segments. The interpolated number of Sea Otters has never exceeded 10% of the total annual count (see Table 2; Nichol *et al.* 2015)

Table 2. Count data used to calculate growth rates for the Sea Otter population in British Columbia. Estimates include values for survey segments not surveyed or not completely surveyed. Interpolation was used to estimate counts in these areas (see Nichol *et al.* 2005).

Year	Count	Estimate	Final
1977	70		70
1978	67		67
1980	74		74
1982	116		116
1984	345		345
1987	370		370

Year	Count	Estimate	Final
1988	354		354
1989	582		582
1990	668		668
1991	590		590
1992	969		969
1993	1045		1045
1994	1300		1300
1995	1522	5	1527
2001	3180		3180
2002	2369		2369
2003	2777	32	2809
2004	2934	251	3185
2008	4734		4734
2013	6754		6754
2017	7696	414	8110

Surveys are conducted from 5-6 m boats by two or three observers and a boat driver using 7 X 50 and stabilized 14 X 40 binoculars. Observers search for and count Sea Otters as the vessel proceeds along the prescribed route. The number of otters, the location, and time of each sighting is recorded. When individuals in a raft are difficult to distinguish, replicate counts are made to obtain a precise estimate of the number of individuals in the raft. Female rafts are distinguished from male rafts by the presence of pups (Nichol *et al.* 2015).

Sea and weather conditions affect survey results. *Good* to *Excellent* conditions are ocean swell up to 1 m or wind up to 18 km/hr. *Fair* conditions are seas 1 to 1.5 m or wind up to 28 km/hr. *Poor* conditions are seas greater than 1.5 m or wind > 28 km/hr. Cloud cover reduces glare and creates ideal counting conditions. Surveys are not started in *Poor* conditions or when visibility is reduced by rain or fog. Weather conditions are recorded and monitored and if conditions become poor the survey is terminated and repeated at a later date. Since 2004, all surveys have been conducted from May through September. In earlier years, surveys were conducted between April and September. Details about survey methodology are described in Nichol *et al.* (2005, 2009, 2015) and in the section **Search Effort**.

Abundance

Global

Prior to the arrival of Europeans in North America, Sea Otters were hunted widely by Indigenous peoples of the North Pacific (Simenstad *et al.* 1978; McKechnie and Wigen 2011; Sloan and Dick 2012; Szpak *et al.* 2012; Salomon *et al.* 2015), but it was the maritime fur trade that started in ca.1741 that drove the species to the brink of extinction (Kenyon 1969). Prior to the fur trade, the total range-wide population of Sea Otters is estimated to have been 150,000 to 300,000, although some authors suggest the number may have been even larger (Kenyon 1969; Johnson 1982). By 1911, the global Sea Otter population included fewer than 2,000 animals (Kenyon 1969). Since then, globally Sea Otters have been recovering from both remnant populations and reintroductions made in the late 1960s and early 1970s.

Sea Otter abundance estimates are largely based on direct counts, made from boats or aerial platforms, that are used to obtain minimum estimates or relative abundance indices (Nichol *et al.* 2015; Jeffries *et al.* 2017; Hatfield *et al*. 2018). However, in South Central and Southeast Alaska, most population estimates are obtained from transect counts with correction factors applied (Bodkin and Udevitz 1999; Esslinger and Bodkin 2009; Doroff *et al.* 2011). Differences in survey methods, timing of surveys, survey platforms, and habitat make generating a reliable global estimate of Sea Otter abundance (obtained by combining all surveys results) difficult (Doroff *et al.* 2011). This caution aside, population estimates made between 2004 and 2012 provide a very crude worldwide estimate of approximately 125,800 Sea Otters (see Table 1; IUCN 2015; but see Doroff *et al.* 2011).

Canada

The size of the Sea Otter population in Canada, prior to the maritime fur trade, is unknown, but there is evidence that they were an ecologically and culturally significant species, appearing in First Nation midden sites back to at least the start of the Holocene, ~12,000 years ago (Szpak *et al.* 2012). At the outset of the fur trade, the number of pelts traded was very high, suggesting Sea Otters were abundant (but see Spzak *et al.* 2012 and Slade 2019). Incomplete historical records suggest that between 1785 and 1809, up to 55,000 Sea Otter pelts were landed in BC. The geographic source of these pelts is difficult to determine, but at least 6,000 came from the west coast of Vancouver Island (Fisher 1940; Rickard 1947; Mackie 1997). In Haida Gwaii, two ships trading for less than 2 months in 1787 and 1791 acquired 1,821 and 1,400 pelts, respectively (Sloan and Dick 2012). From 1790 to 1800, American vessels trading along the northern BC and SEAK coast obtained about 10,000 pelts per year (Dmytryshyn and Crownhart-Vaughan 1976). By 1850, Sea Otters in Canada were considered commercially extinct but may have been ecologically extinct earlier than this (Watson 1993; Lee *et al*. 2016).

From 1969 to 1972, 89 Sea Otters were reintroduced to BC in three translocations. Many of these otters likely did not survive and the initial population may have declined to as few as 28 animals (Estes 1990). The first aerial survey in 1977 found 70 otters in two areas on the west coast of Vancouver Island and by 1995 the population had grown to 1,522: 1,423 Sea Otters were counted along the west coast of Vancouver Island and 99 along the central coast of BC in the Goose Islands (Bigg and MacAskie 1978; Watson *et al.* 1997; Figure 2). Surveys in 2001 resulted in a count of 2,673 otters along the Vancouver Island coast and 507 on the central coast of BC for a total of 3,180 otters (Nichol *et al.* 2005). Coast-wide surveys resulted in population estimates of 2,369 in 2002 (a decline from 2001), 2,809 in 2003, and 3,185 in 2004 (Nichol *et al.* 2005; Table 2). The 2007 status assessment (COSEWIC 2007) was based on a 2004 estimate derived from a count of 2,934 animals and interpolation using prior year counts of the number of animals in three occupied survey segments that had been missed in 2004 but were surveyed in 2001. Subsequent surveys obtained counts of 4,712 animals in 2008, 6,754 in 2013 (Nichol *et al.* 2015), and 8,110 Sea Otters were estimated in 2017 (7,696 animals counted and 414 animals estimated from survey segments that were not surveyed [n=2] or incompletely surveyed [n=1]; DFO unpubl. data; Table 2). Applying this most recent population estimate, Canada's Sea Otter population likely contributes 6-7% to the total global population reported by IUCN (2015).

The proportion of mature Sea Otters in the Canadian population is not known, and cannot be estimated from counts because it is difficult to distinguish immature from mature animals (Kenyon 1969; Ralls *et al.* 1983). Kenyon (1969) calculated 41% of the Sea Otter population at Amchitka Island to be immature, whereas Ralls *et al.* (1983) assumed that the number of immature animals in the CA Sea Otter population did not exceed 50% and ranged from 30-50% (meaning that 50-70% of the population was mature). Because changes in food availability have strong effects on Sea Otter demography, the percentage of mature animals likely varies depending on resource availability or how close the population is to carrying capacity (Monson *et al.* 2000a). The value of 50% mature individuals reflects what Ralls *et al.* (1983) considered to be the lowest estimate for the number of mature individuals in the CA Sea Otter population. It meets the COSEWIC requirement for using the lower estimate for the number of mature individuals, because Sea Otters have a biased breeding ratio (a polygynous mating system (Kenyon 1969) and hence not all males contribute to breeding) and a biased adult sex ratio (fewer males due to higher mortality; Siniff and Ralls 1991; Bodkin *et al.* 2000). Thus, assuming a maturity rate of 50% in Canada, the population in 2017 consisted of 4,055 Sea Otters.

Fluctuations and Trends

Global

Population growth is highly variable among Sea Otter populations. Sea Otter reintroductions to WA, BC, and SEAK were successful, whereas attempts to reintroduce Sea Otters to Oregon in 1970 and 1971 failed (Jameson *et al.* 1982). Once established, all of the reintroduced populations (except OR) increased initially at +17-20% per year, likely as a result of abundant invertebrate prey, which increased after Sea Otters were extirpated (Estes 1990). Population growth seems to be more variable in remnant populations (Table 1).

In Southcentral AK, the remnant Sea Otter population in Prince William Sound declined following the *Exxon Valdez* oil spill of 1989. Although this population was slow to recover (USFWS 2002a), aerial surveys of western Prince William Sound from 1993 to 2009 indicated an average annual population growth rate of +2.6%, providing evidence of a trend toward recovery (Bodkin *et al.* 2011; USFWS 2014b).

Until the early 1980s, about 80% of the global population (~165,000 animals) occurred in the Aleutian Islands (55,100 to 73,700 individuals) (Calkins and Schneider 1985; USFWS 2002b). However, a sharp decline of -17.5% per year starting in the mid-late 1980s reduced the population to 8,742 individuals (CV = 0.22) by the year 2000 (Calkins and Schneider 1985; Estes *et al.* 1998; USFW 2002b; Doroff *et al.* 2003). A similar decline was also detected along the western end of the Alaska Peninsula and Kodiak Archipelago (USFW 2002b). These declines led to Sea Otters in Southwest AK being listed as Threatened under the US *Endangered Species Act* (USFW 2006). Sea Otters in Southwest AK are still listed as threatened and, although no longer declining, show no sign of recovery. Their low abundance means that Sea Otters no longer function as a keystone species in the Aleutian Islands (USFWS 2014c; IUCN 2015).

Estes *et al.* (1998) suggested that predation by mammal-eating Killer Whales was the probable cause of the decline of Sea Otters in Southwest AK (Estes *et al.* 1998). Seals and sea lion populations, which are usually important prey for mammal-eating Killer Whales, declined sharply in Southwest AK, leading Springer *et al.* (2003) to further hypothesize that depletion of baleen whales due to industrial whaling caused Killer Whales to prey more intensely on seals and sea lions, reducing their abundance such that Killer Whales subsequently started hunting Sea Otters. This hypothesis, and its underlying assumptions, was the subject of intense debate.

Kuker and Barrett-Lennard (2010) revaluated the assumptions of Springer *et al.* (2003) and suggested that the data supporting the Killer Whale hypotheses were inconclusive. They further proposed that increases in shark abundance that occurred concurrently with the Sea Otter declines warranted further investigation. Likewise, Trites *et al.* (2007) proposed that the seal and sea lion declines, and other ecosystem changes in the North Pacific Ocean, were the result of an oceanic regime shift that occurred in 1977 and not linked to a cascade of declines following commercial whaling.

Regardless of cause, the decline of Sea Otters in Southwest AK is unprecedented in the current knowledge of Sea Otter populations and took place over a very short period (<15 yrs). One of the challenges to Sea Otter conservation is accurately estimating population size and detecting population trends. Sea Otter counts often exhibit high variance between survey intervals (Bodkin 2003), which meant that the decline in Southwest AK was not detected for almost 10 years.

The most recent global assessment reports significant declines in the remnant Russian Sea Otter population (Doroff *et al.* 2011; IUCN 2015). A 2007 survey of the Commander Islands found 8,000 Sea Otters but by 2008 the population was declining and recent estimates suggest there may be as few as 3,300 animals (Mamaev 2016 cited in Ovsyanikova *et al.* 2020). In 2004, Sea Otter abundance in the Kuril Islands and Kamchatka Peninsula was estimated at ~22,000 but counts conducted in 2012 indicated the population may have declined to about 7,510 animals (Ovsyanikova *et al.* 2020). The causes of these declines are unknown but poaching is possible (Doroff *et al.* 2011; IUCN 2015). More recent counts of the Russian Sea Otter population are provided in Table 1.

The CA Sea Otter population has been monitored for over 50 years (USFWS 2017). It has undergone periods of growth (+5-7% per year) and declines (-5% per year); the current 5-year average growth rate, up to and including spring 2019, is +0.12 % per year (Hatfield *et al.* 2019). Dramatic declines in the 1970s were partially attributed to entanglement in sunken gill nets (Estes 1990; Estes *et al.* 2003b; USFW 2003). At present shark-related mortality is thought to be the factor that most limits range expansion in CA Sea Otters (Tinker *et al.* 2016). Disease and anthropogenic factors, which are important contributing causes (Estes *et al.* 2003b) of mortality (Chinn *et al.* 2016; Thometz *et al*. 2016), are known to interact strongly with density-dependent factors such as resource limitation (see Tinker *et al.* 2019b)

Canada

Based on survey data, Nichol *et al.* (2005) reported the finite growth rate of the Canadian Sea Otter population, estimated from a piecewise regression, to be +20.2% per year from 1977-1994, and +9.4% per year from 1994-2004. The results of a similar regression including data from the more recent counts (2008, 2013, and 2017; Table 2) indicated the rate of population growth slowed after 1995. From 1977 to 1995, the population grew at an average of +20.1% per year then slowed to +8.7% per year thereafter up to and including 2017. The best fit model allowed an inflection at 1995 (SE = 0.189, r^2 = 0.98, $F_{2,21}$ = 602.2, P < 0.0001; Figure 3). These growth rates are similar to those seen in other reintroduced Sea Otter populations (Estes 1990).

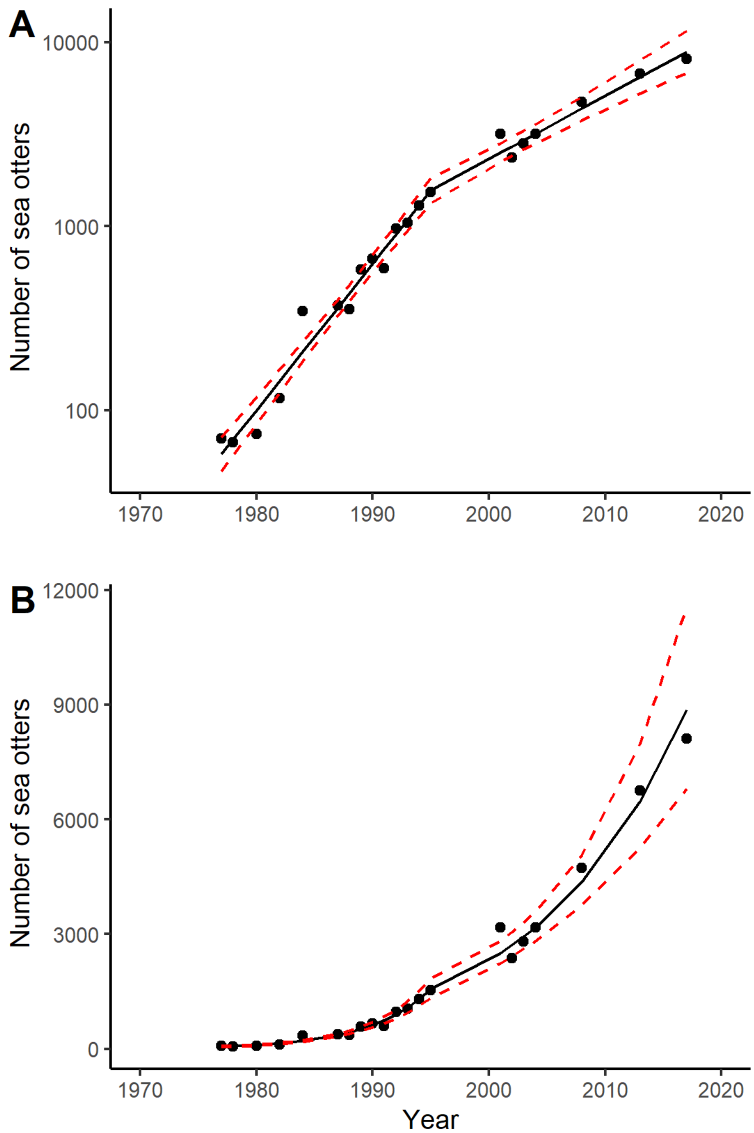

Figure 3. The trend in Sea Otter population growth in British Columbia presented as A) a log scale and B) an ordinal scale. Dots represent the counts used in the regression. Black line represents the piecewise regression. The estimated trend is +20.1% per year until 1995, (confidence intervals of the slope = +18.1-22.2%), and a trend of +8.7% per year after 1995, (confidence intervals of the slope = +3.3-13.3%, r^2 = 0.98, n = 21). Red-dashed lines represent 95% confidence intervals.

Rapid initial growth rates of +17-20% (~ r_{max} for the species) and a subsequent slowing of growth, as parts of the population become resource limited and reach carrying capacity, are typical of reintroduced Sea Otter populations (Estes 1990). Local Sea Otter density is maintained at carrying capacity through mortality and emigration (Estes 1990; Tinker *et al.* 2019a). In Canada, the portions of the Sea Otter population near the centre of the range (Vancouver Island) have been at carrying capacity since the mid-1990s or early 2000s. Sea Otter numbers are stable or growing very slowly in areas where they are at carrying capacity (e.g., +2.6% per year from 2013 to 2017), growing slowly in areas where they are close to *K*, (e.g., +8.3% per year from 2013 to 2017), and growing at rates that are near or exceed r_{max} in recently occupied areas (e.g., +24.5% per year from 2013 to 2017) (see Nichol *et al.* 2015, 2020 for growth rates by area). Assuming a generation time of 7-9 years, abundance in 2017 represents a 12-fold increase since 1990 (3 generations ago at 9 yrs/generation) or a 5-fold increase since 1996 (3 generations ago at 7 yrs/generation, using closest count in 1995).

Using shoreline length and an estimate of Sea Otter density in areas thought to be at carrying capacity, Gregr *et al.* (2008) estimated an upper limit of 52,199 otters (95% CI 48,672-59,018) as the coast-wide carrying capacity of Sea Otters in BC. This estimate, which assumes Sea Otter density is independent of habitat quality, also suggests that the size of the Canadian Sea Otter population (in 2017) was 14-17% of the estimated potential carrying capacity. Having Sea Otter populations near carrying capacity may be ecologically important because the density or abundance of Sea Otters needed to exert ecological effects is larger than the minimum viable population size and may be near carrying capacity (Soulé *et al.* 2005)

Rescue Effect

Sea Otter populations adjacent to BC in WA and SEAK are both below carrying capacity (Walker *et al.* 2008; Gregr *et al.* 2008). However, in the event of a catastrophic incident with widespread effects on Canadian Sea Otters (and likely adjoining populations), movement and colonization by Sea Otters from either WA or SEAK is unlikely. Following the extirpation of Sea Otters from BC, WA, and OR by the early to mid-1900s (Nichol 2015), no natural recovery from remnant populations in Alaska had occurred by 1969, at least 40 years after extirpation. Furthermore, Sea Otters have not repopulated coastal OR from either CA or from WA, likely because Sea Otters exhibit high site fidelity, small home ranges, and limited dispersal (Loughlin 1980; Garshelis *et al.* 1984; Jameson 1989; Bodkin *et al*. 2002; Tarjan and Tinker 2016). Although there is evidence of limited Sea Otter movement between WA and BC, based largely on Sea Otter carcass recovery (Larson *et al.* 2015; S. Larson pers. comm. 2019), dispersal of adults from adjacent areas is not likely to be frequent enough to provide a rescue effect.

Movement to new areas generally occurs when Sea Otters approach carrying capacity and groups of male Sea Otters move into unoccupied habitat. Females follow once the males have moved on (Loughlin 1980; Garshelis *et al.* 1984; Jameson 1989; Rechsteiner *et al.* 2019). A study of the pattern of recovery following the *Exxon Valdez* Oil Spill at two island sites in Prince William Sound emphasizes how unlikely a rescue effect would be in the event of a catastrophic event. Bodkin *et al.* (2002) found that in Prince William Sound, Sea Otter population growth at oiled sites resulted from internal reproduction and local immigration of juveniles, and not from the widespread redistribution of sexually mature adults from other parts of the Prince William Sound.

THREATS AND LIMITING FACTORS

Threats

Globally, the IUCN (2015) identified environmental stressors, increases in predation risk, food limitation, disease, warming ocean temperatures, increased ocean acidity, and changes in geographic distribution of marine communities as threats to Sea Otter populations. In Canada, known threats to Sea Otters include environmental contamination, conflict with fisheries, entanglement in fishing gear, collisions with vessels, illegal killing, and possibly human disturbance. Threats are categorized below, following the IUCN-CMP (International Union for Conservation of Nature – Conservation Measures Partnership) unified threats classification system (based on Salafsky *et al.* 2008). An IUCN Threats Calculator was completed and is included as Appendix 1. The assigned overall threat impact is Very High – Medium, mostly due to the risk of population-level effects of large oil spills, the occurrence of which have high uncertainty, and the potential future effects of ocean acidification on prey. Other ongoing threats are considered Negligible or Medium – Low and do not appear to be affecting population growth and range expansion on the BC coast. Details of these threats are given below, organized by IUCN threat categories, and in Appendix 1.

<u>Pollution (IUCN threat 9.0) (High–Medium threat impact)</u>

Oil spills and exposure to oil-based hydrocarbons

Several biological characteristics make Sea Otters especially vulnerable to oil exposure (Jarvela-Rosenberger *et al.* 2017). Sea Otters lack the insulating layer of blubber found in other marine mammals and rely on air trapped in their fur for body heat, and to a lesser degree buoyancy (Morrison *et al.* 1974; Williams *et al.* 1992). Oil destroys the water-repellency of the fur, eliminates the air layer, and reduces insulation by ~70% resulting in hypothermia and death (Costa and Kooyman 1982; Williams *et al.* 1988). Oil-fouled Sea Otters groom intensely and stop feeding, resting, and caring for young (Ralls and Siniff 1990). As an oiled otter grooms, it spreads and ingests oil, and inhales toxic fumes, which can damage internal organs (Geraci and Williams 1990; Lipscomb *et al.* 1993; Williams *et al.* 1995). Sea Otters can be chronically exposed to oil long after a spill when they forage in substrate or eat prey contaminated by oil (Bodkin *et al.* 2002; 2012). Additionally, Sea Otters typically rest in sexually segregated groups (rafts) of 50-1000 individuals. In the event of an oil spill, large numbers of otters, especially pup-encumbered females, can become simultaneously oiled. Methods to clean and rehabilitate oiled otters are expensive and of questionable efficacy (Estes 1991; Williams and Davis 1995). Finally, the probability of a rescue effect, in the event of a major oil spill, is very unlikely. Recent research has shown that Sea Otters, with their small home ranges, are unlikely to relocate (Davis *et al*. 2019; see **Rescue Effect** section). There have been several large-scale oil spills that provide insight into the scope and severity of the threat of oil contamination.

On December 23, 1988, the oil barge *Nestucca* spilled 875,000 litres of Bunker C oil into the ocean off Grays Harbor, WA (Waldichuk 1989). In 7 days, oil spread north to Cape St. James, Haida Gwaii, and later was found as far north as the Moore Islands along the northern BC mainland coast (EnviroEmerg Consulting 2009). The spread of oil from this spill demonstrated the vulnerability of the Canadian Sea Otter population to oil spills (Watson 1990). The *Nestucca* spill was relatively small, yet it affected the entire current range of Sea Otters in WA and BC, which suggests that a large spill would have widespread geographic dispersion, further reducing any chance of rescue effect. The impact of the *Nestucca* oil spill on Sea Otters is unclear as little was known of the population's abundance and distribution at the time. The spill took place in winter, when access to remote areas with otter concentrations is difficult due to inclement weather. One oiled Sea Otter carcass was observed on an outer island off northwest Vancouver Island but most beach-cast carcasses of small marine mammals tend to be quickly scavenged by wolves and bears. Numerous wolf scats containing Sea Otter fur were found in the weeks following the spill and it is likely that mortality was more extensive than the single carcass would suggest (J. Watson pers. comm. 2021).

In the spring of 1989, the oil tanker *Exxon Valdez* ran aground in Prince William Sound, AK, spilling 42 million litres of crude oil. Nearly 1,000 Sea Otter carcasses were recovered but estimates of total mortality ranged from 2,650 (Garrott *et al.* 1993) to 3,905 animals (DeGange *et al.* 1994). Subsequent studies of this spill illustrated the long-term impact of the oil and demonstrated that for Sea Otters, chronic effects may be as important as acute effects (Monson *et al.* 2011). Population models showed decreased survival rates in all age-classes of Sea Otters in the 9 years following the spill (Monson *et al.* 2000b) and subsequent studies indicated that the Prince William Sound Sea Otter population had reduced survival and continued exposure to lingering oil at least until 2009 (Ballachey *et al.* 2014). Controlled experiments on American Mink (*Neovison vison*) illustrated how oil can affect reproduction and survival in a mustelid. Female mink, fed low doses of crude and bunker C oil to simulate residue levels in invertebrates 4 years after the *Exxon Valdez* spill, had significantly fewer kits/birth than controls. Furthermore, female kits born to exposed mothers had poorer survival to weaning, and those that survived had lower reproductive success than controls (Mazet *et al.* 2001). Although the effects of oil lasted more than 20 years, recent work suggests that in Prince William Sound Sea Otter recovery is underway, and that exposure to oil is no longer biologically significant to the Sea Otter population (Ballachey *et al.* 2014).

Oil from bilge water, vessels, tankers, barges, fuel tanks and shore-based fueling stations are the main sources of water-borne oil in BC (Shaffer *et al.*1990), thus increased vessel traffic increases the likelihood of oil spills (O'Hara *et al.* 2013). In Canada, the largest shipping volumes occur in BC, with the south coast of Vancouver Island having the highest probability of an oil spill event (WSP 2014). Ongoing port expansions in Vancouver, Prince Rupert, and WA are expected to significantly increase vessel traffic over at least the next decade (Van Dorp and Merreck 2013; Canadian Sailings 2019). For example, tanker traffic associated with the Transmountain Pipeline expansion is expected to increase by 7-fold through the Salish Sea and Juan de Fuca Strait (measured as tankers per month and compared to 2018 levels; Johannessen *et al.* 2019). In 2012 there were ~29,000 vessel transits in BC, which included cargo ships (48%), tugs (27%), tankers (6%) and a variety of other vessel types (Nuka 2013). In 2012, documented vessels (excluding tugs) carried ~110 billion litres of petroleum products through BC's inner coastal waters. Persistent oil (petroleum products that do not evaporate) made up the bulk of this: 38% was bunker oil used as fuel in large vessels, 35% was crude oil bound for refineries in WA and about 27% was refined fuel oil (known as nonpersistent petroleum because it evaporates) used for fuel in smaller vessels.

In addition to carrying crude oil, many tankers moving through Juan de Fuca Strait carry diluted bitumen (known as dilbit). The approval of the Trans Mountain Pipeline expansion means the amount of dilbit transported along the BC coast will increase significantly (Johannessen *et al.* 2019). The biological effects of a diluted bitumen spill are unknown because it is not clear how dilbit would behave if spilled into BC coastal waters. Dilbit is composed of heavy bitumen mixed with light oil (to reduce its viscosity so it can flow through pipelines). As dilbit degrades, the lighter oils evaporate whereas the density of the remaining product increases and it sinks. Fresh dilbit has similar toxic effects as other petroleum products (Alderman *et al.* 2017) and marine mammals, including Sea Otters, are considered vulnerable to its effects (Jarvela-Rosenberger *et al.* 2017). The lighter oils are likely to be acutely toxic, whereas the heavier components will most likely have chronic effects (Lee *et al.* 2015 cited in Johannessen *et al.* 2019). At present there is no comprehensive study examining the biological effects of dilbit spilled in the ocean (Johannessen *et al.* 2019).

Small to medium spills may pose the greatest risk to Sea Otters because most (95%) small spills occur nearshore, cause significant damage, and occur more frequently than large spills (see O'Hara *et al.* 2013; Bertazzon *et al.* 2014; Serra-Sogas *et al.* 2014; Fox *et al.* 2016). For example, fuel-carrying barges, which are not monitored, move an estimated 48 billion litres of largely non-persistent oil along the inner coast of BC each year (Nuka 2013). Since 2016, two incidents involving fuel barges have occurred within the range of Sea Otters on BC's central coast.

The first event occurred in October 2016, when the tug *Nathan E. Stewart* ran aground in Seaforth Channel on the central coast of BC, and sank, spilling 110,000 litres of diesel. This contaminated local clam beds (CBC News, October 10, 2018) which the Heiltsuk First Nation closed to harvest for human consumption (CTV News, July 15, 2019). In the second event, in November 2017, the tug *Jake Shearer* lost control of the barge it was pushing off the Goose Island Group on the BC central coast. The barge, carrying 4 million litres of fuel, was tenuously anchored in rough seas, less than 2 km from an area occupied by female Sea Otters, until a second tug was able to assist (CBC News, November 26, 2017). Had the barge ruptured sea conditions would have made containment of the fuel impossible and it would have blown northwards through the central coast range of Sea Otters.

Weather plays an important role in risk assessment. The greatest chance of an oil spill is on the south coast of BC where the volume of vessel traffic is highest (Nuka Research 2013, 2021; WSP 2014). If such a spill were to take place during the winter, when prevailing winds and currents are from the south, oil could spread northwards throughout the Sea Otter range in BC, as was seen in the relatively small *Nestucca* spill of 1988. There are few recent risk models for oil spills in BC, but risk models for southern BC and WA, developed in the 1980s, predicted that spills of crude oil or bunker fuel exceeding 159,000 litres could be expected every 2.5 years whereas spills of any type of petroleum product exceeding 159,000 litres could be expected every 1.3 years (Cohen and Aylesworth 1990). The actual frequency of large spills affecting BC between 1974 and 1991 was close to the predicted frequency (Burger 1992). However, global estimates of the volume of oil spilled annually have declined significantly (by about 50%) since the 1970s, largely because of better enforcement of prevention measures and more responsible shipping practices (Schmidt-Etkin 2011).

Small chronic spills are also of concern. Environment and Climate Change Canada tracks all spills of more than 1,130 litres (Burger 1992). The effect of contamination from chronic spills smaller than this on Sea Otters is not known, but chronic exposure to hydrocarbons can occur in the absence of documented spills. Working off the west coast of Vancouver Island, Harris *et al.* (2011) found that hydrocarbon concentrations (from weathered petroleum and fossil fuel combustion) in sediment and infaunal food webs were sufficient to expose Sea Otters to contaminants.

Sunken vessels with intact fuel tanks also pose an uncalculated risk to Sea Otters. Recent examples include the sunken MV *Schiedyk* in Nootka Sound, which began leaking oil in 2020, 52 years after sinking (Kloster 2020). In 2013, approximately 35,000 litres of Bunker C oil were recovered from the USAT *Brig.-Gen. M.G. Zalinski*, which began leaking oil in 2003, 57 years after running aground and sinking in Grenville Channel on the north coast of BC (Pynn 2019). A more recent example is the ferry MV *Queen of the North*, which sank on March 22, 2006, into 427 m of water after running aground on Gil Island (135 km south of Prince Rupert, BC). The ferry had 225,000 litres of diesel fuel, 15,000 litres of light oil, 3,200 litres of hydraulic fluid, and 3,200 litres of stern tube oil and carried about 20 vehicles. Its sinking created an oil slick that spread through the surrounding waters of Wright Sound, and although the lighter fuels evaporated the ongoing chronic discharges and remaining oil in the ferry are considered an environmental concern (BC Spills and Environmental Emergencies 2021).

Finally, these spill risk assessments do not consider vessel traffic transiting the BC coast in international waters. However, nearshore vessel traffic is considered to pose the greatest risk of spilling oil (Nuka Research 2013; WSP 2014).

Other contaminants

Recent research indicates that in CA, Sea Otter susceptibility to stressors, such as contamination, interacts strongly with resource limitation (Tinker *et al.* 2019b). Reduced immune competence is a documented side effect of contaminants in marine mammals and has been considered a factor in disease-caused mortality in the CA Sea Otter population (Thomas and Cole 1996; Reeves 2002; Ross 2002; Jessup *et al*. 2010), organochlorine contaminant levels have not been measured in BC Sea Otters.

Polychlorinated biphenyls (PCBs) and organochlorine pesticides including DDT and butyltin have been measured in Sea Otters from CA, WA and AK (Bacon e*t al.* 1999; Lance *et al.* 2004; Kannan *et al.* 2004, 2007, 2008). PCB concentrations were higher in AK Sea Otters from the Aleutian Islands (309 µg/kg wet weight) compared to otters from CA (185 µg/kg wet weight) and SEAK (8 µg/kg wet weight) (Bacon e*t al.* 1999). DDT concentrations were highest in CA Sea Otters (850 µg/kg wet weight), compared to the Aleutian Islands (40 µg/kg wet weight) and SEAK (1 µg/kg wet weight). The PCB levels in CA and Aleutian Sea Otters are of concern because similar levels caused reproductive failure in mink (Risebrough 1984 *in* Riedman and Estes 1990), although the levels of DDT measured in CA Sea Otters were not considered exceptionally high when compared to other marine mammals (Bacon e*t al.* 1999).

In a small sample of beach-cast carcasses from CA, those that died from infectious disease contained higher concentrations of butyltin compounds (likely from antifouling paint) and DDTs than animals that had died from trauma and unknown causes (Kannan *et al.* 1998; Nakata *et al.* 1998). Further work led Kannan *et al.* (2007) to suggest a relationship between elevated PCB concentrations and disease in CA Sea Otters. However, although Sea Otters have a great capacity for bio-accumulating persistent organic pollutants (otters concentrate organic pollutants in their tissues 60 to 240 times higher than found in their prey; Kannan *et al.* 2004, 2007; Kannan and Perotta 2008; reviewed in Davis *et al.* 2019), a link between contaminant levels and an increased incidence of disease has not been shown in Sea Otters (Jessup *et al.* 2010). In BC, Sea Otter carcasses are poorly sampled because they occur in remote locations and are subject to being eaten by scavengers such as bears (*Ursus* spp.) and wolves.

<u>Biological Resource Use (IUCN threat 5.0) (Medium–Low threat impact)</u>

Entanglement in fishing gear

The extent of entanglement of Sea Otters in fishing gear in BC has not been investigated. Sea Otters do, however, become incidentally entangled and entrapped in net-fishing gear and these incidents are reported in AK, CA, WA and Japan (Rotterman and Simon-Jackson 1988; DeGange and Vacca 1989; Lance *et al.* 2004; Hattori *et al.* 2005; USFWS 2017). Sea Otters were reportedly entangled and killed in salmon fisheries, particularly in Southcentral and Southwest AK during the 1970s and 1980s, and in the late 1980s there was concern that entanglements might be significant and increasing (Rotterman and Simon-Jackson 1988). Sea Otter mortality from entanglement in sunken gillnets in <30 m depths was a serious problem in CA during the late 1970s and early 1980s. Restrictions on net fisheries within the CA Sea Otter range were put in place and gillnet entanglement is no longer considered a significant source of mortality (USFWS 2003; USFWS 2017). In WA, the treaty gillnet fishery operates within the Sea Otter range. Entanglements and mortality are reported infrequently but may increase as Sea Otters increase in abundance and range (Gerber and VanBlaricom 1998; Lance *et al.* 2004). In BC, there are two reports of Sea Otters becoming entangled and drowned in herring net pens, ghost nets or gillnets (DFO unpublished data).

In BC, there are anecdotal reports of Sea Otters being drowned in commercial-style crab pots (J. Watson pers. comm. 2019), and such mortality has been recorded in AK and CA (Hatfield *et al.* 2011). On the west coast of Vancouver Island alone, up to 35,000 commercial pots can be deployed annually (IFMP Crab by Trap 2017-2018). Hatfield *et al.* (2011) demonstrated that Sea Otters up to 2 years of age (in size) could enter a trap with circular openings of 12.25 to 14.5 cm in diameter or rectangular openings 9.5 cm high (typical of Dungeness Crab, *Metacarcinus magister*, pots) (Hatfield *et al.* 2011). In BC, the potential for entanglement is likely highest when Sea Otters expand their range and overlap with active crab fisheries. At present the greatest overlap between Sea Otters and commercial crab fisheries occurs at the southern end of the Sea Otters' range, in Clayoquot Sound on the west coast of Vancouver Island.

Directed killing

Sea Otters are illegally killed in BC but there are no reliable estimates of how many are taken. Documented illegal kills in BC include 13 animals shot off the west coast of Vancouver Island between 2004 and 2014 (DFO unpublished data). There were also reports of Sea Otters being hunted on the central coast of BC and the west coast of Vancouver Island in 2016 and 2017, respectively (DFO unpublished data.). In 2018, seven to eight Sea Otter carcasses were found at a dump on Vancouver Island (Nanaimo Bulletin April 3, 2018). As in other areas, Sea Otters are likely shot for pelts and in response to their effect on invertebrate stocks (e.g., Rotterman and Simon-Jackson 1988; Bodkin 2003; USFWS 2014, 2017; see **Special Significance** section). These incidents likely underestimate the extent of mortality from illegal killing.

There have been proposals to conduct legal hunting of Sea Otters in British Columbia. To support priority resource access, DFO discusses all Indigenous harvest interests that are identified to DFO, including any for Sea Otter. To date, Food, Social, and Ceremonial (FSC) access to Sea Otters has not been provided by the Department (L. Galbraith, pers. comm. 2021). Any future hunt would be managed as a fishery and should not be considered a direct threat. However, illegal poaching can develop in association with legal hunts (e.g., see Wyatt 2009), which could increase directed but unreported mortality.

Transportation and Service Corridors (IUCN threat 4.0) (Negligible threat impact)

Collisions with vessels

In CA, vessel strike was the primary cause of death in 5 of 105 beach-cast carcasses examined between 1998 and 2001 (Kreuder *et al.* 2003) and in recent years caused several deaths annually (USFWS 2017). Vessel strikes have also been reported in AK (Rotterman and Simon-Jackson 1988). In AK, boat strike is a recurring cause of death, although in most cases there were other contributing factors (disease or biotoxin exposure), which made the Sea Otter more susceptible to being struck by vessels (USFWS 2014b). Incidents of collisions with vessels have not been systematically investigated in BC but boat strikes are known to occur (Watson *et al*. 1997). Since 2004, at least one incident of boat strike and two further necropsy results suggesting blunt force trauma have been reported to DFO (DFO unpublished data). These three incidents likely underestimate the extent of mortality from collisions as most are unlikely to be reported. Collisions with vessels are expected to increase as Sea Otters expand into more areas near human habitation and boat activity.

Human Intrusions and Disturbance (IUCN threat 6.0) (Negligible threat impact)

Boat traffic within Sea Otter habitat, both directed Sea Otter viewing traffic and non-directed traffic, has the potential to cause disturbance. Females with pups, burdened with an increased energy demand (Thometz *et al.* 2016), are more vulnerable to the effects of disturbance than males. However, rafts of males routinely exposed to boat traffic seem to be able to habituate and single males are most tolerant of the presence of boats. Overall, the impact of humans inhabiting the shoreline (noise and presence of people) or from operating boats in the vicinity of Sea Otters does not appear to be a significant concern at this time because Sea Otters in BC occur along portions of the coast that are not densely inhabited.

Invasive & Other Problematic Species & Genes (IUCN threat 8.0) (Unknown threat impact)

Pathogens and Biotoxins

As with their vulnerability to oil spills, Sea Otters possess several biological traits that make them highly susceptible to the effects of pathogens and biotoxins (Miller *et al.* 2007; Jessup *et al.* 2010). Firstly, they have a high metabolic rate and must consume a high biomass of prey, increasing their exposure to pathogens and biotoxins. Secondly, Sea Otters often prey on filter-feeding invertebrates, which can concentrate chemical and biological pollutants if they are present in the water and sediment. Finally, the high metabolic demands of Sea Otters mean that the effects of environmental stressors cannot be considered independently of resource limitation. In resource-limited habitat, Sea Otters will be more susceptible to environmental stressors (Tinker *et al.* 2019b).

Pathogens can be an important source of mortality in CA Sea Otters (Jessup *et al.* 2004; 2007; Conrad *et al*. 2005; Johnson *et al*. 2009; USFWS 2017; but see Tinker *et al.* 2019b). In CA ~25% of the carcasses recovered died from encephalitis caused by the parasites *Toxoplasma gondii* (source: domestic and wild felids) and *Sarcocystis neurona* (source: Opossums – *Didelphis virginiana*). These infections are likely incurred when Sea Otters eat invertebrates that are infected with oocysts filtered from terrestrial runoff that entered coastal waters (Miller *et al.* 2002; Conrad *et al.* 2005; Johnson *et al.* 2009; Miller *et al.* 2010; Lafferty 2015; Burgess *et al.* 2018).

T. gondii and *S. neurona* infections have been reported in Sea Otter populations from CA to AK (Burgess *et al.* 2018, 2020), but the prevalence of either pathogen in BC is low compared to WA and CA. Among 95 Sea Otters captured in BC from 2003-2011, 12% tested positive for exposure to *T. gondii* and 5% for exposure to *S. neurona* (Shrubsole *et al.* 2005; Burgess *et al.* 2018; M. Murray pers. comm. 2019). In WA, these pathogens occurred in 30% (n=30) of captured Sea Otters (Burgess *et al.* 2018) and in 54% (n=333) of carcasses recovered from 2002-2012 (White *et al.* 2018). One beach-cast carcass recovered from Vancouver Island in 2006 died of *S. neurona* infection (Barbosa *et al.* 2015). The low prevalence for exposure to *S. neurona* in BC and AK is likely because the definitive host (Opossums) is not present in coastal areas (Barbosa *et al.* 2015; Burgess *et al.* 2020).

In CA, the relationship between the vulnerability of Sea Otters to pathogens, biotoxins, and density-dependent resource limitation is synergistic (Tinker *et al.* 2019b). For example, dietary specialization, which increases with resource limitation (Tinker *et al.* 2008a), influences the risk of exposure to various pathogens (Johnson *et al.* 2009). Poor body condition increases susceptibility to pathogens, pollutants, and biotoxins produced by harmful algae (Johnson *et al.* 2009; Jessup *et al.* 2010). Finally, among Sea Otter populations, landscape characteristics are also associated with patterns of *T. gondii* prevalence. Proximity to watersheds with forest cover, which may help filter pathogens, was associated with significantly lower *T. gondii* prevalence (Burgess *et al.* 2018).

Pathogens associated with die-offs or reproductive failure in sympatric marine and terrestrial mammals that have been found in Sea Otters include morbilliviruses such as canine and phocine distemper (Shrubsole *et al.* 2005; Goldstein *et al*. 2011; White *et al.* 2018). Although phocine distemper (from pinnipeds) caused isolated die-offs of Sea Otters in Alaska (Goldstein *et al*. 2011) and canine distemper has been detected in Sea Otters from BC and WA (Shrubsole *et al.* 2005; White *et al*. 2018), neither of these pathogens is known to limit Sea Otter populations in BC.

Harmful algal or cyanobacterial blooms, whose frequency and extent can be intensified by anthropogenic nitrogen or phosphorus runoff into the marine environment (Mos 2001), are known to affect Sea Otters (Kreuder *et al.* 2003; Miller *et al*. 2010). The biotoxins released during such blooms include domoic acid, produced by marine diatoms (*Pseudonitzschia* spp.), and microcystin, produced by freshwater cyanobacteria (*Microcystis* spp.). In CA, domoic acid has been identified as the cause of several large die-offs of sea birds, California Sea Lions and Sea Otters (Kreuder *et al.* 2003). Domoic acid intoxication is associated with an increased risk of cardiac disease and death due to heart failure particularly in older otters (Kreuder *et al.* 2003, 2005). Microcystin, which was previously only considered a human health issue, was implicated in the deaths of >40 CA Sea Otters between 1999 and 2013 (Miller *et al.* 2010; Tinker *et al.* 2013). The effect of biotoxins on the BC Sea Otter population is unknown. Harmful algal blooms are also discussed in the **Interspecific Interactions** section.

Climate Change and Severe Weather (IUCN threat 11.0) (Medium–Low threat impact)

Climate change is identified as a threat to Sea Otters by the IUCN (2015). Warming ocean temperatures, increased ocean acidification, and shifts in geographic ranges for marine species brought about by climate change are predicted to affect marine ecosystems and Sea Otter populations (Doroff *et al.* 2011, Coletti *et al.* 2016). Most importantly, ocean acidification, changes in the ocean's carbonate chemistry caused by increased atmospheric carbon dioxide, poses a serious threat to calcifying organisms and how ecosystems such as seagrass beds and kelp forests, which are important to Sea Otters, will function (e.g., Gaylord *et al.* 2015; Sunday *et al.* 2016). Changes in temperature regimes, particularly extreme events, may affect Sea Otter survival by causing direct mortality on intertidal species used as prey (e.g., Seuront *et al.* 2019). The high metabolic rate and thus food requirements of Sea Otters, means that Sea Otters in areas near carrying capacity are resource limited and vulnerable to changes in their prey caused by environmental factors or disease (Coletti *et al*. 2016; Davis *et al*. 2019). In CA, climate change is predicted to affect southern Sea Otters by altering processes that transport pathogens and contaminants from land to the sea (Walther *et al.* 2002; USFWS 2017). Changing ocean temperatures may also change the incidence of harmful algal blooms and could increase the incidence and spread of disease among marine organisms, with unpredictable effects on Sea Otter populations (e.g., Sea Star Wasting Disease and the subsequent changes in prey density; Schultz *et al.* 2015; Burt *et al.* 2018).

Sea Star Wasting Disease (SSWD – likely a viral pathogen; Hewson *et al.* 2015) has almost completely depleted numerous species of sea stars, which may indirectly affect Sea Otters. In central CA, large numbers of Purple Urchins (*Strongylocentrotus purpuratus*) recruited following SSWD and during marine heat wave (MHW, 2013-2014) and El Niño Southern Oscillation (ENSO, 2015-2016) events. The urchins subsequently denuded kelp forests, in turn reducing abalone by 80% – an effect that may extend to other kelp-associated invertebrates (Rogers-Bennett and Catton 2019). Except along the margins of the remaining kelp beds, these urchins are not eaten by Sea Otters because they contain little flesh and thus nutrients (Smith *et al.* 2021). However, a similar invertebrate recruitment event occurred in BC (J. Watson pers. comm. 2021), and in areas with Sea Otters, the urchins accessible to Sea Otters were eaten once they reached ~40 mm in diameter. It is not clear if these invertebrate recruitment events are associated with the loss of sea stars (Burt *et al.* 2018) and better survival of new recruits, recruitment processes facilitated by warm water (Okamoto *et al.* 2020), or a combination of both. Although recent research shows SSWD and MHWs can have both positive and negative short-term effects on several species of invertebrates preyed upon by Sea Otters, it is too soon to do more than speculate as to whether or how Sea Otter recovery could be affected by such changes.

Storms can cause Sea Otter mortality, particularly if pups get separated from their mothers (e.g., Thometz *et al.* 2016). In CA, large storms associated with ENSO events are known to remove kelp (Ebeling *et al.* 1985), with climate change expected to cause more extreme ENSO events (Wang *et al.* 2019). Kelp beds are considered a limiting factor for otters in CA because kelps attenuate storm waves and provide shelter (Nicholson *et al.* 2018). However, the linear shoreline of BC is roughly 10 times greater than in CA, per degree of latitude (Hessing-Lewis *et al.* 2018), creating areas where BC Sea Otters can shelter from inclement weather. Thus, the potential for extreme storm events, caused by changing climate, to limit otter population growth in BC is unknown.

Limiting Factors

Sea Otter population growth is primarily limited by the availability of prey and habitat (Tinker *et al.* 2019b; see **Habitat** and **Population Sizes and Trends** sections). However, other density-independent factors such as predation, pathogens, and biotoxins may also limit growth. For example, Killer Whale predation is hypothesized to be the principal factor in the decline of Sea Otters in Southwest AK (Riedman and Estes 1990; Estes 1990; Estes *et al.* 1998; Doroff *et al.* 2003 but see discussions in the **Interspecific Interactions** and **Population Sizes and Trends** sections) and mortality from shark bites (Tinker *et al.* 2016) may be limiting range extension of Sea Otters in CA. However, predation or incidental mortality from predators is not likely a limiting factor in the Canadian Sea Otter population (see **Interspecific Interactions** section).

Number of Locations

Despite gaps in the distribution of the Canadian Sea Otter, the population is considered a single location because the greatest threat to Sea Otters, a large-scale oil spill, has the potential to affect the entire population (Figure 2; see **Threats and Limiting Factors** section).

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Federally, the *Fisheries Act* (*Marine Mammal regulations*) and the *Species at Risk Act* (SARA) apply to Sea Otters in Canada. In Canada, Sea Otters were designated by COSEWIC as Endangered in 1978. The status was re-examined and confirmed as Endangered in 1986, then reclassified as Threatened in 1996. A re-examination confirmed the status of Threatened in 2000.

The Sea Otter was legally listed as Threatened in 2003 and placed on Schedule 1 of the newly proclaimed SARA. Its status was re-examined by COSEWIC in 2007 and the species was downlisted to Special Concern in 2009 because of increased population growth and expanded range, but remained vulnerable to anthropogenic threats (mostly oil spills). As stipulated under the SARA (S.C. 2002, c.29), a Management Plan for the Sea Otter was put in place (Fisheries and Oceans Canada 2014) with the objective of conserving abundance and distribution and promoting continued population growth and expansion as long as the species remains Special Concern. Sea Otter Critical Habitat had not yet been identified when they were downlisted to Special Concern. Under SARA, species of Special Concern are not subject to general prohibitions nor is there a requirement to identify and protect Critical Habitat. Under Canada's *Marine Mammal Regulations,* Sea Otters (as with all marine mammals) are protected from disturbance and hunting is regulated (SOR/93-56, s. 5, s. 7(1), s. 7(2)). However, the Minister of Fisheries and Oceans may issue authorization to disturb Sea Otter in some circumstances under section 38 of the Canadian Marine Mammal Regulations. This includes for activities related to research or the conservation of the species. The most recent COSEWIC reassessment in May 2022 resulted in a status of Special Concern.

In Canada, the Constitution (*Canada Act* 1982, 1982, c.11 (U.K.) s.35) recognizes and affirms existing Indigenous rights, including the rights of Indigenous people to harvest for "Food, Social, or Ceremonial purposes or for purposes set out in a land claims agreement" (R.S.C. 1985 c. F-14 s.2(1)), a right that includes the harvest of Sea Otters. Such a harvest would be licensed under the Aboriginal Communal Fishing Licence Regulations (SOR/93-332).

Sea Otter recovery was aided by legislation that protected Sea Otters and their habitat. The first law to protect Sea Otters came in Article V, added to the International Fur Seal Treaty of 1911 signed by the United States, Japan, and Great Britain (for Canada). Although the treaty aimed to preserve economic returns from the commercial Northern Fur Seal (*Callorhinus ursinus*) harvest (Kenyon 1969; Nichol 2015; VanBlaricom 2015), Article V also prohibited the hunting of Sea Otters in international waters or >3 nautical miles (5.6 km) from shore. However, because Sea Otters generally occur closer to shore the Fur Seal Treaty may have had a limited effect on Sea Otter harvests in most parts of their range (Nichol 2015). In BC, Sea Otters were first protected under provincial law in 1931, but by that time the species had been extirpated (Cowan and Guiguet 1960; Nichol 2015).

In the US, the Southwest Alaska Sea Otter stock and the Southern Sea Otter (CA) are listed as threatened under the *Endangered Species Act*. Protection for Sea Otters was consolidated under the *Marine Mammal Protection Act* (MMPA) of 1972. Under the MMPA, Sea Otters are protected from harassment, hunting, capturing, killing, or attempts to harass, hunt, capture, or kill (VanBlaricom 2015). Provisions within the MMPA allow Indigenous people in AK to hunt Sea Otters for subsistence purposes or for creating clothing or handicrafts (1,449 Sea Otters were harvested in 2013; Raymond *et al.* 2019). With special permits, Sea Otters may be taken for research, public display, photography for educational or commercial purposes, and incidental to commercial fisheries (see VanBlaricom 2015 for a review of US laws).

The Sea Otter is listed in the *Convention on International Trade in Endangered Species* (CITES) Appendix II but the southern subspecies (*Enhydra lutris nereis*) is listed in Appendix I. Species in Appendix I are considered to be threatened with extinction and CITES prohibits commercial international trade in specimens of these species. Species in Appendix II are not necessarily threatened with immediate extinction but may become so unless trade is closely controlled (CITES n.d.). Under the *British Columbia Wildlife Act and Regulations,* the Sea Otter is considered Threatened and is protected from being hunted, trapped or killed.

Non-Legal Status and Ranks

The British Columbia Conservation Data Centre lists the Sea Otter NatureServe rank as G4, which is globally (G) secure (4). It is on the provincial Blue List (special concern) and has received a provincial rank of S3 (S = provincial status, 3 = special concern) because the species has characteristics that make it particularly sensitive or vulnerable to human activities or natural events (British Columbia Conservation Data Centre 2019).

Sea Otters are listed as Endangered under criteria A2abe by the International Union for Conservation of Nature (IUCN) because of an observed and inferred decline exceeding 50% over the last 30 years (four generations – Doroff *et al.* 2021). This listing is a result of the sharp decline in Southwest AK, a region that previously accounted for the majority of the global Sea Otter population and recent evidence that suggests that Sea Otters in the Commander and Kuril islands are also declining (Doroff *et al.* 2021).

Habitat Protection and Ownership

The Checleset Bay Ecological Reserve, off the west coast of Vancouver Island, was established in 1981 by the BC provincial government. It is a provincially protected area that includes 33,321 ha of marine habitat and is the only area that has a geographically imposed designation intended to protect Sea Otter habitat. There are invertebrate fishery closures, designated by Fisheries and Oceans Canada, for Geoduck (*Panopea generosa*), horse clams (*Tresus* spp.), Red (*Mesocentrotus franciscanus*) and Green Urchins (*Strongylocentrotus droebachiensis*), and Sea Cucumbers (*Apostichopus californicus*) in the reserve (Jamieson and Lessard 2000).

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Linda Nichol completed her MSc at the University of British Columbia (UBC) in 1990, where her research focused on patterns of Northern Resident Killer Whales occurrence in coastal areas in relation to the timing of returning salmon stocks. She has studied Sea Otters since 2001. Linda is a member of the IUCN Otter Specialist Group and currently leads the Sea Otter research program for Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, BC.

Erin Foster completed her MSc at UBC, where she studied the ecology and physiology of Pacific White-sided Dolphins. She is currently a Ph.D. candidate at the University of Victoria. Her research is focused on the foraging ecology of Sea Otters. Erin is at the Hakai Institute where she led the Sea Otter research program from 2013 to 2018.

Jane Watson completed a PhD at the University of California, Santa Cruz in 1993. Her research focuses on the community ecology of Sea Otters. She taught at Vancouver Island University (VIU) from 1996 – 2016. Jane served on the marine mammal SSC of COSEWIC from 2000 to 2012 and was co-chair from 2008 to 2012. She is Professor Emeritus at VIU.

Appendix 1. IUCN Threats Assessment for Sea Otter in Canada.

Species or Ecosystem Scientific Name	*Enhydra lutris* (Sea Otter)				
Element ID		**Elcode**			
Date:	09/04/2021				
Assessor(s):	Jane Watson (author), Linda Nichol (author), Erin Foster (author), John Ford (Co-chair), Hal Whitehead (Co-chair), Dwayne Lepitzki (facilitator), Karen Timm (COSEWIC Secretariat), Greg Wilson, Syd Cannings, Justine Mannion, Ashley Kling, Mike Hammill, Rob Stewart, Kim Parsons, Viv Tulloch, Dan Monson, Patrick O'Hara, Jennifer Yakimyshyn				
References:	draft COSEWIC status report				

Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	1	0
	C	Medium	2	1
	D	Low	0	2
Calculated Overall Threat Impact:			Very High	Medium

Assigned Overall Threat Impact:	**AC = Very High - Medium**
Impact Adjustment Reasons:	Not currently declining. Current threats have mostly negligible impact ratings and have a Medium to Low timing score and are not preventing the Sea Otter population from growing at a mean rate of +8.7% per year and continuing to expand into historical habitat. It is possible in the absence of these threats the species could be recovering even more quickly. The Very High-Medium calculated overall threat impact is due to the risk of population-level effects should there be a large-scale oil spill that affects most of the BC coast. The occurrence of such an event has high uncertainty but the risk is overall considered low. The potential future effects of bycatch and illegal killing as well as the effects of climate change on prey availability are considered Moderate-Slight and again have an uncertain timing score.
Overall Threat Comments	Generation time 7-9 years therefore time frame for severity and timing is 21-27 years into the future; population growth rate 1995-2017 is mean 8.7% per year (slower than the 20.1% during 1977-1995); currently does not occupy all historical habitat; non-migratory, exhibit high site fidelity and occupy relatively small overlapping home ranges; recovery after Exxon Valdez oil spill (Alaska, 1989, 32 years ago = 3.6-4.6 generations) depended entirely on local growth not immigration; more portions are now at K; dispersal to central coast (1989) from Vancouver Island (1969-1972) took 1.9-2.9 generations); Fig 2 shows range in BC; 4055 otters estimated. Threats are all in the future with uncertain timing.

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops					
2.2	Wood & pulp plantations					
2.3	Livestock farming & ranching					In California agricultural runoff (including sewage) may affect pathogen levels in Sea Otters (also see Section 8.1 and 9.3). This is not known to occur in BC because the range of Sea Otters does not overlap with agriculture at this time. Harmful algal blooms (HABs) can be intensified by agricultural runoff into the marine environment. HABs produce biotoxins, and have occasionally affected sea otters in CA but this appears negligible in BC.
2.4	Marine & freshwater aquaculture					Sea otters are not known to be affected by aquaculture at this time. Aquaculture activities for beach-grown clams and oysters could affect Sea Otters in the future if otters were to be excluded from using beaches to forage, or were seen as a threat to aquaculture activities (see Section 5.4). Aquaculture is not presently a threat – but may be over the next 3 generations.
3	Energy production & mining					
3.1	Oil & gas drilling	Not Calculated (outside assessment timeframe)			Low (Possibly in the long term, >10 yrs/3 gen)	Not a threat at this time - possibly in the future. There is presently a moratorium on offshore drilling and oil exploration but the status of such moratoria is determined by the Canadian government that is in power, a time scale that differs from that of Sea Otter generation time, and could change in the future
3.2	Mining & quarrying					
3.3	Renewable energy					Renewable energy is not presently a threat to Sea Otters. The only sea-bed proposal for a windfarm (Haida Gwaii) is presently outside of the range of Sea Otters. Such developments may pose a negligible threat in the next 3 generations.
4	Transportation & service corridors	Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate - Low	
4.1	Roads & railroads					
4.2	Utility & service lines					
4.3	Shipping lanes	Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate - Low	Not currently causing a population decline, but may be contributing to slowing growth of the population Boat strikes are mostly from small craft, particularly in areas where small vessels enter and depart restricted harbour mouths. Boat strikes will increase over the next 10 years (scope). Although only three such strikes have been reported since 2004, this is a gross underestimate of the "ship strike" incidence since they are rarely reported and Sea Otters occur in remote areas, furthermore most otter carcasses are quickly scavenged and carcass recovery (for otters dying of any cause) is uncommon.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.4	Flight paths						
5	Biological resource use	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate - Low	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate - Low	Not currently causing a population decline, but may be contributing to slowing growth of the population. This is will increase in the next 10 years, as sea otters expand into areas used by humans (expansion southward along the east and west sides of Vancouver Island). This includes poaching for pelts, persecution (sea otters compete with humans for invertebrate species) and bycatch in nets and traps. Bycatch is likely the lowest source of mortality compared to poaching and persecution. There are proposals for Indigenous directed harvest, which would be managed as a fishery – so it should not be a threat. However, where legal markets develop, black markets often flourish / develop. Recently, sea otter pelts have been sold from Russia into China, in a black market in trade for pelts.
6	Human intrusions & disturbance		Negligible	Pervasive (71-100%)	Negligible (<1%)	Moderate - Low	
6.1	Recreational activities		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate - Low	Not currently causing a population decline, but may be contributing to slowing growth of the population, Boat traffic within Sea Otter habitat will increase – both from directed Sea-Otter watching and nondirected recreational traffic. Disturbance may exclude otters from habitat; in particular mothers with pups disperse quickly in response to boat traffic. While males may be less sensitive to disturbance (they may habituate to some degree), continually disturbing females with pups may affect pup survival
6.2	War, civil unrest & military exercises						Military exercises do not currently take place in or near Sea Otter habitat
6.3	Work & other activities		Negligible	Pervasive (71-100%)	Negligible (<1%)	Moderate - Low	Not currently causing a population decline, but may be contributing to slowing growth of the population. Research directed at Sea Otters is under permit and poses negligible disruption. Sea otter censuses aim to not disturb otters, because they become more difficult to count. Foraging observations are done from shore, without affecting otter behaviour. At present, the research conducted on BC Sea Otters has a negligible effect.
7	Natural system modifications						
7.1	Fire & fire suppression						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						Presently, there is no evidence that human competition for prey is having a direct effect on Sea Otter population growth. Where otters are expanding their range, the population is growing at close to or in excess of (due to male rafts arriving) physiological maximum, suggesting that prey availability is not limiting population growth.
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
8.1	Invasive non-native/alien species/diseases		Unknown	Unknown	Unknown	Moderate - Low	In California, *Toxoplasma gondii* from felids and *Sarcocystis neurona* from opossums (not yet common in BC) oocysts enter the marine ecosystems via runoff and infect prey that is then consumed by Sea Otters. Neither parasite is presently thought to be important in limiting Sea Otter population growth in BC with a prevalence of 12% (*Toxoplasma*) and 5% (*Sarcocystis)* in 95 otters sampled from 2003-2011. In 2006 one Sea Otter necropsied on Vancouver Island (2006) died from *Sarcosystis*. However, in nearby WA state 30% (n=30) of captured otters and 54% (n=333, 2002-2012) of carcasses recovered tested positive for one or both of these pathogens.
8.2	Problematic native species/diseases						Predation or incidental mortality from predators is not likely limiting in BC, although incidental death from White Sharks in California and possibly Killer Whale predation in Alaska is thought to be responsible for the lack of range expansion (limiting factor) and a drastic population decline respectively (threat).
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	Moderate - Low	
9.1	Domestic & urban waste water						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	Moderate - Low	Not causing a population level decline at present, although may contribute to slowing population growth. Oil destroys the water repellency of fur causing hypothermia and often death. Oil ingested from grooming and from prey can cause organ failure and death. The effect of an oil spill will depend on what, where and how much is spilled, the time of year, and weather conditions. A large scale spill could affect Sea Otters throughout their current range in BC. Even a small spill could have wide-ranging effects (e.g., the Nestucca spill). Oil has long-term effects because it contaminates the substrate Sea Otters forage in and contaminates prey. Three generations were required for Sea Otter recovery following the Exxon Valdes oil spill. In BC vessel traffic will increase in the future; tanker traffic is expected to double in the next 15 years and vessels associated with the Transmountain Pipeline will increase 7-fold compared to 2018 volumes. Small to medium spills are more of a threat because 95% occur nearshore, they cause significant damage, and occur more frequently than large spills. For example; annually, fuel-carrying barges, move ~ 48 billion litres of petroleum products along the inner coast of BC and since 2016, two incidents involving fuel barges have occurred in the range of Sea Otters on BC's central coast. Chronic small spills (e.g., fueling, bilge water) which are most frequent, pose an unknown and undocumented threat to Sea Otters.
9.3	Agricultural & forestry effluents		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Not causing a population level decline at present, although may contribute to slowing population growth. Sea Otters bio-accumulate organic pollutants in their tissues 60 to 240 times higher than found in their prey, however a link between contaminant levels and an increased incidence of disease has not been shown in Sea Otters. Contaminants are not considered a threat in BC.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate - Low	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate - Low	Not causing a population level decline at present, although may contribute to slowing population growth. Ocean acidification is expected to affect invertebrate recruitment and thus food availability for Sea Otters. Changes in carbonate chemistry will also affect how kelp and seagrass ecosystems function, both of which are important to otters and their prey. Increasing sea temperatures may affect Sea Otters, but the effects are at present unknown and could be both direct and indirect. In central California during the marine heat wave (2013-2014) and following ENSO event (2015-2016) large numbers of sea urchins recruited and denuded kelp forests. Although an increase in prey, they were not eaten by Sea Otters, because they contained little soft tissue mass. A similar invertebrate recruitment event occurred in BC (Watson pers obs.). However, in areas with Sea Otters, the urchins accessible to otters were eaten by otters. It is not clear if these recruitment events are associated with the loss of seastar predators from seastar wasting diseases (SWD – see section 11.5) and better survival of new recruits, recruitment processes facilitated by warm water, or a combination of both. The effects of SWD or marine heat waves on Sea Otters can only be speculated upon at this time.
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						Changing ocean temperatures may also change the incidence of harmful algal blooms and could increase the incidence and spread of disease among marine organisms, with unpredictable effects on Sea Otter populations. For example, sea star wasting disease which resulted in the loss of predatory sea stars may cause changes in prey density for Sea Otters, effects that can only be speculated on at this point.

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).