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 Act\(^1\) 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 (\textit{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 \textit{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.

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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 group 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 outsized 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”

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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.
15 Id. § 1532(6).
16 Id. § 1532(20).
17 Id. § 1532(16).
the law. 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. One such measure is species reintroduction.

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. This designation affords the reintroduced animals with the protections of an ESA “threatened” species. 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. The rule also must specify whether the experimental population is “essential to the continued existence of the species” or nonessential.

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.” 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”—would still apply to sea otter reintroduction efforts in a handful of contexts. 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).

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). All marine mammals, including sea otters, are protected under the MMPA. One of

21 Id. § 1532(3).
22 Id. § 1539(j)(2)(A).
23 Id. § 1539(j); 50 CFR §17.80-81.
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.
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.”\textsuperscript{32} Sea otters on the U.S. West Coast fall well below their optimum sustainable population (OSP).\textsuperscript{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.”\textsuperscript{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.”\textsuperscript{35} The law provides an exception for incidental take under certain circumstances.\textsuperscript{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.\textsuperscript{37} Such permits could be issued since sea otter reintroduction would “enhanc[e] the survival or recovery of [the] species.”\textsuperscript{38} The translocation and reintroduction process would be noticed in the Federal Register and include a public comment period.\textsuperscript{39} Incidental take authorizations (excepting those pertaining to commercial fishing) may be issued as needed.\textsuperscript{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.

\textsuperscript{32} Id. § 1361(2).
\textsuperscript{33} U.S. Fish & Wildlife Serv. (USFWS), Southern Sea Otter (\textit{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.
\textsuperscript{34} 16 U.S.C. § 1361(2).
\textsuperscript{35} Id. §§ 1362(16), 1371.
\textsuperscript{36} See generally id. § 1371.
\textsuperscript{37} USFWS, supra note 3, at 95.
\textsuperscript{38} 16 U.S.C. § 1374(c)(1).
\textsuperscript{39} USFWS, supra note 3, at 95.
\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{53} Individual otters tend to specialize on a few select prey items.\textsuperscript{54} Because of their high metabolic requirements, sea otters must consume 20-30\% of their body weight in prey daily.\textsuperscript{55} If these needs are not met, female sea otters may abandon their pups, leading to high variability in pup survival rates.\textsuperscript{56}

Sea otters are a social species, and they live in sex-specific groups called “rafts.”\textsuperscript{57} Females tend to be sedentary and exhibit site fidelity, whereas non-territorial males may disperse more broadly.\textsuperscript{58} Territorial males exhibit site fidelity, defending high-quality habitats containing females and pups.\textsuperscript{59} Home range size is a function of sex, reproductive status, season, habitat, and prey availability.\textsuperscript{60} In California, home ranges average 8.6 km of coastline and 6.5-10 km\textsuperscript{2} (for males) and 7.5-7.8 km\textsuperscript{2} (for females).\textsuperscript{61}

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

\textsuperscript{51} USFWS, supra note 3, at 9, 10.
\textsuperscript{52} Id. at 10, 40.
\textsuperscript{53} Id. at 9.
\textsuperscript{54} Id. at 10.
\textsuperscript{55} Id. at 11.
\textsuperscript{56} USFWS, supra note 3, at 12.
\textsuperscript{57} Id. at 11.
\textsuperscript{58} Id.
\textsuperscript{59} Id.
\textsuperscript{60} Id.
\textsuperscript{61} USFWS, supra note 3, at 12.
\textsuperscript{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.
\textsuperscript{63} Estes & Tinker, supra note 62, at 13; USFWS, supra note 3, at 13-14, 37, 56-58.
\textsuperscript{64} Estes & Tinker, supra note 62, at 13; USFWS, supra note 3, at 56.
\textsuperscript{65} Estes & Tinker, supra note 62, at 7-8; USFWS, supra note 3, at 56.
\textsuperscript{66} USFWS, supra note 3, at 56.
\textsuperscript{67} Id.
\textsuperscript{68} Id.
Otters likewise have important conservation implications for seagrass ecosystems. The return of sea otters to estuaries impacted by eutrophication-induced algal overgrowth has led to seagrass regeneration. 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. Sea otters likely have impacts on other soft-sediment ecosystems as well, though these have not been as well studied. Sea otters also appear to have important evolutionary influence on kelp forest and seagrass ecosystems, for example, by facilitating genetic diversity in eelgrass.

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. These coastal systems also provide important ecosystem services such as storm surge buffering, erosion control, carbon sequestration, and amelioration of ocean acidification. Sea otter restoration allows degraded habitats to quickly recover and enhances ecosystem resilience.

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. See Fig. 1. The global population prior to the fur trade numbered from 150,000-300,000 individuals.

Commercial fur trading began soon after Russian explorers happened upon the species in 1741. The species’ small home ranges and sedentary nature made them particularly vulnerable to overexploitation, and populations were serially extirpated. 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. Eleven of those colonies survived and served as founders for the sea otters alive today. Most of the Pacific Coast of the lower 48

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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.
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.\textsuperscript{83} The southern sea otter (\textit{E. lutris nereis}),\textsuperscript{84} which historically ranged from southern Oregon to present-day Punta Abreojos, Baja California, was driven nearly to extinction.\textsuperscript{85} From an estimated pre-fur trade population of \textasciitilde 16,000, approximately 50 individuals survived near Bixby Creek in Monterey County, California; these otters founded the extant population.\textsuperscript{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.\textsuperscript{87} \textit{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.\textsuperscript{88}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{map.png}
\caption{Historic (yellow) and present-day (purple) distribution of sea otters (figure from Davis et al. (2019)).\textsuperscript{89}}
\end{figure}

\begin{thebibliography}{99}
\bibitem{USFWS} USFWS, supra note 3, at 1-2, 4; Larson & Tinker, supra note 78, at 1.
\bibitem{USFWS2} USFWS, supra note 33, at 1; Wilson, D.E. et al., Geographic variation in sea otters, \textit{Enhydra lutris}, 72 J. Mammalogy 22 (1991).
\bibitem{USFWS3} USFWS, supra note 33, at 1; Doroff & Burdin, supra note 78, at 6.
\bibitem{USFWS4} USFWS, supra note 33, at 1; Marine Mammal Commission, Southern Sea Otter (2022).
\bibitem{USFWS5} USFWS, supra note 33, at 1.
\bibitem{Davis2} Davis et al., supra note 77, at 3, Fig. 2.
\end{thebibliography}
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. Population growth is flat and range expansion—a key component of recovery—has stalled. The most recent stock assessment provides a minimum population estimate of 2,962 otters (see Fig. 2). This is well below the number of otters than the contiguous U.S. Pacific Coast can support.

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.
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. 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. Predators, parasites, biotoxins, bacteria, fungi, and viruses

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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).
all serve as significant sources of mortality for this threatened species and obstacles to its continued recovery. 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. 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.” Reintroduction will be necessary to help sea otters recover along the U.S. West Coast. 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.” 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. The southern sea otter and Southwest Alaska DPS of northern sea otter also are listed as threatened under the ESA. All sea otters are listed as threatened under the Oregon Endangered Species Act and the northern sea otter is listed as threatened under the Washington State Endangered Species Act. Southern sea otters are not listed under the California Endangered Species Act though they are designated as a “fully protected mammal.” California and Washington deem sea otters species of greatest conservation need, and they are a “Watch List Species” in Oregon.

Internationally, sea otters are designated as a species of special concern under Canada’s Species at Risk Act. 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

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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.
105 Rev. Code Wash. 77.15.130.
106 Cal. Fish & Game Code § 4700.
109 Gov’t of Canada, Species at Risk Act (2002).
otters listed under Appendix II. Appendix I species are deemed “threatened with extinction” and international trade is prohibited with limited exceptions for non-commercial purposes such as scientific research. Appendix II species are “not threatened with extinction now but … may become so unless trade is closely controlled.” Trade is permitted with an export permit and a finding that the trade will not be detrimental to the species’ survival.

The IUCN lists sea otters as globally endangered. 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.” The list is “a powerful tool to inform and catalyze action for biodiversity conservation and policy change” and is “widely accepted as the most objective and authoritative system available for assessing the global risk of extinction for species.” 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. 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.” 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.

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112 Id.
113 Id.
114 Doroff & Burdin, supra note 78.
116 Id.
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. 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. 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. 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. The number of heat wave days doubled between 1982 and 2016 and is projected to increase 23 times under 2°C warming. At present, 87 percent of marine heat waves are attributable to human-induced warming.

Exacerbating the harm from rising ocean temperatures is ocean acidification. 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. This increase has occurred at a rate likely faster than anything experienced in the past 300 million years. Ocean acidity could increase 150 percent by the end of the century if CO₂ emissions continue unabated. 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

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120 Doroff & Burdin, supra note 78, at 9.
122 Id.
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).
skeletons and by disrupting metabolism and critical biological functions. Many of these organisms form the foundation of marine food webs, and their demise has ripple effects throughout entire ecosystems.

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

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

132 USFWS, supra note 3, at 51.
135 USFWS, supra note 33, at 14; Gaydos & Drayer, supra note 134.
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.\textsuperscript{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.\textsuperscript{143} See Part III.B.1, App. A, infra. Blooms of toxic \textit{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.\textsuperscript{144} Models suggest that increased frequency and severity of high domoic acid events will lead to declines in southern sea otter populations.\textsuperscript{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 (\textit{Carcharodon carcharias}), which are beginning to occupy more northerly habitats.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{149} The delay led to a suite of anomalies including warm water, low nutrient levels, and extremely low recruitment of intertidal

\begin{itemize}
\item[\textsuperscript{142}] USFWS, supra note 3, at 51.
\item[\textsuperscript{143}] USFWS, supra note 33, at 13; Miller et al., supra note 90, at 19; Bossart, supra note 136, at 680.
\item[\textsuperscript{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).
\item[\textsuperscript{145}] Moriarty, Megan Elizabeth, Cardiomyopathy and domoic acid exposure in southern sea otters, Ph.D. Dissertation, Univ. Cal. Davis (2020).
\item[\textsuperscript{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.
\item[\textsuperscript{147}] Id.; USFWS, supra note 33, at 13. Gulland et al., supra note 144, at 3 (Table 2).
\end{itemize}
organisms.\textsuperscript{150} Such changes have implications for the coastal kelp bed ecosystems preferred by southern sea otters, which rely on nutrient-rich, upwelled waters.\textsuperscript{151}

Climate change already is impacting kelp communities along California’s central coast.\textsuperscript{152} After the 2014 marine heat wave, bull kelp populations decreased by 90% along the coasts of Mendocino and Sonoma counties.\textsuperscript{153} The 2014 marine heat wave was followed by one of the most extreme El Niño events in recorded history.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{159}

\textsuperscript{150} Id. at 3719.
\textsuperscript{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).
\textsuperscript{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.
\textsuperscript{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).
\textsuperscript{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).
\textsuperscript{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).
\textsuperscript{157} Nicholson et al., supra note 90, at 1751, 1758, 1759.
\textsuperscript{158} Id. at 1758.
\textsuperscript{159} Id. at 1757; see also id. at 1758.
The availability of sufficient kelp cover thus appears to dramatically reduce density-independent otter strandings. Increased kelp canopy cover likewise reduced rates of stranding due to trauma and pup loss.

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. Today, the otters are spatially constrained and these kelp-free peripheries may effectively function as population sinks. 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. 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. 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. Multi-pathogen infections are common, subjecting otters to substantial stress and lowering their resistance to other threats (e.g., emaciation).

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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. at 1758; USFWS, supra note 3, at 51.

164 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 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.

165 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).

166 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

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168 Murray, supra note 165, at 20.
169 See generally Miller et al., supra note 90.
170 Id. at 2.
172 Miller et al., supra note 90, at 1, 8.
173 Id. at 8.
pathogens or toxins.\textsuperscript{174} In addition, since otters live at the land-sea interface, they are exposed to terrestrial as well as marine pathogens.\textsuperscript{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,\textsuperscript{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.\textsuperscript{177}

Terrestrial parasites associated with opossums (\textit{Sarcocystis neurona}), cats (\textit{Toxoplasma gondii}), raccoons (\textit{Baylisascaris procyonis}), and rodents (\textit{Capillaria hepatica}), as well as viruses (\textit{Morbillivirus}) and fungi (\textit{Coccidioides} spp.), all contribute to southern sea otter mortality.\textsuperscript{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.\textsuperscript{179} This threat appears to be slowing range expansion and population growth in southern sea otters both to the north and to the south.\textsuperscript{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.”\textsuperscript{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.\textsuperscript{182} The seasonal “peak” for bites increased from two to eight months between 1997-2017.\textsuperscript{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

\textsuperscript{174} Id. at 18.
\textsuperscript{175} Id.; Burgess, Tristan L. et al., Spatial epidemiological patterns suggest mechanisms of land-sea transmission for \textit{Sarcocystis neurona} in a coastal marine mammal, 10 Nature Sci. Reports 3683 (2020).
\textsuperscript{176} See Part III.C.2, infra.
\textsuperscript{178} Miller et al., supra note 90, at 18.
\textsuperscript{179} Id. at 1, 18.
\textsuperscript{180} Miller et al., supra note 90, at 18, 20; Davis et al., supra note 77, at 11.
\textsuperscript{181} Miller et al., supra note 90, at 20.
\textsuperscript{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.
\textsuperscript{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). 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. White shark numbers in the region appear to be increasing as juveniles move into more northerly habitat with warming ocean waters.

White sharks don’t appear to consume sea otters. 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. 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. 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. Subadults, males, and otters in good physical condition are more likely to die of shark bites than other cohorts.

The broadnose sevengill shark (Notorynchus cepedianus) also has the potential to predate on sea otters. This species is a dominant shark predator in coastal marine ecosystems including bays and estuaries from Baja Mexico to southeast Alaska. 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. 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]” and spills from transiting large vessels remain a primary threat to southern sea otters in California. 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. 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. 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. Long-term effects of oil exposure (whether directly or through prey) also can be significant and lead to population-level effects.

Sea otters’ slow range expansion and lack of redundancy across a metapopulation exacerbate the species’ vulnerability to spills. 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. 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. 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. 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

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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).
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. 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. 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. 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. Kannan et al. (1998) found that female sea otter livers contained approximately twice the butyltins than male livers.

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. 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.

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. Elevated PCB and perfluorinated contaminant (PFOS, PFOA) concentrations in sea otter livers have been associated with infectious disease.
Other persistent organic pollutants including C1-dibenzothiopene, PCB 056, cis-chlordane, oxychlordane, and PBDE 028 have been associated with higher incidences of sea otter death from disease and trauma.\textsuperscript{215} Butyltins are known immunosuppressants that contribute to sea otter mortality from other causes.\textsuperscript{216}

Dead southern sea otters have notably higher concentrations of persistent organic chemicals (including PCBs, DDTs, and tributyltin) than other sea otters.\textsuperscript{217} Living southern sea otters present with summed PCB concentrations similar to those in otters exposed to known point sources of these contaminants.\textsuperscript{218} Compared to Alaskan sea otters, California’s sea otters have summed PCB and DDT levels 50-100 times as high.\textsuperscript{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.\textsuperscript{220} As compared to healthy otters, hepatic concentrations of cadmium, cobalt, manganese, and zinc were higher in diseased and emaciated otters.\textsuperscript{221} Elevated concentrations of toxic metals may contribute to oxidative stress-mediated effects in affected otters.\textsuperscript{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.\textsuperscript{223} Genetic diversity affords a species the raw material needed to adapt to environmental change and also provides resilience to

\textsuperscript{215} Miller et al., supra note 204, at ii.
\textsuperscript{216} Kannan et al., supra note 208, at 1169; Kannan, Perotta & Thomas, supra note 214; USFWS, supra note 33, at 13.
\textsuperscript{217} Jessup et al., supra note 177, at 1650.
\textsuperscript{218} Id.
\textsuperscript{219} Id.
\textsuperscript{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).
\textsuperscript{221} Id. at 2160.
\textsuperscript{222} Id.; Larson, Shawn et al., Stress-related hormones and genetic diversity in sea otters (Enhydra lutris), 25 Marine Mammal Sci. 351 (2009).
\textsuperscript{223} USFWS, supra note 3, at 52.
Many sea otter populations are believed to have experienced multiple population reductions over time, with consequent impacts on genetic diversity. 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. Genetic analyses have revealed evidence of inbreeding and a high load of potentially harmful alleles in northern and southern sea otter populations.

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.” 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. 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. This extreme population bottleneck is likely to have had long-lasting effects on population fitness and recovery prospects. 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.

Following a number of studies finding low average levels of genetic variation in sea otters, 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.” This increased genetic load resulted from exposure of harmful recessive alleles as homozygotes. 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.”

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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 Id. at 36. See also id. at 53; Larson & Tinker, supra note 78, at 5.
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).” In addition, low genetic diversity hampers southern sea otters’ ability to adapt to changing environmental conditions.

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. In addition to causing direct mortality through strikes, vessel disturbance may have significant effects on sea otters through stress reactions or energetic expense. This threat is site specific, greater in economically important waterways, and is expected to increase alongside growing coastal populations. 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. This disturbance occurs despite federal prohibitions against harassment; education and enforcement have been insufficient to prevent such harms. 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

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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.
Whether this harassment is sufficient to cause demographically significant effects is unknown. 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. 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. Documented trap mortalities are limited and likely underreported due in part to a lack of observer coverage; lost or derelict gear poses a challenge. Net entanglement and fishhook injuries or consumption also pose a threat. Even with high levels of observer effort, bycatch mortality often would go undetected. 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. 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.”

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.
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.” Reintroductions frequently include translocations, or the movement of animals from one location to another. 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, and making them more likely to persist in the face of climate change and other stressors. Reintroduction as a conservation tool has been used extensively and successfully for a variety of species including sea otters.

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. Such efforts were the foundation for approximately one-third of today’s existing otter populations. 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. Orphaned, surrogate-raised sea otter pups helped build a population at Elkhorn Slough, California. After decades of struggle, the descendants of otters reintroduced to San Nicolas Island, California, appear to be establishing themselves. See Table 1.

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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).

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

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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. Both the Elakha Alliance and FWS outline key lessons learned from previous reintroduction efforts. 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.

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. 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. 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. 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.”

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

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. 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. Post-release monitoring is crucial for reintroduction success and should be an integral part of reintroduction efforts.

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:

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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.
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<td>Southwest Alaska, from Attu Island to Western Cook Inlet, including Bristol Bay, the Kodiak Archipelago, and the Barren Islands</td>
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<td>70 FR 46366, 8/9/2005; 50 CFR 17.40(p); 4d 50 CFR 17.95(a)CH</td>
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<td>Experimental nonessential</td>
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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. 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.

Inaction is no longer an option. 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. 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. Establishing a healthy sea otter population along the U.S. West Coast would help restore the sea otter throughout its historic range.

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. It would re-establish in Oregon the historic transition zone between southern and northern sea otters, which would benefit both subspecies through genetic exchange. Reintroduction also would create needed redundancy that could help southern sea otters survive a catastrophic event such as an oil spill.

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. They also sequester carbon and buffer a variety of climate change impacts including storm surge, erosion, and ocean acidification.

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.

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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. Both *Toxoplasma gondii* and *Sarcocystis neurona* can cause fatal protozoal encephalitis in the species. One or both parasites were detected in over three-quarters of deceased otters sampled in Miller et al. (2020), and actual infection rates were likely higher. *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. Individual animal behavior, prey choice, and habitat use all are associated to infection with these pathogens. 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.

*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. Sandy bays near urban centers that receive freshwater runoff constitute areas of high *Toxoplasma* exposure. Consumption of certain prey species, such as marine snails (*Tegula* spp.), also increases the risk of infection. The risk of infection is positively correlated with age and male sex. The Type X strain of *Toxoplasma gondii* predominates in severe southern sea otter infections, while Type II rarely causes significant disease. That said, infection even with Type II may impact reproductive success. *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. Miller et al. (2020) found identical Type X strains both in deceased otters and terrestrial felids from adjacent watersheds.

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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).
311 Id.
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 prey\(^{322}\) 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

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\(^{320}\) Murray, supra note 165, at 5.

\(^{321}\) Burgess et al., supra note 175, at 1.


\(^{323}\) 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: Diphyllobothriidea) in a southern sea otter has been recorded.\textsuperscript{334} Larval migrans by helminth larvae (e.g., the raccoon roundworm (\textit{Baylisascaris} sp.) and lung fluke (\textit{Paragonimus} sp.) are uncommon but occasionally fatal in sea otters.\textsuperscript{335} The risk of pollution with these pathogens increases at the land-sea interface, particularly where runoff is concentrated near agricultural or urban areas.\textsuperscript{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.”\textsuperscript{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.\textsuperscript{338} Bacteria associated with fatal outcomes include \textit{Streptococcus} spp. (including \textit{Streptococcus phocae}, \textit{S. infantarius ss coli}), \textit{Erysipelothrix} sp. (including \textit{Erysipelothrix rhusiopathiae}), \textit{Klebsiella pneumoniae}, \textit{Pasteurella multocida}, \textit{Salmonella} sp., hemolytic \textit{Escherichia coli}, \textit{Campylobacter} spp., \textit{Staphylococcus} spp. (including \textit{Staphylococcus delphini}, \textit{S. intermedius}, \textit{S. schleiferi ss coagulans}), \textit{Vibrio} spp. (including \textit{Vibrio parahaemolyticus}, \textit{V. alginolyticus}), \textit{Fusobacterium} spp. (including \textit{Fusobacterium necrophorum}, \textit{F. nucleatum}), \textit{Clostridium} sp. (including \textit{Clostridium septicum}, \textit{C. difficile}, \textit{C. perfringens}), \textit{Peptostreptococcus anaerobius}, and \textit{Leptospira} sp.\textsuperscript{339} Many of these bacteria more frequently affect otters near urbanized areas and areas receiving freshwater runoff.\textsuperscript{340} Other problematic pathogens include \textit{Brucella} spp., \textit{Coxiella brunettii}, and \textit{Bartonella} spp.\textsuperscript{341}

Bartlett et al. (2016) found \textit{Streptococcus phocae} infection in 30\% of dead otters examined between 2004-2010.\textsuperscript{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.\textsuperscript{343} Infected otters were more likely to suffer from bacterial septicemia or abcesses.\textsuperscript{344}

\textsuperscript{334} Young, Colleen et al., First report of an adult tapeworm (Cestoda: Diphyllobothriidea) in a southern sea otter (\textit{Enhydra lutris nereis}), 53 J. Wildlife Diseases 934 (2017).
\textsuperscript{335} Murray, supra note 165, at 8.
\textsuperscript{336} Id.
\textsuperscript{337} Id. at 3.
\textsuperscript{338} Miller et al., supra note 90, at 1, 15.
\textsuperscript{339} Id. at 15; Hanni, et al., supra note 305; Burek, Kathy A. et al., Valvular endocarditis and septicemia due to \textit{Streptococcus infantarius ss coli} organisms in stranded northern (\textit{Enhydra lutris kenyoni}) and southern sea otters (\textit{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&iId=3865149; Imai, Denise et al., Characterization of beta-hemolytic streptococci isolated from southern sea otters (\textit{Enhydra lutris nereis}) stranded along the California coast. 136 Veterinary Microbiology 378 (2009) (first reporting \textit{S. phocae} in southern sea otters and noting that beta-hemolytic streptococci are implicated in pneumonia, sepsisemia, opportunistic infections, and other debilitating disease processes); Miller, Melissa A. et al., Enteric bacterial pathogen detection in southern sea otter (\textit{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.
\textsuperscript{340} Miller et al., supra note 339, at 1.
\textsuperscript{341} Murray, supra note 165, at 3.
\textsuperscript{342} Bartlett, Georgina et al., Prevalence, pathology, and risk factors associated with \textit{Streptococcus phocae} infection in southern sea otters (\textit{Enhydra lutris nereis}), 2004-2010, 52 J. Wildlife Diseases 1, 1 (2016).
\textsuperscript{343} Id. at 1, 5.
\textsuperscript{344} Id. at 1.
Some sea otter prey species including Dungeness crab (*Metacarcinus magister*), bay mussels (*Mytilus trossulus*), black turban snails (*Tegula funebralis*), and butter clams (*Saxidomus giganteus*) can bioaccumulate *S. phocae*. 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.

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*. These bacteria have been associated with a heart valve disease called vegetative valvular endocarditis.

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

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

**Viruses:** Viruses also kill southern sea otters, with morbillivirus “undoubtedly the most concerning.” Two morbillivirus species are of great concern for sea otters: canine distemper and phocine morbillivirus. 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. In 2004-05, forty percent of live-captured sea otters from the eastern Aleutians and Kodiak archipelago were sero-positive for phocine morbillivirus. Morbillivirus presently has a low incidence in southern sea otters. Climate change may facilitate the spread of phocine morbillivirus further, increasing the threat it poses to sea otter populations.

Influenza virus was found in 70% of northern sea otters tested in 2011. The northern elephant seal (*Mirounga angustirostris*) appears to have been the source of infection, and virus...
transmission may be facilitated through shared haul out areas.\textsuperscript{360} Mortality risk to sea otters from influenza virus is unknown.\textsuperscript{361}

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

Domoic acid intoxication “has the potential to negatively affect southern sea otter population recovery.”\textsuperscript{366} Domoic acid is a potent neurotoxin produced by *Pseudo-nitzchia* spp., diatoms pervasive throughout waters along the U.S. West Coast.\textsuperscript{367} The toxin is concentrated and maintained for weeks or months in the tissues of many invertebrate species consumed by southern sea otters.\textsuperscript{368} Indeed, high domoic acid concentrations have been found in southern sea otters throughout the year, including periods when there were no known *Pseudo-nitzchia* blooms.\textsuperscript{369} Domoic acid intoxication was a primary factor underlying an unusual mortality event of sea otters in 2003.\textsuperscript{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).\textsuperscript{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.\textsuperscript{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.”\textsuperscript{373} Sea otters with fatal subacute domoic acid toxicosis presented with progressive lesion expansion

\textsuperscript{360} Id.
\textsuperscript{361} Murray, supra note 165, at 3.
\textsuperscript{362} Bossart, supra note 136, at 680.
\textsuperscript{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).
\textsuperscript{364} Miller et al., supra note 90, at 16.
\textsuperscript{365} USFWS, supra note 33, at 13.
\textsuperscript{366} Miller et al., supra note 90, at 19. See also Murray, supra note 165, at 8-10.
\textsuperscript{367} Miller et al., supra note 90, at 19.
\textsuperscript{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).
\textsuperscript{369} Miller et al., supra note 90, at 19.
\textsuperscript{370} USFWS, supra note 33, at 9.
\textsuperscript{371} Miller et al., supra note 90, at 19; Bossart, supra note 136, at 678.
\textsuperscript{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).
\textsuperscript{373} Miller et al., supra note 368, at 1.
and tissue damage in both the central nervous system and cardiovascular system. 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.”

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

Saxitoxin, which causes paralytic shellfish poisoning, also is a potential cause for concern. The group of toxins collectively termed saxotoxin are produced by some dinoflagellate species (*Alexandrium* spp.). Saxotoxin events occur more commonly in warmer waters during the months June-November when upwelling-causing northerly winds subside, bringing dinoflagellate blooms onshore. 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. 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.

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

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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.\textsuperscript{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).”\textsuperscript{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.\textsuperscript{391} Good nutritional body condition and exposure to \textit{S. neurona} or domoic acid also were significant risk factors associated with myocarditis.\textsuperscript{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.\textsuperscript{393} This finding supports the link found in other research between domoic acid exposure and dilated cardiomyopathy.\textsuperscript{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.”\textsuperscript{395} Older otters are more susceptible than younger otters.\textsuperscript{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.\textsuperscript{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.\textsuperscript{398} Ultimately, numerous maternal deaths result from a disease process called “end lactation syndrome.”\textsuperscript{399} The risk of end lactation syndrome increases with age and number of pregnancies, and is exacerbated by resource limitation.\textsuperscript{400} Both end lactation syndrome and emaciation occur primarily in the range center and are strongly associated with sea otter density.\textsuperscript{401}

\textsuperscript{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 (\textit{Enhydra lutris nereis}), 66 Am. J. Vet. Research 289 (2005).
\textsuperscript{390} Kreuder et al., supra note 96, at 4.
\textsuperscript{391} Id.; Kreuder et al., supra note 389, at 289.
\textsuperscript{392} Kreuder et al., supra note 96, at 4; Kreuder et al., supra note 389, at 289.
\textsuperscript{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 (\textit{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);
\textsuperscript{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).
\textsuperscript{395} Miller et al., supra note 90, at 19; see also Moriarty et al., supra note 394.
\textsuperscript{396} Miller et al., supra note 90, at 17.
\textsuperscript{397} Chinn, Sarah M. et al., The high cost of motherhood: end-lactation syndrome in southern sea otters (\textit{Enhydra lutris nereis}) on the Central California coast, USA, 52 J. Wildlife Diseases 307 (2016).
\textsuperscript{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).
\textsuperscript{399} Chinn et al., supra note 397, at 307.
\textsuperscript{400} Id.
\textsuperscript{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.\textsuperscript{402} It served as the primary or a contributing cause of death for 19% of the entire otter sample in Miller et al. (2020).\textsuperscript{403} Nicholson et al. (2018) found that, along with emaciation, end lactation syndrome accounted for approximately two-thirds of sea otter strandings.\textsuperscript{404} It was a major cause of death for 56% of 108 deceased adult female otters examined by Chinn et al. (2016).\textsuperscript{405} End lactation syndrome thus has significant consequences both for this demographic cohort and the overall southern sea otter population.\textsuperscript{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%.\textsuperscript{407} They are more common in otters that are in poor or emaciated condition.\textsuperscript{408} As mentioned above, such lesions also may offer an entry point for *Streptococcus* and other bacteria.
Appendix B:  
Otter Reintroduction – Lessons Learned\textsuperscript{409}

\textsuperscript{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.