

Petition to Reintroduce Sea Otters (*Enhydra lutris*) to the U.S. West Coast



Photo credit: Marc Webber, USFWS



Center for Biological Diversity

January 19, 2023

Notice of Petition

The Honorable Deb Haaland
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Martha Williams, Director
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Dear Secretary Haaland and Director Williams:

Pursuant to the Administrative Procedure Act¹ and Endangered Species Act,² the Center for Biological Diversity hereby petitions the Secretary of the Interior and U.S. Fish and Wildlife Service to reintroduce sea otters (*Enhydra lutris*) throughout their historic range along the U.S. West Coast as an experimental population(s) under section 10(j) of the Endangered Species Act. Specifically, the Center requests that reintroduction occur from San Francisco Bay north into Oregon as described in the U.S. Fish and Wildlife Service's 2022 *Feasibility Assessment: Sea Otter Reintroduction to the Pacific Coast*.³ This region represents the largest gap in the otter's historical range and encompasses habitats that fell within the historic transition zone between northern sea otters and southern sea otters.⁴ Subsequent to reintroduction in this northern zone, the Center requests that the U.S. Fish and Wildlife Service (FWS) conduct an assessment to determine the feasibility of reintroducing otters into the 800-km zone stretching from southern California to central Baja California, Mexico.⁵

Reintroduction is necessary to return sea otters throughout their historic U.S. range, to recover the threatened southern sea otter, and to restore important coastal ecosystems including kelp forests and seagrass beds.⁶ The U.S. Fish and Wildlife Service has determined that reintroducing sea otters to northern California and Oregon is biologically, ecologically, socioeconomically, and legally feasible.⁷ Without reintroduction, sea otters are unlikely to repopulate the existing gaps in their historical range, particularly in the face of increasing threats including white shark bite

¹ 5 U.S.C. §553(e).

² 16 U.S.C. § 1533(h) and 1539(j).

³ U.S. Fish & Wildlife Serv., *Feasibility Assessment: Sea Otter Reintroduction to the Pacific Coast* (2022). This Feasibility Assessment, in turn, relied heavily on the Elakha Alliance Draft Feasibility Study (2021), available at <https://www.elakhaalliance.org/feasibility-study/>, which considered the biological, ecological, legal, economic, and social dimensions of sea otter reintroduction into Oregon. Both of these documents and all literature cited therein are hereby incorporated by reference.

⁴ USFWS, *supra* note 3, at vi, 3-4, 29.

⁵ *Id.* at 3. Reintroduction in Mexico would require international cooperation with the proper authorities in that country.

⁶ *Id.* at vii.

⁷ *Id.* at 140.

mortality.⁸ The Center thus requests that the Service commence a reintroduction program immediately to ensure the conservation of this iconic species.

Respectfully submitted this 19th day of January, 2023.

A handwritten signature in cursive script that reads "Kristin Carden".

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⁸ USFWS, *supra* note 3, at 121.

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Executive Summary

Hundreds of thousands of sea otters (*Enhydra lutris*) once lived across the North Pacific rim. The commercial fur trade devastated the species, wiping out 99% of these iconic animals. While California's sea otters are protected under the U.S. Endangered Species Act, their foothold is tenuous. Population growth is flat and range expansion—critical for the species' conservation—has stalled. Reintroduction of sea otters to their historic range along the U.S. West Coast is necessary for the species' survival and persistence. This petition calls on the U.S. Fish and Wildlife Service to immediately commence with a reintroduction program that focuses on reestablishing sea otters from San Francisco Bay north through Oregon, and subsequently doing an assessment to determine the feasibility of reintroducing otters from southern California through central Baja California, Mexico.

Sea otters are North America's smallest marine mammal. They are unique among marine mammals in that they rely on a dense layer of fur rather than blubber to keep warm. This thick fur made the species attractive to commercial fur traders who engaged in a wholesale slaughter of sea otters throughout their range. So effective was this effort that fur traders nearly drove the species to extinction. In fact, the species was thought to be extinct in California until a group of approximately 50 survivors was discovered near Monterey Bay in the early 20th century. From this small groups of founders grew the entire extant sea otter population in California, today numbering approximately 2,962 individuals.

Reintroductions have proven instrumental in helping sea otters recover in portions of their range. Fifty-nine northern sea otters translocated from Alaska to Washington State in 1969-70 helped establish a population in that state. Yet no otters inhabit Oregon and range expansion in California effectively has ceased. Threats posed by climate change, disease, and white shark bites limit the species' ability to recover without active assistance. Given their limited range and numbers, sea otters in California remain vulnerable to catastrophic events such as oil spills that could decimate the species and make it difficult to recover. The species' low genetic diversity further complicates natural recovery prospects. Reintroduction is necessary to connect the southern and northern sea otter populations and further sea otter conservation.

Reintroducing sea otters throughout their historical range in the United States not only would further the species' recovery, it also would recover vital coastal ecosystems including kelp forests and seagrass beds. Sea otters are a keystone species—that is, a species that plays an outsize role in its ecosystem. By keeping prey populations (*e.g.*, sea urchins, crabs) in check, sea otters help promote growth of kelp and seagrasses. Kelp and seagrass ecosystems, in turn, provide critical food, shelter, and nursery habitat for a diversity of species. They also provide ecosystem services to coastal communities by, *e.g.*, helping buffer coastlines from storm surges and erosion and sequestering CO₂.

Sea otter reintroduction would help to achieve the vision behind two of the United States' primary conservation laws: the Endangered Species Act and Marine Mammal Protection Act. It would help reestablish an iconic keystone species that for too long has been absent from the majority of its historic range in the United States. It also would help restore the coastal ecosystems upon which sea otters and so many other species including humans depend. Reintroduction is necessary to achieve sea otter recovery and the U.S. Fish and Wildlife Service should proceed promptly with initiating a reintroduction program.

I. Statutory & Regulatory Framework

Marine mammal management authority is vested in the federal government.⁹ The U.S. Fish and Wildlife Service (FWS) provides a detailed discussion of the legal framework pertaining to sea otter reintroduction in its 2022 Feasibility Assessment.¹⁰ The following subsections provide a brief overview of the two primary laws that would come into play in a reintroduction effort: the Endangered Species Act and Marine Mammal Protection Act.¹¹

A. *Endangered Species Act*

Sea otter reintroduction would further the goals of the U.S. Endangered Species Act (ESA).¹² The ESA was enacted “to halt and reverse the trend toward species extinction, whatever the cost.”¹³ It seeks to “provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species.”¹⁴

To receive the protections of the ESA, a species must be listed as “threatened” or “endangered.” An endangered species is one that is at risk of extinction throughout all or a significant portion of its range.¹⁵ A threatened species is one that is likely to become endangered in the foreseeable future.¹⁶ Vertebrate “species” are defined to include species, subspecies, and distinct population segments (DPSs).¹⁷ The southern sea otter subspecies and Southwest Alaska DPS of northern sea otter were listed as threatened under the ESA in 1977 and 2005, respectively.¹⁸ Both of these threatened populations have been extended some or all of the protections of endangered species through 4(d) rules.¹⁹

The ESA calls upon “all Federal departments and agencies [to] seek to conserve endangered species and threatened species and ... utilize their authorities in furtherance of the purposes of”

⁹ USFWS, *supra* note 3, at 105; see also 16 U.S.C. § 1379.

¹⁰ See generally USFWS, *supra* note 3, at 92-108.

¹¹ FWS would need to comply with all additional applicable legislation including, *e.g.*, the National Environmental Policy Act, 42 U.S.C. § 4321 *et seq.*, Coastal Zone Management Act, 16 U.S.C. § 1451 *et seq.*, Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1801 *et seq.*, and Animal Welfare Act, 7 U.S.C. § 2131 *et seq.* Reintroduction of sea otters to their historical range would help achieve the Coastal Zone Management Act’s policy “to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation’s coastal zone for this and succeeding generations.” 16 U.S.C. § 1452(1).

¹² 16 U.S.C. § 1531 *et seq.*

¹³ *Tenn. Valley Auth. v. Hill*, 437 U.S. 153, 184 (1978).

¹⁴ 16 U.S.C. § 1531(b).

¹⁵ *Id.* § 1532(6).

¹⁶ *Id.* § 1532(20).

¹⁷ *Id.* § 1532(16).

¹⁸ U.S. Fish & Wildlife Serv., *Endangered and Threatened Wildlife and Plants, Determination that the southern sea otter is a threatened species*, 42 Fed. Reg. 2965 (Jan. 14, 1977) (southern sea otter listing); Fish & Wildlife Serv., *Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Southwest Alaska Distinct Population Segment of the Northern Sea Otter (Enhydra lutris kenyoni)*, 70 Fed. Reg. 46,366 (Aug. 9, 2005) (SW AK DPS listing).

¹⁹ USFWS, *supra* note 3, at 101; see 50 C.F.R. § 17.31 (42 Fed. Reg. 2965 (Jan. 14, 1977)); Fish & Wildlife Serv., *Endangered and Threatened Wildlife and Plants; Special Rule for the Southwest Alaska Distinct Population Segment of the Northern Sea Otter*, 71 Fed. Reg. 46,864 (Aug. 15, 2006).

the law.²⁰ The ESA defines “conserve” and “conservation” to mean “to use and the use of all methods and procedures which are necessary to bring any endangered species to the point at which the measures provided pursuant to this act are no longer necessary”—*i.e.*, until the species has recovered.²¹ One such measure is species reintroduction.²²

Reintroduction can be facilitated through section 10(j) of the ESA, which provides for the establishment of experimental populations. Pursuant to ESA section 10(j), FWS may introduce a species into an area outside of its current range as an “experimental population” if doing so will further the species’ conservation.²³ This designation affords the reintroduced animals with the protections of an ESA “threatened” species.²⁴ A 10(j) rule must designate clear geographic boundaries for the experimental population, and the experimental population must be geographically separated from established nonexperimental populations of the species.²⁵ The rule also must specify whether the experimental population is “essential to the continued existence of the species” or nonessential.²⁶

Critical habitat is not designated for nonessential 10(j) populations and section 7 consultation generally does not apply since the population (unless it is found within the National Park System or National Wildlife Refuge System) is treated as “proposed to be listed.”²⁷ That said, ESA section 7(a)(2)—which requires that “[e]ach Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency ... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species”²⁸—would still apply to sea otter reintroduction efforts in a handful of contexts.²⁹ For example, if FWS proposed using sea otters from a listed stock as the source of a reintroduced population, the agency would need to obtain necessary permits under ESA section 10(a)(1)(A).³⁰

Reintroducing sea otters to their historic range along the U.S. West Coast pursuant to section 10(j) would promote the conservation and recovery of sea otters and the ecosystems upon which they depend, fulfilling the goals of the ESA.

B. Marine Mammal Protection Act

Sea otter reintroduction also will help fulfill the goals of the Marine Mammal Protection Act (MMPA).³¹ All marine mammals, including sea otters, are protected under the MMPA. One of

²⁰ 16 U.S.C. § 1531(c)(1).

²¹ *Id.* § 1532(3).

²² *Id.* § 1539(j)(2)(A).

²³ *Id.* § 1539(j); 50 CFR §17.80-81.

²⁴ 16 U.S.C. § 1539(j)(2)(C).

²⁵ *Id.* § 1539(j)(3).

²⁶ *Id.* § 1539(j)(2)(B).

²⁷ *Id.* § 1539(j)(2)(C).

²⁸ *Id.* § 1536(a)(2).

²⁹ For example, it is possible that reintroduction may affect other ESA-listed species (*e.g.*, marbled murrelet). FWS would have to consult on those species. See USFWS, *supra* note 3, at 102.

³⁰ 16 U.S.C. § 1531(a)(1)(A).

³¹ 16 U.S.C. § 1361 *et seq.*

the express purposes of the MMPA is to ensure that marine mammal species or stocks do not “diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part” or “diminish below their optimum sustainable population.”³² Sea otters on the U.S. West Coast fall well below their optimum sustainable population (OSP).³³ The MMPA provides that “[f]urther measures should be immediately taken to replenish any species or population stock which has already diminished below that [optimum sustainable] population.”³⁴ Such measures include reintroduction, which will help grow the West Coast sea otter population so that it achieves or surpasses OSP.

The MMPA will help protect reintroduced sea otters through the statute’s take prohibitions. The Act prohibits the “take” of marine mammals under U.S. jurisdiction, defined to include actions that “harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.”³⁵ The law provides an exception for incidental take under certain circumstances.³⁶ Sea otter reintroduction would include activities (*e.g.*, capture, handling, transport) that constitute direct take under the MMPA, and thus would require authorization and permitting through Application Form 3-200-43.³⁷ Such permits could be issued since sea otter reintroduction would “enhanc[e] the survival or recovery of [the] species.”³⁸ The translocation and reintroduction process would be noticed in the Federal Register and include a public comment period.³⁹ Incidental take authorizations (excepting those pertaining to commercial fishing) may be issued as needed.⁴⁰

* * * * *

In sum, the ESA and MMPA provide FWS with both the authority and the mandate to reintroduce sea otters throughout their historic range along the U.S. West Coast to further the species’ population growth, conservation, and recovery. Reintroduction also will help recover kelp bed and seagrass ecosystems in furtherance of the ESA’s goals. The remainder of the petition discusses the sea otter: its biology, ecology, and history; threats to the species’ continued existence; and the need for reintroduction. Draft regulatory text to effectuate a reintroduction program is provided.

³² Id. § 1361(2).

³³ U.S. Fish & Wildlife Serv. (USFWS), Southern Sea Otter (*Enhydra lutris nereis*) Stock Assessment 5, 12 (2021); Tinker, M.T. et al., Habitat features predict carrying capacity of a recovering marine carnivore, 85 J. Wildlife Mgmt. 303, 303 (2021). The optimum sustainable population represents 59.4% of the projected carrying capacity. USFWS, *supra* note 3, at 34. For this reason and because southern sea otters both are listed under the ESA, they are considered “depleted” and a “strategic stock” under the MMPA. 16 U.S.C. § 1362(1)(A), (C), (19)(C). See also USFWS, *supra* note 3, at 93.

³⁴ 16 U.S.C. § 1361(2).

³⁵ Id. §§ 1362(16), 1371.

³⁶ See generally *id.* § 1371.

³⁷ USFWS, *supra* note 3, at 95.

³⁸ 16 U.S.C. § 1374(c)(1).

³⁹ USFWS, *supra* note 3, at 95.

⁴⁰ 16 U.S.C. §§ 1371(a)(5)(E)(vi), 1387(a)(4); USFWS, *supra* note 3, at 95, 97.

II. Introduction to Sea Otters

A. Taxonomy

Sea otters are one of North America's most recognizable and cherished wildlife species. Accepted sea otter taxonomy is as follows:

Kingdom: Animalia
Phylum: Chordata
Subphylum: Vertebrata
Class: Mammalia
Order: Carnivora
Family: Mustelidae
Subfamily: Lutrinae
Genus: *Enhydra*
Species: *lutris*

Skull morphology and molecular variation have led to the recognition of three sea otter subspecies: *E. lutris lutris* found in the Kuril Islands, Commander Islands, and Kamchatka Peninsula in Russia; the northern sea otter *E. lutris kenyoni* found in Alaska south to Washington State; and the southern sea otter *E. lutris nereis*, which historically ranged from Oregon to Mexico but currently is found only in California.⁴¹

B. Life History & Behavior

Sea otters are North America's smallest marine mammal.⁴² They exhibit sexual dimorphism with males growing larger than females.⁴³ Adult males reach lengths of 47-56" and weights of 49-88 lbs., whereas adult females grow to 45-52" in length and weigh 31-71 lbs.⁴⁴ Males reach sexual maturity at 5-6 years and females between 2-4 years.⁴⁵ Females give birth to a single pup that is weaned around 6 months of age.⁴⁶ Pupping occurs year-round with some weak seasonality.⁴⁷ In the wild, males typically live 10-15 years and females 15-20 years.⁴⁸

Sea otters are unique in that they rely on a dense, water-resistant fur coat rather than blubber to keep warm.⁴⁹ They are susceptible to hypothermia and death if their pelage becomes compromised through fouling, oiling, or insufficient grooming.⁵⁰

⁴¹ USFWS, supra note 3, at 15.

⁴² Id. at 9.

⁴³ Id.

⁴⁴ Id.

⁴⁵ Id. at 12.

⁴⁶ USFWS, supra note 3, at 12.

⁴⁷ Id.

⁴⁸ Id. at 9.

⁴⁹ Id. at 11.

⁵⁰ Id. at 10.

Sea otters occupy nearshore coastal ecosystems including kelp beds, bays, and estuaries.⁵¹ They typically are restricted to relatively shallow waters (up to 40 m), with highest otter densities in California occurring at depths of 5 m—a depth which often brings them close to shore.⁵² Sea otters dive for a diversity of prey, which varies by habitat and includes numerous benthic macroinvertebrates such as urchins, clams, abalone, crabs, sea cucumbers, worms, scallops, octopuses, sea snails, and mussels.⁵³ Individual otters tend to specialize on a few select prey items.⁵⁴ Because of their high metabolic requirements, sea otters must consume 20-30% of their body weight in prey daily.⁵⁵ If these needs are not met, female sea otters may abandon their pups, leading to high variability in pup survival rates.⁵⁶

Sea otters are a social species, and they live in sex-specific groups called “rafts.”⁵⁷ Females tend to be sedentary and exhibit site fidelity, whereas non-territorial males may disperse more broadly.⁵⁸ Territorial males exhibit site fidelity, defending high-quality habitats containing females and pups.⁵⁹ Home range size is a function of sex, reproductive status, season, habitat, and prey availability.⁶⁰ In California, home ranges average 8.6 km of coastline and 6.5-10 km² (for males) and 7.5-7.8 km² (for females).⁶¹

C. Sea Otter Role in Coastal Ecosystems

Sea otters serve as a keystone species because of the outside role they play in maintaining coastal ecosystem structure and function.⁶² As an apex predator, sea otters help keep herbivore populations (*e.g.*, sea urchins) in check, in turn protecting kelp forests and seagrass beds.⁶³ The sea otter-urchin-kelp trophic cascade has received a great deal of research attention.⁶⁴ In short, sea otter consumption of sea urchins, which eat kelp, allows kelp forests to flourish.⁶⁵ This is true even in systems where other urchin predators occur.⁶⁶ For example, another urchin predator, the sunflower sea star (*Pycnopodia helianthoides*), recently succumbed to a climate change-induced wasting disease epidemic along the U.S. West Coast.⁶⁷ The presence of sea otters appears to have somewhat ameliorated the outcome for kelp in affected areas.⁶⁸

⁵¹ USFWS, *supra* note 3, at 9, 10.

⁵² *Id.* at 10, 40.

⁵³ *Id.* at 9.

⁵⁴ *Id.* at 10.

⁵⁵ *Id.* at 11.

⁵⁶ USFWS, *supra* note 3, at 12.

⁵⁷ *Id.* at 11.

⁵⁸ *Id.*

⁵⁹ *Id.*

⁶⁰ *Id.*

⁶¹ USFWS, *supra* note 3, at 12.

⁶² Estes, J.A. & M.T. Tinker, Ch. 5: Ecosystem effects of otters at 13, in Elakha Alliance, *supra* note 3; USFWS, *supra* note 3, at 13.

⁶³ Estes & Tinker, *supra* note 62, at 13; USFWS, *supra* note 3, at 13-14, 37, 56-58.

⁶⁴ Estes & Tinker, *supra* note 62, at 13; USFWS, *supra* note 3, at 56.

⁶⁵ Estes & Tinker, *supra* note 62, at 7-8; USFWS, *supra* note 3, at 56.

⁶⁶ USFWS, *supra* note 3, at 56.

⁶⁷ *Id.*

⁶⁸ *Id.*

Otters likewise have important conservation implications for seagrass ecosystems.⁶⁹ The return of sea otters to estuaries impacted by eutrophication-induced algal overgrowth has led to seagrass regeneration.⁷⁰ This resulted from the otters' predation on crabs, which released isopods and sea hares from predation. The isopods and sea hares were able to eat the algal overgrowth off of seagrass blades, allowing it to recover.⁷¹ Sea otters likely have impacts on other soft-sediment ecosystems as well, though these have not been as well studied.⁷² Sea otters also appear to have important evolutionary influence on kelp forest and seagrass ecosystems, for example, by facilitating genetic diversity in eelgrass.⁷³

In sum, sea otter populations support healthy kelp forest and seagrass ecosystems, which in turn provide a wide diversity of species—including imperiled species such as abalone and the marbled murrelet (*Brachyramphus marmoratus*)—with food, shelter, and nursery habitat.⁷⁴ These coastal systems also provide important ecosystem services such as storm surge buffering, erosion control, carbon sequestration, and amelioration of ocean acidification.⁷⁵ Sea otter restoration allows degraded habitats to quickly recover and enhances ecosystem resilience.⁷⁶

D. Abundance and Trends

Sea otters historically ranged across the North Pacific rim from Japan through Russia, across to Alaska, and down through Canada and the United States West Coast to central Baja California, Mexico.⁷⁷ See Fig. 1. The global population prior to the fur trade numbered from 150,000-300,000 individuals.⁷⁸

Commercial fur trading began soon after Russian explorers happened upon the species in 1741.⁷⁹ The species' small home ranges and sedentary nature made them particularly vulnerable to overexploitation, and populations were serially extirpated.⁸⁰ The fur trade decimated species populations in the 18th and 19th centuries, killing 99% of sea otters and leaving only a few hundred to 2000 animals across 13 remnant colonies.⁸¹ Eleven of those colonies survived and served as founders for the sea otters alive today.⁸² Most of the Pacific Coast of the lower 48

⁶⁹ Estes & Tinker, supra note 62, at 11.

⁷⁰ Id.

⁷¹ Id.

⁷² Id.

⁷³ Id. at 12-13.

⁷⁴ USFWS, supra note 3, at 59.

⁷⁵ Estes & Tinker, supra note 62, at 8-9; USFWS, supra note 3, at 14, 37-38.

⁷⁶ USFWS, supra note 3, at 14, 57-58.

⁷⁷ Davis, Randall W. et al., Future directions in sea otter research and management, 5 *Frontiers Marine Sci.* 510, at 1 (2019).

⁷⁸ Id.; Doroff, A. & A. Burdin, *Enhydra lutris*, sea otter, The IUCN Red List of Threatened Species, at 2, 5 (2015); Larson, Shawn & M. Tim Tinker, Ch. 4: Genetic and historical consideration of Oregon sea otters at 1, in Elakha Alliance, supra note 3.

⁷⁹ USFWS, supra note 3, at 17.

⁸⁰ Id.

⁸¹ Id. at 18; Davis et al., supra note 77, at 2; Doroff & Burdin, supra note 78, at 3, 5.

⁸² Larson & Tinker, supra note 78, at 1.

states has been without sea otters for over a century, and Oregon completely lacks an otter population.⁸³

The southern sea otter (*E. lutris nereis*),⁸⁴ which historically ranged from southern Oregon to present-day Punta Abreojos, Baja California, was driven nearly to extinction.⁸⁵ From an estimated pre-fur trade population of ~16,000, approximately 50 individuals survived near Bixby Creek in Monterey County, California; these otters founded the extant population.⁸⁶ Today, southern sea otters occupy nearshore waters from San Mateo County to Santa Barbara County, California, and on San Nicolas Island in Ventura County.⁸⁷ See Fig. 1. The highest concentration of southern sea otters occurs in the rocky, kelp-dominated central portion of the range from Seaside to Cayucos.⁸⁸

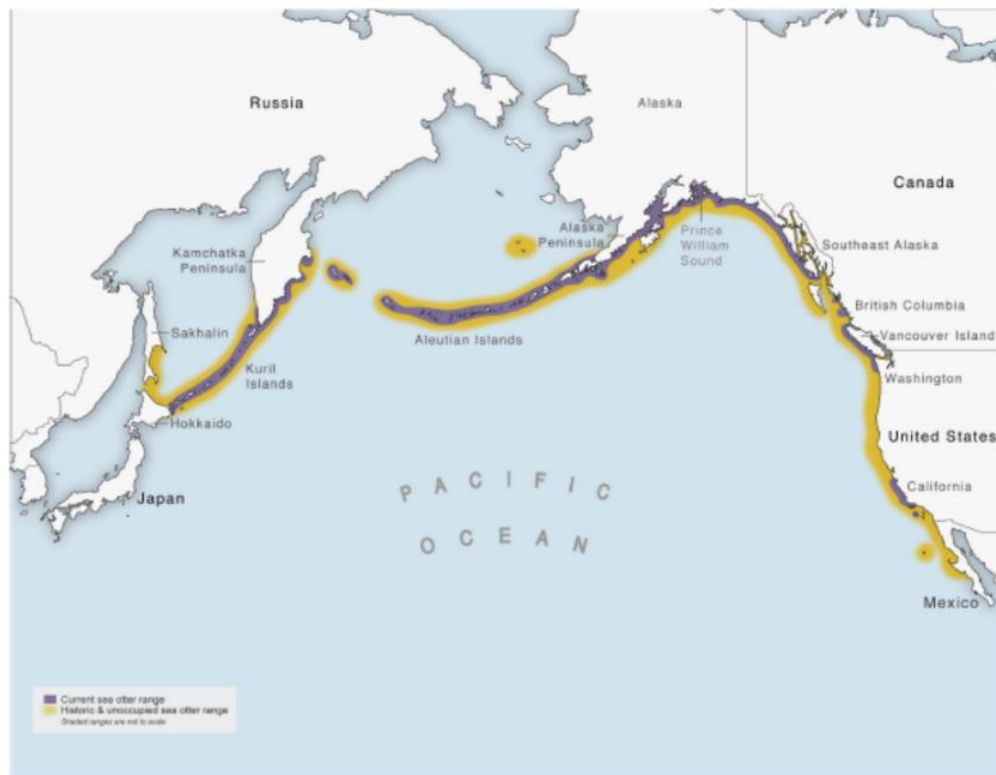


Fig. 1. Historic (yellow) and present-day (purple) distribution of sea otters (figure from Davis et al. (2019)).⁸⁹

⁸³ USFWS, supra note 3, at 1-2, 4; Larson & Tinker, supra note 78, at 1.

⁸⁴ Davis, John & W.Z. Lidicker, Jr., The taxonomic status of the southern sea otter, 14 Proc. Nat'l Acad. Sci. 429 (1975).

⁸⁵ USFWS, supra note 33, at 1; Wilson, D.E. et al., Geographic variation in sea otters, *Enhydra lutris*, 72 J. Mammalogy 22 (1991).

⁸⁶ USFWS, supra note 33, at 1; Doroff & Burdin, supra note 78, at 6.

⁸⁷ USFWS, supra note 33, at 1; Marine Mammal Commission, Southern Sea Otter (2022).

⁸⁸ USFWS, supra note 33, at 1.

⁸⁹ Davis et al., supra note 77, at 3, Fig. 2.

Despite over a century of protection, the southern sea otter population numbers only a fraction of its historic abundance and occupies only 13% of its historic range.⁹⁰ Population growth is flat and range expansion—a key component of recovery—has stalled.⁹¹ The most recent stock assessment provides a minimum population estimate of 2,962 otters (*see* Fig. 2).⁹² This is well below the number of otters than the contiguous U.S. Pacific Coast can support.⁹³

⁹⁰ Nicholson, Teri E. et al., Gaps in kelp cover may threaten the recovery of California sea otters, 41 *Ecography* 1751 (2018); Miller, Melissa A. et al., Predators, Disease, and Environmental Change in the Nearshore Ecosystem: Mortality in Southern Sea Otters (*Enhydra lutris nereis*) from 1998-2012, 7 *Frontiers Marine Sci.* 582, at 2 (2020); USFWS, *supra* note 3, at 33; USFWS, *supra* note 33, at 1; Marine Mammal Commission, *supra* note 87.

⁹¹ Nicholson et al., *supra* note 90, at 1751; Miller et al., *supra* note 90, at 2, 20; USFWS, *supra* note 3, at 33, 36 (noting that there has been no net range expansion for 20 years and that such expansion is required to reach optimum sustainable population); *id.* at 1, 2, 5; Davis et al., *supra* note 77, at 3; Doroff & Burdin, *supra* note 78, at 1; Doroff, A.M. et al., Status review: sea otter (*Enhydra lutris*) population status and trend, 28A *Proc. Xth Int'l Otter Colloquium, IUCN Otter Spec. Group Bull.* 22 (2011); Gerber, Leah R. et al., Mortality sensitivity in life-stage simulation analysis: a case study of southern sea otters, 14 *Ecological Applications* 1554 (2004) (noting slow population recovery of southern sea otters compared to other recovering populations); Lafferty, Kevin D. & M. Tim Tinker, Sea otters are recolonizing southern California in fits and starts, 5 *Ecosphere* 50 (2014). Population growth/decline is variable throughout the otter's range, with annual growth of 2.4% in the central portion of the range and 9.6% on San Nicolas Island, and annual decline of -8.7% in the northern periphery and -1.6% in the southern periphery. USFWS, *supra* note 33, at 3.

⁹² USFWS, *supra* note 33, at 2, 5; Hatfield, Brian B. et al., California Sea Otter (*Enhydra lutris nereis*) Census Results, Spring 2019, U.S. Geological Survey Data Series 1118 (2019). While the southern sea otter population reached the Recovery Plan's three-year index population threshold of 3,090 animals in 2018, a recent study by Gagne et al. revealed inaccurate assumptions made in the Recovery Plan regarding the effective population size needed to ensure species recovery. The authors concluded that the value of $N_e \geq 500$ required by the extant Recovery Plan is not appropriate and recommended that new delisting criteria be developed for the southern sea otter. Gagne, Roderick B. et al., Measures of effective population size in sea otters reveal special considerations for wide-ranging species, 11 *Ecological Applications* 1779, 1779, 1787 (2018). See also U.S. Fish & Wildlife Serv., Final revised recovery plan for the southern sea otter (*Enhydra lutris nereis*) (2003). While the general principle that $N_e > 500$ is a useful estimation, it is not applicable to all situations. Gagne et al. at 1780. See also USFWS, *supra* note 33, at 11; Forester, Brenna R. & Tanya M. Lama, Ch. 11: The role of genomics in the future of ESA decision-making, in Baier, Lowell E. & John Organ (eds.), *The Codex of the Endangered Species Act: The Next Fifty Years – Vol. II* (in press). Such revision is especially appropriate given the recent decline in population trajectory.

⁹³ The estimated carrying capacity is 17,226 in California and the optimum sustainable population level is 10,236. USFWS, *supra* note 33, at 1, 5, 12; Tinker et al., *supra* note 33, at 303. The optimum sustainable population represents 59.4% of the projected carrying capacity. USFWS, *supra* note 3, at 34. These numbers, in turn, represent a fraction of the carrying capacity and optimum sustainable population of otters throughout the species' U.S. range. *Id.* Simply put, optimum sustainable population for southern sea otters cannot be reached without range expansion. *Id.* at 36.

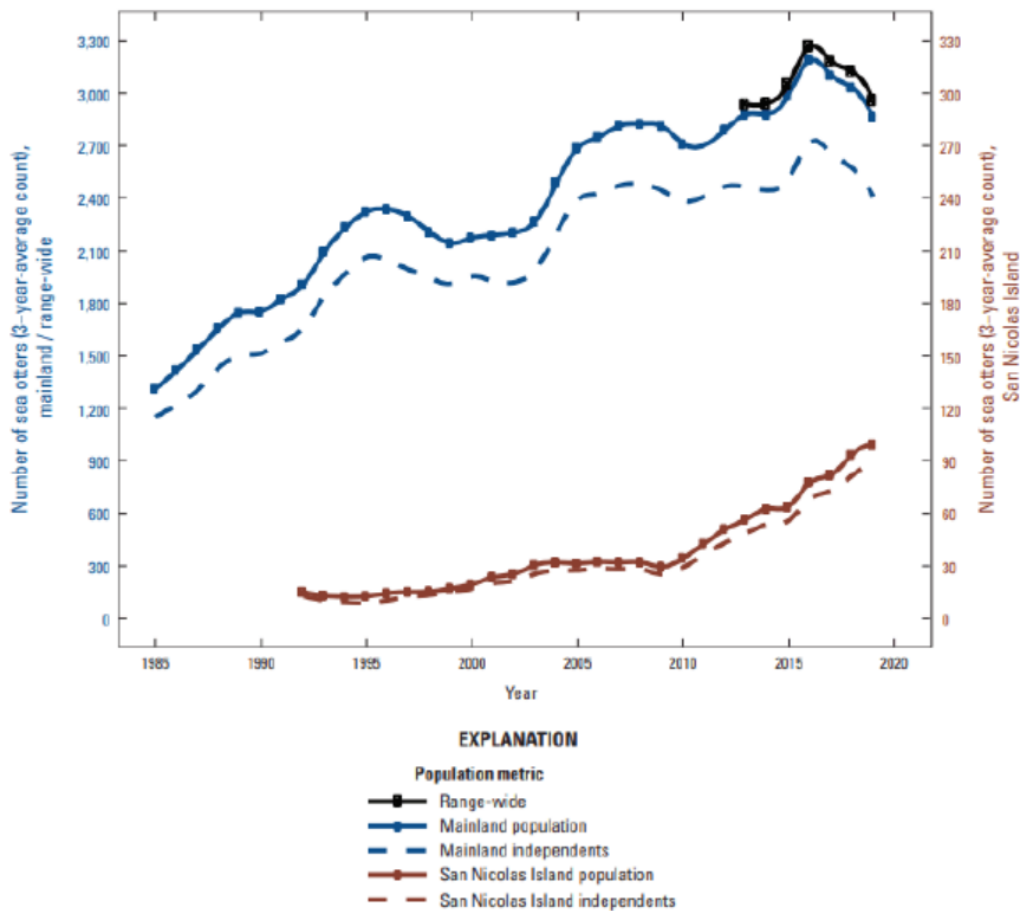


Fig. 2. Southern sea otter population trend over time (Marine Mammal Commission 2022).⁹⁴

Scientists believe growth of the southern sea otter population is constrained by the narrow, linear configuration of otter habitat in California (as compared to the complex habitat structure found in, *e.g.*, Alaska) and the high degree of sea otter population spatial structuring.⁹⁵ High mortality also is hindering population growth. Each year, approximately 20% of the southern sea otter population dies and this mortality (rather than depressed recruitment) appears to underlie the southern sea otter's stalled recovery.⁹⁶ Predators, parasites, biotoxins, bacteria, fungi, and viruses

⁹⁴ Marine Mammals Commission, *supra* note 87, at 3.

⁹⁵ USFWS, *supra* note 33, at 4; Davis et al., *supra* note 77, at 3; Lafferty & Tinker, *supra* note 91; Tinker, M.T., The use of quantitative models in sea otter conservation, in Larson, S.E. et al. (eds.), *Sea Otter Conservation* (2015); Tarjan, L.M. & M.T. Tinker, Permissible home range estimation (PHRE) in restricted habitats: a new algorithm and an evaluation for sea otters, 11 PLoS ONE e0150547 (2016).

⁹⁶ Nicholson et al., *supra* note 90, at 1753. See also USFWS, *supra* note 33, at 9 (noting a relative mortality level of 14.4% from 2015-2019); Jessup, David A. et al., Southern sea otter as a sentinel of marine ecosystem health, 1 *EcoHealth* 239 (2004); Kannan, Kurunthachalam et al., A comparative analysis of polybrominated diphenyl ethers and polychlorinated biphenyls in southern sea otters that died of infectious disease and noninfectious causes, 53 *Arch. Environ. Contam. Toxicol.* 293, 293 (2007); Kreuder, Christine et al., Southern sea otters (*Enhydra lutris nereis*) and emergent disease in the near-shore marine ecosystem: assessment of spatial trends in cause-specific mortality from 1998-2001 and evaluation of an aerial survey method for surveillance of trends in mortality, Final Report, Coastal Env'tl Quality Initiative (2004); Tinker, M. Tim et al., Incorporating diverse data and realistic complexity into demographic estimation procedures for sea otters, 16 *Ecological Applications* 2293 (2006).

all serve as significant sources of mortality for this threatened species and obstacles to its continued recovery.⁹⁷ Many of the diseases affecting southern sea otters have links to anthropogenic activity, such as parasites shed by non-native felids and marsupials and biotoxins produced by harmful algal blooms whose frequency and severity has increased due to eutrophication and climate change.⁹⁸ See discussions Part III.B.1, App. A, *infra*.

The threats facing sea otters are significant and increasing. The International Union for the Conservation of Nature (IUCN) states that sea otter population recovery in California remains a “major concern.”⁹⁹ Reintroduction will be necessary to help sea otters recover along the U.S. West Coast.¹⁰⁰ A recent assessment by FWS found that reintroduction of sea otters to northern California and Oregon is feasible from biological, ecological, legal, and socioeconomic perspectives and “would result in significant conservation benefits to the species, in particular to the threatened southern sea otter, and to the nearshore marine ecosystem.”¹⁰¹ Reintroduction to the southern portion of the species’ range, from southern California to central Baja California, Mexico, would further promote the species’ recovery.

E. Conservation Status

All sea otters under U.S. jurisdiction are protected under the MMPA.¹⁰² The southern sea otter and Southwest Alaska DPS of northern sea otter also are listed as threatened under the ESA.¹⁰³ All sea otters are listed as threatened under the Oregon Endangered Species Act¹⁰⁴ and the northern sea otter is listed as threatened under the Washington State Endangered Species Act.¹⁰⁵ Southern sea otters are not listed under the California Endangered Species Act though they are designated as a “fully protected mammal.”¹⁰⁶ California and Washington deem sea otters species of greatest conservation need,¹⁰⁷ and they are a “Watch List Species” in Oregon.¹⁰⁸

Internationally, sea otters are designated as a species of special concern under Canada’s Species at Risk Act.¹⁰⁹ Under the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), southern sea otters are listed under Appendix I and northern and Russian sea

⁹⁷ Miller et al., *supra* note 90, at 2, 20.

⁹⁸ *Id.* at 2; USFWS, *supra* note 33, at 10; Kreuder et al., *supra* note 96, at 2; Bradley, Catherine A. & Sonia Altizer, Urbanization and the ecology of wildlife diseases, 22 *TRENDS in Ecology & Evolution* 95, 99 (2007).

⁹⁹ Doroff & Burdin, *supra* note 78, at 6.

¹⁰⁰ Nicholson et al., *supra* note 90, at 1759; see also Rudebusch, Jane et al., Assessing anthropogenic risk to sea otters (*Enhydra lutris nereis*) for reintroduction into San Francisco Bay, 8 *PeerJ* e10241 (2020); USFWS, *supra* note 3.

¹⁰¹ USFWS, *supra* note 3, at xi. For further discussion on socioeconomic and stakeholder perspectives, see generally Estes, J.A., J. Hodder & M.T. Tinker, Ch. 7: Socioeconomic considerations, in *Elakha Alliance*, *supra* note 3; Larson, Shawn & M. Tim Tinker, Ch. 11: Stakeholder concerns and perspectives, in *Elakha Alliance*, *supra* note 3.

¹⁰² 16 U.S.C. § 1361 et seq.

¹⁰³ 42 Fed. Reg. 2965 (Jan. 14, 1977) (southern sea otter listing); 70 Fed. Reg. 46,366 (Aug. 9, 2005) (SW AK DPS listing).

¹⁰⁴ Ore. Rev. Stat. 496.171-496.192.

¹⁰⁵ Rev. Code Wash. 77.15.130.

¹⁰⁶ Cal. Fish & Game Code § 4700.

¹⁰⁷ Cal. Dep’t Fish & Wildlife, California State Wildlife Action Plan, Table 5.7-1 (2015); Wash. Dep’t Fish & Wildlife, Washington State Wildlife Action Plan, App. A-1 (2015).

¹⁰⁸ Ore. Dep’t Fish & Wildlife, Oregon Conservation Strategy, Nearshore App. E (2016).

¹⁰⁹ Gov’t of Canada, Species at Risk Act (2002).

otters listed under Appendix II.¹¹⁰ Appendix I species are deemed “threatened with extinction” and international trade is prohibited with limited exceptions for non-commercial purposes such as scientific research.¹¹¹ Appendix II species are “not threatened with extinction now but ... may become so unless trade is closely controlled.”¹¹² Trade is permitted with an export permit and a finding that the trade will not be detrimental to the species’ survival.¹¹³

The IUCN lists sea otters as globally endangered.¹¹⁴ The IUCN Red List, established in 1964, is “the world’s most comprehensive information source on the global conservation status of animal, fungi and plant species.”¹¹⁵ The list is “a powerful tool to inform and catalyze action for biodiversity conservation and policy change”¹¹⁶ and is “widely accepted as the most objective and authoritative system available for assessing the global risk of extinction for species.”¹¹⁷ A species is listed as “Endangered” when, based on the best available science, that species faces an “very high risk of extinction in the wild” based on an analysis of five factors: (A) population reduction, (B) restricted geographic range, (C) small population size and decline, (D) very small or restricted population, and/or (E) extinction probability analysis.¹¹⁸ The Red List’s “value derives from the implementation of a data-driven protocol, which leads to consistent classifications, as well as the compilation of a wealth of supporting data.”¹¹⁹ The IUCN’s comprehensive analysis of sea otters pursuant to these five criteria and its determination that the species is globally endangered highlight the urgent need for effective conservation measures including reintroduction.

III. Threats Facing Sea Otters and How Reintroduction May Ameliorate Those Stressors

Sea otters face myriad threats to their continued existence. The following sections provide an overview of some of these threats and the ways reintroduction would help the species.

¹¹⁰ Convention on International Trade in Endangered Species of Flora and Fauna (CITES), Appendices I, II and III (Feb. 14, 2021).

¹¹¹ Convention on International Trade in Endangered Species of Flora and Fauna (CITES), The Cites Appendices, available at <https://cites.org/eng/app/index.php>.

¹¹² *Id.*

¹¹³ *Id.*

¹¹⁴ Doroff & Burdin, *supra* note 78.

¹¹⁵ International Union for Conservation of Nature (IUCN), The IUCN Red List of Threatened Species (2023), at <https://www.iucnredlist.org/>.

¹¹⁶ *Id.*

¹¹⁷ Vié, Jean-Christophe et al., The IUCN Red List: a key conservation tool, in Vié, Jean-Christophe et al. (eds.), *Wildlife in a Changing World: An analysis of the 2008 IUCN Red List of Threatened Species 1* (2008).

¹¹⁸ IUCN, *supra* note 115; International Union for Conservation of Nature (IUCN), Frequently Asked Questions: What are the IUCN Red List categories and criteria? (2022), at <https://www.iucnredlist.org/about/faqs#What%20are%20the%20Red%20List%20Categories%20and%20Criteria>; International Union for Conservation of Nature (IUCN), Summary of the five criteria (A-E) used to evaluate if a taxon belongs in an IUCN Red List threatened category (critically endangered, endangered or vulnerable), at https://nc.iucnredlist.org/redlist/content/attachment_files/summary_sheet_en_web.pdf (last visited Jan. 6, 2023).

¹¹⁹ Rodrigues, Ana S.L. et al., The value of the IUCN Red List for conservation, 21 *TRENDS in Ecology and Evolution* 71 (2006).

A. The Climate Change Threat to Sea Otters

Climate change poses a threat to sea otters through a variety of pathways including ocean acidification, ocean warming and other ecosystem changes, pathogen transport and emergence, marine invasive species, biotoxins, and increased frequency of storm events.¹²⁰ Through the establishment of multiple populations and the facilitation of genetic exchange, reintroduction will help sea otters by ensuring the species has the evolutionary potential and geographic representation needed to persist in the face of global climate change-related stressors.

Ocean ecosystems worldwide already are exhibiting the effects of anthropogenic climate change. The world's oceans have absorbed more than 90 percent of the excess heat caused by climate change, resulting in average sea surface warming of 0.7°C (1.3°F) per century since 1900.¹²¹ Global average sea surface temperature is projected to rise by 2.7°C (4.9°F) by the end of this century under a higher emissions scenario.¹²² Climate change also contributes to marine heat waves—periods of extreme warm surface temperatures—which have become longer-lasting and more frequent in recent decades.¹²³ The number of heat wave days doubled between 1982 and 2016 and is projected to increase 23 times under 2°C warming.¹²⁴ At present, 87 percent of marine heat waves are attributable to human-induced warming.¹²⁵

Exacerbating the harm from rising ocean temperatures is ocean acidification.¹²⁶ The global ocean has absorbed more than a quarter of the CO₂ emitted to the atmosphere by human activities, which has increased its surface acidity by more than 30 percent.¹²⁷ This increase has occurred at a rate likely faster than anything experienced in the past 300 million years.¹²⁸ Ocean acidity could increase 150 percent by the end of the century if CO₂ emissions continue unabated.¹²⁹ By reducing the availability of key chemicals (namely, aragonite and calcite), ocean acidification negatively affects a wide range of calcifying marine creatures by hindering their ability to build

¹²⁰ Doroff & Burdin, *supra* note 78, at 9.

¹²¹ United States Global Climate Change Research Program (USGCRP), *Climate Science Special Assessment: Fourth National Climate Assessment*, Vol. I (2017).

¹²² *Id.*

¹²³ Laufkötter, Charlotte, Jakob Zscheischler & Thomas L. Frölicher, High-impact marine heatwaves attributable to human-induced global warming, 369 *Sci.* 1621 (2020).

¹²⁴ Frölicher, Thomas L. et al., Marine heatwaves under global warming, 560 *Nature* 360 (2018).

¹²⁵ *Id.*

¹²⁶ See Gruber, Nicolas et al., Rapid progression of ocean acidification in the California Current ecosystem, 337 *Sci.* 220 (2012).

¹²⁷ Simpson et al. (2009) correlate a Caribbean open-ocean aragonite saturation state of 4.0, which is needed to protect corals from degradation from ocean acidification, with an atmospheric CO₂ level of 340 to 360 ppm—far below current levels. Simpson, M.C. et al., *An Overview of Modeling Climate Impacts in the Caribbean Region with contribution from the Pacific Islands* (United Nations Development Programme (UNDP), Barbados, West Indies, 2009).

¹²⁸ Hönlisch, Barbel et al., The geological record of ocean acidification, 335 *Science* 1058 (2012); United States Global Climate Change Research Program (USGCRP), *Climate Science Special Assessment: Fourth National Climate Assessment*, Vol. I (2017).

¹²⁹ Orr, James C. et al., Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms, 437 *Nature* 681 (2005); Feely, Richard et al., Ocean acidification: Present conditions and future changes in a high CO₂ world, 22 *Oceanography* 36 (2009).

skeletons and by disrupting metabolism and critical biological functions.¹³⁰ Many of these organisms form the foundation of marine food webs, and their demise has ripple effects throughout entire ecosystems.¹³¹

Climate change-induced shifts in prey species assemblages could affect sea otter populations.¹³² For example, ocean acidification associated with climate change poses a significant threat to sea urchins and molluscs—important prey species for southern sea otters.¹³³ Climate change also is increasing disease threats in preferred otter prey species, for example withering syndrome in abalone, with implications for otter health.¹³⁴ When sea otters suffer prey limitation, it makes them more susceptible to other threats including disease.¹³⁵

Climate change already is leading to disease emergence and resurgence in the southern sea otter population.¹³⁶ For example, it is modifying hydrological processes including those that transport contaminants and pathogens from land into nearshore marine ecosystems.¹³⁷ Since southern sea otters live at the land-sea interface, they suffer the effects of these influxes.¹³⁸ Extreme weather events will exacerbate runoff and increase pathogen transmission.¹³⁹ Climate-mediated shifts in pathogens and their hosts also may increase disease risk for sea otters throughout their range.¹⁴⁰ In addition, reduced seasonality may increase the persistence of parasite transmission states, making otters more vulnerable to pathogens throughout the year.¹⁴¹ See discussions Part III.B.1, App. A, *infra*.

¹³⁰ Fabry, Victoria J. et al., Impacts of ocean acidification on marine fauna and ecosystem processes, 65 ICES Journal of Marine Science 414 (2008); Kroeker, Kristy J. et al., Impacts of ocean acidification on marine organisms: quantifying sensitivities and interactions with warming, 19 Global Change Biology 1884 (2013).

¹³¹ See, e.g., Wilmers, Christopher C. et al., Do trophic cascades affect the storage and flux of atmospheric carbon? An analysis of sea otters and kelp forests, 10 Frontiers Ecology & Env't 409 (2012) (discussing kelp-urchin-otter trophic cascade).

¹³² USFWS, *supra* note 3, at 51.

¹³³ *Id.* at 52; USFWS, *supra* note 33, at 13-14. See Kannan, Kurunthachalam et al., Profiles of polychlorinated biphenyl congeners, organochlorine pesticides, and butyltins in southern sea otters and their prey, 23 *Env'tl. Toxicology & Chemistry* 49 (2004) (listing sea otter prey species). See, e.g., O'Donnell, Michael J. et al., Ocean acidification alters skeletogenesis and gene expression in larval sea urchins, 398 *Marine Ecology Progress Series* 157 (2010) (impacts of ocean acidification on sea urchin larvae); Harvey, Ben P. et al., Individual and population-level responses to ocean acidification, 6 *Nature Sci. Reports* 20194 (2016) (impacts of ocean acidification on gastropods); Cunningham, Shaun C., Abigail M. Smith & Miles D. Lamare, The effects of elevated *p*CO₂ on growth, shell production and metabolism of cultured abalone, *Haliotis iris*, 47 *Aquaculture Research* 2375 (2015).

¹³⁴ Gaydos, Joseph K. & Karen C. Drayer, Disease and environmental stressors: how they combine to impact endangered species, AMMVEZOO Conferencia (2017). See also USFWS, *supra* note 3, at 51.

¹³⁵ USFWS, *supra* note 33, at 14; Gaydos & Drayer, *supra* note 134.

¹³⁶ See Bossart, G.D., Marine mammals as sentinel species for oceans and human health, 48 *Wildlife & Marine Animals* 676 (2011); USFWS, *supra* note 33, at 13, citing Burge, C.A. et al., Climate change influences on marine infectious diseases: implications for management and society, 6 *Ann. Rev. Marine Sci.* 249 (2014), Harvell, C.D. et al., Disease epidemic and a marine heat wave area associated with the continental-scale collapse of a pivotal predator (*Pycnopodia helianthoides*), 5 *Sci. Advances* eaau7042 (2019). See also USFWS, *supra* note 3, at 51.

¹³⁷ USFWS, *supra* note 3, at 51; USFWS, *supra* note 33, at 13, citing Walther, Gian-Reto et al., Ecological responses to recent climate change, 416 *Nature* 389 (2002).

¹³⁸ USFWS, *supra* note 3, at 51; USFWS, *supra* note 33, at 13.

¹³⁹ USFWS, *supra* note 3, at 51.

¹⁴⁰ *Id.*

¹⁴¹ See Bradley & Altizer, *supra* note 98, at 99-100.

One example of climate change-related disease risk is the increase in harmful algal blooms along the Pacific Coast.¹⁴² Climate change and nutrient enrichment are increasing the risks posed by marine and freshwater harmful algal blooms, including those associated with domoic acid poisoning.¹⁴³ See Part III.B.1, App. A, *infra*. Blooms of toxic *Pseudo-nitzschia* spp., which produce domoic acid, are increasing in frequency, severity, and persistence along the California coast, at least partly due to climate change.¹⁴⁴ Models suggest that increased frequency and severity of high domoic acid events will lead to declines in southern sea otter populations.¹⁴⁵ Reintroducing sea otters throughout their historic range on the U.S. West Coast will provide the species with redundancy, allowing the species to flourish even if an algal bloom, disease outbreak, or prey shortage severely impacts otters in any one locality.

Reintroducing sea otters also is necessary for range expansion and recovery in light of the increase in white shark bite mortality among sea otters, particularly at the peripheries of their current range in California. Warming waters associated with climate change are facilitating range expansion in juvenile white sharks (*Carcharodon carcharias*), which are beginning to occupy more northerly habitats.¹⁴⁶ Tanaka et al. (2021) report a dramatic increase in juvenile white sharks in central California between 2014-2019, a time period that began with the 2014-2016 marine heatwave.¹⁴⁷ An increase in juvenile white shark presence alongside a decrease in kelp communities exerts significant negative pressures on peripheral southern sea otter populations, hindering range expansion, population growth, and recovery.¹⁴⁸ See discussion Part III.B.2, *infra*. Reintroduction will allow the establishment of otter populations in suitable range that is currently inaccessible due to the presence of juvenile white sharks. It also will lead to the establishment of sea otters in refuge sites such as estuaries and kelp beds that offer more protection from white sharks.

Another way that climate change will impact sea otters and their habitats is through impacts to coastal ecosystem processes including upwelling. Barth et al. (2007) found delayed early-season upwelling and stronger late-season upwelling in the northern California current large marine ecosystem consistent with global warming predictions.¹⁴⁹ The delay led to a suite of anomalies including warm water, low nutrient levels, and extremely low recruitment of intertidal

¹⁴² USFWS, *supra* note 3, at 51.

¹⁴³ USFWS, *supra* note 33, at 13; Miller et al., *supra* note 90, at 19; Bossart, *supra* note 136, at 680.

¹⁴⁴ Miller et al., *supra* note 90, at 19; Gulland, Francis M.D. et al., A review of climate change effects on marine mammals in United States waters: past predictions, observed impacts, current research and conservation imperatives, 3 *Climate Change Ecology* 100054 (2022); Trainer, Vera L., Climate extreme seeds a new domoic acid hotspot on the US West Coast, 2 *Frontiers Climate* 571836 (2020).

¹⁴⁵ Moriarty, Megan Elizabeth, *Cardiomyopathy and domoic acid exposure in southern sea otters*, Ph.D. Dissertation, Univ. Cal. Davis (2020).

¹⁴⁶ Tanaka, Kisei R. et al., North Pacific warming shifts the juvenile range of a marine apex predator, 11 *Nature Sci. Reports* 3373 (2021); USFWS, *supra* note 3, at 50; USFWS, *supra* note 33, at 10; Gulland et al., *supra* note 144, at 8, 9.

¹⁴⁷ Tanaka et al., *supra* note 146.

¹⁴⁸ *Id.*; USFWS, *supra* note 33, at 13. Gulland et al., *supra* note 144, at 3 (Table 2).

¹⁴⁹ Barth, John A. et al., Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current, 104 *Proc. Nat'l Acad. Sci.* 3719 (2007).

organisms.¹⁵⁰ Such changes have implications for the coastal kelp bed ecosystems preferred by southern sea otters, which rely on nutrient-rich, upwelled waters.¹⁵¹

Climate change already is impacting kelp communities along California's central coast.¹⁵² After the 2014 marine heat wave, bull kelp populations decreased by 90% along the coasts of Mendocino and Sonoma counties.¹⁵³ The 2014 marine heat wave was followed by one of the most extreme El Niño events in recorded history.¹⁵⁴ Bull kelp have yet to recover to pre-2014 levels, and though it is normal for bull kelp to experience some variability in population size from year to year, the span of years from 2014 to 2021 is the longest period bull kelp has gone without recovering in the last 38 years.¹⁵⁵

This reduction in kelp forest cover has direct impacts on the recovering southern sea otter population. In the center of the southern sea otter's range, canopy-forming kelp forests support a diverse invertebrate prey community; ample grounds for feeding, resting, and pupping; and critical refuge from predators including white sharks.¹⁵⁶ Declining kelp cover may hinder southern sea otter recovery in two ways: first, by intensifying these threats at the range peripheries, and second, by limiting the nursery habitat required by reproductive female sea otters.¹⁵⁷ Greater exposure to the density-independent threats associated with lower kelp cover (*i.e.*, shark bite and neurological disease) may lead to a younger and less reproductively successful population.¹⁵⁸ More specifically,

a 10% increase in kelp cover (at a spatial scale of 5 km) was associated with a 99% reduction in the probability of shark bite. Kelp had a similar but more moderate effect on strandings caused by neurological disease, with a 75% reduction in stranding rate for every 10% increase in kelp canopy cover.¹⁵⁹

¹⁵⁰ Id. at 3719.

¹⁵¹ See Ng, Crystal A. & Fiorenza Micheli, Variability in grazing on juvenile giant kelp throughout an upwelling season, 693 *Marine Ecology Progress Series* 83 (2022).

¹⁵² See generally Center for Biological Diversity, Petition to list bull kelp under the U.S. Endangered Species Act (2022); see also USFWS, *supra* note 3, at 50-51, 57-58. Interestingly, sea otters can help mitigate climate change by preying on urchins and thus supporting healthy kelp biomass. Wilmers et al., *supra* note 131.

¹⁵³ Rogers-Bennet, L. & C.A. Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 *Nature Scientific Reports* 15050 (2019).

¹⁵⁴ Tseng, Y., et al. The warm Blob in the northeast Pacific—the bridge leading to the 2015/16 El Niño, 12 *Environmental Research Letters* 054019 (2017); Rogers-Bennet & Catton, *supra* note 153; McPhadden, M., et al., El Niño

Southern Oscillation in a Changing Climate, American Geophysical Union (2020).

¹⁵⁵ Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. *bioRxiv* (2022).

¹⁵⁶ Nicholson et al., *supra* note 90, at 1758; Doroff & Burdin, *supra* note 78, at 6, 7; USFWS, *supra* note 3, at 51. See also Laidre, Kristin L. & Ronald J. Jameson, Foraging patterns and prey selection in an increasing and expanding sea otter population, 87 *J. Mammalogy* 799 (2006) (noting the importance of increasing kelp bed habitat for growth of Washington's sea otter population).

¹⁵⁷ Nicholson et al., *supra* note 90, at 1751, 1758, 1759.

¹⁵⁸ Id. at 1758.

¹⁵⁹ Id. at 1757; see also id. at 1758.

The availability of sufficient kelp cover thus appears to dramatically reduce density-independent otter strandings.¹⁶⁰ Increased kelp canopy cover likewise reduced rates of stranding due to trauma and pup loss.¹⁶¹

Nicholson et al. (2018) explain that, in the southern sea otter's pre-fur trade metapopulation, areas lacking kelp cover may have served as dispersal corridors or seasonal, transitional foraging zones between more productive, stable populations.¹⁶² Today, the otters are spatially constrained and these kelp-free peripheries may effectively function as population sinks.¹⁶³ Should kelp cover continue to decline under climate change, whether from warming, disease, or other mechanisms, it could preclude southern sea otter recovery and, in fact, contribute to the species' decline.¹⁶⁴ Reintroducing sea otters to kelp forests can help maintain ecosystem structure, function, and resilience, helping these areas persist in the face of climate change. Persistence of kelp forest ecosystems, in turn, helps sea otters thrive.

In sum, climate change poses a variety of threats to southern sea otters including loss of preferred kelp habitat, increased risk of shark bite and disease, and impacts to prey species from ocean acidification and thermal stress. By increasing the numbers of otters along the coast and providing a means for genetic exchange, reintroduction can help sea otters and their habitats recover and persist even in the face of these climate-mediated threats.

B. The Threats of Disease and Predation to Sea Otters

Disease and predation are primary causes of mortality for sea otters, particularly the threatened southern sea otter.¹⁶⁵ The two threats, while distinct, often interact in such a way as to cause greater harm than either would in isolation. For example, certain diseases can make sea otters more vulnerable to white shark bites; white shark bites, in turn, can make sea otters more vulnerable to infection and death.¹⁶⁶ Multi-pathogen infections are common, subjecting otters to substantial stress and lowering their resistance to other threats (*e.g.*, emaciation).¹⁶⁷

¹⁶⁰ Id. at 1751, 1757. In the more populous central portion of the range, density-dependent mechanisms rather than kelp cover canopy appeared to underlie strandings. Nicholson et al., *supra* note 90, at 1757. See also Bentall, Gena Beth, Morphological and behavioral correlates of population status in the southern sea otter, *Enhydra lutris nereis*: a comparative study between central California and San Nicolas Island, Master's Thesis, Univ. of Cal. Santa Cruz (2005) (supporting the idea that "competition for prey resources is a likely factor contributing to the stalled recovery of the threatened Southern sea otter").

¹⁶¹ Nicholson et al., *supra* note 90, at 1757-58.

¹⁶² Id. at 1759.

¹⁶³ Id.

¹⁶⁴ See id. at 1758; USFWS, *supra* note 3, at 51.

¹⁶⁵ Nicholson et al., *supra* note 90, at 1755 (finding that primary threats to sea otters include shark bites, neurological disease, and end lactation syndrome/emaciation); Gaydos, Joseph H. & Kirsten V.K. Gilardi, Addressing disease risks when recovering species at risk, in Hooper, T.D. (ed.), *Proc. Species at Risk 2004 Pathways to Recovery Conference* (2004) (noting that disease has hindered recovery of the southern sea otter). For an overview of the health threats to sea otters in Table form, see Murray, Michael J., Ch. 10: Animal health and welfare considerations, at 21-22, Table 10.1, in Elakha Alliance, *supra* note 3.

¹⁶⁶ Kreuder et al., *supra* note 96, at 3-4 (noting that 57% of examined otters that were attacked by white sharks had pre-existing encephalitis, including from *Toxoplasma gondii* infection, and that this may lead them to exhibit aberrant behaviors that make them more vulnerable to shark attack).

¹⁶⁷ Miller et al., *supra* note 90, at 20. See also Bradley & Altizer, *supra* note 98, at 99 (discussing how stress increases susceptibility); Doroff & Burdin, *supra* note 78, at 8 (discussing emaciation).

Reintroduction would allow sea otters to become established along the U.S. West Coast without requiring them to navigate areas of high shark encounter probability. Human-assisted reintroduction would reduce bite-related mortality and associated disease and allow otter re-establishment to occur more quickly than would occur without such intervention. Reintroducing otters into protected areas such as estuaries also would reduce the risk of shark bite mortality. The establishment of sea otter populations along the U.S. West Coast, which would introduce a higher degree of geographic and dietary variability to the species, would reduce the probability that a disease outbreak would devastate the entire species. Increased population numbers and enhanced genetic exchange also would increase the likelihood of adaptation and resistance to specific diseases, as well as shark avoidance behavior, further promoting sea otter conservation.

The following subsections provide a high-level overview of the specific disease and predation threats faced by sea otters.

1. Disease

In his review of animal welfare implications of sea otter reintroduction, Dr. Michael Murray notes that “it is unlikely that infectious disease will have population-level impacts on the re-introduction program,” but that “it may have significant impacts in specific areas.”¹⁶⁸ Locally severe disease impacts underscore the need for a large, well-established metapopulation. Reintroduction will lead to more robust, geographically distributed sea otter populations, which in turn makes it less likely that disease will cause catastrophic declines that hinder the species’ recovery.

Sea otter disease can be caused by exposure to a host of pathogens, including parasites, bacteria, fungi, viruses, and biotoxins.¹⁶⁹ Because sea otters are exposed to a wide variety of infectious agents, multiple significant but independent disease processes often work synergistically to cause otter death.¹⁷⁰ Some disease processes can be affected by body condition, *e.g.*, dental health.¹⁷¹ When primary and contributing causes of death are combined, infection is the most prevalent cause of death, affecting nearly two-thirds of southern sea otters.¹⁷² Infectious diseases additionally contribute to the death of otters as sequelae when pathogens subsequently invade injured tissue.¹⁷³

Sea otters are particularly vulnerable to disease because of their high metabolic demands, which require that they consume large quantities of nearshore benthic invertebrates that concentrate

¹⁶⁸ Murray, *supra* note 165, at 20.

¹⁶⁹ See generally Miller et al., *supra* note 90.

¹⁷⁰ *Id.* at 2.

¹⁷¹ Winer, J.N., S.M. Liong & F.J.M. Verstraete, The dental pathology of southern sea otters (*Enhydra lutris nereis*), 149 J. Comp. Path. 346 (2013).

¹⁷² Miller et al., *supra* note 90, at 1, 8.

¹⁷³ *Id.* at 8.

pathogens or toxins.¹⁷⁴ In addition, since otters live at the land-sea interface, they are exposed to terrestrial as well as marine pathogens.¹⁷⁵ As Jessup et al. (2007) describe,

A suite of pollutants apparently emanating from terrestrial sources, including protozoal and bacterial organisms, various persistent organic pollutants,¹⁷⁶ and urea, which influences toxic algal blooms, has been a substantial contributor to illness and death in southern sea otters. The magnitude of these pollutants' impact on sea otters may be jeopardizing the recovery of this species.¹⁷⁷

Terrestrial parasites associated with opossums (*Sarcocystis neurona*), cats (*Toxoplasma gondii*), raccoons (*Baylisascaris procyonis*), and rodents (*Capillaria hepatica*), as well as viruses (*Morbillivirus*) and fungi (*Coccidioides* spp.), all contribute to southern sea otter mortality.¹⁷⁸ A more detailed discussion of pathogens affecting sea otters can be found in Appendix A. Because reintroduction will establish sea otters along the U.S. Pacific Coast, it will allow the species to better withstand localized disease outbreaks; this, in turn, will support the species' recovery.

2. Predation

The most common primary cause of death for southern sea otters is white shark bite.¹⁷⁹ This threat appears to be slowing range expansion and population growth in southern sea otters both to the north and to the south.¹⁸⁰ Miller et al. (2020) conclude that “the concentration of shark bite deaths at the range peripheries may impede future population recovery by limiting expansion into unoccupied habitats.”¹⁸¹ Human-assisted reintroduction would eliminate the need for sea otters to ford these peripheral waters in order to expand their range, helping the species gain a foothold along the U.S. West Coast and promoting recovery. Reintroduction into protected areas such as estuaries also would buffer sea otters from the shark bite threat.

There has been a dramatic increase in mortality of southern sea otters from white shark bites in California, with a threefold to eightfold increase in the probability of strandings due to shark bite since the late 1990s and early 2000s.¹⁸² The seasonal “peak” for bites increased from two to eight months between 1997-2017.¹⁸³ Fatal shark bites are a particular risk for southern sea otters living at the northern and southern edges of the species' range (10.23 and 3.06 times higher odds of

¹⁷⁴ Id. at 18.

¹⁷⁵ Id.; Burgess, Tristan L. et al., Spatial epidemiological patterns suggest mechanisms of land-sea transmission for *Sarcocystis neurona* in a coastal marine mammal, 10 Nature Sci. Reports 3683 (2020).

¹⁷⁶ See Part III.C.2, *infra*.

¹⁷⁷ Jessup, David A. et al., Sea otters in a dirty ocean, 231 J. Am. Vet. Med. Ass'n 1648 (2007).

¹⁷⁸ Miller et al., *supra* note 90, at 18.

¹⁷⁹ Id. at 1, 18.

¹⁸⁰ Miller et al., *supra* note 90, at 18, 20; Davis et al., *supra* note 77, at 11.

¹⁸¹ Miller et al., *supra* note 90, at 20.

¹⁸² Tinker, M. Tim et al., Dramatic increase in sea otter mortality from white sharks in California, 32 Marine Mammal Sci. 309 (2015); Miller et al., *supra* note 90, at 1, 7-8, 18; Davis et al., *supra* note 77, at 11. Strandings in general have shown an increasing trend. Doroff et al., *supra* note 91, at 7.

¹⁸³ Moxley, Jerry H. et al., Non-trophic impacts from white sharks complicate population recovery for sea otters, 9 Ecology & Evolution 6378 (2019); Miller et al., *supra* note 90, at 7.

fatal bites than otters elsewhere, respectively).¹⁸⁴ These areas are situated in greater proximity to aggregations of breeding and hauled-out pinnipeds and also feature more kelp-free habitat; kelp canopy is believed to provide otters with refuge from white sharks.¹⁸⁵ White shark numbers in the region appear to be increasing as juveniles move into more northerly habitat with warming ocean waters.¹⁸⁶

White sharks don't appear to consume sea otters.¹⁸⁷ Nonetheless, the trauma induced by the bites frequently kills otters immediately; those that survive often succumb to secondary infections in the coming days to weeks.¹⁸⁸ Miller et al. (2020) found shark bites to be the primary cause of death for 28% and a contributing cause of death for another 1% of 560 sea otters necropsied between 1998 and 2012.¹⁸⁹ Another study found that white shark bites account for more than half of all recovered otter carcasses in California and have had population-level effects on southern sea otters in the state.¹⁹⁰ Subadults, males, and otters in good physical condition are more likely to die of shark bites than other cohorts.¹⁹¹

The broadnose sevengill shark (*Notorynchus cepedianus*) also has the potential to predate on sea otters.¹⁹² This species is a dominant shark predator in coastal marine ecosystems including bays and estuaries from Baja Mexico to southeast Alaska.¹⁹³ While they are not known to be a primary predator of sea otters in California, they do target marine mammals and could potentially pose a threat to otter populations.¹⁹⁴ By actively establishing an otter metapopulation along the U.S. West Coast, reintroduction would both help otters avoid the shark bite mortality that now accompanies range expansion efforts and allow the species to find refuge in estuaries, kelp beds, and other protected habitats. Indeed, reintroduction appears to be the only way to recover sea otters along the U.S. West Coast in the foreseeable future in the face of this threat.

C. Additional Threats to Sea Otters

Additional threats to sea otters including oil spills, contaminant exposure, low genetic diversity, and a handful of anthropogenic stressors further support the case for sea otter reintroduction.

¹⁸⁴ Miller et al., supra note 90, at 7, 8, 18; see also Nicholson et al., supra note 90, at 1751, 1753 (noting that the number of otters stranding at the southern periphery nearly tripled from 2005-2015), 1758 (describing soft-bottom and mixed-sediment subtidal habitats at the otters' range peripheries); USFWS, supra note 33, at 9; Tinker, M. Tim et al., Southern sea otter range expansion and habitat use in the Santa Barbara Channel, California, U.S. Geological Survey Open-File Report 2017-1001 (2017).

¹⁸⁵ Nicholson et al., supra note 90, at 1751, 1758; Miller et al., supra note 90, at 18; USFWS, supra note 33, at 10; Tinker et al., supra note 182

¹⁸⁶ USFWS, supra note 33, at 10.

¹⁸⁷ Miller et al., supra note 90, at 18.

¹⁸⁸ Id. at 7; Davis et al., supra note 77, at 11.

¹⁸⁹ Miller et al., supra note 90, at 7.

¹⁹⁰ Davis et al., supra note 77, at 11; Tinker et al., supra note 182.

¹⁹¹ Miller et al., supra note 90, at 7, 18. See also id. (noting that the 1.5x higher male mortality was not statistically significant); Moxley et al., supra note 183.

¹⁹² Murray, supra note 165, at 15.

¹⁹³ Id.

¹⁹⁴ Id.

1. Oil Spills

Oil spills represent “the greatest anthropogenic threat to sea otter[s]”¹⁹⁵ and spills from transiting large vessels remain a primary threat to southern sea otters in California.¹⁹⁶ Simulations have shown that an oil spill off California’s central coast during the winter, with average southeast prevailing winds, would have an outsize impact on southern sea otters.¹⁹⁷ By establishing populations along the entire U.S. West Coast, some of which would avoid exposure to an oil spill, a reintroduction program would help ensure that such a catastrophe would not drive the species to extinction.

Sea otters are particularly vulnerable to oil spills because they rely on their thick fur, rather than blubber, to insulate them from cold ocean waters. Oiled fur loses its insulative properties and oiled sea otters quickly become hypothermic.¹⁹⁸ Ingestion of oil from grooming or contaminated prey can lead to gastrointestinal disorders, liver damage, other ailments, and death; inhalation of fumes can cause pulmonary emphysema and other lung damage.¹⁹⁹ Long-term effects of oil exposure (whether directly or through prey) also can be significant and lead to population-level effects.²⁰⁰

Sea otters’ slow range expansion and lack of redundancy across a metapopulation exacerbate the species’ vulnerability to spills.²⁰¹ As demonstrated by the 2015 Refugio oil spill, this threat remains paramount to southern sea otters and could quickly kill a sizeable proportion of the current population.²⁰² Reintroduction would help mitigate this threat by ensuring that otters far from a spill would endure.

2. Contaminants

Contaminants likewise pose a threat to sea otters that could be addressed, in part, through reintroduction by ensuring that some sea otter populations live in less polluted waters.²⁰³ Since sea otters occupy the land-water interface, they are exposed to a host of land-based contaminants that enter the ocean via runoff especially near urban and agricultural areas.²⁰⁴ Nearshore ecosystems “arguably [are] among the global ecosystems most vulnerable to human development ... and the coastal oceans are the ultimate receptacles of urban, industrial, and agricultural

¹⁹⁵ Doroff & Burdin, *supra* note 78, at 8.

¹⁹⁶ USFWS, *supra* note 33, at 12; U.S. Fish & Wildlife Serv. (USFWS), Southern sea otter (*Enhydra lutris nereis*) 5-year review: summary and evaluation 29 (2015); Golson, Emily A., Thesis: Predicting oil spill impacts on southern sea otters (*Enhydra lutris nereis*): application of a mechanistic movement model, Moss Landing Laboratories, San José State Univ. (2014); Tinker, M. Tim et al., *supra* note 184.

¹⁹⁷ Golson, *supra* note 196.

¹⁹⁸ Doroff & Burdin, *supra* note 78, at 8; Murray, *supra* note 165, at 13.

¹⁹⁹ Doroff & Burdin, *supra* note 78, at 8; Murray, *supra* note 165, at 13.

²⁰⁰ Murray, *supra* note 165, at 13.

²⁰¹ USFWS, *supra* note 33, at 12.

²⁰² See USFWS, *supra* note 196, at 24-26. See also Murray, *supra* note 165, at 13-14 (discussing oil spill threat to otters in Oregon).

²⁰³ See Jessup et al., *supra* note 177.

²⁰⁴ See Bradley & Altizer, *supra* note 98, at 99; Miller, Melissa et al., Persistent organic pollutant concentrations in southern sea otters (*Enhydra lutris nereis*): patterns with respect to environmental risk factors and major causes of mortality, Submitted to Cal. Regional Water Quality Control Board, Region 3, at i, iv (June 30, 2007).

effluents.”²⁰⁵ Reintroducing sea otters along the U.S. West Coast would provide for the establishment of populations in areas both more and less contaminated. Those in less contaminated areas would avoid some of the stressors associated with pollutants, and likely have more resiliency in the face of other stressors.

In addition to direct exposure, sea otters are exposed to contaminants via filter-feeding invertebrate prey, which can concentrate chemical pollutants.²⁰⁶ Sea otters often ingest multiple contaminants through these prey items, and these contaminant mixtures can interact with each other as well as with otter nutritional status, disease status, and other environmental factors to produce more insidious outcomes.²⁰⁷ A reintroduced otter population spanning the U.S. West Coast would eat a diversity of prey items, some of which would be less contaminated. These otters may have a fitness advantage in the face of other threats.

The threat of contamination is not merely theoretical. Stranded sea otters have presented with accumulations of dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyl-dichloroethylene (DDE), polychlorinated biphenyls (PCBs), polybrominated diphenylethers, and butyltin residues, often at concentrations above toxic effect thresholds.²⁰⁸ These contaminants bioaccumulate and biomagnify up the food chain; concentrations of PCBs and DDT in southern sea otter livers were found to be 60 to 240 times higher than those found in the otters’ prey.²⁰⁹ Kannan et al. (1998) found that female sea otter livers contained approximately twice the butyltins than male livers.²¹⁰ Concentrations of polybrominated diphenyl ethers (PBDEs) and the perfluorinated contaminant PFOA found in southern sea otters were among the highest values reported for marine mammals.²¹¹ Polycyclic aromatic hydrocarbons from petroleum-related sources likewise have been found in sea otter livers; otters likely were exposed through contaminated prey such as mussels, clams, and crabs.²¹²

High body burdens of these contaminants have significant health implications for southern sea otters. High DDT levels have been associated with increased risk of disease from infectious disease, neoplasia, and emaciation in sea otters.²¹³ Elevated PCB and perfluorinated contaminant (PFOS, PFOA) concentrations in sea otter livers have been associated with infectious disease.²¹⁴

²⁰⁵ Jessup et al., supra note 177, at 1648.

²⁰⁶ Miller et al., supra note 204, at iv.

²⁰⁷ Kannan et al., supra note 96, at 294; Miller et al., supra note 204, at ii.

²⁰⁸ Kannan, Kurunthachalam et al., Butyltin residues in southern sea otters (*Enhydra lutris nereis*) found dead along California coastal waterways, 32 Environ. Sci. Tech. 1169 (1998); Nakata, H. et al., Accumulation pattern of organochlorine pesticides and polychlorinated biphenyls in southern sea otters (*Enhydra lutris nereis*) found stranded along coastal California, USA, 103 Env’tl Pollution 45 (1998); Kannan et al., supra note 133; USFWS, supra note 33, at 13.

²⁰⁹ Kannan et al., supra note 133, at 49.

²¹⁰ Kannan et al., supra note 208, at 1169.

²¹¹ Kannan et al., supra note 96, at 293; Kannan, Kurunthachalam, Emily Perotta & Nancy J. Thomas, Association between perfluorinated compounds and pathological conditions in southern sea otters, 40 Environ. Sci. Tech. 4943, 4943 (2006).

²¹² Kannan, Kurunthachalam & Emily Perotta, Polycyclic aromatic hydrocarbons (PAHs) in the livers of California sea otters, 71 Chemosphere 649, 649-50 (2008).

²¹³ Nakata et al., supra note 208, at 45.

²¹⁴ Kannan, Perotta & Thomas, supra note 211; Kannan et al., supra note 96, at 293; USFWS, supra note 33, at 13; Miller et al., supra note 204, at i-ii.

Other persistent organic pollutants including C1-dibenzothiophene, PCB 056, cis-chlordane, oxychlordane, and PBDE 028 have been associated with higher incidences of sea otter death from disease and trauma.²¹⁵ Butyltins are known immunosuppressants that contribute to sea otter mortality from other causes.²¹⁶

Dead southern sea otters have notably higher concentrations of persistent organic chemicals (including PCBs, DDTs, and tributyltin) than other sea otters.²¹⁷ Living southern sea otters present with summed PCB concentrations similar to those in otters exposed to known point sources of these contaminants.²¹⁸ Compared to Alaskan sea otters, California's sea otters have summed PCB and DDT levels 50-100 times as high.²¹⁹ The differences in contaminant levels in these two geographically disjunct populations drives home the importance of reintroduction and establishment of sea otters in less polluted areas of the contiguous 48 states.

Trace element concentrations in southern sea otters also have presented at high levels. For example, hepatic concentrations of cadmium and copper were 10 to 100 times higher in southern sea otter livers than concentrations reported for any other marine mammal species.²²⁰ As compared to healthy otters, hepatic concentrations of cadmium, cobalt, manganese, and zinc were higher in diseased and emaciated otters.²²¹ Elevated concentrations of toxic metals may contribute to oxidative stress-mediated effects in affected otters.²²²

In sum, contaminants pose a threat to some Pacific Coast sea otter populations. Reintroducing sea otters along the U.S. West Coast would allow the species to establish populations in less contaminated areas, which could provide those otters with more resiliency in the face of other stressors.

3. Low Genetic Diversity

Reintroducing sea otters to the U.S. West Coast would promote the species' recovery by enhancing genetic diversity. Reestablishment of the historic transition zone between northern and southern sea otters would allow a mixing of genetic material between these two subspecies to the benefit of both. An infusion of northern sea otter genes would help introduce genetic diversity to the small and isolated southern sea otter population. Southern sea otter genes may help northern sea otters adapt in the face of climate change.

A species' long-term survival depends in part on genetic diversity.²²³ Genetic diversity affords a species the raw material needed to adapt to environmental change and also provides resilience to

²¹⁵ Miller et al., *supra* note 204, at ii.

²¹⁶ Kannan et al., *supra* note 208, at 1169; Kannan, Perotta & Thomas, *supra* note 214; USFWS, *supra* note 33, at 13.

²¹⁷ Jessup et al., *supra* note 177, at 1650.

²¹⁸ *Id.*

²¹⁹ *Id.*

²²⁰ Kannan, Kurunthachalam et al., Comparison of trace element concentrations in livers of diseased, emaciated and non-diseased southern sea otters from the California coast, 65 *Chemosphere* 2160 (2006).

²²¹ *Id.* at 2160.

²²² *Id.*; Larson, Shawn et al., Stress-related hormones and genetic diversity in sea otters (*Enhydra lutris*), 25 *Marine Mammal Sci.* 351 (2009).

²²³ USFWS, *supra* note 3, at 52.

stress.²²⁴ Many sea otter populations are believed to have experienced multiple population reductions over time, with consequent impacts on genetic diversity.²²⁵ The fur trade had a substantial impact on sea otter genetic diversity, with populations losing ~33% of their pre-trade heterozygosity and 69% of their pre-trade alleles.²²⁶ Genetic analyses have revealed evidence of inbreeding and a high load of potentially harmful alleles in northern and southern sea otter populations.²²⁷

Southern sea otters are “the most genetically distinct and isolated of any extant sea otter population” and also have “the lowest genetic diversity of any population measured except the population at Bering Island, Russia.”²²⁸ Southern sea otters appear to have diverged from the northern and Asian otter populations before those populations diverged from each other, perhaps during the last glacial maximum.²²⁹ As a result of the fur trade, sea otter populations that historically contained tens of thousands of individuals were driven down to less than one hundred; in the case of southern sea otters, down to only 30-50 individuals.²³⁰ This extreme population bottleneck is likely to have had long-lasting effects on population fitness and recovery prospects.²³¹ In addition to the effects of inbreeding depression (*e.g.*, decreased fecundity, decreased ability to compete, slowed growth, increased levels of developmental defects, increased disease susceptibility, increased mortality), populations that undergo a bottleneck may suffer from stress-related effects with potential implications for population health.²³²

Following a number of studies finding low average levels of genetic variation in sea otters,²³³ Beichman et al. (2022) conducted genetic analyses and detected “signals of extreme population decline” that may have increased genetic load and “lower[ed] the fitness of recovering populations for generations.”²³⁴ This increased genetic load resulted from exposure of harmful recessive alleles as homozygotes.²³⁵ They conclude that southern sea otters “are the last survivors of a divergent lineage isolated for thousands of years and therefore warrant special conservation concern.”²³⁶

²²⁴ Id. at 52, 53.

²²⁵ Larson & Tinker, *supra* note 78, at 5.

²²⁶ USFWS, *supra* note 3, at 52, citing Larson, S. et al., Genetic diversity and population parameters of sea otters, *Enhydra lutris*, before fur trade extirpation from 1741-1911, 7 PLoS ONE e32205 (2012). While some evidence suggest genetic diversity may have begun declining prior to the fur trade, see Aguilar, A. et al., The distribution of nuclear genetic variation and historical demography of sea otters, 11 *Animal Conservation* 34 (2008), bottlenecks have resulted in low genetic variation.

²²⁷ USFWS, *supra* note 3, at 53. See also Larson & Tinker, *supra* note 78, at 5.

²²⁸ USFWS, *supra* note 3, at 36. See also *id.* at 53; Larson & Tinker, *supra* note 78, at 5.

²²⁹ Beichman, Annabel C. et al., Genomic analyses reveal range-wide devastation of sea otter populations, *Molecular Ecology*, at 11 (2022), at <https://doi.org/10.1111/mec.16334>.

²³⁰ Id. at 1, 2, 11.

²³¹ Id. at 2.

²³² See generally Larson et al., *supra* note 222.

²³³ See Gagne et al., *supra* note 92, at 1786-87 (noting that this low diversity may have preceded the fur trade); Larson, *supra* note 226 (finding twice the genetic diversity in pre-fur trade populations).

²³⁴ Beichman et al., *supra* note 229, at 1-2 (internal citations omitted), 12; Doroff & Burdin, *supra* note 78, at 1.

²³⁵ Beichman et al., *supra* note 229, at 12.

²³⁶ Id. at 1.

The southern sea otters' small population size interacts with reduced genetic diversity to increase extinction risk. As explained by Larson et al. (2009): "A consequence of low population size and slow growth includes higher probabilities of further population reductions due to stochastic events, which can lead to further declines in genetic diversity due to drift and additional population declines, until there is a real possibility of extinction (extinction vortex)."²³⁷ In addition, low genetic diversity hampers southern sea otters' ability to adapt to changing environmental conditions.²³⁸

Low genetic diversity thus presents a threat to sea otter conservation and recovery, particularly for the threatened southern sea otter. Sea otter reintroduction throughout the species' historic range along the U.S. Pacific Coast would promote recovery by enhancing genetic diversity. By helping to reestablish the historic transition zone between northern and southern sea otters in Oregon, reintroduction would facilitate mixing of genetic material between these two subspecies. This interbreeding would benefit southern sea otters through infusion of northern sea otter genes and would benefit northern sea otters through the introduction of southern sea otter genes that may prove beneficial in the face of climate change. Also, and in general, an increasingly large population will provide sea otters with a greater overall genetic pool from which to draw, increasing their resiliency and adaptation potential.

4. Other Anthropogenic Threats

Reintroduction also would help promote sea otter recovery by reducing the proportionate significance of other sources of anthropogenic mortality. In other words, if the sea otter metapopulation was substantially larger than it is today, any anthropogenic mortality from the sources listed below would be less significant to the overall population.

While anthropogenic trauma to southern sea otters appears to have declined overall, boat strikes remain a threat in nearshore waterways.²³⁹ In addition to causing direct mortality through strikes, vessel disturbance may have significant effects on sea otters through stress reactions or energetic expense.²⁴⁰ This threat is site specific, greater in economically important waterways, and is expected to increase alongside growing coastal populations.²⁴¹ Reintroduction of sea otters in less traveled waterways would help ameliorate this threat to the overall otter population.

Southern sea otters also are disturbed daily by kayakers, photographers, and ecotourism operators.²⁴² This disturbance occurs despite federal prohibitions against harassment; education and enforcement have been insufficient to prevent such harms.²⁴³ Harassment of sea otters can disrupt their behavior and deplete their energy reserves; chronic harassment can prove particularly harmful to otters whose health already is compromised by malnutrition, disease, or

²³⁷ Larson et al., *supra* note 222, at 367.

²³⁸ USFWS, *supra* note 3, at 36.

²³⁹ Nicholson et al., *supra* note 90, at 1759. See also USFWS, *supra* note 33, at 5-8 (discussing commercial fishery risks to southern sea otters), 10 (discussing boat strikes).

²⁴⁰ Murray, *supra* note 165, at 16.

²⁴¹ Nicholson et al., *supra* note 90, at 1759; USFWS, *supra* note 33, at 5-8, 10; Murray, *supra* note 165, at 16.

²⁴² USFWS, *supra* note 196, at 19.

²⁴³ *Id.*

trauma.²⁴⁴ Whether this harassment is sufficient to cause demographically significant effects is unknown.²⁴⁵ A larger sea otter metapopulation along the entire U.S. West Coast would include some otters less subject to this type of disturbance.

Data on incidental mortality of southern sea otters from commercial fisheries is limited.²⁴⁶ While entanglement in gillnets has declined since high levels in the 1970s and 1980s, sea otters likely drown in crab, lobster, and finfish pots or traps.²⁴⁷ Documented trap mortalities are limited and likely underreported due in part to a lack of observer coverage; lost or derelict gear poses a challenge.²⁴⁸ Net entanglement and fishhook injuries or consumption also pose a threat.²⁴⁹ Even with high levels of observer effort, bycatch mortality often would go undetected.²⁵⁰ The larger the sea otter population, the less chance this threat would hinder recovery.

Finally, the southern sea otter remains vulnerable to natural and anthropogenic catastrophes due to its small population size and restricted, nearshore geographic distribution.²⁵¹ Reintroducing sea otters throughout their historic range along the U.S. West Coast would reduce the odds that a catastrophic event would decimate the entire sea otter population and prevent its recovery.

IV. Reintroduction Is Required for the Sea Otter's Conservation

*“Reintroduction of sea otters to their former habitats has been the single most important management action contributing to the recovery from near extinction in regions of the eastern North Pacific.”*²⁵²

Reintroduction of sea otters is necessary for the species' conservation. Simply put, without an active reintroduction process, sea otters are unlikely to reinhabit the majority of the species' historic range and will remain vulnerable to stochastic events and anthropogenic catastrophes (e.g., oil spills) and less likely to withstand increasing stressors like climate change.²⁵³

²⁴⁴ Id., citing Yeates, Laura C., Terrie M. Williams & Traci L. Fink, Diving and foraging energetics of the smallest marine mammal, the sea otter (*Enhydra lutris*), 210 J. Experimental Biology 1960 (2007), Thometz, N.M. et al., Energetic demands of immature sea otters from birth to weaning implications for maternal costs, reproductive behavior and population-level trends, 217 J. Experimental Biology 2053 (2014); Nicholson et al., supra note 90, at 1759.

²⁴⁵ USFWS, supra note 196, at 19.

²⁴⁶ Id. at 7.

²⁴⁷ Hatfield, Brian B. et al., Sea otter mortality in fish and shellfish traps: estimating potential impacts and exploring possible solutions, 13 Endangered Species Research 219 (2011). See also USFWS, supra note 33, at 5-6; Doroff & Burdin, supra note 78, at 8; Boustany, Andre M. et al., Examining the potential conflict between sea otter recovery and Dungeness crab fisheries in California, 253 Biological Conservation 108830 (2021) (finding that where southern sea otter populations and crab fisheries overlap, crab fishing success has increased over time in areas where sea otter populations have grown, and that crabs constitute <2% of the otters' total diet); Grimes, Tracy M. et al., Characterizing the impact of recovering sea otters on commercially important crabs in California estuaries, 655 Marine Ecology Progress Series 123 (2020) (finding that sea otters can have localized impacts on crab populations within estuaries but that otter presence did not impact Dungeness crab fishery landings from 2000-2014).

²⁴⁸ USFWS, supra note 33, at 6-7; Murray, supra note 165, at 16.

²⁴⁹ Murray, supra note 165, at 16.

²⁵⁰ Hatfield et al., supra note 247, at 219.

²⁵¹ Id. at 5.

²⁵² Tinker, supra note 260, at 1.

²⁵³ USFWS, supra note 3, at x, 121.

Reintroduction is defined as “the intentional movement and release of an organisms inside its indigenous range from which it has disappeared” and seeks “to re-establish a viable population of the focal species within its indigenous range.”²⁵⁴ Reintroductions frequently include translocations, or the movement of animals from one location to another.²⁵⁵ Reintroductions often are initiated to help introduce redundancy and representation to metapopulations, helping species withstand stochastic and catastrophic events by enhancing the potential for demographic rescue, facilitating genetic exchange,²⁵⁶ and making them more likely to persist in the face of climate change and other stressors.²⁵⁷ Reintroduction as a conservation tool has been used extensively and successfully for a variety of species including sea otters.²⁵⁸

A. Past Sea Otter Reintroductions

Reintroductions have been instrumental in helping sea otters recover from fur trade-associated declines as well as enhancing the species’ genetic diversity.²⁵⁹ Such efforts were the foundation for approximately one-third of today’s existing otter populations.²⁶⁰ *See* Fig. 3. For example, successful reintroductions of sea otters from Prince William Sound, Alaska, and Amchitka Island to British Columbia, other Alaska locations, and Washington helped reestablish populations in those areas.²⁶¹ Orphaned, surrogate-raised sea otter pups helped build a population at Elkhorn Slough, California.²⁶² After decades of struggle, the descendants of otters reintroduced to San Nicolas Island, California, appear to be establishing themselves.²⁶³ *See* Table 1.

²⁵⁴ Int’l Union Conservation Nature (IUCN), Guidelines for reintroductions and other conservation translocations, version 1.0 (2013).

²⁵⁵ Tinker, M. Tim, Ch. 1: Introduction, in Elakha Alliance, *supra* note 3.

²⁵⁶ *See* Larson & Tinker, *supra* note 78, at 5 (explaining how reintroductions have helped increase population connectivity and gene flow within sea otter populations).

²⁵⁷ USFWS, *supra* note 3, at 50, 52; Bodkin, Estes & Tinker, *supra* note 259; Tinker, *supra* note 268, at 17.

²⁵⁸ Tinker, *supra* note 255, at 1; *see generally* Bodkin, Estes & Tinker, *supra* note 259.

²⁵⁹ USFWS, *supra* note 3, at 29; *see generally* Bodkin, J.L., J.A. Estes & M.T. Tinker, Ch. 2: History of Prior Sea Otter Translocations, in Elakha Alliance, *supra* note 3.

²⁶⁰ USFWS, *supra* note 3, at vii, 19. *See also id.* at 29 (stating that “in the long term reintroduction efforts have proven to be successful in restoring the sea otter to large areas of its formerly occupied range. Sea otter populations established through translocation efforts in Alaska, British Columbia, and Washington now account for an estimated 35% of the global population.”); Tinker, M. Tim, Ch. 12: Conclusions, at 1, in Elakha Alliance, *supra* note 3.

²⁶¹ USFWS, *supra* note 3, at 19.

²⁶² *Id.* at 24.

²⁶³ *Id.* at 23.

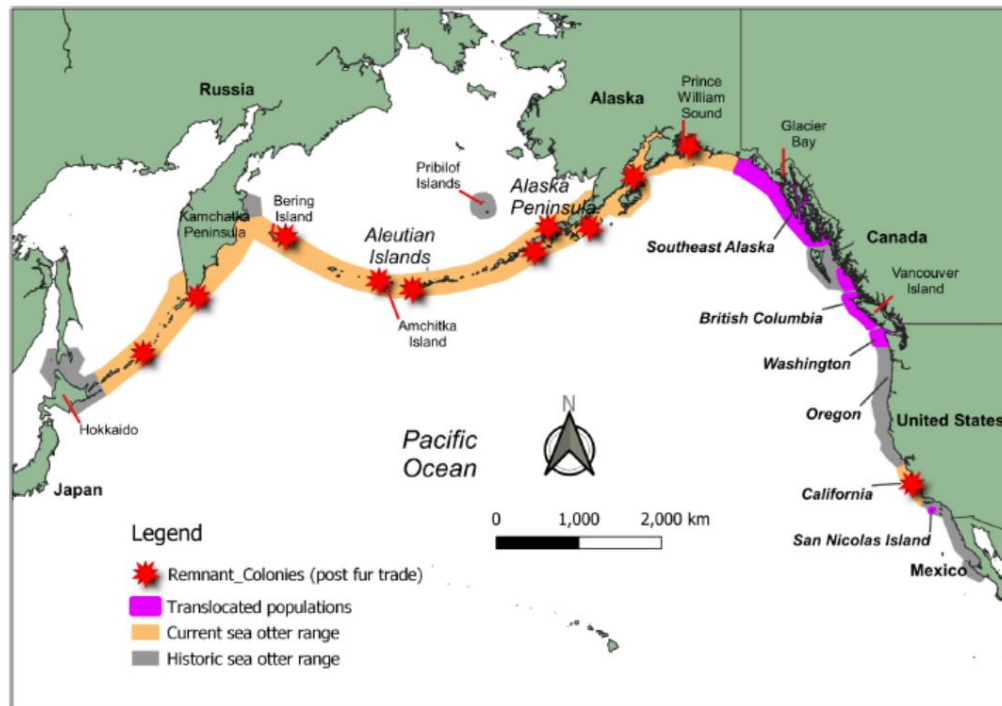


Fig. 3. Historical and current sea otter range in the North Pacific Ocean, including reintroduced populations. Map from Bodkin, Estes & Tinker (2021).²⁶⁴

Release Location	Year(s)	Source	Intended for release	Number released	Success	Approximate Founding number	Recent estimate
Murman Peninsula	1937	Bering Island, Russia	9	2	no	1	0
Pribilofs Is	1951	Amchitka, Alaska	35	0	no	0	0
	1955	Amchitka, Alaska	31	19	no	0	0
	1957	Amchitka, Alaska	8	0	no	0	0
	1959	Amchitka, Alaska	10	7	unknown	3	0
	1968	Amchitka, Alaska	55	55	temporary	unknown	0
Attu	1956	Amchitka, Alaska	5	5	no	0	NA
California	1969	California	17	17	no	NA	NA
North SE Alaska	1965-1969	Amchitka & Prince	297	297	yes	100-150	11,600
Central SE Alaska	1968	William Sound,	51	51	yes	30	13,200
South SE Alaska	1968	Alaska	55	55	yes	21	
SE Alaska - TOTAL			403	403	yes	150	>25,000
British Columbia	1969-1972	Amchitka & Prince William Sound, Alaska	89	89	yes	28	7,000
Washington	1969-1970	Amchitka, Alaska	59	59	yes	10	>2,000
Oregon	1970-1971	Amchitka, Alaska	93	93	no	0	0
San Nicolas Is, CA	1987-1990	California	142	139	yes	12	121
Elkhorn Slough, CA	2002-2016	California	37	37	yes	37 + ~25 wild	120

Table 1. Summary statistics for various past sea otter reintroduction efforts. Table from Bodkin, Estes & Tinker (2021).²⁶⁵

²⁶⁴ Bodkin, Estes & Tinker, supra note 259, at 8, Fig. 2.1.

²⁶⁵ Bodkin, Estes & Tinker, supra note 259, at 9, Table 2.1.

Additional reintroductions of sea otters, as outlined in this petition, will be necessary for the species' conservation. Reintroduction methods have improved over time, increasing the likelihood of success of future reintroduction efforts.²⁶⁶ Both the Elakha Alliance and FWS outline key lessons learned from previous reintroduction efforts.²⁶⁷ See App. B. Tinker (2021) provides a comprehensive overview of considerations for determining source population(s) and release site(s) for reintroduction efforts, as well as potential establishment trajectories.²⁶⁸

B. Future Sea Otter Reintroductions

FWS has determined that reintroduction of sea otters along the northern contiguous U.S. West Coast is biologically, ecologically, socioeconomically, and legally feasible.²⁶⁹ The Center requests that the agency immediately initiate a reintroduction of sea otters in the largest gap in their historic range, from San Francisco Bay, California, north through Oregon.²⁷⁰ Subsequently, the Center requests that FWS conduct an assessment to determine the feasibility of reintroducing sea otters to unoccupied habitat to the south of the otter's current range, from Gaviota State Beach to Baja California, Mexico.²⁷¹ While FWS focuses on the former in its 2022 Feasibility Assessment, it acknowledges that the southern "areas are also important for recovery of the southern sea otter subspecies under the ESA and/or MMPA and for the species globally, and that the ecosystems there would also benefit from the return of this important native predator."²⁷²

Reintroduction will facilitate sea otters' reestablishment in suitable habitat; enhance genetic diversity; aid in the recovery of the southern sea otter; and restore coastal ecosystems along the U.S. West Coast.²⁷³ It further will help mitigate climate change and its effects (*e.g.*, ocean acidification, storm surges) by fostering the development of healthy kelp forests and seagrass beds that buffer shorelines and sequester CO₂.²⁷⁴ These ecosystems, in turn, will provide high-quality habitat for an expanding sea otter metapopulation as well as myriad other species.

²⁶⁶ USFWS, *supra* note 3, at vii, 19-28.

²⁶⁷ See generally *id.* at 28, Box 2.1; Bodkin, Estes & Tinker, *supra* note 259, at 5-6; Tinker, *supra* note 260, at 1.

²⁶⁸ See generally Tinker, M. Tim, Ch. 3: Population and demographic considerations, in Elakha Alliance, *supra* note 3. See also Larson & Tinker, *supra* note 78, at 6-7 (discussing genetic considerations for selection of a source population).

²⁶⁹ See generally USFWS, *supra* note 3, at vii.

²⁷⁰ The Elakha Feasibility Study concludes that "a reintroduced population (or populations) of sea otters [in Oregon] is likely to be viable assuming sufficient numbers of animals are released to appropriate habitats" and that "multiple release locations may be more effective than a single release site." Tinker, *supra* note 260, at 1, 2. See also Tinker, Dr. M. Tim, Appendix A: Oregon Sea Otter Population Model, User Interface App ("*ORSO*" v.1.0), in Elakha Alliance, *supra* note 3; Appendix B: Habitat Maps of Oregon State Waters from the Active Tectonics and Seafloor Mapping Lab at Oregon State University), in Elakha Alliance, *supra* note 3; Appendix C: Substrate Characteristics for Oregon's Marine Resources, in Elakha Alliance, *supra* note 3; Appendix D: Kelp Canopy Extent from ODFW's Kelp Canopy and Biomass Survey Report (2011), in Elakha Alliance, *supra* note 3.

²⁷¹ See USFWS, *supra* note 3, at 35.

²⁷² *Id.* at 35-36. See also *id.* at 36 (noting that much of the information covered in the Feasibility Assessment for reintroduction north of the southern sea otter's current range "would also apply to southern California and Baja California").

²⁷³ *Id.* at vii, 35, 53. See Tinker, *supra* note 260, at 1 (noting that past reintroductions have "increased species viability, helped recover genetic diversity and improved gene flow throughout populations in the regions north of the geographic break between the Washington and California populations").

²⁷⁴ Estes & Tinker, *supra* note 62, at 8-9; USFWS, *supra* note 3, at 60, 76.

FWS has stated that the agency “view[s] the expansion of the sea otter’s range and the establishment of additional populations as essential to enhancing the capacity of sea otters to adapt and persist in the face of ... increased stressors.”²⁷⁵ In its 2022 Feasibility Assessment, FWS outlines the reasons for its initial focus on re-establishing the species in northern California and Oregon. These reasons include:

- Reestablishing sea otters in the largest remaining gap in the species’ historical range, and in an area unlikely to be naturally recolonized along the U.S. Pacific Coast;
- Reestablishing sea otters in Oregon, the only U.S. Pacific Coast state without an otter population and the location of the historic transition zone between northern and southern sea otters;²⁷⁶
- Reestablishing the historic transition zone between northern and southern sea otters, thus renewing connectivity and gene flow between these two otter populations;
- Contributing to the recovery and eventual delisting of southern sea otters;
- Reintroducing otters in areas with a large number of estuaries, habitats that afford otters with some protection from predation;
- Reintroducing otters into kelp forest and seagrass ecosystems that will benefit from the species’ presence.²⁷⁷

Reintroduction will help sea otters persist in the face of the threats described in Part III, *supra*. For example, it will facilitate the establishment of additional populations in areas with lower shark bite-mortality risk.²⁷⁸ It will provide redundancy, helping to ensure species persistence in the face of a catastrophic event (*e.g.*, oil spill).²⁷⁹ Reintroduction also will help address the diminished genetic diversity that plagues sea otter populations.²⁸⁰ Increased genetic diversity, in turn, will provide sea otters with additional adaptive potential in the face of climate change, diseases, and other stressors.²⁸¹ Indeed, FWS has stated that “the uncertainty related to climate change underscores the need to expand the occupied range of sea otters, particularly southern sea otters, to ensure redundancy and to afford this subspecies, and the species overall, with the greatest chance of adapting to and surviving these changes.”²⁸²

In its 2022 Feasibility Assessment, FWS concluded that “sea otter reintroduction is highly desirable from a biological and ecological perspective.”²⁸³ The agency has stated that reintroduction is likely to substantially improve the status of the threatened southern sea otter as long as southern sea otters serve as the source stock and occasional dispersal between populations occurs.²⁸⁴ Various options for source stock and release sites are provided in FWS’s 2022 Feasibility Assessment, and Bodkin & Tinker (2021) provide a thorough overview of

²⁷⁵ USFWS, *supra* note 3, at viii.

²⁷⁶ See *id.* at 31 (discussing Oregon).

²⁷⁷ *Id.* at 4, 36, 53.

²⁷⁸ *Id.* at 36-37.

²⁷⁹ *Id.* at 37.

²⁸⁰ USFWS, *supra* note 3, at x, 37.

²⁸¹ *Id.* at x, 37, 54.

²⁸² *Id.* at 52.

²⁸³ *Id.* at 61.

²⁸⁴ *Id.* at 36.

potential reintroduction strategies.²⁸⁵ Release sites in nearshore ocean habitats and in estuaries should be part of the reintroduction effort.²⁸⁶

FWS has acknowledged the need to conduct site-specific ground-truthing and consider habitat features including prey availability and shelter as well as disease risks and anthropogenic hazards when narrowing down specific reintroduction sites.²⁸⁷ The model developed by Tinker et al. (2021) and applied to Oregon by Kone et al. (2021) provides estimated carrying capacities based on habitat variables including depth, distance from shore, benthic substrate type, net primary productivity, estuary presence, and kelp canopy presence.²⁸⁸ Post-release monitoring is crucial for reintroduction success and should be an integral part of reintroduction efforts.²⁸⁹

Much groundwork for sea otter reintroduction has already been laid and many scientists and organizations with substantial expertise have demonstrated a willingness and capacity to help realize such an effort. We request that FWS immediately commence reintroduction of sea otters along the U.S. West Coast to ensure the species' survival and persistence. Draft regulatory language to effect reintroduction is provided below.

C. Regulatory Language to Effect an Experimental Population of Sea Otters

The Center suggests the “List of Threatened and Endangered Wildlife” found in § 17.11(h) of Chapter 50 of the Code of Federal Regulations be amended to include the following language to establish an experimental population(s) of sea otters:

²⁸⁵ See USFWS, *supra* note 3, at 38; Bodkin, J.L. & M.T. Tinker, Ch. 9: Implementation and logistical considerations, in Elakha Alliance, *supra* note 3.

²⁸⁶ Tinker, *supra* note 260, at 2.

²⁸⁷ USFWS, *supra* note 3, at 39-40. See also *id.* at 41-46 (high-level, state-specific consideration of possible reintroduction sites); *id.* at 47-49 (presenting survey results on prey resource presence in various zones of possible reintroduction). See also Hodder, J., M.T. Tinker & J.L. Bodkin, Ch. 6: Habitat Suitability, in in Elakha Alliance, *supra* note 3.

²⁸⁸ USFWS, *supra* note 3, at 40, citing Tinker et al., *supra* note 33; Kone, D.V. et al., Informing sea otter reintroduction through habitat and human interaction assessment, 44 *Endangered Species Research* 159 (2021).

²⁸⁹ Bodkin & Tinker, *supra* note 285.

Common name	Scientific name	Where listed	Status	Listing citations and applicable rules
Otter, northern sea [Southwest Alaska DPS]	<i>Enhydra lutris kenyoni</i>	Southwest Alaska, from Attu Island to Western Cook Inlet, including Bristol Bay, the Kodiak Archipelago, and the Barren Islands	T	70 FR 46366, 8/9/2005; 50 CFR 17.40(p); ^{4d} 50 CFR 17.95(a) ^{CH}
*	*	*	*	*
Otter, southern sea	<i>Enhydra lutris nereis</i>	Wherever found, except where listed as an experimental population	T	42 FR 2965, 1/14/1977.
Otter, sea	<i>Enhydra lutris</i>	U.S.A. (specific portions of California and Oregon)—see § 17.84(y) ²⁹⁰	Experimental nonessential	[Insert Federal Register page where the document begins.]

The Center further suggests that 50 C.F.R. § 17.84 be amended by adding the following paragraph (y)²⁹¹

Special rules—vertebrates

* * * * *

(y) Otter, sea (*Enhydra lutris*)

- (1) The sea otter (*Enhydra lutris*) population identified in paragraph (y)(10) of this section is a nonessential experimental population (NEP).
- (2) Except as provided in paragraphs (3) through (5) of this section, no person may take this species.
- (3) Any person with a valid permit issued by the U.S. Fish and Wildlife Service under § 17.32 may take sea otters within the NEP area for scientific purposes, the enhancement or propagation or survival of the species, and other conservation purposes consistent with the Endangered Species Act and Marine Mammal Protection Act and in accordance with applicable Tribal or State fish and wildlife conservation laws and regulations.
- (4) Sea otters within the NEP may be taken, provided that such take is incidental to, and not the purpose of, carrying out any otherwise lawful activity; and provided that such taking is in compliance with the Marine Mammal Protection Act and is reported as soon as possible in accordance with paragraph (y)(6) of this section.
- (5) Any employee or agent of the U.S. Fish and Wildlife Service, the California Department of Fish and Wildlife, the Oregon Department of Fish and Wildlife, and the **[LIST OF]**

²⁹⁰ Or, if paragraph “y” is already in use, then at the next lettered paragraph.

²⁹¹ Or, if paragraph “y” is already in use, then at the next lettered paragraph.

Tribes, who is designated for such purpose may, when acting in the course of official duties, take a sea otter if such action is necessary to:

- i. Aid a sick, injured, or orphaned sea otter;
 - ii. Dispose of a dead sea otter, or salvage a dead sea otter that may be useful for scientific study;
 - iii. Move a sea otter for genetic purposes or to improve the health of the population; or
 - iv. Capture and release a sea otter for relocation, to collect biological data, or to attach, service, or detach radio-telemetry equipment.
- (6) Any taking pursuant to paragraphs (3) through (5) of this section must be reported as soon as possible by calling the U.S. Fish and Wildlife Service, Pacific Southwest Region Headquarters, Federal Building, 2800 Cottage Way, Sacramento, CA, 95825, (916) 414-6464, or the U.S. Fish and Wildlife Service, Pacific Regional Office, 911 NE 11th Avenue, Portland, OR, 97232, (503) 231-2176. Upon contact, a determination will be made as to the disposition of any live or dead sea otters.
- (7) No person may possess, sell, deliver, carry, transport, ship, import, or export by any means whatsoever, any sea otter or sea otter parts taken in violation of these regulations.
- (8) It is unlawful for any person to attempt to commit, commit, solicit another to commit, or cause to be committed, any offence defined in paragraphs (y)(2) and (7) of this section.
- (9) All of the sites for reintroduction of sea otters are wholly separate from existing populations of sea otters. All reintroduction sites are within the historic range of the sea otter.
- (10) The boundaries of the designated NEP area are defined as **[FWS DEFINES]**. All release sites will be within the NEP area.
- a. All sea otters found in the wild within the boundaries of the NEP area will be considered members of the NEP.
 - b. A sea otter that disperses beyond the boundaries of the NEP area takes on that status of that area.
- (11) The experimental sea otter populations will be checked regularly to determine the conditions of individual sea otters.
- (12) The Service plans to evaluate the status of the NEP every 5 years to determine future management status and needs, with the first evaluation occurring not more than 5 years after the first release of sea otters into the NEP area. All reviews will take into account the reproductive success and movement patterns of individuals released, food habits, and overall health of the populations. This evaluation will include a progress report.
- (13) Legal actions or other circumstances may compel a change in the sea otter experimental population's legal status to essential, threatened, endangered. Changes in the legal status of the populations will not occur prior to notice and comment. Individuals of the experimental sea otter population will not be removed from the wild unless doing so furthers the recovery of the species.

V. Conclusion

Sea otter reintroduction to the U.S. West Coast is biologically and ecologically necessary for the species' conservation and is socioeconomically and legally feasible.²⁹² In light of the otters' stalled recovery, the Center requests that FWS promptly commence a formal reintroduction effort from San Francisco Bay north into Oregon as described in FWS's 2022 Feasibility Assessment and the Elakha Alliance's 2021 Feasibility Study. Subsequently, the Center requests that FWS conduct an assessment to determine the feasibility of reintroduction(s) into the 800-km zone stretching from southern California to central Baja California, Mexico.²⁹³

Inaction is no longer an option.²⁹⁴ Sea otters are unlikely to repopulate the existing 1,500 km range gap between central California and north-central Washington without active assistance, particularly in the face of increasing white shark bite mortality.²⁹⁵ Waiting for natural range expansion to occur poses a variety of risks: risks flowing from lack of redundancy in the event of catastrophic events; risk of further reduced genetic viability in the threatened southern sea otter; and risk to northern sea otters that might benefit from an infusion of southern sea otter genes in the face of climate change.²⁹⁶ Establishing a healthy sea otter population along the U.S. West Coast would help restore the sea otter throughout its historic range.²⁹⁷

FWS concluded in its Feasibility Assessment that reintroduction would lead to multiple benefits to sea otters and their habitats. Reintroduction would facilitate range expansion for the southern sea otter, something necessary for the species' recovery, conservation, and eventual delisting.²⁹⁸ It would re-establish in Oregon the historic transition zone between southern and northern sea otters, which would benefit both subspecies through genetic exchange.²⁹⁹ Reintroduction also would create needed redundancy that could help southern sea otters survive a catastrophic event such as an oil spill.³⁰⁰

Reintroduction of sea otters to the U.S. West Coast would provide a host of benefits to coastal ecosystems including kelp forests and seagrass beds. Healthy coastal ecosystems provide food, shelter, and nursery habitat for a wide diversity of species including finfish and invertebrates.³⁰¹ They also sequester carbon and buffer a variety of climate change impacts including storm surge, erosion, and ocean acidification.³⁰²

Sea otter reintroduction would help to achieve the vision behind two of the United States' primary conservation laws: the Endangered Species Act and Marine Mammal Protection Act.³⁰³

²⁹² See generally USFWS, *supra* note 3; Elakha Alliance, *supra* note 3.

²⁹³ USFWS, *supra* note 3, at 3.

²⁹⁴ See *id.* at x, 120-121 (noting that threats to sea otters flowing from lack of population redundancy and reduced genetic diversity "will continue or increase as a result of inaction").

²⁹⁵ *Id.* at 121.

²⁹⁶ *Id.*

²⁹⁷ *Id.* at 134.

²⁹⁸ USFWS, *supra* note 3, at 133.

²⁹⁹ *Id.*

³⁰⁰ *Id.*

³⁰¹ *Id.* at 121-22, 134.

³⁰² *Id.* at 134.

³⁰³ See USFWS, *supra* note 3, at 134.

It would help reestablish an iconic keystone species that for too long has been absent from the majority of its historic range in the United States. Reintroduction is necessary to achieve sea otter recovery and FWS should commence with a reintroduction program immediately.³⁰⁴

³⁰⁴ See *id.* at 140 (noting that “reintroduced sea otter population(s), once established, will initially be small in size and take many years to grow and expand”).

Appendix A: Diseases Affecting Sea Otters

Parasites: Fatal infections by protozoa (*e.g.*, *Toxoplasma gondii*, *Sarcocystis neurona*) and acanthocephalans (primarily *Profilicollis* spp.) are particularly prevalent in southern sea otters.³⁰⁵ Both *Toxoplasma gondii* and *Sarcocystis neurona* can cause fatal protozoal encephalitis in the species.³⁰⁶ One or both parasites were detected in over three-quarters of deceased otters sampled in Miller et al.³⁰⁷ (2020), and actual infection rates were likely higher.³⁰⁸ *Toxoplasma gondii* and *Sarcocystis neurona* infection served as a primary or contributing cause of death of 20% of the otters studied; these protozoa commonly co-infect southern sea otters.³⁰⁹ Individual animal behavior, prey choice, and habitat use all are associated to infection with these pathogens.³¹⁰ For example, animals that prey predominantly on abalone have a low risk of infection whereas otters that consume soft-sediment prey have a higher risk.³¹¹

Toxoplasma gondii poses a major threat to southern sea otters, serving as a major cause of mortality and contributing to the species' slow recovery rate.³¹² Sandy bays near urban centers that receive freshwater runoff constitute areas of high *Toxoplasma* exposure.³¹³ Consumption of certain prey species, such as marine snails (*Tegula* spp.), also increases the risk of infection.³¹⁴ The risk of infection is positively correlated with age and male sex.³¹⁵ The Type X strain of *Toxoplasma gondii* predominates in severe southern sea otter infections, while Type II rarely causes significant disease.³¹⁶ That said, infection even with Type II may impact reproductive success.³¹⁷ *Toxoplasma gondii* infections were more likely to be fatal in the southern portion of the otters' range; this accords with other studies which revealed atypical Type X or Type X variants.³¹⁸ Miller et al. (2020) found identical Type X strains both in deceased otters and terrestrial felids from adjacent watersheds.³¹⁹

³⁰⁵ Miller et al., supra note 90, at 1; Doroff & Burdin, supra note 78, at 2; Kreuder et al., supra note 96, at 2, 3; Hanni, Krista D. et al., Clinical pathology and assessment of pathogen exposure in southern and Alaskan sea otters, 39 J. Wildlife Diseases 837 (2003); Mayer, Karl A. et al., Helminth parasites of the southern sea otter *Enhydra lutris nereis* in central California: abundance, distribution and pathology, 53 Diseases Aquatic Organisms 77 (2003).

³⁰⁶ Kreuder et al., supra note 96, at 2-3.

³⁰⁷ Burgess et al., supra note 175, at 1.

³⁰⁸ Miller et al., supra note 90, at 18.

³⁰⁹ Id. at 11. See also Bossart, supra note 136, at 678 (noting that *Toxoplasma gondii* and *Sarcocystis neurona* were the cause of death for ~25% otters examined between 1998-2001).

³¹⁰ Johnson, Christine K. et al., Prey choice and habitat use drive sea otter pathogen exposure in a resource-limited coastal system, 106 Proc. Nat'l Acad. Sci. 2242, 2242 (2009).

³¹¹ Id.

³¹² Conrad, P.A. et al., Transmission of *Toxoplasma*: clues from the study of sea otters as sentinels of *Toxoplasma gondii* flow into the marine environment, 35 Int'l J. Parasitology 1155 (2005).

³¹³ Id. at 1155; Miller, M.A. et al., Coastal freshwater runoff is a risk factor for *Toxoplasma gondii* infection of southern sea otters (*Enhydra lutris nereis*), 32 Int'l J. Parasitology 997 (2002).

³¹⁴ Johnson et al., supra note 310; Gaydos & Drayer, supra note 134; Murray, supra note 165, at 6.

³¹⁵ Murray, supra note 165, at 6.

³¹⁶ Conrad et al., supra note 312, at 1155; Miller, M.A. et al., An unusual genotype of *Toxoplasma gondii* is common in California sea otters (*Enhydra lutris nereis*) and is a cause of mortality, 34 Int'l J. Parasitology 275 (2004); Shapiro, Karen et al., Type X strains of *Toxoplasma gondii* are virulent for southern sea otters (*Enhydra lutris nereis*) and present in felids from nearby watersheds, 286 Proc. Royal Soc'y B 20191334 (2019); Murray, supra note 165, at 6.

³¹⁷ Murray, supra note 165, at 7.

³¹⁸ Miller et al., supra note 90, at 18-19; Miller et al., supra note 316.

³¹⁹ Miller et al., supra note 90, at 19; Shapiro et al., supra note 316.

Sarcocystis neurona infections have been confirmed in Alaska, British Columbia, Washington, and California.³²⁰ This parasite was first recognized as an important source of southern sea otter mortality after a 2004 outbreak that led to the stranding of 40 otters in Morro Bay.³²¹ Consumption of clams and other soft-sediment prey³²² that bioaccumulate the parasite increases exposure risk,³²³ and exposure also is associated temporally with runoff events and certain terrestrial features including high-density human housing, agricultural lands, and wetlands.³²⁴ Sea otters are an intermediate host for *S. neurona*, while Virginia opossum (*Didelphis virginiana*) are the definitive host.³²⁵ The organism can remain inactive in the environment for extended periods of time, posing a substantial risk to sea otters along the U.S. West Coast.³²⁶

Acanthocephalan peritonitis occurs not infrequently in southern sea otters but is rare in northern sea otters.³²⁷ It was a primary or contributing cause of death for approximately a quarter of the otters in Miller et al. (2020).³²⁸ This disease, which often occurred as a co-infection with other bacteria, occurred more frequently in otters that stranded near sandy beach habitat used by crustacean intermediate hosts and disease incidence peaked in the spring (April-May).³²⁹ Kreuder et al. (2004) associated acanthocephalan infection with otter consumption of sand crabs (*Emerita analoga*) and possibly spiny mole crabs (*Blepharipoda occidentalis*).³³⁰ Recently weaned pups, subadults, and aged adults are the age classes most susceptible to this parasite.³³¹ There also appears to be a correlation between food availability and disease incidence, with otters presenting with acanthocephalid peritonitis more frequently in more densely populated areas.³³²

A handful of arthropod and metazoan parasites including *Halarachne halocheri*, *Baylisascaris* sp., and *Capillaria hepatica* have been implicated in southern sea otter deaths.³³³ One report of

³²⁰ Murray, supra note 165, at 5.

³²¹ Burgess et al., supra note 175, at 1.

³²² See Maldini, Daniela et al., Southern sea otter diet in a soft sediment community, 3 J. Marine Animals & Their Ecology 27 (2010) (identifying soft-sediment prey items and noting that 91% of individuals studied specialized on clams); Newsome, Seth D. et al., Using stable isotopes to investigate individual diet specialization in California sea otters (*Enhydra lutris nereis*), 90 Ecology 961 (2009); Newsome, Seth D. et al., The interaction of intraspecific competition and habitat on individual diet specialization: a near range-wide examination of sea otters, 178 Oecologia 45 (2015); Elliott Smith, Emma A. et al., The cost of reproduction: differential resource specialization in female and male California sea otters, 178 Oecologia 17 (2015); Elliott Smith, Emma A. et al., Reductions in the dietary niche of southern sea otters (*Enhydra lutris nereis*) from the Holocene to the Anthropocene, 10 Ecology & Evolution 3318 (2020); Tinker, M. Tim, Gena Bentall & James A. Estes, Food limitation leads to behavioral diversification and dietary specialization in sea otters, 105 Proc. Nat'l Acad. Sci. 560 (2008).

³²³ Cf. prey obtained in kelp and hard-bottom habitats.

³²⁴ Burgess et al., supra note 175, at 1; Murray, supra note 165, at 6.

³²⁵ Murray, supra note 165, at 5.

³²⁶ Id. at 6.

³²⁷ Id. at 7.

³²⁸ Miller, Melissa A. et al., A protozoal-associated epizootic impacting marine wildlife: mass-mortality of southern sea otters (*Enhydra lutris nereis*) due to *Sarcocystis neurona* infection, 172 Vet. Parasitology 183 (2010); Miller et al., supra note 90, at 8, 18.

³²⁹ Miller et al., supra note 90, at 8.

³³⁰ Kreuder et al., supra note 96, at 3.

³³¹ Murray, supra note 165, at 7.

³³² Id.

³³³ Miller et al., supra note 90, at 15, 18; Shockling Dent, Colleen E.. Pathology and epidemiology of nasopulmonary acariasis (*Halarachne* sp.) in southern sea otters (*Enhydra lutris nereis*), 9 IJP: Parasites & Wildlife 60 (2019).

an adult tapeworm (Cestoda: Diphyllbothriidea) in a southern sea otter has been recorded.³³⁴ Larval migrans by helminth larvae (e.g., the raccoon roundworm (*Baylisascaris* sp.) and lung fluke (*Paragonimus* sp.) are uncommon but occasionally fatal in sea otters.³³⁵ The risk of pollution with these pathogens increases at the land-sea interface, particularly where runoff is concentrated near agricultural or urban areas.³³⁶

Bacteria: The majority of bacterial species infecting sea otters are “opportunistic relying on a breach of the host’s intrinsic immune system (skin, mucus membranes), immunosuppression, or co-infection with a primary pathogen to gain access to the body.”³³⁷ Bacterial infections contributed to the death of 68% of sea otters necropsied by Miller et al. (2020), either as a primary process or sequela.³³⁸ Bacteria associated with fatal outcomes include *Streptococcus* spp. (including *Streptococcus phocae*, *S. infantarius* ss *coli*), *Erysipelothrix* sp. (including *Erysipelothrix rhusiopathiae*), *Klebsiella pneumoniae*, *Pasteurella multocida*, *Salmonella* sp., hemolytic *Escherichia coli*, *Campylobacter* spp., *Staphylococcus* spp. (including *Staphylococcus delphini*, *S. intermedius*, *S. schleiferi* ss *coagulans*), *Vibrio* spp. (including *Vibrio parahaemolyticus*, *V. alginolyticus*), *Fusobacterium* spp. (including *Fusobacterium necrophorum*, *F. nucleatum*), *Clostridium* sp. (including *Clostridium septicum*, *C. difficile*, *C. perfringens*), *Peptostreptococcus anaerobius*, and *Leptospira* sp.³³⁹ Many of these bacteria more frequently affect otters near urbanized areas and areas receiving freshwater runoff.³⁴⁰ Other problematic pathogens include *Brucella* spp., *Coxiella burnetii*, and *Bartonella* spp.³⁴¹

Bartlett et al. (2016) found *Streptococcus phocae* infection in 30% of dead otters examined between 2004-2010.³⁴² Skin trauma from any cause (e.g., shark bite, fight or mating wounds, boat strike, fishing hook, entanglement) and of any severity presented a significant risk factor for infection.³⁴³ Infected otters were more likely to suffer from bacterial septicemia or abscesses.³⁴⁴

³³⁴ Young, Colleen et al., First report of an adult tapeworm (Cestoda: Diphyllbothriidea) in a southern sea otter (*Enhydra lutris nereis*), 53 J. Wildlife Diseases 934 (2017).

³³⁵ Murray, supra note 165, at 8.

³³⁶ Id.

³³⁷ Id. at 3.

³³⁸ Miller et al., supra note 90, at 1, 15.

³³⁹ Id. at 15; Hanni, et al., supra note 305; Burek, Kathy A. et al., Valvular endocarditis and septicemia due to *Streptococcus infantarius* ss *coli* organisms in stranded northern (*Enhydra lutris kenyoni*) and southern sea otters (*Enhydra lutris nereis*), Int’l Ass’n Aquatic Animal Medicine Conf. Proc. (2005), available at <https://www.vin.com/apputil/content/defaultadv1.aspx?pId=11257&id=3865149>; Imai, Denise et al., Characterization of beta-hemolytic streptococci isolated from southern sea otters (*Enhydra lutris nereis*) stranded along the California coast, 136 Veterinary Microbiology 378 (2009) (first reporting *S. phocae* in southern sea otters and noting that beta-hemolytic streptococci are implicated in pneumonia, septicemia, opportunistic infections, and other debilitating disease processes); Miller, Melissa A. et al., Enteric bacterial pathogen detection in southern sea otter (*Enhydra lutris nereis*) is associated with coastal urbanization and freshwater runoff, 41 Vet. Res. 01 (2010) (southern sea otter exposure to fecal bacteria). Other underlying conditions including gastrointestinal disease may also be bacterial infections. Miller et al., supra note 90, at 15. See also Murray, Michael J., Ch. 10: Animal health and welfare considerations, at 3-4, in Elakha Alliance, supra note 3.

³⁴⁰ Miller et al., supra note 339, at 1.

³⁴¹ Murray, supra note 165, at 3.

³⁴² Bartlett, Georgina et al., Prevalence, pathology, and risk factors associated with *Streptococcus phocae* infection in southern sea otters (*Enhydra lutris nereis*), 2004-2010, 52 J. Wildlife Diseases 1, 1 (2016).

³⁴³ Id. at 1, 5.

³⁴⁴ Id. at 1.

Some sea otter prey species including Dungeness crab (*Metacarcinus magister*), bay mussels (*Mytilus trossulus*), black turban snails (*Tegula funebris*), and butter clams (*Saxidomus giganteus*) can bioaccumulate *S. phocae*.³⁴⁵ Whether food-borne exposure can occur through breach of gastro-intestinal mucosa, or if some sort of ulcer or other GI wound is needed for entry, is unknown.³⁴⁶

The 2006 unusual mortality event of northern sea otters in Kachemak Bay, Alaska, appears to have been caused at least in part by two other beta-Streptococcus species: *S. bovis/equinus* and *S. infantarius* subsp. *coli*.³⁴⁷ These bacteria have been associated with a heart valve disease called vegetative valvular endocarditis.³⁴⁸

Bordatella bronchiseptica, which causes a respiratory infection in sea otters, generally presents as a secondary infection, often to *Morbillivirus*.³⁴⁹ *Leptospira* is uncommon in sea otters but may be transferred from terrestrial wildlife.³⁵⁰

Fungi: The zoonotic fungus *Coccidioides* sp. (including *Coccidioides immitis*, *C. posadasii*) also serves as a primary or contributing cause of death for southern sea otters.³⁵¹ This pathogen is localized, with otters between Morro Bay and Pismo Beach predominantly affected; coccidioidomycosis also has occurred in otters at Moss Landing.³⁵²

Viruses: Viruses also kill southern sea otters, with morbillivirus “undoubtedly the most concerning.”³⁵³ Two morbillivirus species are of great concern for sea otters: canine distemper and phocine morbillivirus.³⁵⁴ Canine distemper virus was a primary (though unconfirmed) suspect in the otters examined by Miller et al. (2020) and likely the cause of the 2000 mass mortality event in Washington State.³⁵⁵ In 2004-05, forty percent of live-captured sea otters from the eastern Aleutians and Kodiak archipelago were sero-positive for phocine morbillivirus.³⁵⁶ Morbillivirus presently has a low incidence in southern sea otters.³⁵⁷ Climate change may facilitate the spread of phocine morbillivirus further, increasing the threat it poses to sea otter populations.³⁵⁸

Influenza virus was found in 70% of northern sea otters tested in 2011.³⁵⁹ The northern elephant seal (*Mirounga angustirostris*) appears to have been the source of infection, and virus

³⁴⁵ Murray, supra note 165, at 3.

³⁴⁶ Id.

³⁴⁷ Id.

³⁴⁸ Id.

³⁴⁹ Id. at 4.

³⁵⁰ Murray, supra note 165, at 4.

³⁵¹ Miller et al., supra note 90, at 15-16; Jessup et al., supra note 96, at 243. See also Murray, supra note 165, at 4.

³⁵² Miller et al., supra note 90, at 16.

³⁵³ Murray, supra note 165, at 2.

³⁵⁴ See generally id.

³⁵⁵ Miller et al., supra note 90, at 16; Murray, supra note 165, at 2.

³⁵⁶ Murray, supra note 165, at 2.

³⁵⁷ Id.

³⁵⁸ Id.

³⁵⁹ Id. at 3.

transmission may be facilitated through shared haul out areas.³⁶⁰ Mortality risk to sea otters from influenza virus is unknown.³⁶¹

Biotoxins: Harmful algal blooms produce a variety of potent neurotoxins that have been implicated in the mass mortality of marine mammals.³⁶² Biotoxins including domoic acid, saxitoxin, and microcystin all contribute to southern sea otter deaths.³⁶³ Together, they were the primary cause of death for 10% of otters examined by Miller et al. (2020).³⁶⁴ Exposure can lead to acute, subacute, and chronic effects in exposed otters.³⁶⁵

Domoic acid intoxication “has the potential to negatively affect southern sea otter population recovery.”³⁶⁶ Domoic acid is a potent neurotoxin produced by *Pseudo-nitzschia* spp., diatoms pervasive throughout waters along the U.S. West Coast.³⁶⁷ The toxin is concentrated and maintained for weeks or months in the tissues of many invertebrate species consumed by southern sea otters.³⁶⁸ Indeed, high domoic acid concentrations have been found in southern sea otters throughout the year, including periods when there were no known *Pseudo-nitzschia* blooms.³⁶⁹ Domoic acid intoxication was a primary factor underlying an unusual mortality event of sea otters in 2003.³⁷⁰

Sea otters are especially vulnerable to domoic acid exposure due to their small body size and high metabolic demands (consuming 25-35% of their body weight daily).³⁷¹ While southern sea otters consume a wide variety of invertebrates, clams and crabs appear to be particularly high-risk prey; these species predominate southern sea otter diets in the soft-bottom and mixed sediment habitats that characterize the peripheries of the species’ range.³⁷²

Sea otters presenting with acute, fatal domoic acid toxicosis exhibited “neurological signs and severe, diffuse congestion and multifocal microscopic hemorrhages (microhemorrhages) in the brain, spinal cord, cardiovascular system, and eyes. The congestion and microhemorrhages were associated with detection of high concentrations of [domoic acid] in postmortem urine or gastrointestinal content and preceded histological detection of cellular necrosis or apoptosis.”³⁷³ Sea otters with fatal subacute domoic acid toxicosis presented with progressive lesion expansion

³⁶⁰ Id.

³⁶¹ Murray, supra note 165, at 3.

³⁶² Bossart, supra note 136, at 680.

³⁶³ Miller et al., supra note 90, at 2; Bossart, supra note 136, at 680; Miller, Melissa A. et al., Evidence for a novel marine harmful algal bloom: cyanotoxin (microcystin) transfer from land to sea otters, 5 PLoS ONE e12576 (2010).

³⁶⁴ Miller et al., supra note 90, at 16.

³⁶⁵ USFWS, supra note 33, at 13.

³⁶⁶ Miller et al., supra note 90, at 19. See also Murray, supra note 165, at 8-10.

³⁶⁷ Miller et al., supra note 90, at 19.

³⁶⁸ Id.; Bradley & Altizer, supra note 98, at 99; Miller, Melissa A. et al., Clinical signs and pathology associated with domoic acid toxicosis in southern sea otters (*Enhydra lutris nereis*), 8 Frontiers Marine Sci. 585501, at 1, 3 (2021).

³⁶⁹ Miller et al., supra note 90, at 19.

³⁷⁰ USFWS, supra note 33, at 9.

³⁷¹ Miller et al., supra note 90, at 19; Bossart, supra note 136, at 678.

³⁷² Bossart, supra note 136, at 678; Miller et al., supra note 90, at 19; Nicholson et al., supra note 90, at 1758. See also USFWS, supra note 33, at 10 (noting that even in the central portion of the range, lower per-capita food availability may lead to a greater reliance on sub-optimal prey, which in turn increases exposure to pathogens).

³⁷³ Miller et al., supra note 368, at 1.

and tissue damage in both the central nervous system and cardiovascular system.³⁷⁴ Sea otters with chronic domoic acid toxicosis often exhibit “cardiovascular pathology that was more severe than the [central nervous system] pathology; however, the lesions at both sites were relatively quiescent, reflecting previous damage.”³⁷⁵

The entire southern sea otter population likely is intermittently or chronically exposed to domoic acid.³⁷⁶ Domoic acid toxicosis served as a primary or contributing cause of death for at least 20% of otters examined by Miller et al. (2020).³⁷⁷ When chronic and *in utero* effects are taken into account, the population-level effects are far greater.³⁷⁸ Climate change will increase the risk of *Pseudo-nitzschia* blooms, increasing the risk to the struggling southern sea otter population.

Saxitoxin, which causes paralytic shellfish poisoning, also is a potential cause for concern.³⁷⁹ The group of toxins collectively termed saxitoxin are produced by some dinoflagellate species (*Alexandrium* spp.).³⁸⁰ Saxitoxin events occur more commonly in warmer waters during the months June-November when upwelling-causing northerly winds subside, bringing dinoflagellate blooms onshore.³⁸¹ While sea otters are susceptible to saxitoxin, they appear to have an ability to avoid heavily contaminated prey and—if they are exposed—to recover once they stop consuming contaminated prey.³⁸² That said, saxitoxin can be fatal but often presents “with no discernible gross or microscopic lesions” so it is not always possible to detect during necropsy.³⁸³

Another biotoxin of concern is microcystin.³⁸⁴ Microcystin is a biotoxin produced by cyanobacteria in freshwater lakes.³⁸⁵ It is washed into marine waters via freshwater runoff, where it is sequestered and biomagnified up to 170x by filter-feeding molluscs.³⁸⁶ Otters consuming contaminated prey items can develop hepatitis (hepatocellular vacuolation, apoptosis, necrosis, hemorrhage, liver failure), and some die.³⁸⁷ Between 1999-2007, at least 21 otters became ill or perished due to microcystin poisoning.³⁸⁸ This threat also is expected to increase with climate change.

³⁷⁴ Id. at 2.

³⁷⁵ Id. at 2.

³⁷⁶ Miller et al., supra note 90, at 19.

³⁷⁷ Id. at 1, 16, 19; see also Gulland et al., supra note 144, at 8.

³⁷⁸ Miller et al., supra note 90, at 19.

³⁷⁹ Murray, supra note 165, at 10.

³⁸⁰ Id.

³⁸¹ Id.

³⁸² Id. at 11.

³⁸³ Miller et al., supra note 90, at 17.

³⁸⁴ Murray, supra note 165, at 11.

³⁸⁵ Miller et al., supra note 363; Gaydos & Drayer, supra note 134.

³⁸⁶ Miller et al., supra note 363; Gaydos & Drayer, supra note 134; Murray, supra note 165, at 11.

³⁸⁷ Miller et al., supra note 363; Gaydos & Drayer, supra note 134; Murray, supra note 165, at 11.

³⁸⁸ Miller et al., supra note 363; Gaydos & Drayer, supra note 134.

Cardiac Disease: Kreuder et al. (2004, 2005) first recognized cardiac disease as a primary cause of death in southern sea otters in the early 2000s.³⁸⁹ They noted that “[s]ea otters had inflammation of heart tissue (myocarditis) and, in some cases, heart inflammation was accompanied by an enlarged, rounded, heart (cardiomyopathy) with congestive heart failure (pulmonary edema, pleural and peritoneal effusion, and hepatic congestion).”³⁹⁰ The bulk of cardiac disease observed occurred in prime-aged or aged adults, and females were 3.5 times more likely to die of heart disease than males.³⁹¹ Good nutritional body condition and exposure to *S. neurona* or domoic acid also were significant risk factors associated with myocarditis.³⁹²

Cardiomyopathy associated with domoic acid intoxication or protozoal infection was highly prevalent in otters from the Miller et al. (2020) sample, serving as a primary or contributing cause of death for 41% of examined otters.³⁹³ This finding supports the link found in other research between domoic acid exposure and dilated cardiomyopathy.³⁹⁴ As Miller et al. (2020) explain, “our data suggest that many animals survived the acute impacts of [domoic acid] exposure, but died later from severe, progressive, [domoic acid]-mediated cardiomyopathy.”³⁹⁵ Older otters are more susceptible than younger otters.³⁹⁶ As exposure to biotoxins and parasites increases alongside climate change, the threat of cardiac disease to southern sea otters can be expected to grow.

End lactation syndrome & Emaciation: Sea otters have incredibly high energetic requirements, and these requirements nearly double during lactation and postweaning pup care.³⁹⁷ This leads to the depletion of energy reserves, placing postpartum females at extreme risk of caloric insufficiency and emaciation, particularly in areas with limited food resources.³⁹⁸ Ultimately, numerous maternal deaths result from a disease process called “end lactation syndrome.”³⁹⁹ The risk of end lactation syndrome increases with age and number of pregnancies, and is exacerbated by resource limitation.⁴⁰⁰ Both end lactation syndrome and emaciation occur primarily in the range center and are strongly associated with sea otter density.⁴⁰¹

³⁸⁹ Kreuder et al., supra note 96, at 4; Kreuder, Christine et al., Evaluation of cardiac lesions and risk factors associated with myocarditis and dilated cardiomyopathy in southern sea otters (*Enhydra lutris nereis*), 66 Am. J. Vet. Research 289 (2005).

³⁹⁰ Kreuder et al., supra note 96, at 4.

³⁹¹ Id.; Kreuder et al., supra note 389, at 289.

³⁹² Kreuder et al., supra note 96, at 4; Kreuder et al., supra note 389, at 289.

³⁹³ Miller et al., supra note 90, at 1, 17; see also id. at 20 (noting that “[domoic acid] intoxication and cardiomyopathy ... appear to be inter-related, suggesting that their combined impacts are more substantial than previously understood”); Moriarty, Megan E. et al., Exploration of serum cardiac troponin I as a biomarker of cardiomyopathy in southern sea otters (*Enhydra lutris nereis*), 82 Am. J. Vet. Res. 529, 529 (2021) (noting that protozoal infection and domoic acid exposure are risk factors for cardiomyopathy in southern sea otters);

³⁹⁴ Miller et al., supra note 90, at 19; Moriarty, supra note 145; Moriarty, Megan E. et al., Exposure to domoic acid is an ecological driver of cardiac disease in southern sea otters, 101 Harmful Algae 101973 (2021).

³⁹⁵ Miller et al., supra note 90, at 19; see also Moriarty et al., supra note 394.

³⁹⁶ Miller et al., supra note 90, at 17.

³⁹⁷ Chinn, Sarah M. et al., The high cost of motherhood: end-lactation syndrome in southern sea otters (*Enhydra lutris nereis*) on the Central California coast, USA, 52 J. Wildlife Diseases 307 (2016).

³⁹⁸ Id. at 307; Thometz, N.M. et al., Trade-offs between energy maximization and parental care in a central place forager, the sea otter, 27 Behavioral Ecology 1552 (2016).

³⁹⁹ Chinn et al., supra note 397, at 307.

⁴⁰⁰ Id.

⁴⁰¹ Nicholson et al., supra note 90, at 1757; Thometz et al., supra note 398.

End lactation syndrome was a primary or contributing cause of death for the vast majority (83%) of adult and aged adult females surveyed by Miller et al. (2020) who died in late pup care or post-weaning.⁴⁰² It served as the primary or a contributing cause of death for 19% of the entire otter sample in Miller et al. (2020).⁴⁰³ Nicholson et al. (2018) found that, along with emaciation, end lactation syndrome accounted for approximately two-thirds of sea otter strandings.⁴⁰⁴ It was a major cause of death for 56% of 108 deceased adult female otters examined by Chinn et al. (2016).⁴⁰⁵ End lactation syndrome thus has significant consequences both for this demographic cohort and the overall southern sea otter population.⁴⁰⁶

Gastrointestinal Illness: Gastrointestinal problems including erosions and ulcers were present in more than half of 500 examined for this condition and were a contributing cause of death in 47%.⁴⁰⁷ They are more common in otters that are in poor or emaciated condition.⁴⁰⁸ As mentioned above, such lesions also may offer an entry point for *Streptococcus* and other bacteria.

⁴⁰² Miller et al., supra note 90, at 1, 16.

⁴⁰³ Id. at 16.

⁴⁰⁴ Nicholson et al., supra note 90, at 1755, 1758.

⁴⁰⁵ Chinn et al., supra note 397, at 307.

⁴⁰⁶ Miller et al., supra note 90, at 16.

⁴⁰⁷ Id. at 17.

⁴⁰⁸ Id.

Appendix B: Otter Reintroduction – Lessons Learned⁴⁰⁹

⁴⁰⁹ USFWS, *supra* note 3, at 28 (Table 2.1).

BOX 2.1**KEY LESSONS LEARNED FROM PAST REINTRODUCTIONS**

- If traditional capture and translocation methods are employed, high initial losses should be anticipated, up to 90% of the numbers of individuals released, though holding pens may improve retention if conditions allow their use. Many animals may return to the area of their original capture (depending upon the distance to the release site), but high levels of undetected mortality should not be unexpected and should be considered.
- The availability of high-quality habitat and abundant food resources may not be sufficient to ensure sea otters will remain at a release site; site fidelity and possibly established social relationships appear to also play an important role in determining the likelihood of retaining individuals.
- To achieve the maximum population size within a reasonable period of time, releases of translocated animals should favor a very high proportion of adult females, followed by subadult females, and then relatively small proportions of all other sex and age classes. Although subadult or juvenile sea otters appear to have a higher probability of remaining at the release site, there is a tradeoff with immediate reproductive potential.
- Sea otters may not remain at or near the intended reintroduction site and may instead establish in areas that were not initially anticipated. A corollary to this is that containment of sea otters to a particular geographic area is not a reasonable expectation and should never be relied upon.
- The release of surrogate-reared pups poses a promising new strategy to consider for reintroductions, as the vast majority of juveniles released at Elkhorn Slough remained at the site and quickly became members of a reproducing population. However, this approach has never been tested as a means of establishing a new population in an area entirely unoccupied by sea otters, which is a significant source of uncertainty.
- Estuaries present potential benefits for consideration as reintroduction sites, as they generally provide sheltered habitats, abundant prey within appropriate foraging depths, and protection from predators; the natural containment provided by a bay or estuary may also be a benefit.
- The growth rate of sea otters reintroduced to the coasts of northern California or Oregon is likely to be more similar to that observed in California (5-6% growth annually) as opposed to southeast Alaska (establishment rate of 17-21% annually) due to the one-dimensional linear nature of the habitat and consequent constraints on population expansion and resource limitation.