Feasibility Assessment: Sea Otter Reintroduction to the Pacific Coast

U.S. Fish and Wildlife Service

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Executive Summary photo: Sea otters resting in Moss Landing, California. Photo taken from land with a 400mm zoom lens and cropped; Lilian Carswell, USFWS.

We thank all of the photographers for sharing their photographs with us.

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Prepared
by

U.S. Fish and Wildlife Service

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Contents

LIST OF ACRONYMS AND ABBREVIATIONS

AK	Alaska
APHIS	USDA Animal and Plant Health Inspection Service
AS	Alaska Statutes
ASSESSMENT	Feasibility Assessment of Sea Otter Reintroduction to the Pacific Coast
AWA	Animal Welfare Act
BiOp	Biological Opinion
°C	Celsius
CA	California
CDFW	California Department of Fish and Wildlife
CESA	California State Endangered Species Act
CEQA	California Environmental Quality Act
CI	confidence interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	carbon dioxide
CrI	credible interval
CVM	Contingent Valuation Method
CZMA	Coastal Zone Management Act
DA	domoic acid
DPS	Distinct Population Segment
EA	Environmental Assessment
EAFS	Elakha Alliance Feasibility Study
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
°F	Fahrenheit
fm	fathom
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	Federal Register
$g\ C\ m^{-2} yr^{-1}$	grams of carbon per square meter per year
GIS	Geographical Information Systems
IHA	Incidental Harassment Authorization
IPM	Sea Otter Integrated Population Model (specific to southern sea otter, CA)
ITIS	Integrated Taxonomic Information System
IUCN	International Union for the Conservation of Nature
kg	kilograms
Km	kilometers
lb	pounds
LOA	Letter of Authorization
m	meters
MARINe	Multi-Agency Rocky Intertidal Network
mi	miles
MMPA	Marine Mammal Protection Act

n	sample size
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce
NPP	net primary productivity
NSO	northern sea otter
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
OR	Oregon
ORS	Oregon Revised Statutes
ORSO	Oregon Sea Otter Population Model
OSP	optimum sustainable population
PISCO	Partnership for Interdisciplinary Studies of Coastal Oceans
PL	Public Law
RCW	Revised Code of Washington
ROD	Record of Decision
SARA	Species at Risk Act (Canada)
SERVICE	U.S. Fish and Wildlife Service, Department of the Interior
SF	San Francisco
SSA	Species Status Assessment
SSC	Species Survival Commission
SSO	southern sea otter
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WA	Washington
WDFW	Washington Department of Fish and Wildlife

EXECUTIVE SUMMARY

Sea otters (*Enhydra lutris*) once lived in coastal environments across the north Pacific Rim, from Hokkaido, Japan to Baja California, Mexico. A target of hunting for the maritime fur trade of the 1700s and 1800s, by 1911 the species was nearly extinct and survived in only a few small disjunct populations. As a result of slow population recovery and past reintroduction efforts, sea otters once again inhabit some areas of their historical range but are still absent from a substantial portion of the Pacific coast of the contiguous United States.

With the passage of Public Law 116-260 on December 27, 2020, in recognition of the sea otter's critical ecological role as a keystone species that significantly affects the structure and function of its marine environment, the U.S. Fish and Wildlife Service (Service or USFWS) received direction "to study the feasibility and cost of reestablishing sea otters on the Pacific Coast of the contiguous United States." This Feasibility Assessment of Sea Otter Reintroduction to the Pacific Coast (Assessment) constitutes our report to Congress.

To develop this Assessment, we relied upon the principles of the International Union for the Conservation of Nature (IUCN) guidelines for evaluating conservation reintroductions (IUCN/SSC 2013). These guidelines call for the identification of clear objectives for a reintroduction; an assessment of whether the reintroduction will result in a net conservation benefit to the species and its ecosystem; an evaluation of feasibility from a biological, socioeconomic, and legal perspective; and an evaluation of the risks to ecological, social, and economic interests associated with the reintroduction.

Approach and Scope of this Assessment

This Assessment is intended to be read as a companion to a study of the feasibility of restoring sea otters to the Oregon coast released on August 30, 2021, by an Oregon non-profit organization, the Elakha Alliance. The Elakha Alliance Feasibility Study (EAFS) is available online at https://www.elakhaalliance.org/feasibility-study/). Because the Elakha Alliance has already compiled much of the best available scientific information on the topic, we largely adopt and incorporate their compendium of the science by reference, and to avoid duplication of effort in our Assessment we emphasize the socioeconomic and legal aspects of feasibility (section 1.2). This Assessment expands the scope of geographic consideration beyond the Oregon coast; as explained in section 1.2.1, we focus our study of feasibility on the potential reintroduction of sea otters to the largest remaining gap in their historical range, from northern California (from San Francisco Bay) into Oregon.

Objectives of Reintroduction: Benefits to the Species and to the Ecosystem

Sea otter reintroduction would advance two interrelated and overarching conservation goals (section 3.1):

1. Restoration of the species, *Enhydra lutris*, within important gaps in its historical range, including improving the status of the federally threatened subspecies, *E. l. nereis* or southern sea otter, and

2. Restoration of ecosystem function, including enhancing ecosystem resilience, biodiversity, carbon sequestration, and resilience to the effects of climate change.

We conclude there would be multiple substantial benefits to the species from a reintroduction of sea otters to their historical range in northern California and Oregon. These benefits would stem from the improved conservation status of the species rangewide, and depending on the reintroduction scenario, could benefit the threatened southern sea otter in particular through range expansion and enhanced genetic diversity (section 6.1.1).

There would also be multiple substantial biological and ecological benefits to the nearshore marine ecosystem from a reintroduction of sea otters to their historical range in northern California and Oregon. These benefits would be realized as a consequence of the ecological effects of the sea otter as a keystone predator and its positive indirect effects in restoring ecosystem function, including facilitating recovery of kelp and seagrass systems, greater biodiversity, enhancing resilience of these systems to the effects of climate change, and other valuable ecosystem services (section 6.1.2).

Feasibility and costs of sea otter reintroduction

On the basis of our evaluation of the biological, socioeconomic, and legal aspects of reintroduction, we conclude overall that the reintroduction of sea otters to northern California and Oregon is feasible. The ultimate success of reintroduction, however, would require additional work to overcome some challenges, particularly in the socioeconomic sector.

Biological feasibility

The sea otter has been the subject of intensive biological study for many decades. Although our knowledge is by no means complete, a remarkable amount of data exist on the biological and ecological needs and interspecific relationships of the sea otter, as well as a growing understanding of sea otter behavior and population dynamics. The EAFS provides a thorough summary of the state of biological and ecological knowledge of the sea otter, which we have further supplemented in this report. The EAFS includes a web-based population model that is specifically designed to forecast sea otter population growth and expansion under various reintroduction scenarios on the Oregon coast. A similar integrated population model was recently developed for the southern sea otter in California. These models serve as essential tools for any future decision making regarding potential sea otter reintroductions.

We also have the advantage of learning from past reintroductions of sea otters. Although not all were successful, and many experienced high levels of post-release dispersal and/or mortality, most ultimately resulted in significant improvements to the conservation status of the sea otter following its near extinction. Populations established through past translocations account for roughly one-third of all sea otters in existence today and have successfully restored the species in many parts of its historical range. Experiences with past translocations have also informed the improvement of reintroduction techniques.

Uncertainties with regard to whether nearshore marine systems will be suitable to support a reintroduced population of sea otters due to the negative effects of climate change are often raised as a risk factor. We view 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 these increased stressors. Our position is that reintroduction would reduce the risk to the species or subspecies associated with climate change.

On the basis of the current state of knowledge of sea otter biology, ecology, behavior, and habitat availability, as well as the demonstrated success of past translocation efforts, we conclude sea otter reintroduction is feasible from a biological perspective.

Socioeconomic feasibility

Biological feasibility alone does not determine the probable success of a species reintroduction; social and economic factors are also essential considerations (IUCN/SSC 2013). This report identifies both the potential benefits and potential negative impacts of restoring sea otters to their historical range on the Pacific coast from a socioeconomic perspective, adding to the discussion provided in the EAFS to inform decisions regarding a possible reintroduction.

We conclude the species and ecosystem will benefit from the restoration of this keystone species, but we are aware of concerns regarding potential socioeconomic impacts of sea otters, in particular with regard to competition for shellfish resources. Recent studies have demonstrated an overall net economic benefit in areas where sea otters have recolonized, with economic gains from increased ecotourism and ecosystem benefits such as carbon sequestration substantially outweighing losses to the shellfish industry. We recognize that such a high-level approach does not fully appreciate the economic and potentially cultural impacts to individuals, families, and businesses or communities that could be most directly affected by a reintroduction effort. Although ultimately sea otter reintroduction might result in net economic gains, there will be inequities in who will share in those gains. In this document we recommend the exploration of both traditional and innovative measures to mitigate potential negative economic impacts and increase the likelihood of reintroduction success.

Our initial but necessarily cursory evaluation leads us to conclude that substantial widespread economic impacts from the reintroduction of sea otters to northern California and Oregon are unlikely and that socioeconomic impacts that may be experienced are likely to remain localized for the foreseeable future (see Socioeconomic Feasibility, section 4.2). We therefore conclude that reintroduction is feasible overall from a socioeconomic perspective. However, there is a significant degree of uncertainty (and therefore risk) associated with that conclusion. In part this is due to the fact that specific reintroduction sites have yet to be identified. It is important to understand the likely socioeconomic impacts, both positive and negative, that will be experienced specific to the areas, communities, and stakeholders that would be affected by a specific reintroduction effort. The need for a comprehensive socioeconomic impact assessment focused on likely reintroduction sites is one of our primary recommendations in this Assessment.

Legal feasibility
Implementing the reintroduction of sea otters would involve navigating multiple regulatory and administrative processes to ensure compliance with all applicable laws. We have not identified any legal issues that would prevent the reintroduction of sea otters to northern California and/or Oregon; thus, reintroduction is legally feasible. However, we have identified a few legal issues that, while not insurmountable, may require more attention to increase the likelihood of reintroduction success.

For the southern sea otter, the concern of some stakeholders is that the Marine Mammal Protection Act (MMPA) specifically excludes the subspecies from the section of the statute that allows for the authorization of incidental take in the course of commercial fishing operations (16 USC §1387). Another issue is that the take moratorium for marine mammals under the MMPA (16 USC §1371) does not easily allow for the subsequent removal of sea otters (by capture or culling) should they be deemed a problem[1] (e.g., if they were determined to have significant negative impacts on catch or harvest in shellfisheries), as some ocean user groups have suggested as a prerequisite for reintroduction.

Cost estimates
The actual costs of reintroducing sea otters are uncertain and will vary based on the source population, distance to reintroduction site, capture techniques, transportation methods, and number of sea otters captured annually. To estimate potential costs, we evaluated a range of plausible reintroduction scenarios (section 4.4). Based on these scenarios, we estimated that the total cost of sea otter reintroduction will range from $26 million to $43 million dollars over a 13-year period. This estimate includes pre-reintroduction habitat evaluation (3 years), acquisition and release of sea otters (releases of wild captured otters over 5 years and/or surrogate reared otters over 10 years), habitat and population monitoring (10 years), and postmortem and oil spill response programs.

Risk Assessment
Species reintroductions are intended to achieve conservation benefits, but they can also carry risks to ecological, social, and economic interests. A wise decision as to whether to proceed with a reintroduction therefore relies upon a thoughtful and informed evaluation of both the benefits and risks of the action. We used the IUCN's definition of risk as "the probability of a risk factor occurring, combined with the severity of its impact" (IUCN/SSC 2013). If a potential risk factor has a low probability of occurring or the anticipated impacts are inconsequential, we did not consider that factor to pose a risk. As described in our Risk Assessment (section 5), we concluded that several of the potential risk factors we assessed are either unlikely to be realized or would have negligible adverse impacts. We did, however, identify a few important risk factors that require further consideration.

The primary risks we identified in association with sea otter reintroduction are as follows:

- The possible mortality or dispersal of a high percentage of individuals from the reintroduction site, particularly if reintroduced otters are translocated from the wild as opposed to from a surrogate-raising facility
- Possible negative socioeconomic impacts on shellfish fisheries as a result of reductions in target species from sea otter predation
- Economic losses as a result of potential prohibitions or restrictions on certain fishing gear uses
- Regulatory risk as a result of the take moratorium under the Marine Mammal Protection Act (MMPA), which makes it extremely difficult to authorize take associated with any actions to

[1] The MMPA does allow for individual nuisance animals to be captured and removed.

remove sea otters after reintroduction, should such an action be desired. In addition, section 118 of the MMPA, which allows incidental take of other marine mammals in the course of commercial fisheries, does not authorize incidental take for southern sea otters in the course of commercial fisheries.

- Financial risk due to the as-yet unidentified source of adequate and reliable funding to support all years of reintroduction and monitoring

We also considered the risk associated with not reintroducing sea otters (the "no action" alternative) as suggested by the IUCN Guidelines. We conclude there is risk, particularly to the threatened southern sea otter, from the lack of population redundancy (and therefore vulnerability to random catastrophic events) and diminished genetic diversity (and therefore diminished adaptive potential), that will continue or increase as a result of inaction.

Further information and/or study is required to reduce the uncertainties regarding the relative probability and severity of these risks. We have identified the need for further consideration of these risks under Recommendations (section 6.3) and additionally recommend possible measures to mitigate the degree of risk posed by these factors.

Key Uncertainties or Data Gaps

The following information or actions are recommended for further consideration of potential reintroduction efforts:

- Identification and application of site selection criteria to narrow the range of possibilities for analysis and reduce costs
- Identification and selection of a range of most likely reintroduction scenarios (founder animals, numbers, etc.) to narrow the range of possibilities for analysis and reduce costs
- Baseline evaluation of prey availability, mortality risk, and other biological and ecological criteria for sustaining a healthy sea otter population at potential reintroduction sites
- Comprehensive evaluation of the probable socioeconomic impacts of sea otter reintroduction at specific reintroduction sites, including positive and negative impacts and monetary and non-monetary values
- Exploration of possible regulatory flexibilities or changes, or other ways to mitigate potential negative socioeconomic impacts associated with reintroduction
- Identification of resources to support reintroduction and long-term post-release monitoring and management

Recommendations and Next Steps

To promote continued constructive dialogue regarding possible sea otter reintroduction and enhance the likelihood of success, in section 6.3 we make several recommendations to address key concerns or uncertainties identified in the course of developing this feasibility report for further consideration (see also Measures to Reduce Risk, section 5.2).

Having concluded that the reintroduction of sea otters is feasible, we recommend the following next steps for action presuming consideration of reintroduction to northern California and Oregon continues:

- Convene a series of facilitated structured decision making workshops with stakeholders and scientific experts to engage in collaborative problem-solving regarding the uncertainties or data gaps identified, and to explore reintroduction options that might present an acceptable level of risk to all parties and increase the likelihood of success of a reintroduction effort

- Develop criteria for selection and evaluation of potential reintroduction sites using facilitated structured decision making workshops described above; criteria should include consideration of socioeconomic as well as biological information
- Initiate a rigorous socioeconomic impact study that considers the full range of negative and positive effects of sea otter reintroduction, including ecosystem services and other non-monetary values, once potential reintroduction sites are identified
- Develop plans for pilot studies and/or small-scale experimental reintroductions to assess the viability of using surrogate-reared southern sea otter pups or small numbers of wild captured sea otters in estuaries as a source for the establishment of new populations
- Integrate the population growth and expansion models that are currently separate for California and Oregon such that simulations can forecast outcomes considering the potential for interaction between reintroduced populations

Conclusion

The reintroduction of sea otters to northern California and Oregon would result in significant conservation benefits to the species, in particular to the threatened southern sea otter, and to the nearshore marine ecosystem.

Sea otter reintroduction is feasible from a biological perspective. Recent analyses demonstrate that suitable habitat is available, and the restoration of this native keystone species is anticipated to have positive effects on biodiversity, enhance kelp and seagrass systems, and provide valuable ecosystem services. Sea otter reintroduction is feasible from a legal standpoint as well, although some regulatory changes may be considered to increase the likelihood of reintroduction success.

Our preliminary evaluation indicates that reintroduction is feasible from a socioeconomic perspective, but we flag this as the factor with the greatest uncertainty (and thus risk). Although sea otters may produce significant economic gains from tourism, ecosystem services, and benefits to finfish fisheries, questions remain regarding the potential severity and scope of negative economic consequences on shellfish fisheries in particular, and sufficient data are not available at this time to inform consideration of these questions at the site-specific level. We recommend the completion of a comprehensive socioeconomic impact assessment once potential reintroduction sites are identified to determine the probability and scope or magnitude of all socioeconomic impacts, positive or negative, that may result from the reintroduction of sea otters to northern California and Oregon.

This document is intended solely to provide information to Congress and the interested public on the feasibility and estimated cost of a potential reintroduction of sea otters to the Pacific coast of the contiguous United States. We do not make any recommendation in this document as to whether reintroductions should take place. This is not a decision document and does not represent or predetermine any proposal for action.

The mission of the U.S. Fish and Wildlife Service is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people

1. INTRODUCTION—REASON, APPROACH, SCOPE, AND PURPOSE OF THIS REPORT

1.1. Why is the U.S. Fish and Wildlife Service evaluating the feasibility of reintroducing of sea otters?

The U.S. Congress has specifically instructed the U.S. Fish and Wildlife Service (Service) to develop a report on the feasibility and cost of reintroducing sea otters to the Pacific Coast of the contiguous United States. This direction came through the passage of Public Law 116-260, the Consolidated Appropriations Act 2021 (also known as the Omnibus Appropriations and Coronavirus Relief Package), which was signed into law and became effective on December 27, 2020. Congress gave the Service one year from the passage of the law to complete this report (Box 1.1).

BOX 1.1 DIRECTION TO THE U.S. FISH AND WILDLIFE SERVICE TO PRODUCE A REPORT ON THE FEASIBILITY AND COST OF SEA OTTER REINTRODUCTION, FROM EXPLANATORY STATEMENT ACCOMPANYING DIVISION G—DEPARTMENT OF THE INTERIOR, ENVIRONMENT, AND RELATED AGENCIES APPROPRIATIONS ACT, 2021; PL 116-260

"***Sea Otters***.—Sea otters play a critical ecological role in the marine environment as a keystone species that significantly affects the structure and function of the surrounding ecosystem. However, sea otters were effectively eliminated from the Pacific Coast of the United States by hunters and traders during the 1700s and 1800s. The Service is directed to study the feasibility and cost of reestablishing sea otters on the Pacific Coast of the contiguous United States, and to report to the Committees on the results of such a study within one year of enactment of this Act."

The language of this directive limits our consideration to the Pacific Coast of the contiguous U.S. (i.e., California, Oregon, and Washington); it does not include the State of Alaska.

This document constitutes the Service's report to Congress on our assessment of the feasibility and cost of reestablishing sea otters on the Pacific Coast of the contiguous U.S. Hereafter we use the term "Assessment" to refer to our report.

1.2. Assessing the feasibility of sea otter reintroduction to the Pacific Coast

Restoring native species of fish, wildlife, and plants to the ecosystems in which they evolved and where each plays a unique ecological role in the function of those systems is integral to the Service's conservation mission. Sea otters have now been absent from most of the Pacific coast of the contiguous

United States for more than a century. Because sea otters are a keystone species with significant positive effects on the composition and function of the nearshore marine ecosystem (see section 2.1.4), their potential return to their native range is clearly aligned with the Service's mission. For these reasons, the Service believes it is reasonable to explore the potential for restoring sea otters as functioning components of their native ecosystems in areas of the Pacific coast where they remain absent.

Several years before the Service received the directive from Congress to produce this report, an Oregon-based non-profit organization, the Elakha Alliance, had launched an independent effort to consider bringing sea otters back to restore resiliency in coastal ecosystems (Oregon is the only U.S. State where sea otters remain entirely absent within their historical range; see section 2.4.3.2). In early discussions with the Elakha Alliance, the Service provided technical assistance in the form of guidance regarding the laws and administrative requirements that would be involved in such an undertaking, and also advised the development of a thorough feasibility study. When the Elakha Alliance decided to pursue such a study, the Service contributed to that effort in the interest of ensuring it would incorporate the best available science on the relevant biological and ecological factors, as well as important socioeconomic and logistical considerations, to better inform any future deliberations.

The Elakha Alliance engaged preeminent experts in sea otter research and modeling to complete their feasibility study and released a draft for public review on August 30, 2021, available online at https://www.elakhaalliance.org/feasibility-study/). We refer to the Elakha Alliance's draft feasibility study throughout the remainder of this document as the EAFS (Elakha Alliance Feasibility Study). The EAFS presents information on sea otter biology, potential habitat suitability, ecological considerations, possible source populations, and genetic and logistical considerations; it also includes discussion of the political, legal, economic, and social contexts that factor into the evaluation of the feasibility of sea otter reintroduction to the Oregon coast. An interactive, web-based population model ("ORSO" v 1.0; see section 4.1.2.1) is available as part of the study and allows the user to forecast the growth and expansion of sea otter populations in Oregon under various reintroduction scenarios. The Elakha Alliance has also separately contracted independent economists with specialization in fisheries to prepare an assessment of potential fishery-related impacts, although that assessment is not yet available.

The Service has carefully reviewed the EAFS and finds that it represents a comprehensive compilation of the science relevant to the consideration of sea otter reintroductions, with additional information specific to Oregon. Because the Elakha Alliance has already aggregated much of the best available science relevant to the topic, and because this work was supported by the Service, we conclude it is not an effective use of public resources for the Service to attempt to duplicate their efforts in our Assessment. As a consequence, the approach we adopt here is to objectively assess and use the information presented in the EAFS. Thus, we adopt and incorporate their compendium of the science by reference where appropriate and to the extent possible. Where we may have additional data that were not considered in the EAFS, we present that information here. If we have different perspectives to offer on a topic, we do so. We also present information that is not covered by the EAFS; for example, we include relevant information from geographic areas other than Oregon that are under consideration in our Assessment (see section 1.2.1).

To further avoid duplication with the EAFS, we have adopted a somewhat different conceptual framework; we rely here upon the guidelines of the International Union for the Conservation of Nature (IUCN) for evaluating conservation reintroductions (IUCN/SSC 2013; see also section 1.2.2, this document). In brief, those guidelines call for the evaluation of reintroduction feasibility from a biological, socioeconomic, and legal perspective. They also call for the inclusion of an assessment of risk. In our Assessment, we summarize the state of scientific knowledge with regard to sea otter biology, ecology, population modeling, and other scientific information, but we largely refer the reader to the EAFS for a detailed accounting of these subjects. Because the EAFS comprehensively addresses the relevant science, we focus our efforts here on addressing the socioeconomic and legal aspects of feasibility. As part of this effort, we identify sources of risk and make recommendations to improve overall feasibility by rebalancing reintroduction-associated losses with reintroduction-associated gains to different segments of society (see section 5.2.1.5).

Although we rely in part on the scientific information compiled in the EAFS, the ultimate conclusions and recommendations in our Assessment regarding the biological and socioeconomic feasibility of reintroducing sea otters to the Pacific coast of the contiguous U.S. are solely those of the U.S. Fish and Wildlife Service.

1.2.1. Geographic scope of this Assessment

This is a feasibility assessment. For something to be feasible, it must, by definition, be practicable or achievable. Species reintroductions are inherently complex, lengthy, and costly undertakings, and resources to successfully execute conservation reintroductions are often limited. In fact, inadequate funding is one of the primary reasons cited for failed reintroduction attempts (Berger-Tal et al. 2019). Recognizing these inherent constraints, we concluded early in this process that it would not be realistic for our Assessment to consider reintroducing sea otters throughout all of their historical range along the contiguous U.S. where they remain extirpated, as there are two extensive unoccupied areas that collectively comprise close to 2,300 km (1,500 mi) of coastline: from southern California to central Baja California, Mexico (800 km; 500 mi), except for a relatively small but growing translocated population at San Nicolas Island; and from central Washington to Pigeon Point (near Half Moon Bay) in northern California (1500 km; 930 mi)[2] (Davis et al. 2019). We therefore decided to concentrate our Assessment on reintroduction in that portion of the sea otter's historical range that in our estimation would yield the greatest net conservation benefit. We concluded that it is most reasonable to focus our Assessment on the potential reintroduction of sea otters to northern California (from San Francisco Bay north) and Oregon, and that reintroductions in this area were likely to result in the greatest net conservation benefit to the species for the following reasons:

- Globally, this area represents the largest remaining gap in the historical range of the sea otter;
- Reintroducing sea otters within this area would begin to reestablish the historical transition zone that existed between northern and southern sea otters;

[2] Globally sea otters remain extirpated from roughly 4,000 km (2,500 mi) of their former range. The largest unoccupied stretches are between Northern Japan and the east coast of Sakhalin Island, Russia (1,000 km or 620 mi); between southern Alaska and British Columbia (400 km or 250 mi); and in the contiguous United States, between Point Grenville in central Washington State (southernmost extent of the northern sea otter) and Pigeon Point, California, midway between Monterey Bay and San Francisco Bay (northernmost extent of the southern sea otter) (1,500 km or 900+ mi); and south of Santa Barbara, California (southernmost extent of the southern sea otter) to central Baja California (800 km or 500 mi). From Davis et al. (2019, p. 8), citing to Larson and Bodkin (2015).

- Enabling renewed connectivity between northern and southern sea otters would create the potential for genetic exchange and increased genetic diversity, which is diminished (particularly in the southern sea otter) as a result of historical bottlenecks;
- Establishing additional population(s) of the southern sea otter within this gap would contribute to the recovery and potential delisting of that subspecies under the Endangered Species Act, not only by increasing the number and range of southern sea otters (as would a reintroduction to southern California) but also by increasing future connectivity and genetic diversity, as well as reducing vulnerability to stochastic events such as oil spills or disease;
- Oregon is the only State along the Pacific Coast of the contiguous U.S. that remains entirely without a sea otter population;
- The unoccupied habitat from Oregon southward to northern California is probably the area least likely to be naturally recolonized along the Pacific Coast of the contiguous U.S. and therefore in the greatest need of reintroduction, as the southernmost extent of the sea otter's unoccupied range within the U.S. has the potential to become populated by sea otters dispersing from the nearshore area of Point Conception or, eventually, from the growing population that has become reestablished at San Nicolas Island (of the Channel Islands);
- Oregon and northern California contain numerous estuaries (including the largest estuary on the Pacific Coast of the contiguous U.S., San Francisco Bay), which afford greater protection from white sharks than outer-coast areas, can support high densities of sea otters, and could benefit from the positive indirect effects of sea otters on seagrass; and
- Northern California (and, to some extent, southern Oregon) bull kelp forests were disproportionately affected during and after the Northeast Pacific Marine Heat Wave of 2014–2016, in part due to sea star wasting disease and a lack of redundancy in sea urchin predators, suggesting that the return of sea otters could, over time, provide an especially important ecosystem benefit in this area by increasing resilience to future perturbations (see section 4.1.4.1).

We did not include southern Washington within the scope of our assessment for the following reasons:

- The population of sea otters in Washington State, founded with the translocation of 59 sea otters from Alaska in 1969-1970 (Jameson et al. 1982), has become well established, with the most recent minimum count at 2,785 animals and a positive annual growth rate of 9.81% between 1989 and 2019 (Jeffries et al. 2019);
- Population growth in the south segment of the Washington population since the late 1990s (22%) has been much faster than in the north segment (5.5%), and in 2019 88% of the Washington population was observed in this segment (Jeffries et al. 2019), suggesting that sea otters are likely to continue to expand their range southward in Washington; and
- Occasional single sea otters (presumed to be from the Washington population) have been observed in Oregon (Rice 2021), indicating that eventually there would be the opportunity for genetic mixing with a population reestablished in Oregon without the need for additional reintroductions in the State of Washington.

With these points in mind, we concluded that reintroductions to Washington State are unnecessary and would yield little conservation return for the investment of resources.

Based on all of these considerations, we have limited the geographic scope of our Assessment to the coasts of northern California and Oregon. This does not mean that other areas of the sea otter's historical range are not important or should not be considered for reintroductions in the future, only that for the purposes of the current Assessment we have prioritized this portion of the sea otter's historical range for evaluation.

1.2.2. Purpose and framework of this Assessment

This Assessment is a compendium of the state of knowledge relevant to the potential reintroduction of sea otters within their historical range on the Pacific Coast of the contiguous United States. Many considerations come into play in this regard; in addition to basic sea otter biology, ecology, and behavior, factors such as the economic and social climate are integral to the question of reintroduction feasibility (Berger-Tal et al. 2019).

We intend for this Assessment to be an objective, fact-based report that will enable Congress and the public to consider and weigh important factors bearing on the feasibility of sea otter reintroduction. It is our intention to focus on the question of whether the reintroduction of sea otters is reasonably achievable, to identify any significant challenges to the feasibility of reintroduction, and to recommend areas that require further research, planning, or possible changes in policy or law to increase the likelihood of success should reintroduction be pursued. There is no active proposal to reintroduce sea otters at this time, and the Service will not be making any recommendation in this report as to whether reintroduction should or should not take place.

1.2.2.1. Assessment framework

For the purposes of our Assessment, we employ the principles laid out by the International Union for the Conservation of Nature Species Survival Commission (IUCN/SSC) in their *Guidelines for Reintroductions and Other Conservation Translocations* (Guidelines; IUCN/SSC 2013). These Guidelines emphasize that any conservation translocation[3] must yield a measurable conservation benefit at the levels of a population, species, or ecosystem. They emphasize the effectiveness of translocation as a potential conservation tool while simultaneously underscoring the need for rigorous justification to undertake such an action through a weighing of conservation benefits against risks and costs.

The Guidelines lay out successive stages of project design and evaluation to implement species reintroduction as a potential conservation tool (Figure 1-1). The first step, prior to any decision to act, is to ask, "is reintroduction is a reasonable option?" In our Assessment, we focus on providing the information to answer this key question, which includes working through the following steps:

- assessing the current conservation situation;
- identifying the goal(s) of any potential reintroduction; and
- assessing feasibility and risk of reintroduction (biological, legal, and socioeconomic).

[3] The term "conservation translocation" as used in the IUCN Guidelines refers to the reintroduction of a species within its historical range, as well as the possible introduction of a species outside of its historical range for conservation purposes. In our Assessment we use the term "reintroduction" as a general term that encompasses what the IUCN refers to as a "translocation," the assisted movement of animals from place to place within their historical range, as well as the release of surrogate-reared sea otters from rehabilitation facilities into unoccupied locations within their historical range.

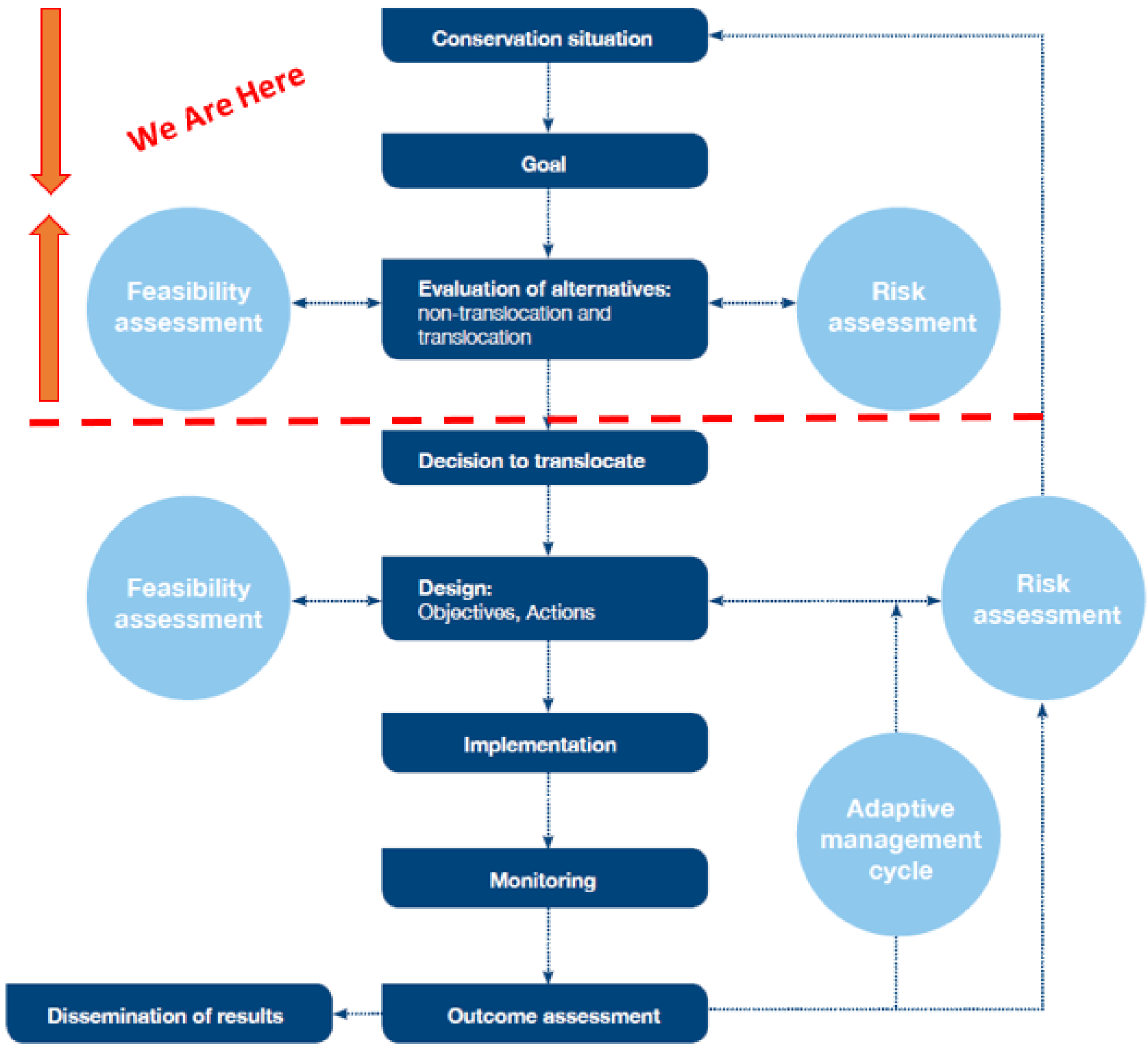

Figure 1.1. The conservation translocation cycle from the IUCN Reintroduction Guidelines (IUCN/SSC 2013). The area above the red dashed line highlights the objectives we seek to achieve in this report: an assessment of the conservation situation, clarification of the goals of any potential reintroduction, and an assessment of the feasibility and risk that will allow for an evaluation of whether a reintroduction is a viable conservation option.

We begin this Assessment by outlining conservation goals and objectives for a reintroduction of sea otters to the Pacific Coast of the contiguous United States (see section 3). Once clear conservation goals are identified, the Guidelines present several conditions and criteria for determining whether reintroduction may be a reasonable way to attain those goals (IUCN/SSC 2013, Annex 3). For reintroduction of a species within its historical range, the following considerations are relevant to this Assessment:

- Assessment should include identification of potential benefits and potential negative impacts, covering ecological, social, and economic aspects;
- Reintroduction may achieve intended conservation benefits but also carry risks to ecological, social, and economic interests; the future decision as to whether to take the proposed action relies on the thoughtful evaluation and consideration of those benefits and risks or costs; and
- Indications that risks are unacceptably high or there are significant uncertainties with regard to the degree of risk and impacts may be cause to re-evaluate reintroduction as an option. The risk analysis should include an evaluation of options to reduce the risk of undesirable outcomes, which would also play into the evaluation of costs/benefits.

Answering the fundamental question of whether reintroduction is a viable option requires an assessment of both feasibility and risk (see Figure 1-1), and the majority of this report will focus on these two components. We begin by assessing biological feasibility (section 4.1), evaluating what we know about fundamental factors such as sea otter biology, ecology, behavior; availability of suitable habitat and prey; and the success or failure of previous reintroduction attempts. Next, we consider socioeconomic feasibility (section 4.2), including a summary of information gathered on attitudes, values, and potential economic impacts from a variety of affected communities. Finally, we examine issues associated with legal feasibility (section 4.3), as well as estimated costs and resource needs (section 4.4). Where sufficient information is not currently available and important data gaps remain, we identify these as future research needs should reintroduction consideration proceed.

In terms of risk assessment (section 5), given the short timeline specified by Congress, we briefly discuss those areas where we believe we have sufficient information in hand to conduct a reasonable evaluation of risk (e.g., risk to potential source populations from removal of individuals for translocation), but for the most part this portion of our Assessment is limited to identifying those areas in greatest need of further evaluation (e.g., potential location-specific impacts to commercial, recreational, or subsistence shellfish fisheries) should reintroduction consideration proceed.

We did not extend the scope of our assessment to the phases of design, release, implementation, monitoring, or continuing management and assessment of outcomes, concluding that it would be premature to do so unless and until there is a decision to move forward with reintroduction. Instead, we conclude our report by identifying suggested next steps should reintroduction remain under consideration for future implementation.

1.3. Summary of Assessment contents

Following the framework developed by the IUCN in their *Guidelines for Reintroductions and Other Conservation Translocations* (IUCN/SSC 2013), our Assessment focuses on:

- Assessing and summarizing baseline knowledge of sea otter biology, ecology, behavior, and availability of suitable habitat;
- Identifying conservation goals and objectives that would be achieved through reintroduction;
- Ascertaining whether sufficient information is available to evaluate whether reintroduction will result in a net conservation benefit to the species or ecosystem;
- Describing the potential risks to ecological, social, and economic interests and identifying those areas where additional information is required;
- Estimating costs of potential reintroduction(s) and subsequent monitoring; and
- Clearly articulating important data gaps and identifying next steps, should interest in reintroduction continue.

This document is intended solely to provide information to Congress and the interested public on the feasibility and estimated cost of a potential reintroduction of sea otters to the Pacific coast of the contiguous U.S. We do not make any recommendation in this document as to whether reintroductions should take place. This is not a decision document and does not represent or predetermine any proposal for action.

Photo by Laird Henkel, used with permission.

2. BACKGROUND

For those who may not be familiar with sea otter biology, ecology, or the history of the species, we present here a brief overview of the basics to assist the reader in understanding the remainder of this report. For a more detailed accounting of any of these topics, we recommend the original exhaustive monograph *The Sea Otter in the Eastern Pacific Ocean* (Kenyon 1969); *The Sea Otter* (Enhydra lutris)*: Behavior, Ecology, and Natural History*, a thoroughly comprehensive review by Riedman and Estes (1990); and *Sea Otter Conservation*, a more recent summary of the state of knowledge regarding sea otters, edited by Larson et al. (2015*a*).

2.1. Natural history

Sea otters are the smallest marine mammal in North America. Southern sea otters are smaller than northern and Asian sea otters (see section 2.2), and females tend to be smaller than males (Riedman and Estes 1990). Typical weights are 49–88 lb (22–40 kg) for adult males and 31–71 lb (14–32 kg) for adult females (Riedman and Estes 1990, Monson 2009, Tinker et al. 2019*b*). Typical body lengths are 47–56 in (119–143 cm) for adult males and 45–52 in (115–133 cm) for adult females (Riedman and Estes 1990, Monson 2009, Tinker et al. 2019*b*). Females tend to be longer-lived, with an estimated lifespan of 15 to 20 years in the wild, compared to 10 to 15 years for males (Riedman and Estes 1990).[4] Sea otters can spend the entirety of their lives in the marine environment, even giving birth in the water, and are not obligated to haul out (Riedman and Estes 1990). However, hauling out helps to preserve energy by reducing heat loss, and sea otters in some areas haul out regularly (Tinker et al. 2019*b*). Sea otters in colder latitudes tend to haul out more frequently than those in warmer areas, though if sites protected from human disturbance are available, sea otters in California may haul out regularly as well (Riedman and Estes 1990, Eby et al. 2017). Haul-out behavior is also influenced by reproductive status, season, and individual differences (Tinker et al. 2019*b*).

2.1.1. Diet and habitat

Sea otters are carnivores and live in nearshore coastal systems, bays, and estuaries where they forage by diving for a wide variety of benthic (bottom-dwelling) macroinvertebrates, animals such as sea urchins, crabs, clams, mussels, abalone, sea cucumbers, tubeworms, and sea snails. They forage in rocky substrate subtidal and intertidal communities on the coast but also utilize soft-sediment habitats (Estes et al. 1982, Riedman and Estes 1990, Kvitek and Oliver 1992, Hughes et al. 2013, Weitzman 2013, Estes 2015, Hale et al. 2019). Sea otters bring all of their food items to the surface for consumption while floating on their backs, making it possible to determine the composition of their diet by visually observing foraging bouts.

Sea otters are generalist predators. More than 150 species of prey have been documented (Estes 2015). In rocky substrate habitats, animals such as crabs, abalone, sea urchins, octopuses, scallops, and mussels tend to be preferred prey items, whereas in soft or mixed-sediment habitats clams and worms often predominate (Doroff and DeGange 1994, Weitzman 2013, Hoyt 2015, Tinker et al. 2019*b*, LaRoche

[4] More recent data for California indicate that typical life spans are slightly shorter, 12–18 years for females and 10–15 years for males (USGS unpublished data), although some individuals may live longer. One female sea otter translocated to San Nicolas Island in 1987 as a juvenile was documented in 2006 to have reached at least 19 years of age in the wild (USGS unpublished data).

2020). Energetically profitable prey items such as red urchins, abalone, rock crabs, or large clams are selected when habitats are first reoccupied by sea otters, but as the abundance of these prey types declines over time, sea otters diversify their diet to include animals such as snails, barnacles, chitons, sea stars, and tubeworms (Estes 1980, Kvitek and Oliver 1992, Kvitek et al. 1993, Estes 2015, Hoyt 2015, Tinker et al. 2019*b*, LaRoche 2020). This diversification occurs at the population level, with individuals minimizing direct competition with other sea otters by specializing on only a few prey types (Estes et al. 2003, Tinker et al. 2008*a*, Newsome et al. 2015). Specialists on hard-shelled prey, such as marine snails and bivalves, are especially likely to use tools (usually rocks) to access them (Fujii et al. 2015, 2017).

Although many people assume that sea otters eat fish, similar to seals or sea lions, they are known to regularly incorporate fish into their diet only in Alaska and Russia (Kenyon 1969, Estes et al. 1978, 1982, Riedman and Estes 1990). Fish consumed by sea otters in these areas are primarily slow-moving groundfish, such as sculpin and lumpsuckers, and the proportion of fish in the diet varies according to availability as well as sea otter density (Estes 1980, Estes et al. 1982, Watt et al. 2000). Sea otters do not eat fast-moving fish such as salmon, nor do they regularly include shrimp in their diet.

The limited diving capabilities of sea otters, combined with their need to make numerous, repeated dives to the ocean floor to secure prey (see section 2), generally restrict their distribution to relatively shallow waters within the 40-m (131-ft) bathymetric contour (Riedman and Estes 1990). Although male sea otters in Alaska can dive to depths up to 100 m (328 ft), they do so only infrequently, and numerous studies have confirmed that preferred foraging habitat for sea otters is in waters up to 20–25 m (66 to 82 ft) in depth (Riedman and Estes 1990, Bodkin et al. 2004, Tinker et al. 2006, 2021*c*, Thometz et al. 2016*b*). Within this depth band in California, the highest densities of sea otters occur at depths of only 5 m (16 ft) (Tinker et al. 2021*c*).

Because sea otters are restricted to relatively shallow coastal waters and estuaries, they are usually found no more than 1 to 2 km (0.6 to 1.2 mi) from land (Riedman and Estes 1990), though local bathymetry plays a significant role. They are found particularly close to shore in areas where the coastal shelf drops off quickly into deeper waters, such as in many areas off California. In areas where relatively shallow depths extend further off the coastline, sea otters may be found at a greater distance from the shore (Lensink 1960, Bodkin 2015, Tarjan and Tinker 2016). For example, in Washington south of Cape Flattery, the continental shelf provides foraging habitat for sea otters at 40-m (131-ft) depths as far as 15 km (9 mi) offshore (Hale et al. 2019). Sea otters rarely use far-offshore areas (tens of km from shore) unless they include shallow rocky reefs with kelp canopy (Tinker et al. 2021*c*).

Sea otter habitat includes areas with rocky substrate or soft sediment. Although they tend to prefer areas with surface kelp canopies, this is not an absolute requirement, and sea otters may reach high densities in areas lacking kelp (Estes 1980, Riedman and Estes 1990, Bodkin 2015, Tinker et al. 2017). Areas with kelp canopies are utilized for both foraging and resting, and kelp forests likely provide important protection from predators such as sharks (Nicholson et al. 2018). In California, optimal habitats have been described as areas that provide a combination of canopy forming kelps, sheltered areas for resting, and adequate food resources (Riedman and Estes 1990, Tinker et al. 2021*c*). More recently, the high densities of sea otters observed in Elkhorn Slough, California, suggest that estuaries may serve as particularly valuable habitat (USFWS 2015, Hughes et al. 2019*a*, Tinker et al. 2021*c*).

2.1.2. Thermoregulation and energetic requirements

Unlike other marine mammals, sea otters do not maintain a layer of subcutaneous fat or blubber to help keep them warm. Instead, they rely on an extraordinarily dense, water-resistant coat of hair—the densest fur of any mammal (Riedman and Estes 1990). Sea otters scrupulously maintain a trapped layer of air within their fur through meticulous and frequent grooming, which provides insulation by preventing the skin from contacting water. If the integrity of the fur and the effectiveness of these insulating properties are compromised (e.g., by oiling, fouling, or inability to groom properly), sea otters can quickly become hypothermic and die (Costa and Kooyman 1982, Murray 2015).

As a consequence of their small size (and thus high surface area-to-volume ratio) and frigid aquatic environment, sea otters are highly vulnerable to heat loss through thermal conductance. Their dense coat alone is insufficient to maintain homeothermy, so sea otters must also rely upon a high rate of internal heat production to maintain their internal body temperature. Sea otters exhibit a high basal metabolic rate, up to 3 times that of a land mammal of similar size, and the highest known rate for any mammal over 1 kg (2.2 lb) in weight (Riedman and Estes 1990, Wright et al. 2021). This hypermetabolism results in high energetic requirements; to meet their caloric needs, sea otters consume the equivalent of 20–30% of their body weight in food every day and may spend up to half of their waking hours actively foraging (Kenyon 1969, Costa and Kooyman 1982, 1984, Yeates et al. 2007, Murray 2015). Sea otters have also adapted to challenging thermoregulatory conditions by having single, large pups able to withstand being born in the exposed marine environment, with pup-to-female mass ratios similar to those of pinnipeds and an order of magnitude larger than the pup-to-female mass ratios of other mustelids that give birth in the protection of a den (Monson et al. 2000).

2.1.3. Social system, population structure, and reproduction

Sea otters are social animals, and groups of resting individuals form aggregations known as rafts. Rafts tend to be segregated by sex, with groups of males resting in different areas from females and pups, though in long-established portions of the range, these areas can be in relatively close proximity (approximately 1–2 km or 0.6–1.2 mi) to each other. Single territorial males defend territories in high-quality habitats dominated by females and pups in a mating system known as resource defense polygyny (Riedman and Estes 1990, Tarjan 2016). Territorial males attempt to control reproductive access to females within their territory, and they actively exclude other males through aggressive defense behaviors.

Males exhibit two distinct home range strategies that reflect their reproductive status: territorial males maintain strong site fidelity to a small home range consisting of a single center of use, whereas males that are non-territorial (or territorial only during certain parts of the year) move between multiple range centers over a larger total area and over a longer span of coastline (Garshelis et al. 1984, Tarjan 2016, Tinker et al. 2019*b*). Female sea otters are more sedentary, with adult females rarely dispersing more than 20 km (12 mi) within a 1-year period (Riedman and Estes 1990, Tinker et al. 2019*b*). Although normally sea otters remain within a relatively small range, they are capable of swimming very long distances on occasion (see below).

The typical home range sizes of sea otters are quite small for a marine mammal. Home range size varies depending upon habitat, prey abundance, season, sex, and reproductive status (i.e., for females, presence and age of pups). In Prince William Sound, Alaska, average home range size ranged from 1 to

4.8 km^2 (0.4 to 1.8 mi^2) for adult females and 4.6 to 11 km^2 (1.8 to 4.2 mi^2) for males (Garshelis et al. 1984). In California, average home range sizes for females were 7.8 and 7.5 km^2 (3 and 2.9 mi^2) in Big Sur and Monterey, respectively, whereas average home range sizes for males were 6.5 and 10 km^2 (2.5 and 3.9 mi^2), respectively (Tinker et al. 2019*b*). The average length of a home range in California is 8.6 km (5 mi) of coastline (Tarjan and Tinker 2016). The length of the home range depends on coastal bathymetry; in areas where available foraging habitat (less than 40 m (131 ft) in depth) extends further offshore, sea otters can meet their foraging needs within a shorter linear distance. Tarjan and Tinker (2016) found that in the area of Big Sur, which has only a narrow coastal shelf providing preferred foraging depths, sea otters required home ranges 1.16 km (0.72 mi) longer than those in Monterey Bay, which has a wider continental shelf and provides a greater area of shallow foraging habitat extending offshore within a shorter distance of coastline.

Adult sea otters exhibit a high degree of site fidelity, and sea otter aggregations may be found in the same geographic area over a period of many years and even decades (Larson and Bodkin 2015). The site fidelity of sea otters to their home ranges has been demonstrated inadvertently through past translocation efforts that resulted in a significant proportion of animals returning to their point of origin (Wild and Ames 1974, Rathbun et al. 1990, 2000, Carswell 2008). This homing tendency appears to be stronger in adults than in juveniles or subadults (Carswell 2008). Tracking of tagged individuals released at San Nicolas Island in California clearly documented that sea otters are capable of swimming across the open ocean for distances of more than 100 km (62 mi) (Rathbun et al. 1990), and there are instances of translocated individuals traveling at least 318 km (200 mi) to return to their site of capture (Ralls et al. 1992).

Because male sea otters tend to disperse the farthest from their home ranges, they tend to be the first to occupy newly colonized areas. The typical pattern for range expansion in sea otters is seasonal usage of new areas by groups of males, potentially followed only years later by young females to establish a new breeding population (Garshelis et al. 1984, Lafferty and Tinker 2014). Range expansion is not necessarily a steady process, and occasional retractions in the range have been observed when females did not begin to use the new area (Lafferty and Tinker 2014). Sea otters in an estuary environment at Elkhorn Slough exhibited the same pattern of colonization, where a group of male sea otters took up residency for many years before females eventually moved in and a breeding population became established (Mayer et al. 2019).

Sea otters exhibit delayed reproductivity maturity, with males reaching sexual maturity at 5 to 6 years of age and females at age 3 to 4, with some as early as age 2 (Riedman and Estes 1990, Bodkin et al. 1993, Estes 2015). Mating and pupping may take place throughout the year, although there is some weak seasonality exhibited, and more pronounced peaks in pupping can develop in areas with strong seasonal weather patterns and limited food resources (Riedman and Estes 1990, Monson and DeGange 1995, Monson et al. 2000). Females typically give birth to a single pup every year, with care provided solely by the female for the approximately 6 months until weaning (Riedman and Estes 1990, Jameson and Johnson 1993).

Pup rearing and provisioning impose an additional demand on the already high energetic requirements of females (Thometz et al. 2014, 2016*a*, Chinn et al. 2016). Because sea otters do not store significant amounts of fat, females cannot assess whether they have the energetic resources necessary to raise a pup until after birth; if resources are lacking the pup may be abandoned (Monson et al. 2000, Estes 2015). Pup production is therefore relatively high and constant, but survival is highly variable. It is this reproductive strategy, compounded by other causes of mother/pup separation (shark bite trauma to the mother, severe seasonal storms, and maternal inexperience), that is responsible for the number of sea otter pups that strand every year (Estes and Palmisano 1974, Estes and Duggins 1995).

2.1.4. The sea otter as a keystone species

A keystone species is a species that has an effect on its environment disproportionate to its abundance (see also section 4.1.4). That is, a relatively small number of individuals can have a large impact on the structure and function of the ecosystem. Keystone species play a critical role in maintaining ecosystem balance. The sea otter is considered a keystone species in the nearshore marine environment because of its role as an apex predator at the top of multiple trophic cascades, resulting in the creation and maintenance of healthy kelp forests and seagrass beds. A trophic cascade occurs when a predator limits the density of a prey species, indirectly enhancing the abundance of species at lower trophic levels. Sea otters benefit kelp forests in rocky nearshore areas by controlling densities of herbivores such as sea urchins that can devastate these marine communities through overgrazing if left unchecked (Estes and Palmisano 1974, Estes and Duggins 1995) (Figure 2.1).

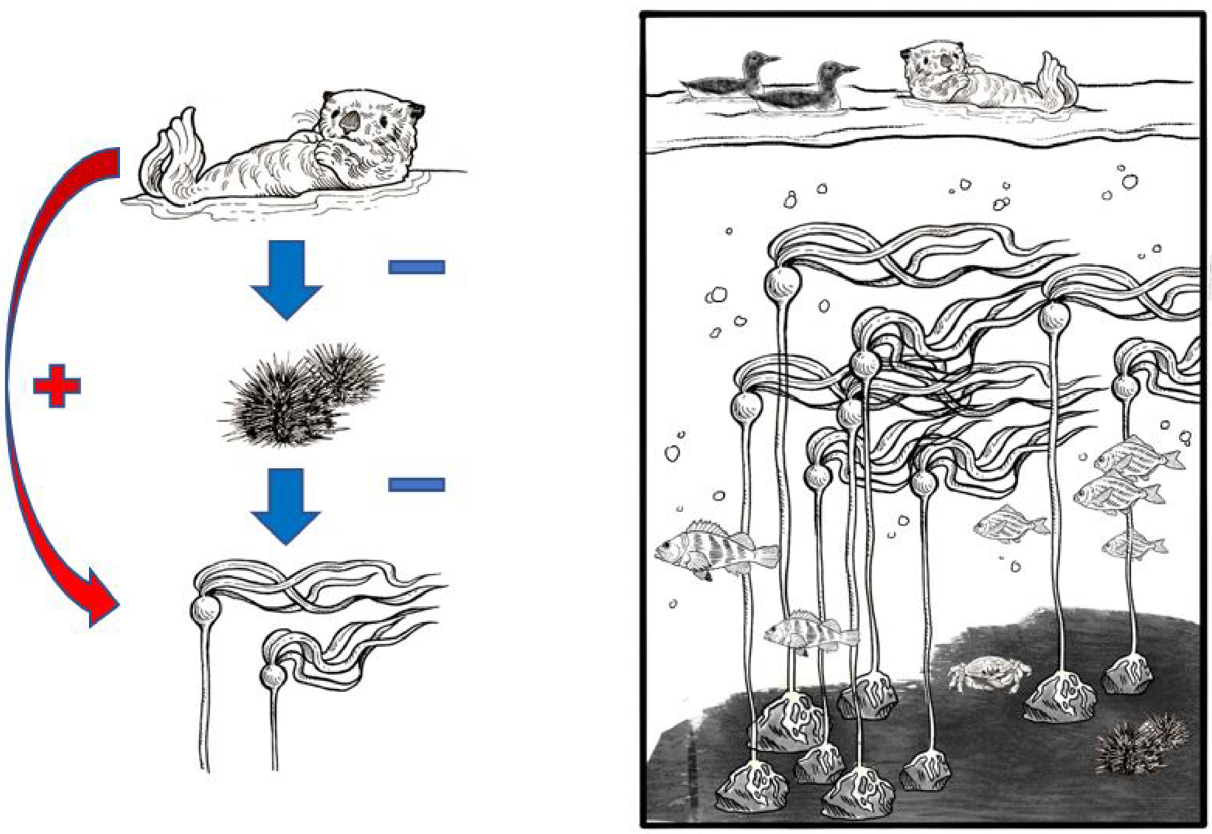

Figure 2.1. The sea otter-urchin-kelp trophic cascade (left). Negative effects are coded in blue, positive effects are coded in red. Urchins graze on kelp, which reduces kelp growth and biomass. By eating sea urchins, sea otters control their numbers, which in turn allows for greater growth of kelp. Sea otter predation on urchins cascades downward through the trophic levels, resulting in an overall positive effect on kelp. Kelp forests in turn provide structure and habitat for a wide variety of nearshore marine species (right), reflecting the keystone role of the sea otter in the ecosystem. Illustration courtesy of Crowley Zwartjes.

In soft-sediment estuaries or bays, sea otters are part of a more complex trophic cascade that can result in enhanced productivity and biomass of seagrasses (Hughes et al. 2013) and increase genetic diversity within seagrass communities (Foster et al. 2021), although this effect is more variable than that consistently observed in the sea otter-urchin-kelp trophic cascade (e.g., Hessing-Lewis et al. 2018) (Figure 2.2).

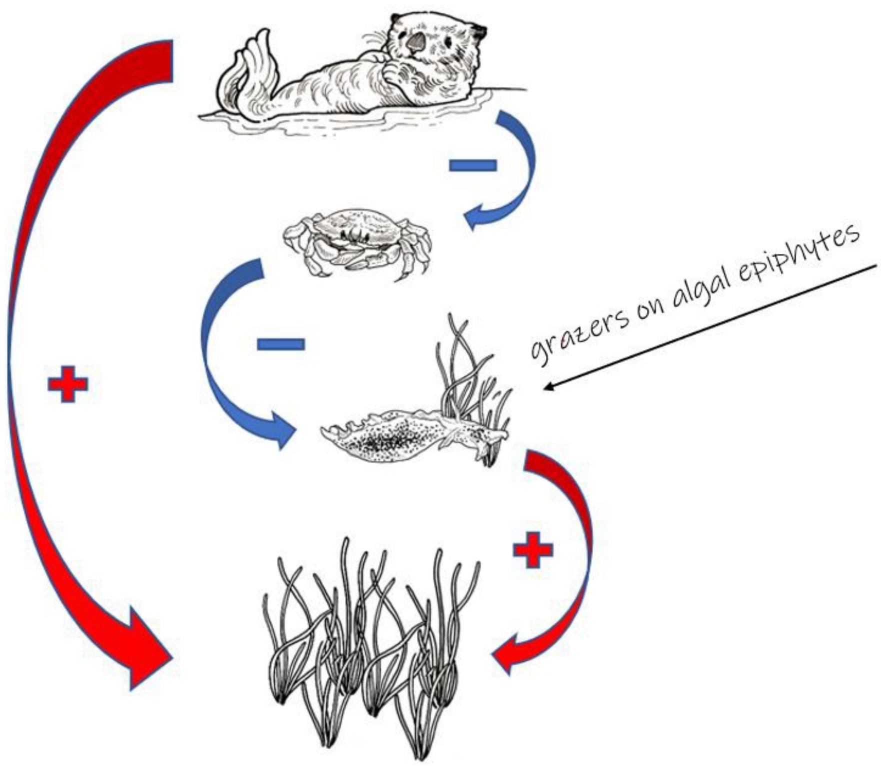

Figure 2.2. A simplified diagram of the four-level trophic cascade observed in the eelgrass system at Elkhorn Slough, California, by Hughes et al. (2013). Negative effects are coded in blue, positive effects are coded in red. In this system, algal epiphytes growing on the eelgrass in this nutrient-loaded system prevent sunlight from penetrating and smother the eelgrass. Grazers such as sea slugs benefit the eelgrass by feeding on and removing the algal epiphytes. Because crabs are predators of the sea slugs, sea otters have an indirect positive effect that cascades downward through the system. By controlling numbers of crabs through predation, the number of sea slugs (and other mesograzers) increases in turn. These mesograzers control algal epiphytes, and results in an overall increase in growth of eelgrass. Illustration courtesy of Crowley Zwartjes.

Kelp forests provide numerous direct and indirect benefits, including habitat for hundreds of invertebrate and fish species, reductions in coastal erosion, and carbon storage that can moderate climate change and reduce ocean acidification; seagrasses also provide ecosystem services in terms of nursery habitat for many species, shoreline protection, and carbon sequestration (e.g., Jackson 1997, Nellemann et al. 2009, Wilmers et al. 2012, Markel and Shurin 2015, Krause-Jensen and Duarte 2016). Both kelp forests and seagrass beds have been shown to recover surprisingly quickly when sea otters have returned to areas where they have long been absent (e.g., Estes and Duggins 1995, Lee et al. 2016, Burt et al. 2018, Hughes et al. 2019). We address the far-reaching effects of the sea otter on the structure and function of the Pacific nearshore ecosystem further in sections 3.1.2 and 4.1.4.

2.2. Taxonomy

The sea otter (*Enhydra lutris*) is a member of the Mustelidae, the family of mammalian carnivores that also includes skunks, weasels, badgers, and wolverines. It is the sole species in the genus *Enhydra* and, of the 12 species of otters that comprise the subfamily Lutrinae (otters) (ITIS 2021*a*), it is the only one considered to be an exclusively aquatic marine species.

There are three recognized subspecies of *Enhydra lutris*, based primarily on differences in skull morphology (Wilson et al. 1991, ITIS 2021*b*) as well as variation at the molecular level (Cronin et al. 1996, Larson et al. 2002*a*). The Russian or Asian sea otter, *E. l. lutris*, is found in the Kuril Islands, Kamchatka Peninsula, and Commander Islands in Russia. *E. l. kenyoni*, also known as the northern sea otter or Alaskan sea otter, ranges from the Aleutian Islands in southwestern Alaska to the coast of Washington, though historically its range extended into Oregon. *E. l. nereis*, the southern sea otter, sometimes known as the California sea otter, is currently restricted to coastal California, although historically it ranged from Oregon into Mexico (Figure 2.3, Figure 2.6).

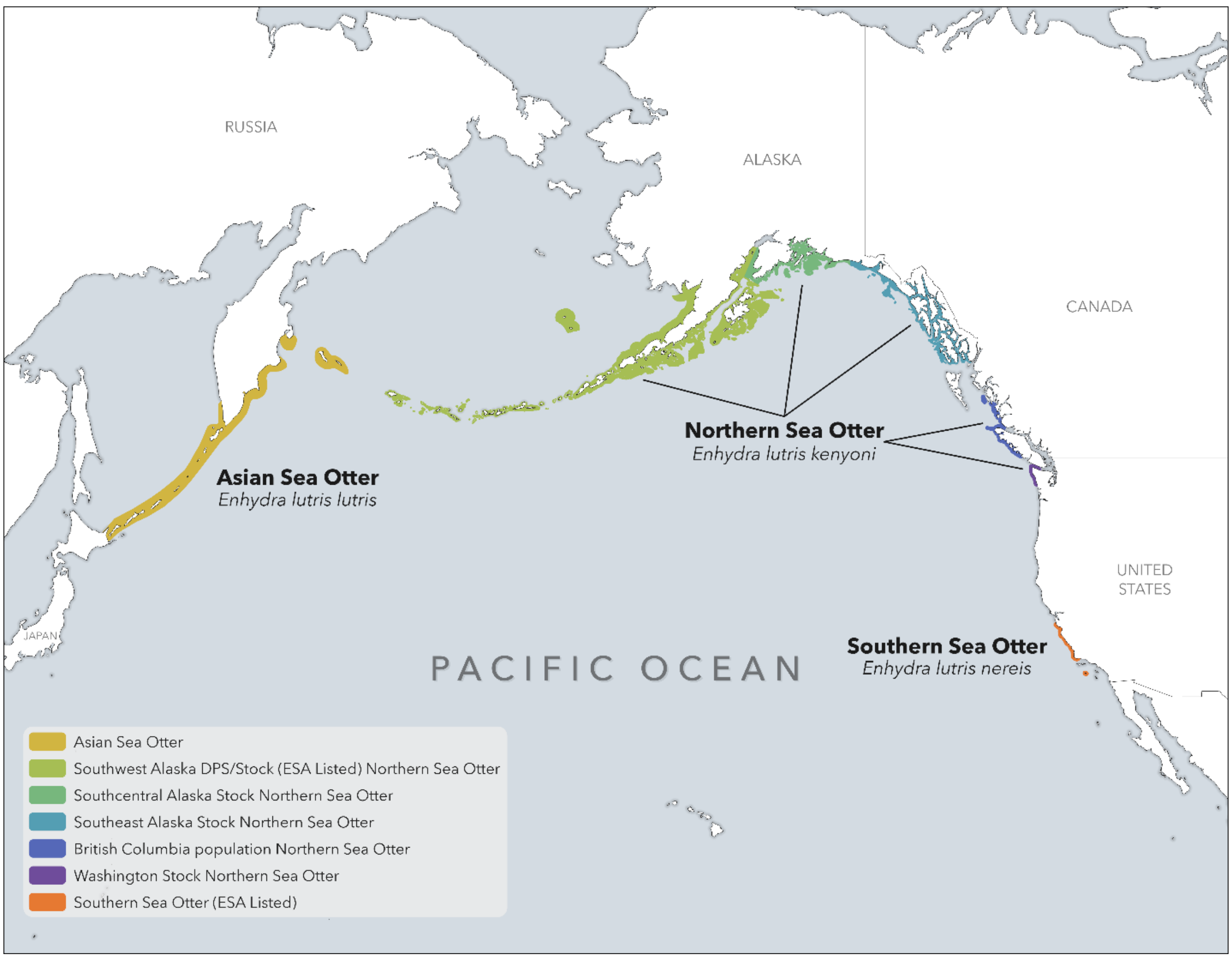

Figure 2.3. Global distribution of the three recognized subspecies of the sea otter, Enhydra lutris, and recognized stocks of sea otters in the U.S. The southern sea otter (Enhydra lutris nereis) and southwest Alaska Distinct Population Segment (DPS) of the northern sea otter are listed as threatened species under the Endangered Species Act (ESA).

2.3. Conservation status

International
In Canada, sea otters are considered a species of special concern under the Species at Risk Act (SARA) (Government of Canada 2002). The southern sea otter is listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and both Russian and northern sea otter subspecies are listed under CITES Appendix II. On a global scale, the sea otter species *Enhydra lutris* is considered endangered by the International Union for the Conservation of Nature (IUCN) (Doroff and Burdin 2015).

Federal
In the United States, there are two sea otter entities listed under the Endangered Species Act (ESA) (Endangered Species Act of 1973, as amended; 16 U.S.C. 1531 et seq.). The southern sea otter, subspecies *E. l. nereis*, was listed as a threatened species[5] in 1977 (42 FR 2965; January 14, 1977). The Southwest Alaska Distinct Population Segment (DPS) of the northern sea otter *E. l. kenyoni* was listed as a threatened species in 2005 (70 FR 46366; August 9, 2005).

No other subspecies or populations of sea otters are protected under the ESA, but as with all marine mammals under U.S. jurisdiction, all sea otters are protected under the Marine Mammal Protection Act of 1972 (MMPA; 16 U.S.C. 1361 et seq.). Any marine mammal listed under the ESA is, by definition, considered depleted under the MMPA. The southern sea otter and the Southwest Alaska DPS of the northern sea otter are therefore considered depleted under the MMPA and are additionally considered strategic stocks (see section 4.3.1.1). The MMPA recognizes four stocks of the northern sea otter altogether: Southwest Alaska (threatened DPS; strategic); Southcentral Alaska (non-strategic); Southeast Alaska (non-strategic); and Washington (non-strategic) (Figure 2.3).

State
The southern sea otter is designated under California State law as a “fully protected mammal” (California Fish and Game Code section 4700) but is not listed under the California State Endangered Species Act (CESA; California Code of Regulations, Title 14, Chapter 6, §§ 783.0-787.9; Fish and Game Code Chapter 1.5, §§ 2050-2115.5). The California Wildlife Action Plan identifies the southern sea otter as a marine species of greatest conservation need (CDFW 2015, Table 5.7-1).

The sea otter (*Enhydra lutris*[6]) is listed as a threatened species under the Oregon Endangered Species Act (Oregon Revised Statutes (ORS) 496.171 through 496.192). The Oregon Conservation Strategy identifies the sea otter as a Watch List Species for rocky subtidal and neritic (shallow nearshore) habitats, although its presence is noted as sporadic (ODFW 2016, Nearshore Appendix E).

The northern sea otter is currently listed as threatened under the Washington State Endangered Species Act (Revised Code of Washington (RCW) 77.15.130 after being downlisted from endangered status in 2019. The Washington State Wildlife Action Plan identifies the northern sea otter as a species of greatest conservation need (WDFW 2015, Appendix A-1).

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[5] As defined by the ESA, the term “species” includes any species, subspecies, varieties (for plants), or, for vertebrate animals only, distinct population segments (U.S. Fish and Wildlife Service Policy Regarding the Recognition of Distinct Vertebrate Population Segments (61 FR 4722; February 7, 1996)).
[6] The sea otter is listed at the species level only in the State of Oregon.

Alaska's Wildlife Action Plan (Alaska Department of Fish and Game 2015) recognizes the northern sea otter as a species of greatest conservation need (specifically, as an ecologically important stewardship species[7]); it is not on the State of Alaska's list of endangered species (Alaska Statutes (AS) 16.20.190).

Section 4.3 provides details on the protections afforded sea otters by both the ESA and the MMPA, as well as other laws and regulations relevant to the question of sea otter reintroduction.

2.4. History of sea otter populations

Sea otters once occupied the nearshore marine waters of the North Pacific Rim, ranging from the northern islands of Japan; Russia's Kuril Islands, Kamchatka Peninsula, and Commander Islands; across the Aleutian Islands to Alaska; and southward along the Pacific coast to central Baja California, Mexico (Figure 2.4). Prior to the maritime fur trade, the worldwide population is estimated to have numbered from 100,000 to 150,000 individuals (Kenyon 1969, p. 136), up to "somewhat greater than 200,000" (Johnson 1982, p. 294). It is impossible to know the actual historical abundance, and these estimates are based only on the assumption that the historical global population size was likely no more than five times greater than the 30,000 sea otters presumed to exist in 1969 (Kenyon 1969).

Man posing with sea otter skins, Alaska 1892.

Although long utilized by indigenous peoples, sea otters in the Commander Islands were encountered by Russian explorers under the command of Vitus Bering in 1741, and intensive harvest of sea otters for their fur began soon thereafter (Kenyon 1969). Bailey (1936, p. 305) describes the pelt of the sea otter as "generally considered the most beautiful and valuable fur in the world." Over the next roughly 150 years, sea otters were hunted to the verge of extinction; during the period of greatest active harvest from 1741 to 1867, about 800,000 sea otters are estimated to have been killed (Johnson 1982). By the early 1900s, sea otter numbers had been reduced to an estimated 1% of their original global abundance. Bodkin (2015) describes the relatively sedentary nature and small home ranges of sea otters as rendering them particularly vulnerable to serial depletion, in which the entire population of an area would be wiped out by hunters before they moved on to an adjacent area, leaving no individuals behind to rebuild it. Although sea otters technically gained protection from harvest under the International Fur Seal Treaty of 1911, by the late 1800s hunting had already all but ceased because sea otters had become so rare it was no longer profitable to hunt them (Baur et al. 1996, Bodkin 2015).

[7] A stewardship species is any taxon with a large percentage of its population or range in Alaska.

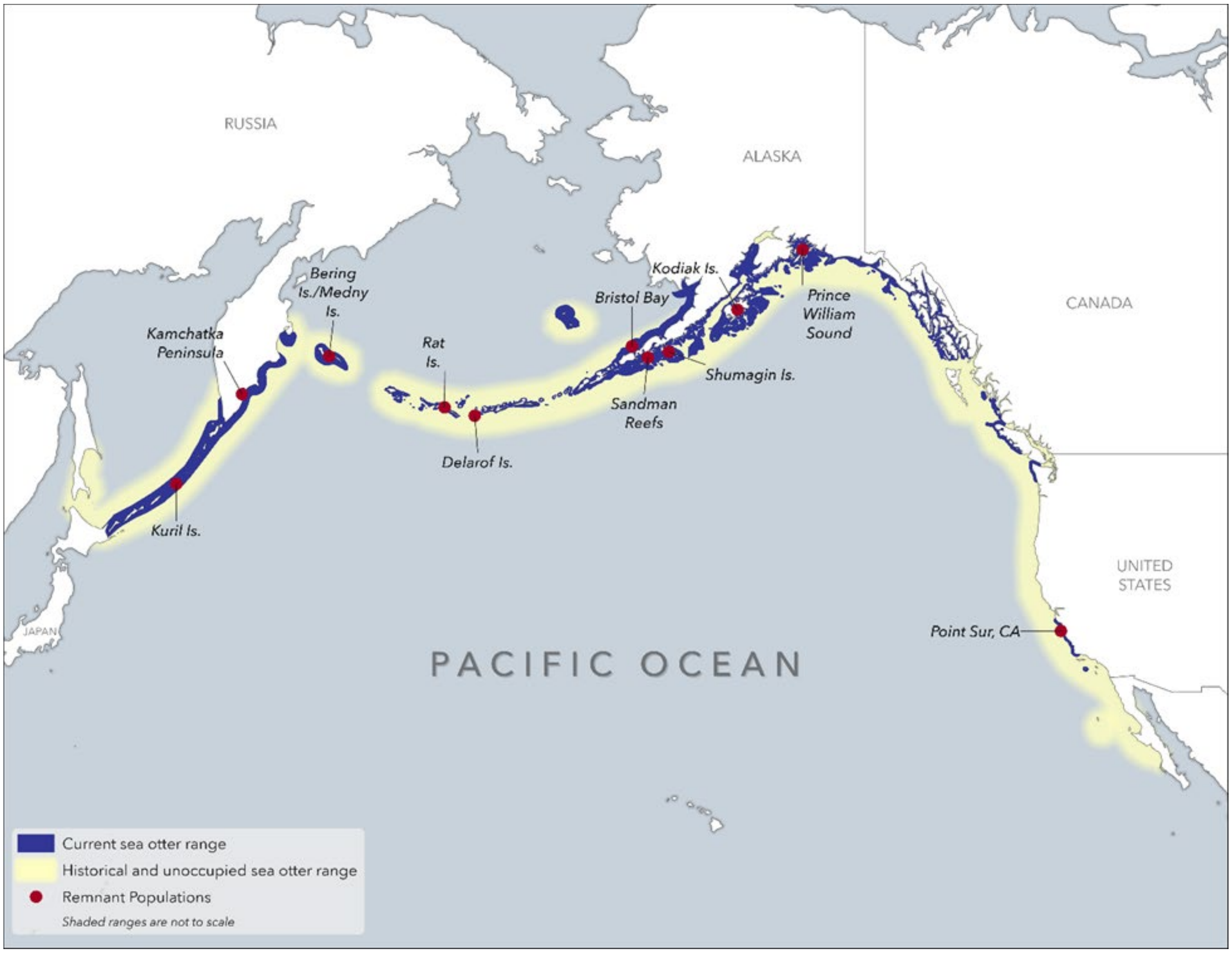

Figure 2.4. Historical global range of the sea otter (yellow) and currently occupied range (indigo). Also shown are the 11 isolated remnant groups of sea otters that survived the maritime fur trade, likely numbering fewer than 1,000-2,000 animals total (red dots). All sea otters today are descended from these remnant populations.

At the time legal harvest of sea otters ended in 1911, it is estimated that from a few hundred up to perhaps as many as 2,000 sea otters had survived in 13 small and widely dispersed locations: three in the Kuril Islands, Kamchatka Peninsula, and the Commander Islands off Russia; seven small scattered groups from the Aleutian Islands to Prince William Sound in Alaska; and one small group off the coast of central California near Big Sur (Kenyon 1969, Jameson et al. 1982, Riedman and Estes 1990, Bodkin 2015). Two additional groups had remained briefly in the Queen Charlotte Islands of Canada and San Benito Island of Mexico, but these soon died out (Kenyon 1969). The last wild sea otter in Oregon was killed in 1906, and in Washington in 1910 (Kenyon 1969). Sea otters in California were nearly extirpated, except for a small group of perhaps 50 animals off of Big Sur that appear to have gone largely undetected until 1938 (Riedman and Estes 1990). This was the only surviving group of sea otters across thousands of miles of their historical range from central Baja California, Mexico northward to Prince William Sound, Alaska, and the only remaining representatives of the southern sea otter subspecies, *E. l. nereis* (Figure 2.4). All southern sea otters in existence today are descended from this small founder population.

2.4.1. Past Sea Otter Reintroductions

Sea otters have been the subject of multiple translocation efforts in the past, which are reviewed in Chapter 2 of the EAFS: https://www.elakhaalliance.org/feasibility-study/chapter-2-history-of-prior-sea-otter-translocation/. We will not repeat all of that history here, but in brief, roughly one-third of the sea otters in the world today are the result of past successful reintroduction efforts. In the 1960s and 1970s, sea otters from populations that survived the maritime fur trade at Amchitka Island and Prince William Sound, Alaska, served as the source for translocations to areas where sea otters had been extirpated in other regions of Alaska as well as British Columbia, Washington, and Oregon. All of these reintroductions were successful, with the exception of the translocations to the Pribilofs in Alaska and to the southern coast of Oregon.

Because Oregon is once again being contemplated as a potential reintroduction site, one of the first questions that arises is why the first reintroduction was not successful. The Oregon reintroduction was attempted in 1970 and 1971 through the translocation of 93 sea otters from Amchitka Island, Alaska, to Cape Arago and Port Orford in southern Oregon. The failure of the population to persist does not appear to be a simple matter of the number of sea otters, as fewer sea otters were released in Washington (59 total), and the Washington population became established whereas the Oregon population did not. Some of the sea otters released remained in southern Oregon for 10 years following reintroduction (with a high count of 23 individuals) and successfully produced at least 17 pups over the years subsequent to the releases (Jameson et al. 1982).[8] However, by 1981 only a single sea otter was observed and was the last animal documented from this release (Jameson et al. 1982).

The majority of sea otters released at the Oregon sites disappeared relatively quickly, and there were no documented large mortality events (Jameson 1974), although Riedman and Estes (1990) suggest that possible unobserved postrelease mortality may nonetheless have been high. Homing behavior and emigration of sea otters away from the release sites resulting in an unsustainably small population is believed to be the most likely cause for failure of the Oregon reintroduction (Jameson 1974, Jameson et al. 1982, Riedman and Estes 1990). It is notable that sea otters appear to have abandoned the Oregon release sites despite the apparent availability of sufficient prey and high-quality habitat[9], a phenomenon similarly observed in the subsequent reintroductions to San Nicolas Island in California (2.4.1.2, below). Also notable is that there appears to be a tipping point of founding population size in the establishment phase, at which populations of fewer than 20 animals or so appear to have a roughly equal chance of either declining to extinction (as in Oregon) or managing to persist at a low level for a long period of time before gradually commencing a phase of population growth (as in Washington and at San Nicolas Island).

Summing up their analysis of the sea otter reintroductions that took place between 1965 and 1972, Jameson et al. (1982, pp. 106-107) conclude as follows:

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[8] For an in-depth evaluation of the failed attempt to reintroduce sea otters to Oregon in 1970-71, see Jameson (1974).

[9] In his thesis evaluating the sea otter reintroduction effort in Oregon, Jameson (1974) describes the south coast area where sea otters were released as “good to excellent sea otter habitat” with “abundant sea otter food resources.” Subsequent analyses by Kone et al. (2021) confirm that lack of suitable habitat on the southern Oregon coast is an unlikely explanation for the failure of this early reintroduction attempt.

1. The number of sea otters at a transplant site decreases dramatically soon after release;
2. Emigration appears to be an important factor in the initial decline of translocated populations;
3. Small populations (< 25–30 animals) are probably destined for extinction[10] because reproduction rates cannot overcome the combined rates of mortality and emigration;
4. It is possible to select a general area to reestablish sea otters, but exact locations are difficult to predict; and
5. It is possible to reestablish sea otters in unoccupied habitat, but it appears to require a relatively large nucleus population.

Although these observations were made based on reintroductions that occurred on the order of 50 years ago now, subsequent experiences in California, discussed below, have largely confirmed several of these general principles.

2.4.1.1. Central California 1969–1989

There have been several translocations of sea otters in California that have proved particularly instructive, as they have differed in some characteristics from the earlier translocations described above. For one, these efforts have largely utilized marked individuals and employed rigorous post-release monitoring to the extent possible, so we have gained helpful data on post-release behaviors or fates of individuals. In addition, at least some of these translocations moved animals to areas that were already occupied by sea otters, which differs from all earlier cases. Finally, California has been the subject of releases of surrogate-reared juveniles originally stranding as young pups, as opposed to all other reintroduction efforts that have relied upon the capture, movement, and release of wild-captured subadult or adult animals.

The first translocation of sea otters in California took place in 1969, when the California Department of Fish and Game captured, tagged and relocated 17 individuals from the southern portion of their range near Cambria and released them a short distance (72 km; 45 mi) to the north to Big Creek (Wild and Ames 1974). The movement of these individuals was meant to reduce pressures on the commercial abalone fishery in the Cambria-Point Estero area (Wild and Ames 1974), and the animals were released in an area that was already occupied by sea otters (Riedman and Estes 1990). Of note from this initial translocation, at least five of the otters were documented as having returned to their original site of capture within 9 months, and the researchers tracking the animals suggested that "in all probability, more otters returned than the approximately 30% that were sighted" (Wild and Ames 1974). Based on their results, they concluded that translocation of sea otters across continuous rocky reef-kelp bed habitat was an ineffective means of controlling range expansion.

From 1988 to 1989, researchers in California carried out an experiment designed specifically to evaluate the homing tendencies of relocated sea otters (Ralls et al. 1992). Nineteen sea otters were captured near Shell Beach, just south of San Luis Obispo in the southern portion of the sea otter's range, and released at Moss Landing off Monterey Bay, about 291 km (180 mi) to the north. Similar to the Cambria study, the release site was already occupied by an established sea otter population. All of the otters

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[10] Although Jameson et al. (1982) use the term "extinction," the Service uses the term "extirpation" when referring to the loss of a population as opposed to the entirety of the species.

were tagged with radio transmitters to monitor their movements; although the tags had an expected life of 60 days, a few lasted as long as 87 days. Importantly, one element of the experimental design was to test whether keeping sea otters in holding pens prior to release might increase the probability that they would remain in the intended translocation area. Accordingly, 10 of the otters were held in floating pens for 48 hours prior to release and 9 were released immediately upon arrival (Ralls et al. 1992). Five of the 9 animals (56%) that had been released immediately returned to their original site of capture; by contrast, all 10 of the otters that had been held in the floating pens remained in the general release area (Ralls et al. 1992).[11] Animals that made the return journey of 250-318 km (155-200 mi) back to the Shell Beach area took 12 days on average to cover the distance (Ralls et al. 1992). The authors concluded that holding sea otters prior to release increases the likelihood that they will subsequently remain in the area, although they noted that their results differed from those at San Nicolas Island (2.4.1.2, below).

2.4.1.2. San Nicolas Island, California 1987–1990

From 1987 to 1990, the U.S. Fish and Wildlife Service carried out the translocation of 140 sea otters to San Nicolas Island, the outermost of the Channel Islands in the Southern California Bight. The goal of the translocation program was to establish a second, geographically removed population of the southern sea otter to reduce the threat of catastrophic loss from an event with potential to affect the entirety of the single remaining population along the central California coast (i.e., due to a large oil spill).[12] The action was also specifically intended to obtain data for assessing translocation and containment techniques, with the fortunate consequence that great emphasis was placed on thoroughly documenting capture, transportation, and release techniques, as well as tracking individuals and monitoring of the population post-release (52 FR 29754; August 11, 1987; Rathbun et al. 2000).

The southern sea otter is protected under both the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). Because the MMPA has no provision for the establishment of an experimental population that is comparable to the provision under section 10(j) of the ESA, which can adjust the legal protections afforded the population with the goal of increasing public acceptance of a reintroduction, the potential translocation of southern sea otters was authorized through the passage of Public Law (PL) 99-625 in 1986. PL 99-625 provided for the capture and movement of southern sea otters to establish an experimental population, but it also required zonal management of the otters with the intention of reducing potential conflicts with fishery resources. Under this law, an area around the reintroduction site was to be delineated as a "translocation zone" where otters were intended to remain, and any otters that moved into a designated "management" (aka "no otter") zone were required to be captured and moved back either to the translocation zone or to the parent range (see section 4.3, Box 4.1, for more information on PL 99-625).

Following the evaluation of several potential reintroduction sites, including northern California and southern Oregon (USFWS and Institute of Marine Sciences 1986), San Nicolas Island was ultimately chosen for the establishment of an experimental population of southern sea otters as it was considered to provide excellent habitat, had several logistical advantages (support facilities on island due to the presence of a naval facility, viewpoints for land-based monitoring of otters, and deep ocean channels

[11] It should be noted that these results are only relevant to the first two to three months after release, as none of the radio transmitters remained operational for more than 87 days.
[12] As called for in the U.S. Fish and Wildlife Service's 1982 recovery plan for the southern sea otter. The southern sea otter was listed as a threatened subspecies under the Endangered Species Act in 1977 (42 FR 2965; January 14, 1977).

surround the island that were anticipated to serve as a barrier to dispersal), and was believed to be sufficiently remote to isolate the population from a large oil spill that could impact the primary mainland population (Rathbun et al. 2000). The translocation effort employed refined capture, transport, and holding methods and careful selection and screening of individuals to achieve demographic targets for reintroduction (e.g., ending up with a ratio of ~3.5 females for every male, and slightly more juveniles than adults) as well as ensure good physical condition (Rathbun et al. 2000), and methods were refined as the translocation progressed to adjust these targets (Carswell 2008, USFWS 2012). Ultimately 140 sea otters were released on San Nicolas over a period of 4 years (139 wild-captured and 1 rehabilitated pup); all but four of those releases occurred in the first 3 years).

The initial plan was to hold sea otters in floating pens at the island prior to release to reduce the probability of immediate dispersal, but the 45 sea otters initially held exhibited signs of extreme agitation and the plan was abandoned after 3 of the animals died from apparent stress (Rathbun et al. 1990, 2000). All subsequent releases were made directly into the ocean from the shore, and no more immediate mortality was documented (Rathbun et al. 2000). Although the hope had been to tag all of the released animals to track their movements, issues with permitting authorizations prevented this from occurring, resulting in only 79 of the 139 wild-captured sea otters (57%) being radio-tagged. All of the animals were flipper-tagged for visual identification of individuals, but these tags are eventually lost over time so were only useful for a few years (Rathbun et al. 2000). Monitoring of the released sea otters was done weekly from 1987 through 1992 and has occurred on a regular basis but with longer intervals since that time (now on a quarterly basis; see Yee et al. 2020).

Most of the sea otters left the island soon after release; in 1990, after 140 sea otters had been released over the previous 3 years, the high count was 16 adults, and this number stayed relatively constant over the next 8 years with an average of 15 animals (range 13 to 17) observed through 1998 (Rathbun et al. 2000). The animals that remained successfully produced pups, ranging from 3 to 8 pups per year (mean of 5 annually) from 1990 through 1998 (Rathbun et al. 2000). Eighty-two otters remained for some known period following release but subsequently disappeared and were not detected again, thus their fates are unknown; most of these stayed at the island less than 1 year, but at least 4 individuals stayed 3 years or more. Juveniles and subadults stayed significantly longer than adults (Carswell 2008). For those sea otters whose fates are known, 3 were found dead within a few days of being translocated; 36 are known to have returned to the parent population range; and 18 were either captured (11) or found dead (7) in the management zone. The rest are suspected to have either returned to the mainland or moved to the management zone, or to have died (USFWS 2003). Carswell (2008) found that adults were twice as likely to return to the site of original capture compared to juveniles and subadults, which tended to return to the general mainland area but not necessarily to their specific home range.

Similar to earlier reintroductions, the number of animals remaining at the release site in subsequent years dropped dramatically, with most (~90%) either returning to the mainland or disappearing entirely (Rathbun et al. 2000, Hatfield 2005, Carswell 2008). Immediately following the last releases, the high count of animals at San Nicolas Island represented only 10% of the number originally released, and remained at very low levels for many years, leading to questions regarding the nascent population's long-term viability (Riedman and Estes 1990, Rathbun et al. 2000, USFWS 2012). Although high levels of dispersal away from the island had been initially documented, there was no clear explanation for the continuing lack of growth in the population that remained. Observed levels of pup production should have been sufficient to support population increases, and food availability was not limiting, leading Rathbun et al. (2000) to conclude that dispersal and death must be the two factors suppressing population growth. Although the dispersal of many sea otters elsewhere was known to have occurred, many of the animals who simply disappeared were suspected to have died, possibly in the course of attempting to return to their home range, or possibly drowned in lobster pots in the vicinity of the island, although this was never documented (Rathbun et al. 2000, USFWS 2012).

The San Nicolas Island translocation program and associated zonal management was terminated in 2012 following an extensive review and a conclusion that the program as implemented under PL 99-625 was incompatible with the recovery and management goals for the southern sea otter (77 FR 75266; December 19, 2012). An evaluation of the translocation program unequivocally concluded that "the successful containment of sea otters, or maintenance of an 'otter-free' management zone, cannot be accomplished by simply capturing animals in the management zone and moving them to another location" (USFWS 2012). The capture program was significantly more challenging than expected, and it was suspected that sea otters were experiencing elevated mortality as a result of stress or other sources (USFWS 2012). Even 25 years after the initial translocations to San Nicolas Island, the translocation program never met its target goal of establishing a core population of 70 animals or minimum annual recruitment of 20 animals, resulting in the conclusion that it was unlikely to ever grow large enough to serve as a useful reserve population for recolonization via translocation if the mainland population were reduced or extirpated from a catastrophic oil spill or other event (USFWS 2012).

Despite the early indications that the reintroduced population at San Nicolas faced an uncertain future and the declaration of the translocation program a failure, after years of low population numbers and marginal growth rates, the number of otters at San Nicolas began to increase. Numbers remained low, ranging from 21 to 45 animals through 2010, but then began to increase more steadily until the count reached a high of 121 sea otters (109 adults, 12 pups) at San Nicolas in 2019 (Yee et al. 2020). The most recent annual growth rates for San Nicolas Island have been calculated at 22% per year (95 percent CI 11-34%) (Yee et al. 2020), within the range of theoretical maximum growth for sea otters (19.6 – 23.7% per year; Estes 1990). Based on these growth rates, it is increasingly likely that the San Nicolas Island translocation effort will ultimately have been successful in establishing a population of the southern sea otter.

As an additional but unrealized indicator of potential reintroduction success, it is notable that an indirect consequence of the releases to San Nicolas Island was the dispersal of several individuals to another of the Channel Islands, San Miguel. At least 10 sea otters translocated to San Nicolas are known to have dispersed to San Miguel; 6 of these sea otters were females, and several of them were known to have produced pups. Thus, the translocation to San Nicolas Island might have successfully produced not one but two additional sea otter populations, had San Miguel Island not been within the management zone of PL 99-625, which required all of the sea otters at San Miguel Island to be removed. Fifteen sea otters were eventually removed from San Miguel Island under PL 99-625 (Hatfield 2005). More recently, the reintroduced population at San Nicolas Island has been identified as the likely source of several sea otters documented in Baja California, Mexico (Schramm et al. 2014).

2.4.1.3. Releases of surrogate-reared pups at Elkhorn Slough, California 2002–2015

California has been the site of the most novel reintroduction attempt thus far: using orphaned southern sea otter pups who are surrogate-reared (raised by non-releasable female sea otters) and then released as juveniles into the wild. As discussed in section 2.1.3, sea otter mothers may abandon their pups due to resource limitations or become separated for other reasons. As a consequence, sea otter pups strand on a relatively regular basis. Because a pup is entirely dependent on its mother for the first several months of life, stranded pups have no chance of survival if left in the wild. In most cases, barring injury or other issues, these pups are merely malnourished and can be readily restored to good physical condition with proper care. The Monterey Bay Aquarium is an authorized rehabilitation facility for sea otters in California and is the recipient of stranded sea otter pups needing care, although their capacity to do so is limited.

From 2002 through 2015, 37 rehabilitated southern sea otter pups that had been raised at the Monterey Bay Aquarium were released into Elkhorn Slough, an estuary off of Monterey Bay, and closely monitored as part of an experimental release program designed to assess the retention, reproduction, and survivorship of the animals (Mayer et al. 2019, Becker et al. 2020). Releasing captive-reared animals for reintroduction purposes is generally discouraged because the animals tend to fare poorly in the wild (due, for example, to the lack of opportunity to develop effective foraging or predator avoidance skills) (e.g., Miller et al. 1999). In this case, however, the pups were purposely reared with non-releasable female sea otters as surrogate mothers to ensure they were properly socialized and learned essential survival skills, such as tool use; care was also taken to ensure they did not become habituated to humans (Mayer et al. 2019, and supplementary materials). Pups were housed with other juveniles on occasion, when possible, for additional socialization.

The choice of Elkhorn Slough as the release site differs from other earlier sea otter reintroductions in that it is a sheltered, soft-sediment estuary with intermittent eelgrass (*Zostera marina*) beds as opposed to a rocky substrate nearshore coastal system characterized by kelp forest. At the time releases were started, Elkhorn Slough was occupied by wild otters, but these were mostly non-territorial males, and numbers had fluctuated at a relatively low level since sea otters had initially reappeared in the estuary in the 1980s. Thus, there was not a large, well-established population at Elkhorn Slough when the first releases of surrogate-reared pups began in 2002, as the first pup born in the estuary was not documented until 2000 (Mayer et al. 2019, p. 537, citing to T.R. Kiekhefer et al., unpubl. data). This pup was, incidentally, born to a sea otter that had originally stranded as a pup and been reared at Monterey Bay Aquarium before implementation of the surrogacy study (Nicholson et al. 2007). Nonetheless, there were already other sea otters in the area when releases were initiated.

Individuals were released singly at 0.5 to 1.5 years of age and closely monitored for a 2-week "soft release" period, during which they were recaptured if necessary (e.g., if they showed signs of physical deterioration or stress), restored to good condition, and re-released. Dispersal was fairly likely to occur during the initial 2–3 weeks following release, but individuals that followed the release-dispersal-recapture trajectory were less likely to disperse on subsequent releases; this method thus increased the probability of retention/establishment near the release site (Becker et al. 2020). From one to four releases occurred annually between 2002 and 2015, and in most cases pups required at least one or in some cases several recaptures during the soft release period (Mayer et al. 2019). All pups received a surgically implanted radio transmitter for detection by telemetry as well as flipper tags for visual monitoring; study animals were monitored on a regular basis (1-5 times per week) from release until death, disappearance, or until the end of the study (Mayer et al. 2019).

Releasing a juvenile, surrogate-reared southern sea otter at Elkhorn Slough, California. Photograph ©Monterey Bay Aquarium, used with permission.

A total of 37 surrogate-reared pups, 20 males and 17 females, were successfully released and monitored over the course of the study, from 2002 to 2016. Observed retention rates supported the hypothesis that young animals without an established home range would be more likely to remain at a release site: 80% of the males and 88% of the females remained within Elkhorn Slough throughout the duration of the study (Mayer et al. 2019, Figure 3).[13] The study was also successful in demonstrating that survivorship of surrogate-reared pups was indistinguishable from that of wild sea otters, and reproductive rates of females likewise overlapped entirely with those of wild sea otters on the outer coast as well as those within Elkhorn Slough (Mayer et al. 2019, Table 2). Surrogate-reared sea otters and their progeny accounted for 55% of observed population growth at Elkhorn Slough over the study period and may have served as the catalyst for the transition from a population dominated by non-territorial males to an established mixed-sex reproductive population (Mayer et al. 2019). Because of the release of individuals before the surrogacy study began (Nicholson et al. 2007), reintroductions may have accounted for an even greater percent of observed population growth. As an indirect benefit of the increased number of sea otters in Elkhorn Slough and their effect on the community through trophic cascades, increased eelgrass cover and improved ecosystem health were documented during this time period as well (Hughes et al. 2013, Mayer et al. 2019).

The successful establishment of a reproducing sea otter population at Elkhorn Slough through the experimental releases of surrogate-reared pups shows that this method may offer a viable and novel alternative to the traditional capture and relocation approach to achieve reintroductions. However, there are some important differences between this and other efforts that must be taken into consideration. For one, in this case pups were released into an area already inhabited by sea otters; how well young individuals might do if released into a novel, unoccupied habitat is unknown. Second, these releases took place with an estuary system. This environment likely provided several advantages, including shelter, abundant prey, and protection from predators such as sharks; it also provided accessibility for shore and boat-based monitoring and recapture, raising the question of whether this release strategy might be similarly successful outside of an estuarine system.[14] And finally, the number

[13] Notably, environmental factors (both physical and social) have recently been found to influence dispersal behavior of newly released sea otters (Becker et al. 2020).

[14] From 2016–2021, Monterey Bay Aquarium has conducted several releases of surrogate-reared sea otters in the open-coast environment along the Monterey peninsula, as well as in a second estuary, Morro Bay, California. Release methods followed soft release strategy in Elkhorn Slough (with recaptures of individuals as needed). These releases have demonstrated that the soft release strategy may also be successfully applied in open-coast habitats and other estuaries, although dispersal rates and mortality due to white shark predation were somewhat higher in open-coast releases than in either Elkhorn Slough or Morro Bay (MBA unpublished data). These 2016–2021 releases also tested logistics and efficacy of simultaneous releases of multiple (2–3) surrogate-reared pups.

of surrogate-reared pups that could be available to implement such releases is extremely limited at present due to the availability of facilities with the capacity, female sea otters to act as surrogates, and necessary approvals to support surrogate-rearing. The Monterey Bay Aquarium has historically housed 2–5 resident female sea otters, previously deemed non-releasable by the Service, who potentially serve as surrogate mothers. Authorization by the Service for two additional facilities to begin using surrogate-rearing methods in coordination with the Monterey Bay Aquarium is currently pending. The number of available surrogate sea otter mothers could increase to 12 animals when these facilities are approved. Once this bottleneck is sufficiently reduced, the potential establishment of additional sea otter populations through the introduction of surrogate-reared pups appears to hold great promise, as this strategy has resulted in lower rates of post-release dispersal or mortality than previous efforts to reintroduce or translocate sea otters. The benefits of releasing surrogate-reared sea otters into unoccupied areas of the historical range accrue both to the individuals being released (they avoid the strong intra-specific competition for prey resources in the range core) and to the population as a whole (through expansion of the range).

2.4.2. Growth rates of reintroduced populations

For all translocated populations of sea otters for which post-release monitoring data are available, there has been a consistent pattern of significant initial losses of individuals soon after release, as exemplified by the loss of 90% of the individuals released at San Nicolas Island. In cases where some level of documentation of animal movements has been possible, dispersal of sea otters back to their home range appears to account for a significant percentage of these losses. Although not possible to definitively demonstrate, it is likely that many, if not most, of the animals that disappeared and were not subsequently observed again died. In most cases, translocated populations have stabilized at about 10-20% of the numbers of animals originally released for some period of time (Bodkin 2015) before commencing a period of relatively rapid growth at a rate of between 17 to 20% a year (Estes 1990, Bodkin 2015). In general, this period of high population growth can continue for several decades before dropping again and leveling off at about 7% or so (Bodkin 2015), although the rate of growth varies at small spatial scales (Tinker 2015). Tinker et al. (2019) found a significant correlation between duration of occupation and population growth rate in southeast Alaska, with long-occupied regions leveling off in growth as the population approaches carrying capacity, but recently colonized regions continuing to demonstrate rapid exponential growth. Eisaguirre et al. (2021) used a different analytical approach to analyze the same data for southeast Alaska, finding a similar pattern of local equilibrium in long-occupied areas and extremely high growth rates in newly occupied habitats, on the order of 29%. They also concluded that the high growth rates seen for southeast Alaska at the regional scale are the result of a multi-site reintroduction (seven different sites) in an area of highly complex habitats.

Growth rates for the remnant population of southern sea otters in California have been very different. Growth in this population has averaged roughly 5 to 6% per year (Estes 1990, USFWS 2015; described as "anemic" by Davis et al. (2019)). Although initially it was thought that perhaps differences in birth or mortality rates might account for the slow growth observed in the southern sea otter, recent studies have demonstrated similar rates of age- and sex-specific rates of survival and reproduction when compared to northern sea otters (Tinker et al. 2019*b*), and that as with southeast Alaska, population growth rates and equilibrium densities vary at smaller scales. In the central part of the range, it is now believed that sea otters are at or very near the carrying capacity of the environment, which would explain the lack of growth in those areas (Tinker et al. 2019*b*), while growth rates at the expanding northern and southern fronts of the population (prior to an increase in shark-bite mortality in the early 2000s) were approximately 18%, only slightly lower than southeast Alaska (Tinker et al. 2021).

Perhaps of greatest import for consideration in this Assessment, it has recently been demonstrated that habitat configuration has a significant influence on the growth rate of sea otter populations, with highly complex habitats demonstrating greater opportunities for range expansion and rapid population growth. This factor, combined with the spatial structuring of sea otter populations due to small home ranges and high site fidelity of females, explains much of the differentiation in growth rates that has been observed between sea otter populations (Tinker 2015, USFWS 2015, Davis et al. 2019, Eisaguirre et al. 2021). Habitats with highly convoluted coastlines and shallow waters that provide ample foraging opportunities that extend a great distance in every direction—such as the islands, bays, and inlets of southeast Alaska; and Washington, which is characterized by numerous emergent offshore rocks (in the north) and a broad, shallow sandy shelf (in the south)—provide sea otters with the option of successful dispersal and abundant resources in nearly any direction and hence high levels of population growth. Areas with relatively simple habitat configurations, by contrast—such as the narrow, linear strip of coastline in California that is bounded by the offshore continental shelf—restricts range expansion to just north or south, such that populations quickly become resource limited and growth is constrained as a consequence (Tinker 2015, USFWS 2015, Davis et al. 2019) (see also Figure 5.1 and associated discussion in section 5.1.5.2). This principle will have a significant influence on considerations of future potential reintroduction sites, as it indicates that populations reintroduced to the northern California or Oregon outer coast (with relatively one-dimensional nearshore habitats similar to the central California coast) are more likely to exhibit relatively slow population growth, on the order of that observed in California, as opposed to the more rapid rates of population growth and wide range expansion demonstrated by sea otters in the highly complex habitats of southeast Alaska or British Columbia.

We summarize the key lessons learned from past reintroductions in Box 2.1.

Female southern sea otter periscoping while foraging in Morro Bay, California. Photo taken from shore with a 400mm zoom lens and cropped; Lilian Carswell, USFWS.

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.

2.4.3. Current status of populations on the Pacific Coast of the contiguous U.S.

Although all of the past translocations have experienced high initial losses and population declines in the establishment phase, 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 (Bodkin 2015). These reintroductions are additionally credited with enhancing levels of genetic diversity in populations that had been diminished by isolation and founder effects after the fur trade (Davis et al. 2019 and references therein).

Today, sea otter populations remain absent from their historical range from approximately Point Grenville, Washington, south to Pigeon Point, California, a distance of more 1,500 km (~ 900 mi). They also remain absent from approximately Santa Barbara, California, southward, except for the relatively small but growing reintroduced population at San Nicolas Island in the Channel Islands of the Southern California Bight.

2.4.3.1. Washington

Although no historical estimates of abundance are available, prior to their extirpation in Washington in 1910, concentrations of otters were reported from the mouth of the Columbia River northward along the coast of Washington (Scheffer 1940). The current population of northern sea otters in Washington is descended from 59 animals translocated from Amchitka Island, Alaska and released at Point Grenville (29 otters in 1969) and LaPush (30 otters in 1970), Washington, just over 50 years ago. After overcoming an establishment phase with significant initial losses, reduced to perhaps as few as 12 otters in 1978 (Jameson et al. 1982), this population began to increase at relatively high rates. From 1977 to 1989, the population increased at an annual rate of 20%, near the maximum theoretical rate of increase for sea otters (Estes 1990, USFWS 2018). Between 1989 and 2016, however, the annual rate of increase decreased and has remained at about 9% on a rangewide scale (U.S. Fish and Wildlife Service 2018). Growth rates are differential in the northern and southern portions of the range, however, with the population of sea otters north of LaPush appear to be approaching equilibrium density and growing at a slower pace, while south of LaPush the population is continuing to show rates of growth near the theorical maximum (~22% per year; USFWS 2018).

Range expansion of sea otters in Washington since the original reintroductions has been primarily to the north and east; the current distribution extends from roughly Point Grenville (one of the original reintroduction sites) north along the coast of the Olympic Peninsula to Pillar Point in the Strait of Juan de Fuca (Figure 2.3). The most recent count, completed in 2019, recorded a total of 2,785 otters, which is considered a minimum estimate (Jeffries et al. 2019). Individuals are reported on occasion dispersing southward to the Oregon coast, as well as into the San Juan Islands and southern Puget Sound (Lance et al. 2004).

In Washington, sea otters were State listed as endangered in 1981, due to their small population size, restricted distribution, and vulnerability to extinction from catastrophic threats, particularly oil spills. Washington downlisted the sea otter to threatened status in 2019 when the population exceeded the growth criteria set in the State's recovery plan (set as a 3-year running average of 1,640 sea otters; Lance et al. 2004), citing the "steady and substantial increase in numbers and evidence of genetic exchange with the British Columbia sea otter population" (Sato 2018).

Figure 2.5. Current range of northern sea otter in Washington, from individuals reintroduced in 1969 and 1970 from Amchitka Island, Alaska.

2.4.3.2. Oregon

Oregon is the only State where sea otters once lived that still has no sea otter population; the last known resident sea otter on the Oregon coast was killed in 1906 (Kenyon 1969). Occasionally single sea otters show up on the coast of Oregon. Since 2007, 18 sea otters have stranded and 32 individual live animals have been observed; most of these are likely young male northern sea otters dispersing from the Washington population (Rice 2021). Two of these stranded sea otters (one found in Newport in 2011, and the other found in Seaside in 2013) have been genotyped and found to be northern sea otters (Larson 2021).

There is no historical estimate for the number of sea otters that may have once inhabited Oregon's nearshore environment. Based on the availability of suitable habitat, which is highly discontinuous and makes up only about one-third of the Oregon coast (Kone et al. 2021), they were almost certainly never continuously distributed along the coastline.

Prior to the fur trade, the Oregon coast appears to have been a transition zone between the southern and northern sea otter subspecies. In *The Mammals and Life Zones of Oregon*, Bailey (1936, p. 303) stated that all sea otters from California, Oregon, and Washington "can be safely referred to" as members of *Enhydra lutris nereis*, but conceded sufficient specimens were not available to determine the exact area of intergradation with the northern sea otter subspecies. More recently both morphometric and genetic evidence from a combination of museum specimens and materials collected from shell middens have added support for a latitudinal cline and narrowed the scope of the transition zone (Lyman 1988, Wilson et al. 1991, Valentine et al. 2008, Wellman et al. 2020*a*). Although there is no bright line between the two subspecies, the work of Valentine et al. (2008) found that specimens from the central Oregon coast just south of Newport were most similar to the southern sea otter, whereas those tested by Wellman et al. (2020) from Seaside to the north clustered with the northern sea otter (Figure 2.6). Although the southern sea otter has consistently been identified as genetically distinct from all other subspecies, there is evidence for historical gene flow with the northern sea otter (Larson et al. 2012, 2021, Wellman et al. 2020*a*). See also section 4.1.3.1.

2.4.3.3. California

Populations of the southern sea otter (*E. l. nereis*) are currently found only in California, where it has been listed as a threatened subspecies under the Endangered Species Act since 1977 (42 FR 2965; January 14, 1977). Southern sea otters occupy the nearshore waters along the mainland coastline of California from Pigeon Point in San Mateo County to Gaviota State Beach in Santa Barbara County (Figure 2.6). A small subpopulation of southern sea otters also exists at San Nicolas Island, Ventura County, as a result of the translocation efforts that took place between 1987 and 1990 (see section 2.4.1.2). Individual southern sea otters are occasionally found well beyond the limits of the established current range and have been documented as far south as Baja California, Mexico (Schramm et al. 2014). Two sea otters found stranded in Humboldt County in northern California have been genotyped. One of these, found at Gold Bluffs Beach in 2012, was determined to be a southern sea otter, and the other, found in 2014, was determined to be a northern sea otter (Larson 2021). The 2015 5-year review for the southern sea otter provides a comprehensive overview of the status of the species (USFWS 2015).

Figure 2.6. Current and historical ranges of the two sea otter subspecies within the geographic focus area of this report. The southern sea otter historically occurred from Baja California, Mexico, northward into Oregon, but is currently restricted to central California and San Nicolas Island. The northern sea otter historically occurred from the Aleutian Islands into northern Oregon, but its current distribution in Washington is restricted to the northern coast of the State. Morphological and genetic evidence from pre-fur trade specimens indicate that Oregon was a transition zone between the two subspecies (see section 2.4.3.2).

Historically, the southern sea otter ranged from present-day Punta Abreojos, Baja California, Mexico, to at least as far north as Seal Rock, just south of Newport on the central Oregon coast (Valentine et al. 2008). As noted in section 2.4.3.2, genetic evidence suggests the historical existence of a transitional zone or latitudinal cline between southern sea otters and northern sea otters in Oregon, with gene flow occurring both to the north and south (Larson et al. 2012, 2021, Wellman et al. 2020*a*).

All southern sea otters are founded from a small population that escaped the fur trade on the central California coast off Monterey County (Riedman and Estes 1990). Since receiving protection under the International Fur Seal Treaty in 1911, sea otters in California have expanded their range gradually but have exhibited significantly slower rates of population growth than the populations reintroduced in other portions of the sea otter's range to the north (see section 2.4.2). In more than 100 years since the rediscovery of the southern sea otter, the population is estimated to have reclaimed just 13 percent of its historical range (USFWS 2015). No net range expansion has occurred in approximately 20 years.

Populations in the central portion of the mainland range (Seaside to Cayucos) were estimated to be at or near carrying capacity for many years (USFWS 2015, p. 10 and references therein). In recent years, an increase in sea urchins and mussels due to sea star wasting disease is believed to have been responsible for modest population growth in the center of the range (2.4% for the period 2015-2019; Hatfield et al. 2019, Smith et al. 2021). However, the effects of that prey subsidy now appear to be diminishing (Hatfield et al. 2019).

The situation is very different at the northern and southern peripheries of the range, where regional trends demonstrated negative growth over the years 2015-2019 (–8.7% per year in the northern portion of the range, Seaside to Pigeon Point; –1.6% per year in the southern portion of the range, Cayucos to Gaviota State Park) (Hatfield et al. 2019). Shark-bite mortality appears to be the main factor preventing range expansion at the northern and southern peripheries of the population (USFWS 2015, Hatfield et al. 2019, Tinker et al. 2021*a*). Based on 3-year running averages of the spring counts, the rangewide (combined mainland and San Nicolas Island) population growth trend over the 5-year period from 2015 to 2019 (inclusive) is flat at 0.12% per year (Hatfield et al. 2019; Figure 2, p. 6), indicating the population rangewide is not increasing. At present, the southern sea otter appears to be limited in both the ability to increase its population or expand the boundaries of its present range (see USFWS 2015 and USFWS 2021 for a comprehensive review).

Since termination of the experimental status of the San Nicolas Island sea otter population in 2012, the island and mainland counts have been combined to arrive at an annual rangewide index of abundance for the southern sea otter, which consists of the 3-year running average of the combined spring counts. In 2019, the rangewide index of abundance was 2,962 sea otters in California (Hatfield et al. 2019).

2.4.3.3.1. Status under the ESA

A Species Status Assessment (SSA) for the southern sea otter, which will inform a new 5-year review, is underway (see additional explanation below). In our last 5-year review of the southern sea otter (USFWS 2015), we concluded that a change in its "threatened" status under the ESA was not warranted for the following reasons: the southern sea otter remained restricted to a small fraction of its historical range; it remained possible that a large oil spill could affect a large proportion of the population; high levels of shark-bite mortality were affecting significant portions of the mainland range and preventing range expansion; food limitation, disease/biotoxin intoxication, mortality in fishing gear, and recreation-related harassment had emerged since listing as factors affecting or potentially affecting the population;

limited genetic diversity indicated the subspecies may not have the capacity to adapt to novel pathogens or new risks associated with climate change; and the population index remained below the threshold for delisting consideration (3,090) as identified in the recovery plan (USFWS 2003). Of these factors, we identified the main demographic drivers of trends along the mainland range, where the vast majority of southern sea otters occur, as food limitation in areas at/near carrying capacity (most of the central portion of the range) and shark-bite mortality, which has depleted the population in the northern and southern peripheries of the range and prevented further range expansion (USFWS 2015).

In 2018, the southern sea otter population index exceeded 3,090 for the third consecutive year, meeting the threshold for delisting consideration (Hatfield et al. 2018). However, that same year, a study found that assumptions made in the recovery plan regarding the relationship between effective population size and actual population size, which serve as the basis for the uplisting and delisting criteria, are not accurate (Gagne et al. 2018). Gagne at al. (2018) recommended an alternative approach to evaluating the status of the species, such as conducting population viability analyses that can incorporate genetic and demographic factors to determine extinction risks. In 2019, the population index declined to 2,962 (Hatfield et al. 2019). Also in 2019, we announced our initiation of an SSA (84 FR 36116; July 26, 2019). The SSA will examine in detail the southern sea otter's needs (ecology), status under current conditions, and status under future conditions in terms of resiliency, redundancy, and representation. The SSA is in progress. In 2021, the Service received a November 2020 petition from the Pacific Legal Foundation, counsel for California Sea Urchin Commission and Commercial Fishermen of Santa Barbara, requesting that the southern sea otter be delisted. Our findings on that petition are pending.

2.4.3.3.2. Status under the MMPA

The MMPA defines a "stock" as a group of marine mammals, of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature. All sea otters of the subspecies *Enhydra lutris nereis* are considered to belong to a single stock because of their recent descent from a single remnant population (USFWS 2021). As a consequence of its threatened status, the southern sea otter stock is considered to be "strategic" and "depleted" under the MMPA. "Depleted" means the stock is below its "optimum sustainable population" (OSP) level, or "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element" 16 U.S.C. § 1362(9). If southern sea otters were delisted under the ESA, a formal determination of the status of the stock in relation to its OSP would be made, and if it were found to be below its OSP, it would be designated as "depleted."

The status of the southern sea otter stock in relation to its OSP has not been formally determined, but population counts are far below the candidate value proposed for California–10,236–which represents 59.4% of the projected carrying capacity estimate of 17,226 sea otters (Tinker et al. 2021*c*). This candidate value is for California only, as it does not account for habitat outside of California but within the historical range of the subspecies. Thus OSP for the stock in its entirety would be considerably higher. Because much of the occupied range is at or near its carrying capacity, and the range peripheries are affected by high levels of shark-bite mortality, range expansion into areas that will allow for further population growth is a crucial component of attaining OSP.

3. GOALS AND OBJECTIVES OF REINTRODUCTION

3.1. Goals and objectives

Any conservation reintroduction proposal should clearly articulate its goals and objectives. IUCN guidelines emphasize this point and provide useful definitions of these terms (IUCN/SSC 2013, p. 5):

> A Goal is a statement of the intended result of the conservation translocation. It should articulate the intended conservation benefit, and will often be expressed in terms of the desired size and number of populations that will achieve the required conservation benefit either locally or globally, all within an overall time frame.
>
> Objectives detail how the goal(s) will be realized; they should be clear and specific and ensure they address all identified or presumed current threats to the species.

Because this Assessment is an evaluation of the feasibility of reintroduction, and not a reintroduction proposal, we do not attempt at this stage to prescribe a goal in terms of the specific number and size of populations that would achieve a desired conservation benefit or to identify clear objectives. However, at the end of this chapter we identify potential options that could be combined into a proposal, should reintroduction consideration proceed, that would allow a more concrete set of goals and objectives to be developed. It *is* possible at this stage to articulate broadly the desired conservation benefit of reintroducing sea otters to the Pacific Coast of the contiguous U.S. Sea otter reintroduction would advance two interrelated and overarching conservation goals:

1. Restoration of the species, *Enhydra lutris*, within important gaps in its historical range, including improving the status of the federally threatened subspecies, *E. l. nereis* or southern sea otter, and
2. Restoration of ecosystem function (improving ecosystem resilience, including resilience to the effects of climate change; enhancing biodiversity; and increasing carbon sequestration).

These conservation goals are reflected in the Congressional language that directed the Service to conduct this Assessment, and they also align with the Service's mandates under the Endangered Species Act of 1973, as amended (ESA), and Marine Mammal Protection Act of 1972, as amended (MMPA). The ESA requires that we "protect and recover imperiled species and the ecosystems upon which they depend." The MMPA requires that we "prevent marine mammal species and population stocks from diminishing, as a result of human activities, beyond the point at which they cease to be significant functioning elements of the ecosystems of which they are a part."

For reasons discussed in section 1.2.1, we are focusing this Assessment on the gap in range between the population of northern sea otters in Washington and the population of southern sea otters in California, specifically the area from the Washington/Oregon border to the northern terminus of the southern sea otter range, which is located at Pigeon Point (near Half Moon Bay) in California. Although we are not focusing on unoccupied historical habitat to the south of the currently occupied range (i.e., south of Gaviota State Beach, Santa Barbara County, California), we acknowledge that these 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. Much of what we outline below regarding the conservation benefit of reintroducing sea otters to Oregon/northern California would also apply to southern California and Baja California.

3.1.1. Restoration of the species, *Enhydra lutris*, within important gaps in its historical range, including improving the status of the federally threatened subspecies, *E. l. nereis* or southern sea otter

3.1.1.1. Population connectivity

Restoration of sea otters to one or more locations within their unoccupied historical habitat from Oregon to northern California would begin to populate the largest remaining gap (1500 km [930 mi]; Davis et al. 2019) in the global sea otter range. Importantly, it would also begin to restore population connectivity and gene flow between the northern sea otter subspecies in Washington and the southern sea otter subspecies in central California (Larson et al. 2021). Unlike the reintroduced population in Washington, which has levels of genetic diversity comparable to those in most remnant populations (despite its small founding population size), the remnant southern sea otter population is the most genetically distinct and isolated of any extant sea otter population, and it also has the lowest genetic diversity of any population measured except the population at Bering Island, Russia (Larson et al. 2021). Although there is currently no evidence of inbreeding depression, genetic diversity is crucial to allow a species to adapt to changing environmental conditions. Connectivity between northern sea otters and southern sea otters would in turn help to restore the hybridization zone or latitudinal cline that existed prior to fur-trade-era extirpations (Lyman 1988, Wilson et al. 1991, Valentine et al. 2008, Larson et al. 2012, Wellman 2018, Wellman et al. 2020*b*).

3.1.1.2. Contribution to southern sea otter recovery

Sea otter range expansion is inherently slow along a linear coastline with a narrow, steep shelf, which largely explains the chronically slow recovery of the southern sea otter relative to northern sea otter populations (see section 2.4.2). The habitat of northern sea otters in southeast Alaska, British Columbia, and Washington is characterized predominantly either by convoluted shorelines or by a broad, shallow shelf (Tinker 2015, Davis et al. 2019). During the past 20 years, the problem of chronically slow range expansion has been compounded by increasing shark-bite mortality in the northern and southern peripheries of the southern sea otter's range, which appears to be preventing range expansion (Tinker et al. 2016, Hatfield et al. 2019). As noted in section 2.4.3.3, net range expansion of the southern sea otter has not occurred for approximately 20 years, and OSP goals for the stock cannot be reached without range expansion.

The specific effects that reintroduction of sea otters to Oregon/northern California would have on southern sea otter recovery under the ESA and MMPA depend in part on the source of animals used for reintroduction, in part on the number and location of reintroduction sites, and in part on the timescale used to assess progress. We address possible configurations of reintroduction effort in section 3.2. In general, however, so long as southern sea otters were the source population for one or more reintroduction sites that became successfully established, and so long as these sites were close enough to each other—and to a new or existing northern sea otter population—that animals (likely adult males and/or subadults) making occasional long-distance movements could travel between them, the status of the southern sea otter would be expected to improve substantially. This improvement would occur through (1) increases in population size and range in areas with a lower risk of shark-bite mortality than those areas that currently impede expansion of the central California range and (2) increased genetic diversity resulting from connectivity with northern sea otters. Increased population size and range would increase the likelihood that the southern sea otter would survive a catastrophic event, such as an oil spill, by ensuring that some subpopulations would be located in unaffected areas. Increased genetic diversity would help the subspecies adapt to changing environmental conditions over time, most crucially those changes associated with climate change.

3.1.2. Restoration of ecosystem function (improving ecosystem resilience, including resilience to the effects of climate change; enhancing biodiversity; and increasing carbon sequestration)

We describe the kinds of ecological consequences expected from sea otter reintroduction in greater detail, and with supporting references, in section 4.1.4. Here we provide only a brief summary of the ecosystem effects that would result from sea otter reintroduction. As a keystone species, sea otters have disproportionately large effects on ecosystem health and function relative to their abundance (see section 2.1.4). These effects are a result of sea otters' high metabolism, which requires that they consume approximately 20–30% of their body mass in benthic invertebrates daily (see section 2.1.2).

3.1.2.1. Ecosystem resilience, including resilience to the effects of climate change

Where sea otters occur at ecologically relevant densities, they tend to maintain rocky, nearshore ecosystems in a forested, instead of deforested, state. By consuming large numbers of sea urchins, which otherwise would overgraze kelp forests, sea otters help to maintain kelp canopy and understory and reduce the persistence of urchin barrens (see section 3.1.2.2; Figure 4.6). As such, they provide kelp forests with increased resilience, which may be especially important when these kelp forests are affected by multiple stressors, such as marine heat waves and losses of other important sea urchin predators. Sea otters also enhance the resilience of seagrass, although this positive relationship may not exist in all locations, and mechanisms differ depending on the physical and biological components of ecosystems in different areas.

Effects of climate change include increased shoreline erosion and ocean acidification. Kelp and seagrass help to mitigate these effects. Sea level rise and high-intensity storms driven by climate change speed the process of coastline erosion. Kelp and seagrass dampen wave energy before it reaches the shore, reducing the pace of coastline erosion. Kelp and seagrass also locally ameliorate ocean acidification. Intensifying ocean acidification is driven by the dissolution of excess atmospheric carbon dioxide (CO_2) in ocean waters. It can be devastating to calcifying organisms, including commercially valued shellfish. Kelp and seagrass locally mitigate ocean acidification by taking in dissolved inorganic carbon through photosynthesis.

3.1.2.2. Biodiversity

Urchin barrens are characterized by crustose coralline algae, no physical structuring of the water column, and relatively few species. In contrast, kelp forests structure the water column, providing substrate, shelter, and food to hundreds of other species. Seagrass beds also provide shelter, food, and/or important nursery habitat for birds, fishes, and invertebrates, including for many species that spend the remainder of their lives offshore. The species that depend on kelp or seagrass habitats for all or a portion of their lives include many commercially valued finfish and shellfish species. The fish and invertebrate populations supported by kelp and seagrass provide food for other members of these ecosystems, including seabirds and marine mammals.

3.1.2.3. Carbon sequestration

Excess atmospheric CO_2 released by the burning of fossil fuels is the primary driver of global climate change. Kelp and seagrass absorb CO_2 from the atmosphere and convert it to organic carbon as part of their bodies. A substantial portion of this standing biomass (approximately 40%) is exported to the deep sea (in the case of kelp) or buried in sediments (in the case of seagrass), where it is removed from exchange with the atmosphere (sequestered). As such, kelp and seagrass are potentially strong sinks for atmospheric CO_2 (see section 4.1.4.5).

3.2. Reintroduction options for future consideration

Possible options for reintroduction include different combinations of source animals and reintroduction locations. Options for source animals include subspecies (northern sea otter, southern sea otter), type (wild, rehabilitated), population source if using wild animals (Alaska, Washington, California), and more detailed criteria that are not enumerated here, such as number, age, and sex. Options for reintroduction location include regions that are more northerly or southerly within Oregon and northern California and outer coast vs. estuary. We enumerate some of these options in Table 3-1, primarily to give a sense of what is not being considered in this assessment. For instance, we are not currently assessing the option of reintroducing northern sea otters to northern California, which would be outside of the historical range of that subspecies, nor are we currently considering reintroducing southern sea otters to southern California. We discuss biological and socioeconomic considerations with respect to source animals and reintroduction locations in sections 4 and 5 of this Assessment.

Table 3-1. Suggested reintroduction options for future consideration within the currently unoccupied Oregon/northern California range. Options are listed geographically, not in any order of preference, and may be mixed and matched. Note that determining optimal scenarios is beyond the scope of this Assessment, and not all options or combinations are likely to be equally feasible or desirable.

Reintroduction Location	Option	Source Animals
Northern OR	1	NSO (AK) wild
estuary or open coast	2	NSO (WA) wild
	3	SSO wild
	4	SSO rehab
Central/Southern OR	5	NSO (AK) wild
estuary or open coast	6	NSO (WA) wild
	7	SSO wild
	8	SSO rehab
Northern CA	9	SSO wild
estuary or open coast	10	SSO rehab
San Francisco Bay, CA	11	SSO wild
estuary	12	SSO rehab

NSO = northern sea otter subspecies
SSO = southern sea otter subspecies
AK = Alaska subpopulation of northern sea otter
WA = Washington population of northern sea otter
Rehab = surrogate-reared southern sea otter

4. FEASIBILITY ASSESSMENT

4.1. Biological feasibility

Sea otters historically occupied the entire coastline of Oregon and northern California, though densities likely varied considerably, as suggested by hunting records (Ogden 1941). Although sea otters have been absent essentially since the late 1800s, during which time human activities have radically transformed the terrestrial landscape and precluded the return of native species to many of these areas, the nearshore marine environment, albeit altered by human activity, is largely intact. Thus, it is conceivable that sea otters could reoccupy any portion of this coastline, although some areas will be better or worse from the perspective of biological feasibility depending on a spatial mosaic of resource availability and natural and anthropogenic risk factors. In the following sections, we discuss sea otters' habitat needs; what we know about the distribution of favorable habitat and prey in Oregon and northern California and how climate change might affect resources and hazards; potential sources of founding animals for a reintroduction; and the expected ecological consequences of reintroduction. The potential effects of sea otters on human activities are discussed in section 4.2.

4.1.1. Habitat needs

Sea otter densities vary with local habitat quality and resource availability, which are themselves the result of physical, biotic, and oceanographic factors (Tinker et al. 2021*c*). The most crucial resource for sea otters is adequate prey (Estes 1979), though other habitat features that provide shelter from rough seas or security from predators are also important. For example, kelp canopy cover and shallow, protected waters (such as estuaries) dampen wave action and also provide some safety from non-consumptive bites by white sharks, which are the most common primary cause of death of southern sea otters (Tinker et al. 2016, Nicholson et al. 2018, Hughes et al. 2019*a*, Moxley et al. 2019, Miller et al. 2020). An unknown factor is the broadnose sevengill shark (*Notorynchus cepedianus*), which is common in Oregon's estuaries (Williams et al. 2012) and may have an impact on sea otters, though no interactions have been documented. Infectious and non-infectious diseases—such as those caused by harmful algal blooms—also have the potential to affect sea otters, both in sites that may be proposed for reintroduction and in the existing sea otter range (see Chapter 10 of the EAFS for an in-depth discussion of disease risk in sea otters: https://www.elakhaalliance.org/feasibility-study/chapter-10-animal-health-and-welfare-considerations/). Hazards originating from human activities are unlikely to preclude sea otter recolonization of any area but may alter its desirability for a potential reintroduction. Human-caused hazards range from rare and catastrophic, such as large oil spills, to low-intensity but chronic, such as other kinds of pollution or disturbance. Bycatch of sea otters in fishing gear may also be a potential issue in some areas. Because these hazards can vary locally, an in-depth treatment is beyond the scope of this Assessment. However, disease risks and human-caused hazards would need to be evaluated alongside habitat suitability and prey availability for any candidate reintroduction sites that may ultimately be considered.

Because sea otters' prey consists almost exclusively of benthic invertebrates, they must dive to the bottom to obtain food, making water depth an important habitat constraint. Sea otters typically forage in water depths from the intertidal zone to 40-m deep, although deeper dives occur (Riedman and Estes 1990, Bodkin et al. 2004, Thometz et al. 2016*b*, Tinker et al. 2019*b*). Males are unconstrained by pup rearing and tend to dive deeper, on average, than females (Tinker et al. 2019*b*). Because of sex-, age-, and location-specific variation in dive depths (most dives occur in shallow waters, but deeper dives do occur, though less frequently), sea otter habitat has been variously characterized as extending to the 40-m, 60-m, or 100-m contour (Laidre et al. 2001, Bodkin et al. 2004, Tinker et al. 2019*b*, 2021*c*). The highest densities of sea otters occur at depths of 3–20 m (with peak abundance at 5 m; Tinker et al. 2021*c*).

Prey type and abundance vary with depth, substrate type, and the presence or absence of kelp (Miller et al. 2018, Tinker et al. 2021*c*). Because prey abundance can be logistically infeasible to determine, particularly over large areas at the relatively fine spatial resolution relevant to sea otters (tens of km), proxies for invertebrate prey productivity such as benthic habitat type and oceanographic productivity have been used, in concert with other physical variables, to estimate equilibrium sea otter densities (carrying capacities) for coastline segments. Tinker et al. (2021*c*) developed a model to predict local carrying capacities based on sea otter survey data from California using the following habitat variables, all of which were determined to be statistically significant: depth, benthic substrate type, presence of kelp canopy, net primary productivity, distance from shore (assessed independently of depth), and whether an area was within an estuary. Sea otter densities at carrying capacity ranged from 2.23 otters/km^2 (95% CrI=1.23–4.47) in sandy areas on the outer coast to 9.38 otters/km^2 (95% CrI=1.64–47.65) in estuaries. Equilibrium densities in rocky areas of the outer coast were higher than those in soft-sediment areas and varied with the proportion of rocky substrate; an increase from 0% to 50% in rocky substrate doubled the mean carrying capacity of an area (Tinker et al. 2021*c*). This model has also been applied to Oregon (Kone et al. 2021; see section 4.1.2.1).

4.1.2. Are suitable habitat and prey available?

Although, as noted above, there are various areas of habitat along the coastlines of Oregon and northern California that could potentially support sea otters, we assume that areas with higher estimated local carrying capacities, as determined based on habitat features by Tinker et al. (2021*c*) and Kone et al. (2021), would be preferred to areas with lower estimated carrying capacities for reintroduction consideration. These model results represent a highly credible and data-driven first pass at identifying potential high-quality habitat for sea otters. However, detailed ground-truthing of proposed reintroduction sites would be recommended before any reintroduction proceeded. Ground-truthing would involve collecting or assembling survey data on local prey availability and other natural and physical habitat features. Additionally, local natural hazards (e.g., sharks), human-caused hazards (potential human impacts on sea otters) (see section 5.2.1.1), and local socioeconomic effects (potential impacts by sea otters on human activities/values; see section 4.2) would need to be evaluated. Other considerations, such as furthering local ecosystem restoration goals, ensuring easier access for monitoring of released sea otters, or conducting a pilot study in a confined area could motivate the use of modified selection criteria (i.e., selection of one or more areas for reintroduction that were not among those having the highest local estimated carrying capacities) (see sections 6.3.1.2, 6.4.2). Finally, it should be acknowledged that sea otters are mobile animals, particularly when removed from an established home range; thus, as seen in previous reintroduction efforts, the sea otters themselves would likely be the ultimate indicators of where preferred habitat exists (Jameson et al. 1982, Hatfield 2005).

4.1.2.1. Oregon

The EAFS contains an in-depth discussion of available habitat and prey in Oregon. We do not duplicate that discussion here. Instead, we direct readers seeking additional detail to Chapter 6 of that document: https://www.elakhaalliance.org/feasibility-study/chapter-6-habitat-suitability/. Here we summarize what we consider to be the points most salient for our Assessment, namely the methods used to evaluate suitability of habitat and the conclusions drawn on the basis of that analysis.

Kone et al. (2021) applied the model developed in Tinker et al. (2021*b*) to Oregon, estimating expected local carrying capacities across the State and identifying core habitat areas where high sea otter densities would most likely occur (Figure 4-2). Additionally, Kone et al. (2021) investigated human activities in selected areas with high expected sea otter densities, which we address further in section 4.2. The above analyses, supplemented with additional detailed data on kelp, seagrass, and prey availability in specific locations, form the basis of the conclusions of Chapter 6 of the EAFS regarding outer coast and estuarine areas that appear to have the best potential to support high densities of sea otters. Along the outer coast, these are Depoe Bay/Yaquina Head in central Oregon and Blanco Reef, Orford Reef, and Redfish Rocks (all near Port Orford) and Simpson Reef (near Cape Arago) in southern Oregon. Among estuaries, the areas identified are Tillamook Bay in northern Oregon, Yaquina Bay in central Oregon, and Coos Bay in southern Oregon, with the latter two having the additional benefit of being relatively close to outer-coast reefs and kelp beds.

A user-friendly population modeling tool, described in Appendix A to the EAFS (Oregon Sea Otter Population Model, User Interface App ["ORSO" v 1.0]), has been developed based on Tinker et al. (2021) and Kone et al. (2021). Available online at https://nhydra.shinyapps.io/ORSO_app/, it can be used to model various reintroduction scenarios in different locations within Oregon. Importantly, this model incorporates age- and sex-specific movement probabilities, which are now understood to account for the greatly differing population growth rates in the recolonization of different areas depending on the shape of the coastline (Tinker 2015; see section 2.4.2). For instance, areas with complex, convoluted shorelines tend to have abundant shallow-water habitat in all directions within the travel range of sea otters; this is especially relevant in the case of adult females, who have the shortest travel range (along with subadult females) of all age- and sex-classes but also the greatest impact on intrinsic population growth (Ralls et al. 1996, Tinker et al. 2019*b*). These areas have much higher population growth rates when recolonized by sea otters than do areas with habitat available only in two directions, as is the case for those with narrow, linear coastlines (Tinker 2015). Thus, the population growth rates seen in southeast Alaska, which has a highly convoluted shoreline, are much higher than the population growth rates that have been seen, or would be expected, in areas with a relatively steep shelf and a narrow, linear coastline, like California and Oregon.

Using ORSO, authors of the EAFS modeled scenarios that would achieve an abundance of 200 animals (and a 90% probability of at least 50 animals) after 30 years (see Chapter 9, https://www.elakhaalliance.org/feasibility-study/chapter-9-implementation-and-logistical-considerations/). Numerous model scenarios could achieve this abundance, but one such scenario presented in the EAFS used two reintroduction sites: 50 animals released at an outer-coast site near Port Orford and 25 animals released into Coos Bay, with supplementary releases of 3 juveniles per year for 10 subsequent years. Notably, using multiple release sites helps to overcome the problem of slow population growth along a linear coastline and buffers against risk should a reintroduced population at one site fail to persist. We discuss the pros and cons of different potential release strategies further in section 4.1.3.

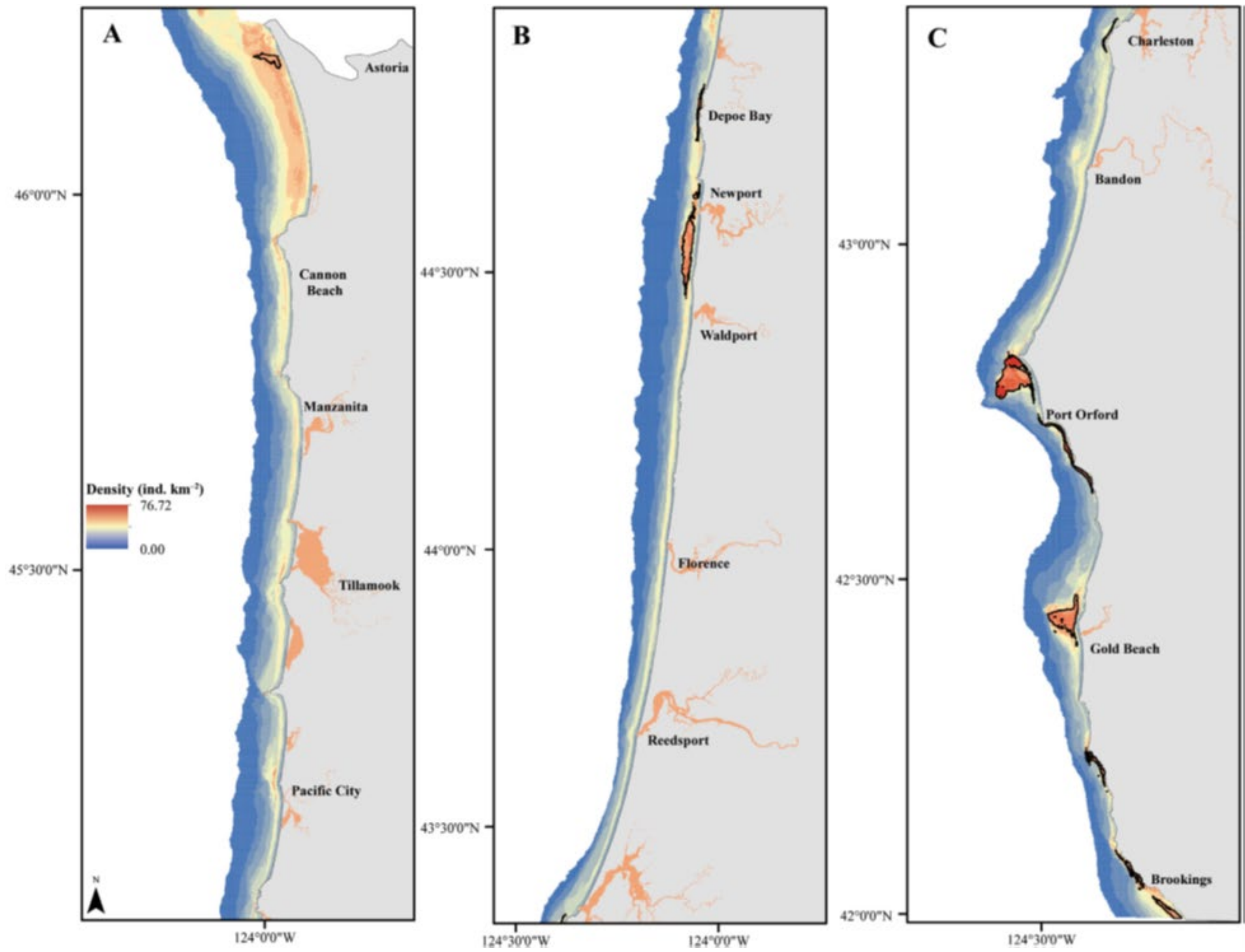


Figure 4.1. Predicted equilibrium densities of sea otters along the outer coast and in the estuaries of Oregon for the (A) north, (B) central, and (C) south regions. Warmer colors indicate habitats with greater potential for supporting sea otters. Areas outlined in black are "core" areas where high density potential habitats are concentrated. Note the authors caution a high degree of uncertainty with regard to estimates for estuaries in particular, due to a small sample size (n=2) for calibrating model variables. From Kone et al. (2021), originally published in Endangered Species Research 44:159-176.

4.1.2.2. California

Tinker et al. (2021b) predict area-specific carrying capacities throughout California based on fine-scale variation in habitat features (see Figures S4 A–K from Tinker et al. 2021b, available at https://wildlife.onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1002%2Fjwmg.21985&file=jwmg21985-sup-0004-Figure_S4.pdf). For convenience, we include here thumbnail versions of the first five of those figures (*Figure 4.2*), which represent the areas of northern California under consideration in this Assessment. In addition to presenting detailed data for coastline segments, Tinker et al. (2021b) also summarize five regional carrying capacities for California: North Coast, San Francisco Bay, Central Coast, South Coast, and Channel Islands (Figure 4.3). One notable finding is that because of its large area of contiguous shallow-water habitat and the high densities of sea otters that can be supported in estuaries, San Francisco Bay could theoretically support approximately as many sea otters as the entire North Coast or the (currently occupied) Central Coast, though with considerable uncertainty surrounding this estimate (Hughes et al. 2019a, Tinker et al. 2021c).[15]

An integrated population model (IPM) for the southern sea otter (Tinker et al. 2021*a*) brings together all available datasets, namely annual survey data; movement, survival, and reproductive rates from studies of individually marked animals; cause-of-death data from necropsies of stranded animals; and the area-specific carrying capacities from Tinker et al. (2021*c*). A user-friendly population modeling tool for California ("Sea Otter IPM" v. 2.0), similar to the ORSO, allows users to compare population-level effects of changes in mortality risk factors and to evaluate management scenarios, including the reintroduction of sea otters to areas of California outside their current range. However, unlike the ORSO, the Sea Otter IPM simulates effects of these scenarios on the southern sea otter population as a whole, including scenarios with simultaneous changes in environmental hazards (such as might be expected with climate change or rare but catastrophic oil spills) and reintroduction actions. An additional difference from the ORSO is that the Sea Otter IPM was designed primarily for simulating the reintroduction of rehabilitated surrogate-reared sea otters. Thus, the Sea Otter IPM does not account for the expected low retention probabilities associated with translocation of wild sea otters (though simulations can be performed based on the number of animals one expects to remain *after* initial dispersal has occurred). Consequently, the results of simulated reintroduction scenarios for Oregon and California should not be compared without keeping these differences in mind.

[15] Human-caused hazards may be an especially important consideration for the San Francisco Bay region relative to other areas of northern California because of the extremely high level of urbanization of the surrounding lands. These hazards include vessel traffic (from commercial shipping, high-speed ferries, and recreational vessels), large oil spills, contaminants (methylmercury and polychlorinated biphenyls), and interactions with commercial fishing (Rudebusch et al. 2020). Despite the presence of these hazards, a cumulative risk map (Figure 4.4) shows that large portions of San Francisco Bay have low (North Bay) or relatively low (South Bay) cumulative risk levels (Rudebusch et al. 2020).

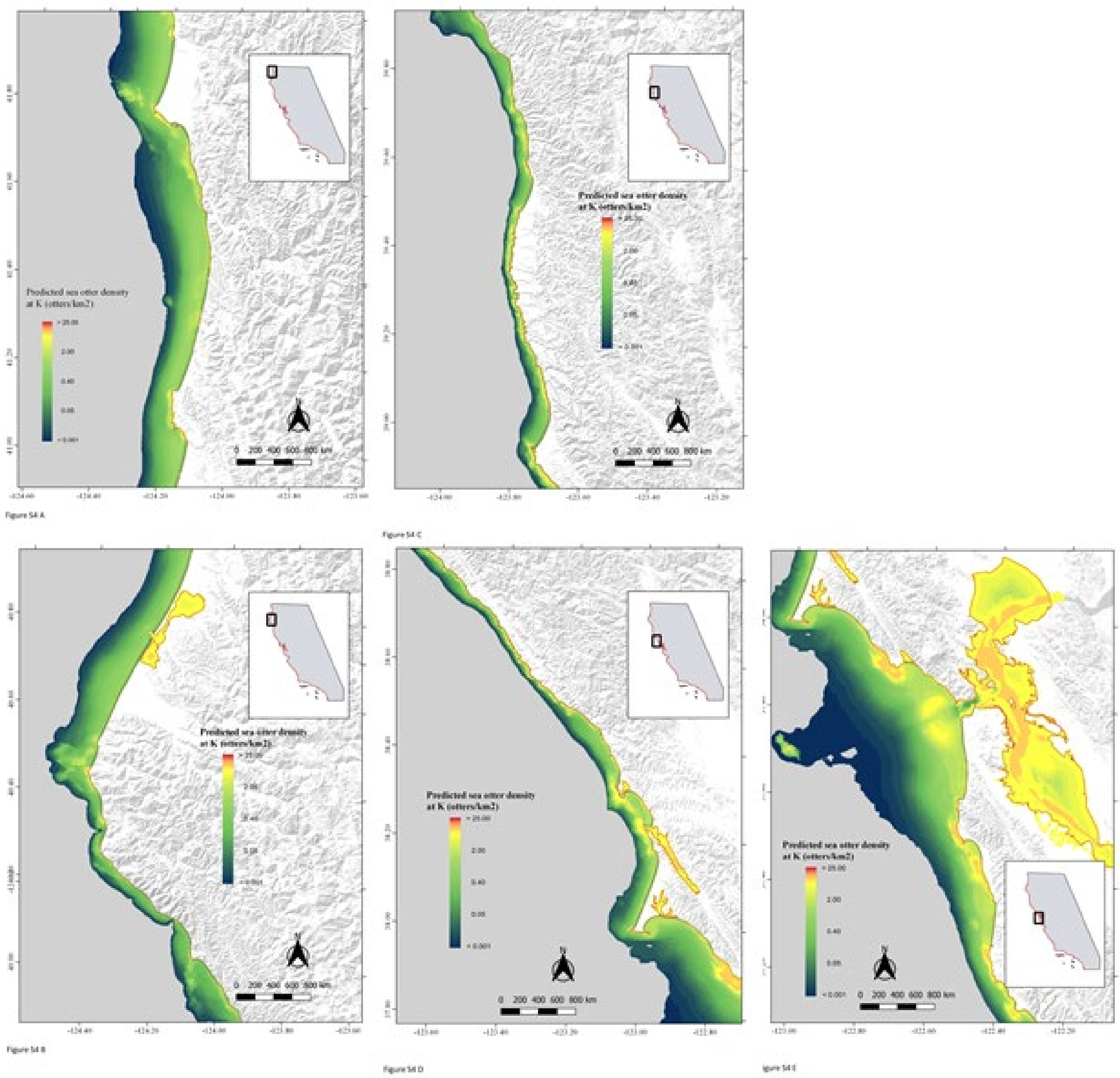


Figure 4.2. Predicted equilibrium densities of sea otters along the outer coast to the 60-m isobath and in the estuaries of northern California (including San Francisco Bay). An inset in each map indicates the area of California shown. Warmer colors indicate areas of higher predicted sea otter densities. From Tinker et al. (2021b), originally published in the Journal of Wildlife Management 85:303-323.

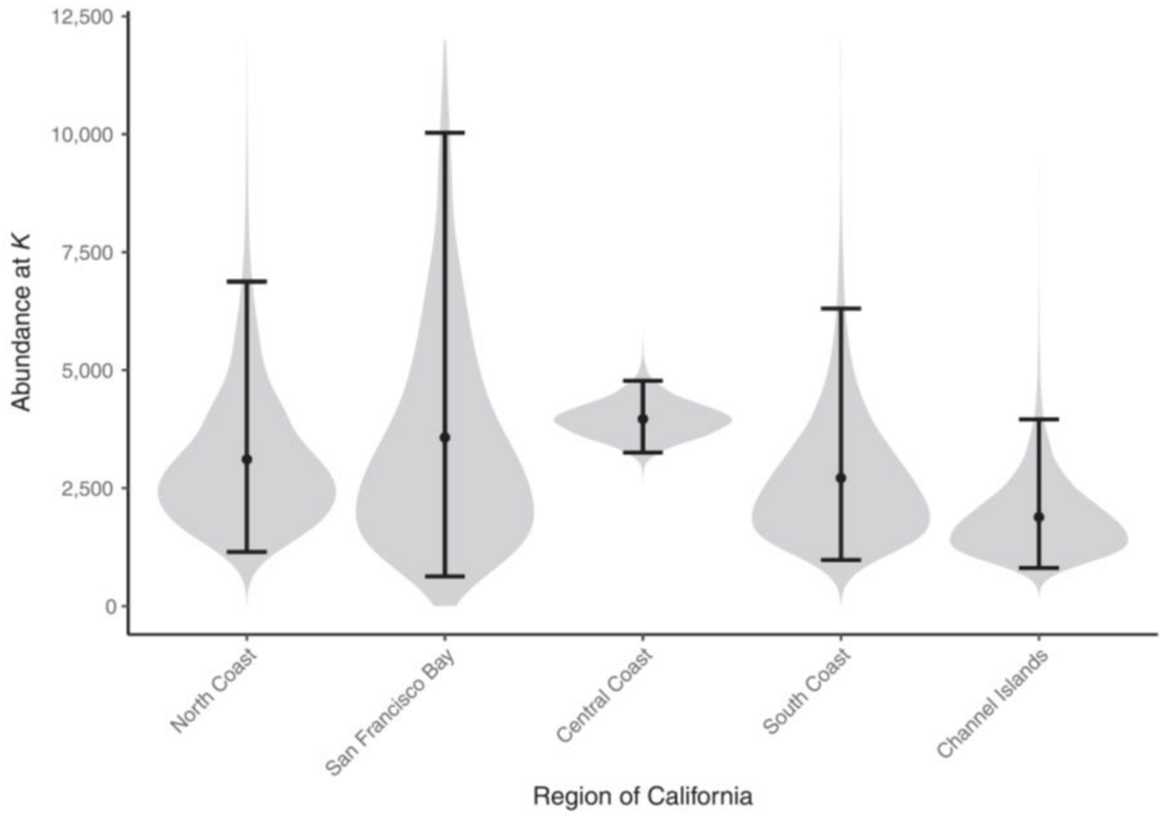


*Figure 4.3. Predicted abundance at carrying capacity for sea otter populations in 5 regions of California. The width of the gray shaded bands illustrates the degree of model support for a given value, and the error bars span the 95% credible intervals for the estimates. From Tinker et al. (2019*b*), originally published in Journal of Wildlife Management 85:303-323.*

Tinker et al. (2021*a*) present a reintroduction scenario (addition of 5 subadult sea otters, 3 females and 2 males, per year for 5 consecutive years) that when applied to different locations within California (San Francisco Bay [coastal area SF], Drake's Estero Lagoon [coastal area DE], Sonoma Coast State Park [coastal area N2], and Channel Islands National Park [coastal area C1] resulted in greatly differing impacts on total southern sea otter population abundance after 50 years, reflecting habitat configuration and quality (Tinker et al. 2021*a*). Reintroduction to Sonoma Coast State Park resulted in the least proportional gain, followed by Drake's Estero, then Channel Islands National Park and San Francisco Bay (Figure *4.4*). Reintroduction to San Francisco Bay had by far the greatest proportional impact, with a median resulting population size for the subspecies in 50 years almost double the current southern sea otter population size of ≈ 3,000 animals (Tinker et al. 2021a).

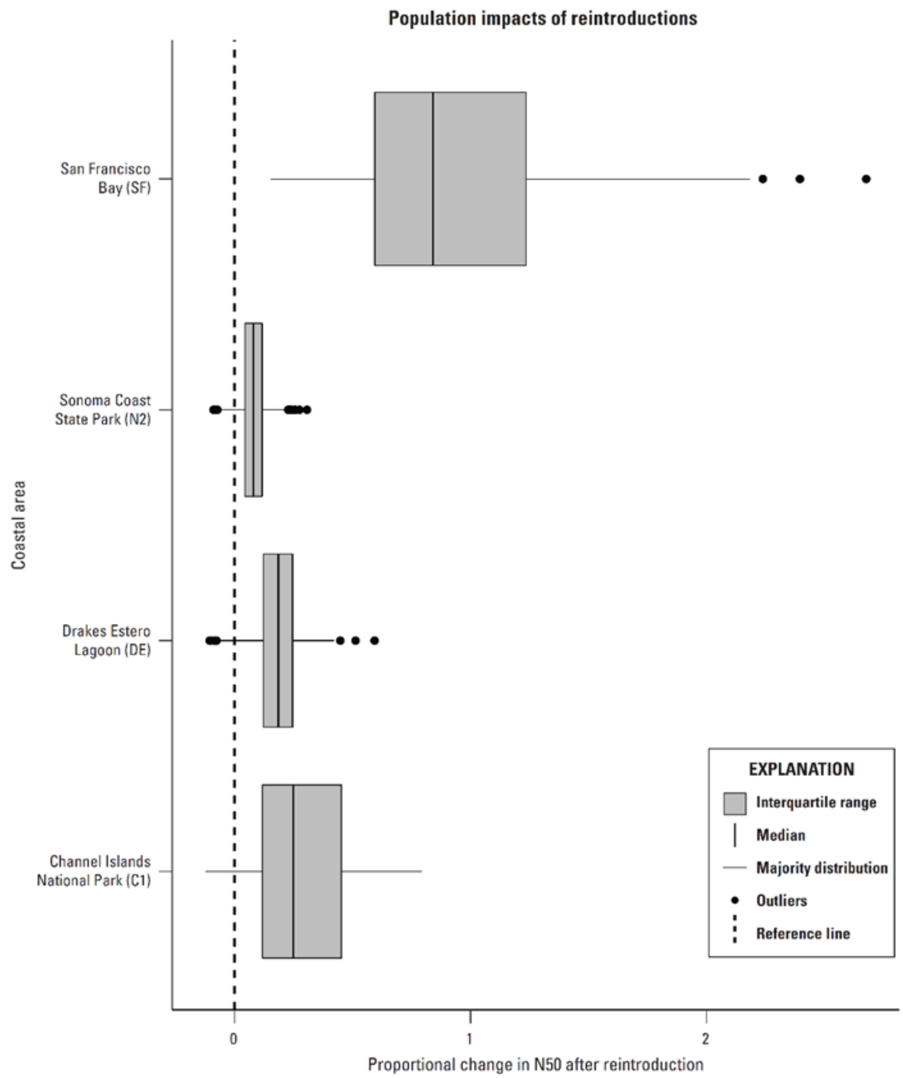


Figure 4.4. Modeled effects of reintroducing 5 subadult sea otters (3 females and 2 males) per year for 5 consecutive years to different locations within California (San Francisco Bay [coastal area SF], Drakes Estero Lagoon [coastal area DE], Sonoma Coast State Park [coastal area N2], and Channel Islands National Park [coastal area C1]. Reintroductions resulted in greatly differing impacts on total southern sea otter population abundance after 50 years, reflecting habitat configuration and quality (from Tinker et al. 2021a).

4.1.2.3. *Survey data on prey resources*

The diet of a sea otter is determined primarily by the habitat in which it forages, with rocky-bottomed habitats providing sea urchins, snails, abalone, octopus, crabs, mussels, and chitons (Riedman and Estes 1990; Tinker et al. 2008; Tinker et al. 2012), while clams, worms, mussels and crabs are more common prey items in soft-bottomed habitats. Prey switching is common among sea otters, who will exploit preferred items until they are depleted and then switch to more abundant but less preferred species, with individuals tending to specialize on just a few prey types, even as the overall population diet broadens (see section 2.1.1). Sea otters also take advantage of periodically abundant prey (Watt et al. 2000).

Only limited data are available to inform our understanding of distribution, abundance, and trends of important sea otter prey items in the nearshore environment in northern California and Oregon. A primary source of data is commercial crab harvest reports, summarized by county or port. In addition, periodic, short-term studies have occurred at specific sites for other species but there is little long-term monitoring for non-commercial species. Table 4-1 summarizes some of the data sources relevant to our understanding of sea otter prey resources; in addition, the Oregon Department of Fish and Wildlife has indicated that they have additional relevant datasets that are not included here. We recommend the additional completion of surveys for baseline information on sea otter prey resources once potential reintroduction sites have been identified for further evaluation (see sections 6.3.1.4, 6.4.4).

Table 4-1. Known sea otter prey data – California and Oregon coast. Data sources include the California Department of Fish and Wildlife (CDFW), Oregon Department of Fish and Wildlife (ODFW), and Multi-Agency Rocky Intertidal Network (MARINe). We are aware that this is not an exhaustive list of available datasets.

Regional information	Prey	Year(s)	Sources of Information	Data
CA	red sea urchins	2009-2011	Teck et al. 2018	regional and seasonal fishing patterns and landings
CA	oysters and aquaculture	1950-2007	CDFW	oyster 2008 status report
Central CA	Dungeness crabs	1970-2020	Richerson et al. 2020	population estimates in central CA; stable to increasing; NOAA news feed
San Francisco Bay, CA	intertidal benthic communities	2007/2008 and 2009/2010	MARINe	19 sites were surveyed due to 2007/2008 and 2009/2010 oil spill impact assessment; ~5 sites have since been revisited; Alcatraz Island is surveyed every year looking at changes in barnacles, rockweed, washcloth, and sea stars
North Coast CA	intertidal benthic communities	2007-2020	MARINe	44 sites along the CA coast have had at least 1 biodiversity survey

North Coast CA	abalone	2002-2015	CDFW	estimated sport catch; broken down by site and county; season was shut down in 2018-2021; shut down early in 2017
North Coast CA	abalone	2007-2019	Reef Check	densities of abalone in northern CA counties
North Coast CA	Dungeness crabs	1919-2019	CDFW	number of landings in lbs. per management area
North Coast CA	razor clams	2021	CDFW	Razor clams opening season announcement
North Coast CA	purple urchins	2007-2019	Reef Check	densities of purple urchins and kelp, RCC manual
OR/CA	Dungeness crabs	1925-2006	Rasumson 2013	crab landings in CA and OR to 2009 and economics through 2013
OR/CA	shellfish	2011	Pacific Shellfish Institute 2013	aquacultural economic impact by location
OR/CA	mussels	2000-2019	MARINe	% cover across all states through time; very little change over the last 30 yrs in CA
OR/WA/CA	Dungeness crabs	2006-2011	Pacific States Marine Fisheries Commission	commercial crab landings
South OR	red sea urchins	1986-2015	ODFW	commercial landings
South OR	bivalves	2008-2009; compared to 1970s	ODFW	Coos Bay; 4 species (butter, cockle, gaper, and native littleneck clams) surveyed
South OR	red sea urchins	1992-2012	ODFW	trends in density; Port Orford
South OR	abalone	1996-2016	ODFW	harvest rates along with some surveys 1996 to 2016; closed fisheries reported next steps for 2019-2021
South OR	Dungeness crabs	1996-2012	Shanks 2012	Coos Bay ; Pacific Decadal Oscillation has impacts on megalopae
South OR	purple urchins	1991-2019	ODFW	news report of the new survey; unpublished data by S. Groth, ODFW
South OR	rock scallops	2013-2019	ODFW	in EAFS; harvest numbers provided by S. Groth, ODFW

South OR	intertidal benthic communities	2001, 2005, 2013, 2019	MARINe	Cape Arago, biodiversity surveys
South OR	intertidal benthic communities	2002, 2006, 2013	MARINe	Burnt Hill, biodiversity surveys
Central OR	intertidal benthic communities	2015, 2019	MARINe	Otter Rock - biodiversity survey; density estimates and percent cover
Central OR	sea stars	2014-2020	MARINe	Yachats, species counts
Central OR	intertidal benthic communities	2013, 2019	MARINe	Seal Rock, biodiversity surveys
Central OR	intertidal benthic communities	2001, 2007, 2013, 2019	MARINe	Bob Creek, biodiversity surveys
Central and South OR	urchins	2010-2019	ODFW	mean red and purple urchin densities at Marine Reserves (Otter Rock and Redfish Rocks) in OR
North OR	bivalves	2010-2012	ODFW	Tillamook, 4 decades of studies on clams, ended 2012
North OR	bivalves	2014	ODFW	Netarts Bay, 2014 studies including eelgrass
North OR	intertidal benthic communities	2001,2005, 2014,2019	MARINe	Ecola Sate Park, biodiversity surveys of barnacles, mussels, and algae
North OR	razor clams	2004-2020	ODFW	in Elakha report; harvest numbers provided by S. Groth, ODFW
North OR	sea stars	2014-2020	MARINe	Haystack, species counts
North and Central OR	rockfish	2015-2017	Schwartzkopf 2020	Nehalem and Yaquina Bay; 6 years of study looking at habitat variables -dock vs eelgrass system
OR	Dungeness crabs	2014-2021	ODFW	commercial crab landings by port
OR	bivalves	2014	ODFW	2014 clam report on stocks; Coos Bay, Tillamook Bay, Yaquina Bay, Netarts Bay
OR	Dungeness crabs	2012-2019	ODFW	draft management plan with population surveys and maps of fishing areas

4.1.2.4. *Potential climate change impacts on reintroduction*

Ongoing climate change involves complex, interrelated changes in temperatures, weather patterns, and ocean conditions. Changing physical conditions, such as increasing temperatures, hypoxia, or ocean acidification, will have increasing direct effects on some marine species. Other species will be affected by changes in the abundance, distribution, or other characteristics of their competitors or prey species. Changes in the timing of seasonal events may lead to mismatches in the timing of consumers' life history requirements with their habitat conditions. The combination of these effects is likely to cause changes in community dynamics, such as competitive interactions and predator-prey relationships, that are often complex and difficult to predict.

Sea otters will be affected by ongoing climate change wherever they occur in their North Pacific range. Therefore, reintroductions of sea otters from Alaska, Washington, or central California (see section 4.1.3) to Oregon or California would not necessarily result in greater or lesser exposure of those individuals and their offspring to climate-related risks. Although the implications of climate change for sea otters may differ along the coast depending on local combinations of physical and biotic factors, the uncertainty surrounding how these local combinations of factors will play out means it may not be possible to determine a priori which areas have greater or lesser climate-related risks. Even where some risks are reasonably foreseeable, it may be that a particular location holds reduced risks for sea otters in one category but increased risks in another. For example, estuaries may provide protection from climate-driven risks of shark-bite mortality (see section 4.1.2.4.1) but pose greater risks of disease due to sea level rise and extreme precipitation events (see section 4.1.2.4.2). Despite these uncertainties, the presence of sea otter populations across a wider range of conditions would provide increased representation (ability to adapt, as characterized by breadth of genetic and environmental diversity; Smith et al. 2018) and redundancy (ability to withstand catastrophic events; Smith et al. 2018) and thus increased security for the southern sea otter subspecies and the species as a whole.

Sea otters inhabit areas with cold, nutrient-rich waters that are largely free of winter sea ice (Riedman and Estes 1990). These water temperatures tend to be below the lower critical temperature of the sea otter's thermoneutral zone (the ambient temperatures at which a core body temperature of 37°C [98.6°F] can be maintained at rest with basal metabolism); thus, an important problem for sea otters is heat loss, for which they compensate with an elevated metabolism (Costa and Kooyman 1982, Davis 2019). Because thermal deficits, not thermal excesses, are the main thermoregulatory challenge for sea otters, the warming sea surface temperatures expected along the coast of Oregon and northern California in association with climate change (Alexander et al. 2018) are not expected to harm sea otters directly. However, the indirect effects of climate change are likely to affect sea otters in numerous ways, both positive and negative.

4.1.2.4.1. Shark-bite mortality

Shark-bite mortality of southern sea otters in central California is likely to increase in connection with climate change because warming waters will intrude further north for longer periods and increase the overlap between juvenile white sharks and sea otters (Tinker et al. 2016, Moxley et al. 2019, Tanaka et al. 2021). If continued warming extends a thermal envelope suitable for juvenile white sharks into northern California and Oregon, sea otters will be increasingly subject to mortality caused by white sharks in these more northern latitudes as well. In Oregon, seven of the last eight sea otters that stranded had evidence of shark bite; five of these were confirmed, and two were suspected (USFWS, unpublished data). Warming waters can have devastating effects on kelp canopy cover through direct and indirect effects, as has been seen especially in northern California (Rogers-Bennett and Catton 2019, McPherson et al. 2021). Because kelp canopy cover is thought to afford sea otters with some protection from white shark attacks (Nicholson et al. 2018), kelp losses may further increase sea otters' vulnerability to this source of mortality along the outer coast. Notably, this problem would not apply to shallow-water estuaries, where kelp is not normally found, and where water depths are thought to exclude white sharks. Because interactions between broadnose sevengill sharks and sea otters have not been documented, it is not possible to anticipate what effects ongoing climate change may have on the risk they may pose to sea otters.

4.1.2.4.2. Disease and parasites

Climate change will likely increase the risks of disease in sea otters. Rising sea surface temperatures are expected to further intensify harmful algal and cyanobacterial blooms, which produce biotoxins such as domoic acid or microcystin (Preece et al. 2017, Trainer et al. 2020). These biotoxins already have acute and chronic effects on sea otters in California (Miller et al. 2010, 2020, Moriarty et al. 2021), though they have not been identified as a significant factor in Washington (White et al. 2018) or Alaska (Burek Huntington et al. 2021). Temperature extremes may be especially acute in estuaries, though sea level rise could lessen some of these effects in their lower-lying areas (Brown et al. 2016). At the same time, sea level rise will inundate coastal wetlands and salt marshes, reducing their capacity to filter out pathogens and pollutants (Shapiro et al. 2010, Nelson and Zavaleta 2012, Thorne et al. 2018; view sea level rise scenarios here https://coast.noaa.gov/slr/). Extreme precipitation events are also expected to increase (Pierce et al. 2018), which could further overwhelm natural and human methods of filtration of storm runoff. Increased runoff and reduced filtration could allow for increased transmission of land-borne pathogens, such as *Toxoplasma gondii* and *Sarcocystis neurona*, into the marine environment (Miller et al. 2002, Conrad et al. 2005, Shapiro et al. 2010, 2012, Burgess et al. 2020). These pathogens can cause neurological disease in sea otters (Miller et al. 2004, 2010a, 2020b, Thomas et al. 2007). Finally, novel pathogens may emerge due to climate-mediated range shifts in hosts and pathogens (Harvell et al. 2002, Hoberg and Brooks 2015).

4.1.2.4.3. Prey availability

Climate change will likely have mixed effects on sea otters' prey, though precise outcomes are difficult to predict. One major source of uncertainty comes from the complexity of food web responses to climate-driven alterations in coastal upwelling and hypoxia (Xiu et al. 2018, Howard et al. 2020). Another source of uncertainty is the potential for disease outbreaks among marine invertebrates, which is likely to increase with ocean warming (Harvell et al. 2002) but could have different consequences for sea otters depending on which species are positively or negatively affected. For instance, withering syndrome directly reduced the abundance of abalone (Ben-Horin et al. 2013, Crosson and Friedman 2018), whereas sea star wasting disease removed a crucial mesopredator from the food web, indirectly resulting in a super-abundance of sea urchins and mussels (Schultz et al. 2016, Burt et al. 2018, Harvell et al. 2019, Hatfield et al. 2019, Weitzman et al. 2021). Warming- or disease-induced declines in kelp distribution and abundance could have far-reaching effects on sea otters' benthic invertebrate prey through the loss of habitat structure and reduced production of drift kelp and detritus, as seen with starving red abalone in northern California (Rogers-Bennett and Catton 2019, McPherson et al. 2021). Temperature-related shifts in the distribution of species (Poloczanska et al. 2016, Lonhart et al. 2019) could alter sea otters' prey abundance directly or through changes in ecological interactions.

Ocean acidification could be especially devastating for sea otter prey; it is expected to affect a broad range of calcifying marine organisms through decreases in survival, calcification, growth, development, and abundance, with mollusks and the larval stages of echinoderms among the groups most negatively affected (Gruber et al. 2012, Kroeker et al. 2013, 2014, Waldbusser et al. 2015). Trophic effects may result in uncertain results here too, though. Marshall et al. (2017) modeled ecosystem dynamics in the California Current 50 years into the future with an anticipated 0.2 unit decrease in pH and found the strongest direct negative effects were on epibenthic invertebrates such as crabs, shrimps, benthic grazers, benthic detritivores, and bivalves. Indirect negative effects occurred for other species, such as Dungeness crabs (*Metacarcinus magister*), that consume species affected by ocean acidification (Marshall et al. 2017). Surprisingly, however, nearshore sea urchins benefited because they are fed upon by fish groups that experienced indirect negative effects (Marshall et al. 2017). The dietary breadth of sea otters provides some buffering against losses of particular prey species (Ballachey and Bodkin 2015), but scenarios in which the effects of climate change directly or indirectly devastate populations of multiple prey species important to sea otters are plausible.

4.1.2.4.4. Summary

Reintroducing sea otters would benefit the species (and subspecies) through increased redundancy and representation. Although climate change could negatively affect sea otters in Oregon or northern California if reintroduced there, it must be remembered that climate change will affect sea otters throughout their North Pacific range. Because many species in the northern hemisphere are expected to shift northward due to rising temperatures, it is plausible that southern sea otters would benefit from assistance in reestablishing range northward of their current distribution. It is also plausible that the ability of northern sea otters to adapt to climate change would improve if gene flow with southern sea otters occurred, as southern sea otters carry unique alleles and are adapted to the warmest conditions of any extant sea otter population (see section 4.1.3.1). Overall, 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.

4.1.3. Founder source and availability

4.1.3.1. Genetic considerations

One of the primary goals of conservation is to preserve genetic diversity. Genetic diversity serves as the basis for evolutionary adaptation, which is important for the long-term survival of a species. The capacity to adapt is especially crucial in the face of rapid environmental change, such as that caused by climate change, although the pace of change may be too fast even for some species with ample genetic diversity.

Sea otters suffered a substantial loss of genetic diversity during the era of fur trade hunting, which reduced sea otter numbers by more than 99 percent (Cronin et al. 1996, Bodkin et al. 1999, Larson et al. 2002*b*, *a*, 2012, Aguilar et al. 2008, Gagne et al. 2018, Beichman et al. 2019). Remnant populations suffered from small population sizes and a lack of gene flow due to their geographic isolation (Larson et al. 2015*b*). Based on a study of microsatellite diversity, Larson et al. (2012) determined that modern sea otter populations have lost an average 33% of their pre-fur-trade heterozygosity and 69% of their pre-fur-trade alleles (from 19.8 to 6.2 alleles per locus). Genomic analysis has also revealed extremely low heterozygosity, evidence of recent inbreeding (which likely occurred in the small remnant populations after the post-fur-trade bottleneck), and an elevated burden of putatively deleterious alleles in both northern and southern sea otters (Beichman et al. 2019). Genetic variation in the southern sea otter, in particular, is among the lowest observed for any mammal and is similar to that seen in other species that have undergone population bottlenecks or persistent population declines, such as the northern elephant seal (*Mirounga angustirostris*) and the Mediterranean monk seal (*Monachus monachus*) (Larson et al. 2002*a*, 2021, Aguilar et al. 2008, Gagne et al. 2018).

The loss of genetic variation in sea otter populations is consistent with the extreme population bottleneck caused by the fur trade (Larson et al. 2002*b*, 2012). However, Aguilar et al. (2008) suggested that the decline in effective population size of southern sea otters may have begun up to 550 years ago, potentially as a result of a sustained small breeding population or a severe reduction in population size that predates the fur trade, and Larson et al. (2012) also detected evidence of pre-fur-trade bottlenecks. Genomic analysis has further indicated that population bottlenecks—or other changes in population structure, population mixing, or migration—occurred in both northern and southern sea otters sometime around 35,000–45,000 years ago, and that an additional more recent (but still pre-fur-trade) bottleneck may have occurred in southern sea otters 1,000–3,000 years ago (Beichman et al. 2019). The authors speculated that the more recent pre-fur-trade decline may reflect exploitation by indigenous people (Aguilar et al. 2008, Larson et al. 2012, Beichman et al. 2019) and that ancient declines may reflect changes in sea level resulting from climate change around the last glacial maximum (Beichman et al. 2019). Another possibility is intermittent prey-switching by groups of killer whales or orcas (Monson 2021). Regardless of cause, historical bottlenecks, along with more recent bottlenecks, have contributed to the current low levels of genetic variation in sea otters, particularly southern sea otters.

Although the southern sea otter population has low genetic diversity due to its population history and may suffer from some degree of inbreeding depression, its fecundity and survival rates (Gerber et al. 2004, Tinker 2015, Tinker et al. 2021*b*) are comparable to those of northern sea otter populations (after controlling for density-dependent effects) and are adequate to sustain population growth where extrinsic factors (e.g., prey availability or shark-bite mortality) are not limiting. The southern sea otter population has increased to a size (≈ 3,000 individuals) where it is no longer inbreeding and losing genetic variation (Gagne et al. 2018). However, the low levels of genetic variation and putatively deleterious alleles detected in southern sea otters are a concern for management because inbred animals are generally less resilient to stress than outbred ones, and populations with low genetic diversity have a diminished ability to adapt to environmental change.

Increasing the potential for gene flow is one important reason to conduct sea otter translocations (Davis et al. 2019, Larson et al. 2021). Sea otters once exhibited genetic and morphological variation along a latitudinal cline, with historical sea otters in Oregon reflecting characteristics of both present-day northern and southern sea otters (Lyman 1988, Wilson et al. 1991, Valentine et al. 2008, Larson et al. 2012, Wellman 2018, Wellman et al. 2020*b*). If northern and southern sea otters came into contact and interbred, it could help to reestablish this historical cline. It could also potentially improve the health and adaptive ability of southern sea otters through the introduction of additional genetic diversity (Larson et al. 2021). Genetic diversity is less of a concern for the reintroduced northern sea otter populations in British Columbia (founded with animals from Amchitka Island and Prince William Sound, now numbering ≈ 8,000 individuals; Nichol et al. 2020) and Washington (founded with animals from Amchitka Island, now numbering ≈ 2,800 individuals; Jeffries et al. 2019), which have levels of genetic diversity comparable to those of their parent populations and show evidence of gene flow with each other (Larson et al. 2021). Still, these populations, whose founders were brought from Alaska, will be confronted with warming conditions in association with climate change. Southern sea otters are the most genetically distinct population (Larson et al. 2021) and also the only remnant population adapted to southern latitudes; as such, their unique alleles may be important in facilitating the adaptation of northern sea otters to climate change. Genomics data are revealing that hybridization between populations, subspecies, and even species is a normal occurrence in both animals and plants and often provides an important source of new genetic variation upon which natural selection can act (vonHoldt et al. 2018, Taylor and Larson 2019).

In order to restore gene flow between the northern and southern sea otter subspecies and recreate the potential for a latitudinal cline, and to ensure preservation and circulation of the unique alleles of the southern sea otter, we identify the following possible scenarios for restoring connectivity:

> 1) Reintroduction of southern sea otters to central or southern Oregon, with northern sea otters mixing either through occasional natural dispersal of males from the Washington population, or through more frequent exchanges with another population consisting of northern sea otters reintroduced to northern or central Oregon; *and*
>
> 2) Reintroduction of southern sea otters to northern California, with the expectation that occasional dispersing animals from reestablished populations(s) in Oregon would help to ensure some level of gene flow with northern sea otters.

These scenarios are preliminary and subject to further discussion and refinement should a reintroduction proposal be developed. They are similar, though not identical, to the scenarios proposed in Chapter 4 of the Elakha Alliance Feasibility Analysis (https://www.elakhaalliance.org/feasibility-study/chapter-4-genetic-and-historical-considerations-of-oregon-sea-otters/), to which we direct readers for additional discussion of genetic considerations. We note that although simultaneous reintroduction of both subspecies at the same site might be desirable from the perspective of accelerating genetic mixing, this scenario would present legal difficulties since northern and southern sea otters are subject to different regulatory provisions under both the ESA (southern sea otter is listed as threatened) and MMPA (incidental take in the course of commercial fishing operations cannot be authorized for southern sea otters; see section 4.3.1).

4.1.3.2. Reintroduction of wild vs. surrogate-reared rehabilitated sea otters

An in-depth discussion of reintroduction strategies using wild vs. surrogate-reared rehabilitated sea otters, including possible combinations of these strategies, is included in Chapter 9 of the EAFS (https://www.elakhaalliance.org/feasibility-study/chapter-9-implementation-and-logistical-considerations/). We do not duplicate that discussion here but merely summarize, in tabular form, the pros and cons of using these sources of animals (Table 4-2).

Table 4-2. Pros and cons of using wild vs. rehabilitated stranded sea otters for reintroduction (from EAFS, Chapter 9)

Type of source	Potential source population(s)	Pros	Cons
Wild	Alaska Washington California	Large numbers available Could provide a social "critical mass" for subsequent reintroductions of surrogate-reared animals Methods have been used in previous translocations to unoccupied habitat so outcomes are anticipated	High initial dispersal/mortality Possible impacts on source populations (though minimal if taken from areas at/near carrying capacity)
Surrogate-reared, rehabilitated stranded juveniles*	California	Lower dispersal/mortality Reduced euthanasia of stranded sea otter pups in California Potential model for development of surrogate-rearing and release program for stranded northern sea otter pups Could be used to supplement a wild-animal translocation	Small numbers (5–10) available annually, though more could potentially be available as other rehabilitation facilities become permitted Methods have not been tested in areas where no sea otter population currently exists

*Although not mentioned in the EAFS, we note that additional cons of using surrogate-reared rehabilitated sea otters are a higher cost per animal (see section 4.4.3) and the potential need for more intensive post-release management if recapture is needed following initial release (see section 2.4.1.3).

4.1.4. Ecological consequences of reintroduction

The EAFS contains an in-depth discussion of sea otters' ecological effects. We direct readers seeking additional detail to Chapter 5 of that document: https://www.elakhaalliance.org/feasibility-study/chapter-5-ecosystem-effects-of-sea-otters/. Here we summarize the sea otters' keystone role in nearshore marine ecosystems of the North Pacific Ocean and describe what we consider to be the most relevant consequences of their potential return, namely their expected effects on ecosystem resilience, species diversity, and the drivers and consequences of climate change.

As described in section 2.1.4, sea otters are a keystone species in nearshore marine ecosystems. Keystone species have disproportionately strong effects relative to their abundance in the ecosystem (Paine 1969). Through their trophic effects (consumption of invertebrates), sea otters increase the distribution and abundance of kelp and seagrass, with widespread implications for other species that depend on kelp or seagrass for food, shelter, or substrate.

4.1.4.1. Effects on kelp

Sea otters' effects on kelp have been extremely well documented (the sea otter-urchin-kelp trophic cascade; see section 2.1.4). By eating large numbers of sea urchins, sea otters enhance the abundance and distribution of kelp (Estes and Palmisano 1974) (Figure 4.5). The resulting change can take the form of a distinct switch between an urchin barrens state and a heavily forested state, as it does in Alaska (Estes et al. 2010), or it can be more gradual, as in California, because it is mediated by additional species (Foster and Schiel 1988, Kenner and Tinker 2018). Even in systems that include complementary sea urchin predators, the presence of sea otters imparts stability. This is the case because predator redundancy enhances ecosystem resilience to perturbations. Recent events along the coastline of North America illustrate this point.

Beginning in 2013, an epidemic of sea star wasting disease associated with anomalously warm waters affected more than 20 sea star species along the coast of North America and was especially lethal to the sunflower star (*Pycnopodia helianthoides*), whose abundance declined by 80–100% (Harvell et al. 2019). Because sunflower stars are an important predator of purple sea urchins (*Strongylocentrotus purpuratus*), the resulting release of these sea urchins from sea star predation, in combination with thermal and nutrient stress associated with the North Pacific marine heat wave that occurred from 2014–2016, has led to substantial kelp reductions along the coast of North America. Reductions have affected annual bull kelp (*Nereocystis luetkeana*) and perennial giant kelp (*Macrocystis pyrifera*) forests. Whether other important sea urchin predators (such as sea otters in parts of British Columbia and central California, or sheephead fish and spiny lobsters in southern California) were present to buffer the effects of these multiple stressors appears to have been partly responsible for the differences in outcomes along areas of the coast (Burt et al. 2018, Eisaguirre et al. 2020, McPherson et al. 2021, Smith et al. 2021).

In one region of British Columbia, the return of sea otters approximately one year before the disappearance of sunflower stars induced a nearly threefold increase in kelp canopy extent and also increased kelp density; after the disappearance of sunflower stars, kelp canopy cover was reduced by approximately half, kelp stipe densities had decreased, and variation within and among sites had increased, but a widespread barrens state did not develop (Burt et al. 2018). In central California kelp forests, where sea otters have been present at high densities for many decades, a similar buffering occurred. Although sea otters did not eat starving (non-gravid) sea urchins and did not prevent urchin barrens from forming in the wake of sea star wasting disease and the marine heat wave, they enhanced the resistance of remaining kelp patches to overgrazing by eating healthy sea urchins at the kelp forest margins (Smith et al. 2021). In doing so they maintained a mosaic of urchin barrens and kelp patches that can provide the spores for kelp forest recovery (Smith et al. 2021).

In northern California kelp forests, sunflower stars have been the primary predator of sea urchins since the extirpation of sea otters. These kelp forests were disproportionately affected, losing more than 90% of kelp coverage (Rogers-Bennett and Catton 2019, McPherson et al. 2021). Loss of these kelp forests has resulted in mass (80%) mortality of abalone, closure of the north coast recreational red abalone fishery, and severe impacts on the north coast commercial red sea urchin fishery (Rogers-Bennett and Catton 2019). It has also had as-yet unquantified effects on other kelp-dependent species and the ecological and human communities that rely on them.

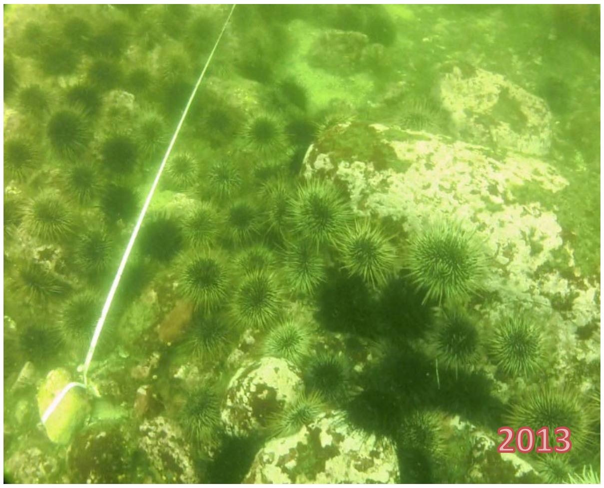


Figure 4.5. Example of rapid recovery of kelp forest following recolonization by sea otters in British Columbia. Left: In 2013, with sea otters long absent, transect site is dominated by high densities of sea urchins and no visible kelp. Right: In 2014, one year following recolonization of the same transect site by sea otters; recovery of the kelp forest is evident. Photos © Dr. Jenn Burt, used with permission.

In southern Oregon, which has most of the State's kelp, bull kelp forests did not decline substantially after 2014 (Hamilton et al. 2020). At Depoe Bay and Orford Reef, summer kelp canopy coverage from 2015–2018 remained about the same as the previous 10 years, whereas canopy coverage at Cape Arago, Redfish Rocks, and Rogue Reef increased. Differences in recruitment dynamics and densities of purple sea urchins between Oregon and California may have played a role, though population data are insufficient to confirm this comparison (Hamilton et al. 2020). More recently, however, a survey at Orford Reef conducted by the Oregon Department of Fish and Wildlife found it had become an urchin barren, with a 10,000% increase in purple urchin abundance since 2015 (Groth 2021). It is thus possible that large-scale kelp losses could also affect Oregon (see Figure 4.6, p. 71) and the preservation of Oregon's bull kelp ecosystems and associated ecosystem services are a source of local concern (e.g., Oregon Kelp Alliance) as well as continued research and monitoring.

Could a reintroduction of sea otters improve the condition of northern California and Oregon kelp forests? The ecological dynamics, controlling factors, and spatial variability of bull kelp beds in Oregon are not well understood, and the bull kelp beds located along the southern Oregon coast are known to exhibit substantial spatial heterogeneity in cover, density, and biomass, even during the current situation characterized by elevated abundance of sea urchins (S. Rumrill, pers. comm. 2021). In northern California, environmental (abiotic, as opposed to biotic) factors are believed to have played a substantial role in bull kelp declines. Therefore, the extent to which sea otters would influence the spatial extent of kelp canopy in Oregon or California cannot be predicted with certainty. Additionally, the lag time associated with establishing a population of sea otters via reintroduction ensures that no widespread changes would occur immediately. However, intense grazing pressure by sea urchins is expected to threaten recovering patches of bull kelp even when environmental conditions improve (Hohman et al. 2019). Although sea otters observed in California did not eat starving sea urchins, they still foraged in urchin barrens (Smith et al. 2021), and there is no *a priori* reason to assume there is not adequate alternate prey to support sea otters in or near urchin barrens elsewhere (here we differ from Hohman et al. [2019, p. 25]), though the abundance of alternate prey types should be assessed. If there are sufficient alternate prey, then the return of sea otters would likely provide important ecosystem benefits by facilitating kelp forest recovery (through consumption of gravid sea urchins feeding on recovering kelp) and increasing ecosystem resilience to future perturbations.

4.1.4.2. Effects on seagrass

In addition to the sea otter-urchin-kelp trophic cascade, researchers have documented sea otters' beneficial effects on seagrass, such as eelgrass (*Zostera marina*). In Elkhorn Slough, California, sea otters' consumption of large numbers of crabs reduces predation on mesograzers, like isopods and sea hares, that effectively graze algal epiphytes from seagrass blades and allow sunlight to penetrate, thereby enhancing seagrass growth (Hughes et al. 2013; see Figure 2.2, p. 14). These influences impart resilience to seagrass, allowing for increases in seagrass distribution even in an environment with high anthropogenic nutrient loading, which fuels the growth of epiphytes (Hughes et al. 2013). In Alaska, sea otter abundance is positively correlated with seagrass abundance, but as of yet there is no known trophic mechanism linking the two (Raymond et al. 2021). In British Columbia, sea otters have been shown to increase genetic diversity, and thus resilience, in seagrass through the disturbance caused by their digging for infaunal prey (Foster et al. 2021). However, increases in seagrass biomass similar to those observed in Elkhorn Slough were not observed in British Columbia, perhaps as a result of greater species richness and thus trophic complexity than that observed in Elkhorn Slough (Hessing-Lewis et al. 2018).

Eelgrass (Zostera marina) bed. NPS photo.

Whether and to what extent sea otters would increase seagrass resilience and biomass in Oregon and northern California is likely to be context dependent. Whereas the estuarine tidal channel in Elkhorn Slough is known to experience excessive nutrient loading from adjacent agricultural fields and eutrophication, both of which contribute to heavy growth of epiphytes and communities of mesograzers (Hughes et al. 2013), nutrient loading is likely to be much lower in some estuaries (or portions of estuaries). For instance, the estuarine tidal channels located in the marine-dominated regions of Coos Bay and South Slough in Oregon do not generally experience comparable levels of excessive nutrient loading and eutrophication (O'Higgins and Rumrill 2007), though more recent research using proxies for nutrient loading and dissolved oxygen stress indicate that nutrient loading has increased substantially within the hydrodynamically-isolated South Slough tidal channel over recent decades (Johnson et al. 2019). Heavily urbanized estuaries like San Francisco Bay experience high levels of nutrient loading (Cloern et al. 2020). Spatial heterogeneity in nutrient loading and trophic structure in Pacific Coast estuaries means that the potential effects of sea otters on seagrass will likely have to be evaluated on a case-by-case basis.

4.1.4.3. *Effects on species diversity*

Sea otters' effects on species diversity arise largely from their effects on kelp and seagrass. Kelp forests are highly productive and can be compared to the most productive of terrestrial systems (Tegner and Dayton 2000). They provide a complex biological structure that supports large numbers of species, providing them with shelter, food, and nursery habitat (Foster and Schiel 1985, Steneck et al. 2002). Similarly, seagrasses are foundational species that contribute high levels of primary production and provide food and habitat for birds, fish, and invertebrates (Robinson et al. 2011, Sherman and DeBruyckere 2018). Fish species that benefit from increased kelp or seagrass include kelp greenling (*Hexagrammos decagrammus*), lingcod (*Ophiodon elongatus*), rockfish (*Sebastes* spp. and *Scorpaenichthys* spp.), Pacific herring (*Clupea pallasii*), and salmonids (*Oncorhynchus* spp.; Reisewitz et al. 2006, Markel 2011, Markel and Shurin 2015, Gregr et al. 2020).

4.1.4.4. *Effects on special-status species*

Despite being predators of invertebrates, sea otters' effects on special status invertebrates, namely ESA-listed abalone, are not unidirectional (see section 4.2.1.2.3.2 for a discussion of potential effects on abalone fishing). Sea otters co-evolved with abalone, and it has been suggested they may have been indirectly responsible for the evolution of large body size in abalone in the North Pacific Ocean: by enforcing a sit-and-wait strategy among herbivores, sea otters allowed kelps to decrease their chemical defenses against herbivory, making them more nutritious for consumers and allowing size increases to evolve (Estes et al. 2005). Sea urchins and abalone have similar food and habitat preferences and thus compete for these resources. Although sea otters readily consume abalone that are unprotected by deep crevice habitat or depth refugia, they also consume large numbers of sea urchins, thereby enhancing kelp forest habitat and reducing sea urchin competition with abalone for food. Additionally, sea otter predation on crabs, sea stars, and octopuses reduces predation by these organisms on abalone. In a central California study, southern sea otter density was positively associated with increased densities of the federally endangered black abalone, though it is important to note these abalone were in deep crevices inaccessible to sea otter predation (Raimondi et al. 2015).

Sea otters may have positive indirect effects on some special status species, including the ESA-listed marbled murrelet (*Brachyramphus marmoratus*), through enhancing habitat for forage fish in areas of spatial overlap. Marbled murrelets were recently uplisted to endangered status under the Oregon State Endangered Species Act, in large part due to deteriorating ocean conditions and the consequent deleterious effects on fish forage resources for murrelets (ODFW 2021). As a keystone predator with anticipated positive effects on increased biomass of a diversity of finfish species, including potentially herring, smelt, anchovies, and sand lance – all prey species of the marbled murrelet – the restoration of sea otters could be of benefit if populations were to become established in or near foraging areas utilized by marbled murrelets (M. Nugent, pers. comm. 2021).

Marbled murrelet. USFWS photo.

4.1.4.5. *Effects on climate change*

Predators such as sea otters are increasingly recognized as playing an influential role in the global carbon cycle through their indirect positive effects on autotrophs such as kelps and seagrasses, which are highly efficient at carbon capture (Atwood et al. 2015). Kelp and seagrass remove CO_2 from the atmosphere, storing it in living biomass or sequestering it in the deep sea or estuarine sediments where it no longer contributes to climate change (Fourqurean et al. 2012, Krause-Jensen and Duarte 2016, Duarte and Krause-Jensen 2017, Ortega et al. 2019). Wilmers et al. (2012) estimated that sea-otter-induced increases in kelp biomass from Vancouver Island, British Columbia, to the western edge of the Aleutian Islands in Alaska represented an increase in carbon storage of 4.4–8.7 million metric tons worth US $205–408 million (in 2012) on the European Carbon Exchange. Limiting consideration to Vancouver Island, Gregr et al. (2020) estimated that sea otter effects on kelp biomass resulted in a median net annual benefit of CA $2.2 million. Due to differences in methodology, the latter value is approximately one-third of that estimated by Wilmers et al. (2012) when scaled to Vancouver Island and, the authors suggest, may be considered a conservative lower bound (Gregr et al. 2020). Due to potential differences in deep sea export depending on macroalgal species and ocean dynamics, site-specific estimates of carbon sequestration would be highly desirable.

Seagrass is thought to be a potent carbon sink (Nellemann et al. 2009, Fourqurean et al. 2012, Duarte et al. 2013, Duarte and Krause-Jensen 2017), though reported rates of sequestration vary considerably, and *Zostera marina*, the most widespread species on the Pacific coast of the U.S, may have an inherently low carbon sequestration capacity (Poppe and Rybczyk 2018). Because of local variation in the mechanisms underpinning the relationship between sea otters and seagrass (see section 4.1.4.2), carbon sequestration attributable to the indirect effects of sea otters will likely have to be quantified on a case-by-case basis. Explicit quantification of carbon sequestration by potential sea-otter-induced increases in seagrass remains a research need.

See further discussion of sea otters' effects on carbon sequestration in section 4.2.1.2.6.1.

4.1.4.6. *Effects on resilience to climate change consequences*

Effects of climate change include increased shoreline erosion and ocean acidification. Kelp and seagrass help to mitigate these effects. Sea level rise and high-intensity storms driven by climate change speed the process of coastline erosion. Kelp and seagrass dampen wave energy before it reaches the shore, reducing the pace of coastline erosion (Jackson 1997, Morris et al. 2020). Intensifying ocean acidification is driven by the dissolution of excess atmospheric CO_2 in ocean waters. Ocean acidification can be devastating to calcifying organisms, including commercially valued shellfish. Kelp and seagrass mitigate ocean acidification by taking in dissolved inorganic carbon through photosynthesis, though these changes are local (not widespread throughout the water column) and may be of short duration (Frieder et al. 2012, Koweek et al. 2017, Pacella et al. 2018, Wahl et al. 2018, Pfister et al. 2019, Hirsh et al. 2020). Sea otters have also been shown to mediate climate-induced declines in calcareous reefs through their trophic effects on sea urchins (Rasher et al. 2020).

4.1.5. Summary

Based on modeling of habitat features and limited survey data on prey abundance, we conclude that sea otter reintroduction is biologically feasible. In light of the potential effects of climate change on sea otters rangewide, the benefits to the southern sea otter subspecies and the northern sea otter subspecies of restored gene flow, the benefits to the southern sea otter subspecies of increased range and number, and the ecological benefits of sea otter restoration, including increases in biodiversity, carbon sequestration, and resilience to the consequences of climate change, we conclude that sea otter reintroduction is highly desirable from a biological and ecological perspective.

Kelp forests help dampen the physical energy of wave action, which protects shorelines from erosion. Photo by Michelle St. Martin, USFWS.

4.2. Socioeconomic feasibility

From a purely ecological perspective, the question of whether a species should be restored to its native ecosystem from which it was extirpated due to anthropogenic causes is straightforward. Such an action (assuming success) clearly benefits the viability of the species itself, but it also serves to restore ecosystem function and enhance resiliency through reinstating the species as an integral component of the ecosystem in which it evolved. Ecosystem restoration benefits people as well as other species, but there are often competing human interests at play. The assessment of feasibility from a socioeconomic perspective considers the human dimensions of the potential reintroduction of sea otters to northern California and Oregon.

Evaluating socioeconomic feasibility is a complex subject. The various economic impacts that may result from a reintroduction may be either positive or negative, and it is important to consider both for a balanced assessment. Furthermore, economic impacts may be assessed at multiple levels, and it will be important to stakeholders to evaluate potential economic impacts not only at the level of costs or benefits on a global or regional basis, but to bring that assessment down to the local level as well. Ocean users in affected communities need to understand how sea otter restoration may influence their livelihoods or experiences, whether those influences are positive, negative, or neutral. Finally, the human dimensions aspect of the question includes many considerations that may be non-monetary in nature, such as the values placed on wildlife viewing and photography opportunities (although these can have significant monetary value as well; USFWS 2016), existence values that reflect satisfaction in knowing a native species has been restored, or longstanding cultural values for indigenous peoples. One of the great challenges of socioeconomics is devising a method to establish a common currency to weigh and consider all of these values.

Comprehensive consideration of the socioeconomic feasibility of sea otter reintroduction and the appropriate analysis that is required to properly evaluate all of the monetary and non-monetary factors that must go into such an assessment is outside the realm of expertise of the U.S. Fish and Wildlife Service and requires the application of highly specialized economic methods. Given the high level of importance of this subject, and the potentially far-reaching consequences should a reintroduction result in inadvertent harm to human interests, we recommend the initiation of an in-depth socioeconomic assessment by a team of qualified resource economists and social scientists at the earliest available opportunity to provide accurate information for further consideration of sea otter reintroduction to the Pacific coast (see 6.3.2.1 and 6.4.2).

In this section we identify those factors that should be considered in a thorough socioeconomic assessment to fully inform the question of whether sea otter reintroduction is a viable conservation option; these include consideration of community attitudes, values, and potential economic and regulatory impacts. We start with a preliminary review of the possible economic impacts, including both the potential positive and negative factors that would need to be evaluated in an expert socioeconomic impact assessment (section 4.2.1). We then provide a summary of stakeholder attitudes and values surrounding the question of sea otter reintroduction, based on a series of interviews with representatives from a broad spectrum of interests in both California and Oregon, ranging from commercial crabbers to port commissioners to coastal conservation advocates (section 4.2.2). In addition, we invited federally-recognized Tribes on the coasts of northern California, Oregon, and Washington to share their views with us on the subject of sea otter reintroduction, and we present a summary here of the feedback we received (section 4.2.3). We also asked the California and Oregon

State Fish and Wildlife Departments to share their perspectives (section 4.2.4). None of these sections is meant to be exhaustive by any means, but we share this information as a starting point for future consideration and expert analysis.

4.2.1. Economic Impacts

Many small coastal communities rely heavily upon fisheries for economic sustenance, and although shellfish fisheries alone do not support these communities, some shellfish such as Dungeness crab are highly valued and represent lucrative single-species fisheries (e.g., ODFW 2019*a*). In addition, generations of commercial and recreational fishers have developed a traditional or cultural relationship with various species of shellfish that is important to their personal values. For indigenous coastal peoples, the cultural and subsistence values of shellfish have a history that long precedes the near-extinction of sea otters on the Pacific coast. All of these values must be incorporated into a comprehensive socioeconomic assessment.

The EAFS provides a discussion of the known direct and indirect effects of sea otters on shellfish species that are of economic importance to both commercial and recreational harvesters in Oregon. We do not duplicate that discussion here, but summarize the key points made in the EAFS in section 4.2.1.1 below and direct readers seeking additional detail to Chapter 7 of the EAFS and supporting references therein at https://www.elakhaalliance.org/feasibility-study/chapter-7-socioeconomic-considerations/. We note the Elakha Alliance has an additional study underway that is focused on the economic impacts of sea otter reintroduction to Oregon, but that study is not yet available.

Here in section 4.2.1.1 we summarize the key points from the EAFS most relevant to our discussion for background. Information provided by the U.S. Fish and Wildlife Service begins in section 4.2.1.2; we provide additional information and perspectives on these economic impacts and further broaden the discussion beyond Oregon to include consideration in northern California.

4.2.1.1. Key points from the Elakha Alliance Feasibility Study (Chapter 7)

4.2.1.1.1. Direct effects on shellfish of commercial or recreational importance—Oregon (summarized from the EAFS)

As an apex predator that feeds on benthic macroinvertebrates, sea otters compete with humans for shellfish resources in the nearshore marine environment. Sea otters preferentially select the largest and most energetically profitable prey when available, and in early stages of recolonization nearly half of the prey consumed may be composed of commercially valuable shellfish species. In areas of substantial overlap between sea otters and particular fisheries, profitable shellfish harvest may be reduced or even eliminated. The magnitude of the impact will vary depending upon species and location, as well as length of time of occupancy by sea otters.

- Red sea urchin fisheries in Oregon are most vulnerable to negative impacts from sea otters, as sustainable urchin dive fisheries have been shown to be incompatible with sea otter populations, and in Oregon urchin fishing activities overlap with the areas of greatest suitable sea otter habitat.[16]

- Clam abundance is likely to be reduced in areas where high numbers of sea otters occur in soft sediment habitats. In Oregon, clams that could be affected by sea otter reintroduction include razor clams on the north coast, and in estuary habitats, butter clams, gaper clams, littleneck clams, and cockles.
- Abalone may become less available for human harvest following reoccupation by sea otters, but although exposed abalone decrease in numbers, abalone in cryptic habitats increase. The effect on abalone fisheries is negative[17], but the viability of abalone populations is not likely at risk (see our discussion below in section 4.2.1.2.3.2).
- The effects of sea otters on Dungeness crab harvests have been highly variable on a regional basis. Prince William Sound and southern southeast Alaska have experienced severe negative impacts on their Dungeness crab fisheries, whereas little effect has been demonstrated in central California (see our discussion below in section 4.2.1.2.4.1). These regional differences appear to reflect differences in bathymetry (areas with deeper water provide refugia for Dungeness crabs from shallow-diving otters) and size selectivity (preference for larger prey). By preying on larger crabs, sea otters reduce competition for larval or juvenile crabs, and thus exert little cost on, or may even benefit, Dungeness crab fisheries in some areas. Coastal areas such as California that have deep nearshore waters that provide refugia for Dungeness crabs may be able to sustain crab populations despite the presence of sea otters, whereas areas of Alaska where crab populations have crashed are shallow enough that crabs have little refuge from foraging sea otters. Further study of this relationship is desirable given the economic importance of the Dungeness crab fishery for Oregon.

4.2.1.1.2. Indirect effects on fisheries of commercial or recreational importance and ecosystem services

Whereas most of the direct effects of sea otter reintroduction are perceived as negative due to competition and conflict with the shellfish industry, some of the indirect effects of sea otters are expressed through food web interactions and are likely to have positive economic effects on finfish fisheries. These positive effects stem from the otter-urchin-kelp trophic cascade, which results in restoration and increased cover of kelp and associated increased primary productivity and habitat structure (see Chapter 5 of the EAFS at https://www.elakhaalliance.org/feasibility-study/chapter-5-ecosystem-effects-of-sea-otters/ for details on these ecosystem effects). The indirect positive effects of sea otters on kelp and eelgrass may also provide significant ecosystem and other economically valuable benefits; these include the following:

- Significant increases in the abundance of commercially or recreationally valuable finfish (including rockfishes, greenlings, and ling cod) have been documented following sea otter colonization and recovery of kelp cover

[16] Adding to the information provided by the EAFS, the Oregon Department of Fish and Wildlife notes that the red sea urchin fishery in Oregon has seen a substantial increase in value recently, with ex-vessel price per pound more than tripling over the past 5 years (S. Groth, ODFW, unpublished data).

[17] There are no open abalone fisheries in either northern California or Oregon at this time, although the California Department of Fish and Wildlife has a target date of 2026 to reopen the recreational red abalone fishery in northern California.

- Likely positive effects on other finfish species such as herring that utilize kelp habitats; in turn herring serve as forage fish for other species that humans value, including salmon and whales, further magnifying ecosystem benefits
- Increases in seagrass biomass as a result of trophic cascades associated with sea otter predation in estuarine environments benefits invertebrates and finfishes that utilize seagrasses as nursery habitats, although these effects have varied regionally
- Positive effects on carbon sequestration as a consequence of increased biomass of kelp and eelgrass, which are highly efficient at carbon capture
- Reduced wave energy due to physical interference from kelp beds, which protections shorelines from coastal erosion
- Substantial economic benefits from increased ecotourism, wildlife viewing, and downstream effects on the hospitality industry; tourism effects in particular can be substantial, with one study estimating tourism gains outweighing losses to invertebrate fisheries by a factor of four (see our discussion in sections 4.2.1.2.7 and particularly 4.2.1.2.7.4, below)
- Positive contributions to spiritual, cultural, and existence values

Female southern sea otter eating a Pacific gaper clam (Tresus nuttalii), Morro Bay, California. Photo taken from a public pier with a 400mm zoom lens and cropped; Lilian Carswell, USFWS.

4.2.1.2. Supplemental information on potential economic impacts – U.S. Fish and Wildlife Service

Here we provide information germane to our Assessment supplemental to that provided in the EAFS discussion of Socioeconomic Considerations summarized above and provide additional perspectives for consideration.

4.2.1.2.1. New depth restrictions on crab gear in Oregon to avoid whale entanglements

New regulations were recently put into place in Oregon waters to reduce the entanglement of whales in commercial Dungeness crab gear (ODFW 2020). The majority of whales entangled in crab fishing gear off the coast of Oregon have been humpback whales that are protected under the Endangered Species Act. The new regulations reduce crab pot limits by 20% and prohibit the placement of gear outside of 40 fathoms (fm; 73 m; 240 ft) depth after May 1. The depth limit for placement of crab pots increases the potential overlap between crab fishers and sea otters, since sea otters usually forage in relatively shallow waters less than 40 m (131 ft) in depth. This depth restriction could increase competition between fishers and sea otters for Dungeness crab within the 40-fm depth contour during this portion of the crabbing season. Fishers have pointed out that these new depth limits nullify the assumption that they can adjust to the presence of sea otters by simply fishing further offshore. However, the vast majority of Dungeness crab landings in Oregon occur before May 1, and most of those landings are already within the 40-fm depth limit (D. Fox, pers. comm. 2021). In addition, prohibiting the placement of crab pots beyond 40 fm will provide a greater area of deepwater refugia for Dungeness crabs from both fishers and sea otters. The overlap between placement of crab pots and sea otter foraging depths increases the potential for take of sea otters through accidental entrapment in crab pots unless trap fyke regulations are put into place (see 5.2.1.2).The new provisions sunset after three seasons (2023), at which point they will be evaluated for effectiveness and may be adjusted or continued thereafter.

4.2.1.2.2. Oyster farms

As noted in the Elakha Alliance discussion of oyster (*Crassostrea gigas*) farming in Oregon (presented in Chapter 6; see https://www.elakhaalliance.org/wp-content/uploads/2021/08/Chapter-6-Habitat-Suitability.pdf), there is relatively little information regarding sea otter predation on oysters in aquaculture systems. However, we believe this is likely an artifact of relatively little range overlap to date between recovering sea otter populations and oyster farming operations and does not necessarily indicate that sea otters will not eat oysters, which represent a large and energetically profitable prey item. Most oyster farms culture oysters in off-bottom systems, in which oysters are grown suspended in the water contained in racks, trays, bags, or cages suspended from floats. In Prince William Sound, Alaska, where sea otters do co-occur with oyster farms, they have been observed to chew through the plastic cages containing the oysters to consume them (Dobbyn 2018). In Morro Bay, California, on the other hand, sea otters were not observed to eat oysters cultured in grow-out bags although tagged and tracked sea otters were regularly seen foraging in the vicinity of oyster farm operations (K. Mayer, pers. comm. 2021). Sea otters in this area were observed to forage on crabs in seagrass beds or mussels attached to barges in or near the oyster processing area.

In Oregon, oysters tend to be grown directly on the substrate and are not protected by any kind of container system. Oyster farms are found in several of the estuary systems that could potentially serve as habitat for reintroduced sea otters in both northern California and Oregon. The potential economic impacts of sea otters on oyster farms should be included in any socioeconomic impact assessment but will be most useful once the range of potential reintroduction sites has been narrowed.

4.2.1.2.3. Direct effects on shellfish of commercial or recreational importance—Northern California

The nature of the direct effects of sea otter reintroduction on northern California's shellfish fisheries are likely to be similar to those described for Oregon, with a few exceptions. As with Oregon, for species such as red sea urchins or clams there is reason to expect that abundances will be significantly reduced if high densities of sea otters overlap with commercial or recreational fishery areas for these species, as has been documented elsewhere (Weitzman 2013, Carswell et al. 2015, Hoyt 2015). However, we do not yet have modeling for northern California that predicts the spatial overlap of habitats with the potential to support high densities of sea otters (see Figure 4.3) and various shellfish fisheries, as was done by Kone (2019) for Oregon.

The most likely reintroduction sites for sea otters in northern California would fall within or near estuarine habitats (Tinker et al. 2021*a;* Figures 4-3, 4-4, and 4-5). Most of the northern California bays and estuaries support the recreational harvesting of shellfish; thus, the restoration of sea otters to these areas would have an impact on recreational harvesting. North of San Francisco, Pacific gaper clams (*Tresus nuttallii*), fat gaper clams (*Tresus capax*), and Washington clams (*Saxidomus nuttalli*) are the object of intensive sport harvesting in the intertidal areas of bays with sand and mud bottoms, mainly in Humboldt Bay, Bodega Bay, Tomales Bay, and Drake's Estero. In April 2021, the California Department of Fish and Wildlife (CDFW) reopened recreational fishing for razor clams (*Siliqua patula*) on beaches in Del Norte County after a 5-year toxin-related closure, though razor clamming remains closed in Humboldt County. Recolonization of any these areas by sea otters would likely have a significant effect on the recreational clam fishery by reducing the number of larger-sized clams available for harvest.

In the sections below we concentrate on the potential impacts of sea otter reintroduction specific to three fisheries in California, focusing on Dungeness crab because of the high value of the fishery, and on the red abalone and red sea urchin fisheries because of their potential association with sea otters as a suggested indirect mechanism for recovery of recently collapsed bull kelp forest systems. In addition to further rigorous examination of these three fisheries, we recognize and advise economic analysis to evaluate possible impacts on clam fisheries as well as oysters in aquaculture once specific potential reintroduction sites have been identified for further evaluation.

4.2.1.2.3.1. California Dungeness crab fishery

California has both commercial and recreational fisheries for Dungeness crab in two management areas, Northern and Central, which are divided at the Sonoma-Mendocino County line. Dungeness crab is consistently one of the highest value fisheries in California, and one of the highest in the State in pounds landed annually for a single-species fishery (Juhasz and Kalvass 2011, California SeaGrant 2021). In 2019, more than 15 million pounds of Dungeness crab were landed in California (CDFW 2020*a*). Dungeness Crab are harvested from Point Conception to the Oregon border. Fishing effort in the north is concentrated between Crescent City and Eureka and north of Fort Bragg. In the central coast region, fishing occurs near Morro Bay, Monterey Bay, Half Moon Bay, San Francisco, and Bodega Bay. There is some concern over the high level of fishing effort for Dungeness crab in California, as landings have consistently increased over the last 50 years, with 4 of 5 record seasons having occurred over the last decade (California SeaGrant 2021).

The range of the southern sea otter in central California overlaps with the Dungeness crab fishery in the Central management area for the State. Two separate studies recently examined Dungeness crab landing data in California and found no evidence of negative impacts on the fishery associated with sea otters. In Elkhorn Slough and Monterey Bay, Boustany et al. (2021) estimated that confirmed Dungeness crab composed less than 2% of the total observed biomass consumed by sea otters. For the years 1980-2018, Dungeness crab landings in areas occupied by sea otters showed positive trends over time; in fact, increases in local abundance of Dungeness crab were greater in areas within the sea otter range than without (Boustany et al. 2021). The results of Boustany et al. (2021) have received some criticism, based primarily on the argument that areas analyzed for crab catch had insufficient spatial overlap with areas occupied by high numbers of sea otters, as well as the fact that the focal study area is outside the prime fishing range for Dungeness crab. Regardless of concerns as to the study design, however, there is no evidence that Dungeness crab landings are decreasing in the central management area of the California coast (Juhasz and Kalvass 2011).

Grimes et al. (2020) also compared trends in sea otter abundance in California relative to Dungeness crab landings and found no evidence for negative impacts on catch from 2000 to 2014. Their work demonstrated a reduction in the size and abundance of juvenile Dungeness crabs in Elkhorn Slough in association with sea otter abundance, but this did not correspond to any reduction in landings of adult Dungeness crabs. Recruitment of juvenile crabs is an important driver of crab landings in subsequent years; thus, the question of sea otter impact on juvenile Dungeness crabs in estuarine nursery habitats poses an uncertainty in the ability to forecast potential future economic impacts on the fishery. The continued increases in landings of adult Dungeness crabs despite decreases in juveniles in the estuarine environment may indicate that the positive indirect effects of sea otters on eelgrass nursery habitat for juvenile crabs outweigh the direct effects of predation, or that sufficient numbers of small juvenile crabs successfully migrate to develop into adults due to their sheer abundance and size selectivity of sea otters for larger prey (Grimes et al. 2020, Boustany et al. 2021).

These results, combined with the consistent overall increasing trend observed in landings of Dungeness crab in the Central management area of California occupied by southern sea otters (Juhasz and Kalvass 2011), suggest that the effect of sea otters on Dungeness crab fisheries in California may be very different than that observed in Alaska, where the fishery has suffered declines in catch in response to sea otter recolonization (Hoyt 2015). There are multiple factors that might reasonably explain this difference, including the extremely high density of sea otters and greater reliance on Dungeness crab in the diet in some regions of Alaska as well as the lack of deepwater refugia for Dungeness crabs to avoid predation in the relatively shallow bays and inlets largely occupied there (Shirley et al. 1995; for further discussion, see section 5.1.5.2).

Dungeness crab landings are highly variable from year to year depending upon a number of factors, including physical oceanographic variables that affect the annual population size. The evidence from elsewhere in California suggests that sea otters are unlikely to have negative effects on the fishery on a regionaI scale that would be discernible from this natural variation. It is more probable that any negative effects on the Dungeness crab fishery would remain highly localized in the area(s) where sea otters become established over time (see, e.g., 4.2.1.2.5).

4.2.1.2.3.2. Recreational red abalone fishery – Northern California and Oregon

The red abalone (*Haliotis rufescens*) is the largest abalone in the world and until recently was the subject of the last open recreational abalone fishery in California. Historical overharvest led to the closure of all other abalone fisheries in the State by 1997, and two abalone species, the black (*H. cracherodii*) and white (*H. sorenseni*), are now listed as endangered under the ESA.[18] The contribution of sea otter predation to the reduced numbers of abalone in central California served as a major source of conflict with the fishery in the 1960s and 1970s (Carswell et al. 2015). Prior to the most recent closure, recreational harvest of red abalone by freediving took place along the northern California coast between San Francisco and the Oregon border; an estimated 245,000 red abalone were taken a year and the fishery was valued at $44 million [US] (Reid et al. 2016, Rogers-Bennett and Catton 2019).

The fishery for red abalone was closed in 2017 due to the widespread collapse of the bull kelp ecosystem beginning in 2014, which resulted in mass starvation of the abalone (drift kelp being their primary food source) (Rogers-Bennett and Catton 2019; see section 4.1.4.1). The California Department of Fish and Wildlife (CDFW) is currently planning to reopen the red abalone fishery in 2026 and has a Fishery Management Plan under development for the species.

The red abalone fishery in Oregon is much smaller and is considered a recreational “trophy” fishery. In Oregon red abalone are found on the south coast in shallow kelp beds. About 300 permits a year are provided for red abalone, and on average about 189 abalone a year were taken between 2007 and 2016 (ODFW 2019*b*). In 2018 the Oregon Department of Fish and Wildlife (ODFW) suspended the red abalone fishery for many of the same reasons the California fishery closed, including the extensive loss of bull kelp forests on the southern Oregon coast, generally poor environmental conditions, and declining abalone densities. In addition, fishery pressure and harvest had increased approximately three-fold between 1996 and 2016 (ODFW 2019*b*). Since the initial suspension of the fishery, environmental conditions have worsened, with warm water conditions continuing, further reductions in kelp, and increasing numbers of purple sea urchins. Like CDFW, ODFW aspires to restore a sustainable recreational abalone fishery in the future.

The reintroduction of sea otters to the coast of northern California simultaneous with efforts to recover the red abalone and reopen this highly valued fishery is likely to raise concerns. The Oregon recreational fishery is not a significant fishery from a purely economic perspective, although it has other values for fishers. Abalone co-evolved with sea otters, and there are several studies demonstrating that abalone populations—including red abalone specifically—can maintain stable densities over long timescales in the face of sea otter predation, although those populations are most often composed of smaller individuals that escape predation by occupying cryptic habitats (Lowry and Pearse 1973, Fanshawe et al. 2003, Lee et al. 2016). Densities of small, cryptic abalone may even increase in the presence of sea otters (Raimondi et al. 2015, Lee et al. 2016), and Raimondi et al. (2015) suggest that abalone may additionally benefit from protection from poaching if increasing proportions take refuge in crevices or other difficult-to-access microhabitats. In Big Sur, California, where sea otters have been at high densities for decades, Tinker et al. (2019*b*) found that they continue to rely heavily on abalone in their

[18] Withering syndrome is considered the primary threat to the black abalone

diet. The authors suggest the positive indirect effects of sea otter predation (reduction of urchin competitors and increased kelp abundance) may be sufficient to allow an abundant abalone population to persist despite direct predation. The highly complex habitat in the area also likely provides significant refugia, with the result that even very large abalone continue to be observed despite the long-term occupation by sea otters (J. Tomoleoni, pers. comm. 2021). In all cases, although numbers of abalone coexisting with sea otters were sufficient for population persistence, the reduction of large abalone, particularly in exposed, less complex habitats, likely prevents the ability to sustain a fishery under such conditions (Fanshawe et al. 2003, Lee et al. 2016).

The recovery of already diminished red abalone populations could be at risk. Abalone are broadcast spawners and must occur in sufficient proximity to one another to allow fertilization to occur. Predation by sea otters could further reduce the density of sexually mature abalones such that reproduction and recruitment are compromised, with negative consequences for natural population growth and recovery. Whether this would be likely to occur would depend in part upon the spatial overlap of sea otters with habitats occupied by red abalone, as well as factors such as the diversity and abundance of other prey.

Sea otters are likely to have a substantial negative impact on the recreational red abalone fishery in areas where the species co-occur. The likelihood that this potential will be realized will thus depend on the geographic area(s) that may be chosen as a release site and the potential for overlap with red abalone populations in that area.

4.2.1.2.3.3. California red sea urchin fishery

Red sea urchins are available for harvest statewide in California, but there are two primary centers for the commercial fishery, one in southern California near San Diego and the Channel Islands, and other in the north, with most of the landings coming from the Mendocino County and some from Sonoma County. The red sea urchin commercial fishery is exclusively a diver-based fishery. Areas fished for the recreational fishery are known to be scattered along the entire coast of California, although effort is believed to be small. Red sea urchins are also an important part of Tribal subsistence along many parts of the coast.

The California Department of Fish and Wildlife (2020*b*) reports that the red sea urchin fishery is consistently one of California's top fisheries by volume each year, although landings in the southern management zone generally exceed those from the northern management zone. In 2013, the last year for which data are available, CDFW reports that 43 red sea urchin divers in the northern management zone landed just over 4 million pounds of red sea urchins, valued at $3.6 million [US] (CDFW 2014).

Like the red abalone (see 4.2.1.2.3.2), the red sea urchin fishery in northern California was decimated by the collapse of the bull kelp forests beginning in 2014 and competition with purple sea urchins. In 2019, the Secretary of Commerce declared the 2016-2017 northern red sea urchin seasons a fishery resource disaster under the Magnuson-Stevens Fishery Conservation and Management Act (U.S. Department of Commerce 2019). CDFW is in the process of working to recover the fishery.

Sea otters and red sea urchin fisheries are generally incompatible; CDFW (2020*b*) specifically identifies sea otter predation as the reason that red sea urchin densities are too low to sustain a commercial fishery on California's central coast. In Neah Bay, Washington, the red sea urchin fishery in District 5 closed in the 1997/98 harvest season subsequent to colonization of the area by sea otters and reductions in harvestable numbers of urchins (W. Jasper, pers. comm. 2021). The potential for significant negative economic impacts to the commercial red sea urchin fishery from the reintroduction of sea otters to the northern California coast will primarily depend on the geographic area that may be chosen as a release site and the potential for overlap with the center of the commercial red sea urchin fishery.

4.2.1.2.4. Indirect effects on fisheries of commercial or recreational importance and ecosystem services—Northern California

Due to broad similarities in the function of the nearshore marine ecosystem between California and Oregon, we anticipate the nature of the indirect effects of sea otters on finfish fisheries and ecosystem services in California would be similar to the positive effects described above for Oregon (4.2.1.1). It is possible the magnitude of the potential gain from the indirect effects of sea otters could be greater in California, however, in terms of the positive effects from increased kelp biomass and associated ecosystem services. The coast of northern California historically had significantly more canopy forming kelp than Oregon. But as discussed above, northern California's bull kelp forests have been reduced by more than 90% in just the past 10 years (Rogers-Bennett and Catton 2019). Visual observations indicate that southern Oregon may have experienced a similar loss of bull kelp canopy in some areas, although that loss has not been quantified (ODFW 2019*b*). Indications are that canopy forming kelps in southern Oregon have thus far been more resilient to the extreme changes observed in northern California in recent years (Hamilton 2020), although negative impacts have been observed, with some areas clearly reduced to urchin barrens (Figure 4.6).

Figure 4.6. Urchin barrens in a former kelp forest off the coast of southern Oregon. Note purple sea urchins, which normally eat drift kelp, actively grazing remaining kelp stipes. Photo by Scott Groth, Oregon Department of Fish and Wildlife; used with permission.

The ability of sea otters to restore resilience and productivity to kelp ecosystems is one potential mechanism for recovering the Pacific coast kelp forests. If the return of sea otters to the northern California coast results in the rapid recovery of kelp cover that has been documented elsewhere (e.g., Estes and Duggins 1995), this would provide a significant boost to restoration efforts for that ecosystem and the species that depend upon it, including the red abalone and red sea urchin. There is some uncertainty as to how quickly this might occur, however, due to some complicating factors. For one, it is unknown how quickly sea otters might manage to exert positive influences in a kelp forest already reduced to an urchin barren (see discussion in 4.1.4.1). Watson and Estes (2011) found that barren areas dominated by urchins and subsequently recolonized by sea otters do not necessarily experience a rapid phase shift to kelp forest, but tend to undergo a series of small-scale system shifts resulting in a mosaic of kelp or urchin-dominated areas before ultimately transitioning into a more resilient yet dynamic kelp-dominated state. The return of sea otters would be likely to promote kelp recovery, as has been observed consistently in other urchin-dominated areas (e.g., (Estes and Duggins 1995, Watson and Estes 2011, Estes et al. 2013), but it may not occur as rapidly as some would hope.

Secondly, suitable habitat for sea otters occurs in a patchy mosaic along the coast, and it is not anticipated that reintroduced sea otters will reoccupy and enhance degraded kelp forest systems over a significant extent of coastline anytime in the near future. Finally, although the indirect benefits of sea otter predation on urchins could benefit red abalone and red sea urchins by restoring the kelp forests they need to survive, red abalone and red sea urchins are also negatively affected by sea otters through the direct effect of predation. On balance, the restoration of kelp forests would benefit the recovery of red abalone and red sea urchins by providing the food resources and shelter they require, but individuals would likely remain cryptic to prevent predation by sea otters such that future harvest levels by humans would be reduced. The return of sea otters could thus contribute to the recovery of the species but would be unlikely to succeed in recovering a sustainable fishery.

If significant recovery of the bull kelp canopy in northern California were realized as a result of the indirect effect of sea otters, there would be significant gains in ecosystem services benefits, particularly in the form of carbon capture and sequestration, due to the great amount of area and biomass that stands to be restored. For the reasons described above, whether this positive effect may be realized, to what degree, or how soon it would occur, remains a source of uncertainty.

All of the ecosystem benefits that are listed above for Oregon in section 4.2.1.1.2 (wildlife viewing, ecotourism, existence values, etc.) would similarly apply in northern California. Of particular economic importance to northern California is the potential positive effect on groundfish fisheries, which is one of the top fisheries in California in pounds landed annually, right behind Dungeness crab (California SeaGrant 2021).

4.2.1.2.5. Observations from the Washington Dungeness crab and razor clam fisheries

Crabs of various species make up a good proportion of the sea otter's diet in Washington. Hale et al. (2019) found that kelp crabs (*Pugettia* spp.) make up the greatest proportion of the diet (14.69%), followed by unidentified crabs (13.71%), and razor clams (*Siliqua patula*; 10.56%); Dungeness crabs were observed to constitute 9.20% of prey consumed by sea otters.

The Dungeness crab fishery on the outer coast of Washington is divided into four catch areas, from north to south 59A-1, 59A-2, 60A-1, and 60A-2. The two northernmost areas, 59A-1 and 59A-2, are occupied by sea otters. Sea otters have not expanded their populations southward into 60A-1 and 60A-2, so these two areas remain unoccupied. The State of Washington shares the harvest of Dungeness crab with three coastal Tribes: the Makah, Quileute, and Quinault. These Tribes have treaty rights to fish within their usual and accustomed areas but cannot fish outside of those traditional areas. Figure 4.7 shows Dungeness crab landings from the 2006/2007 season through 2020/2021 for each of the four catch areas. Areas 59A-1 and 59A-2 where sea otters are present have exhibited downward trends over that time; in the northernmost areas, Dungeness crab landings are down from about 12% of the Statewide harvest to less than 2%; in 59A-2 they have declined from roughly 20% of the Statewide harvest to less than 5% (WDFW, unpublished data 2021). In contrast, the two southernmost fishery areas without sea otters, 60A-1 and 60A-2, have remained relatively steady over this same time period.

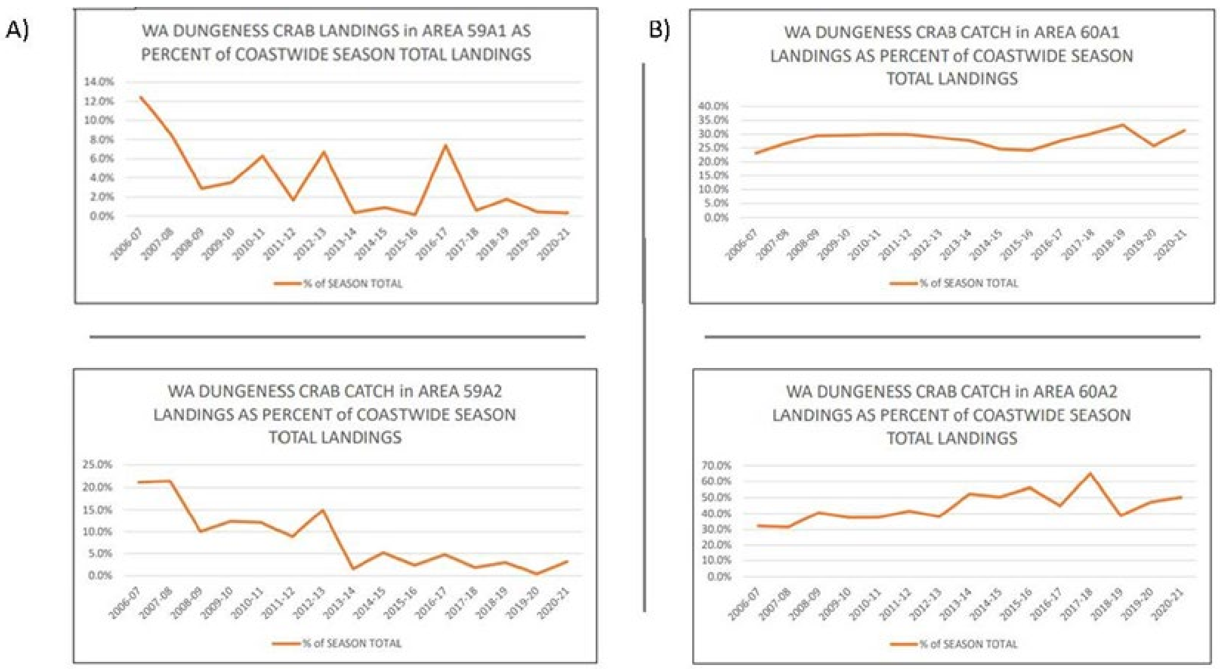


Figure 4.7. Dungeness crab landings as percent of Statewide landings in Washington 2006-2021. A) Catch areas 59A-1 and 59A-2, sea otters present. B) Catch areas 60A-1 and 60A-2, sea otters absent. Note scale on Y-axis varies for each catch area. Source: Washington Department of Fish and Wildlife.

There is a clear pattern of declining trends in Dungeness crab landings for the portion of the Washington coast that is occupied by sea otters versus the relatively steady trend in that which is not. This correlation has led to speculation that sea otters are driving the declines in Dungeness crab catch in these areas. Although the graphs appear convincing, we lack information on other factors that could be affecting the number of landings in the northern fishery areas; factors such as hypoxia, domoic acid, changes in fishing effort, or some combination thereof, could also be influencing these trends. This does not rule out sea otters as a contributing factor to the observed decreases, but there has been no direct assessment to conclusively determine if the rates of Dungeness crab consumption observed are sufficient to threaten the fishery (Hale et al. 2019).

Collectively across the entire coast of Washington, commercial landings of Dungeness crab have continued to increase overall from 1950 through present; landings have been trending upward relatively steadily (with annual variation) since after the 1986/87 season, after sea otters were reintroduced (Figure 4.8) (WDFW 2021*b*).

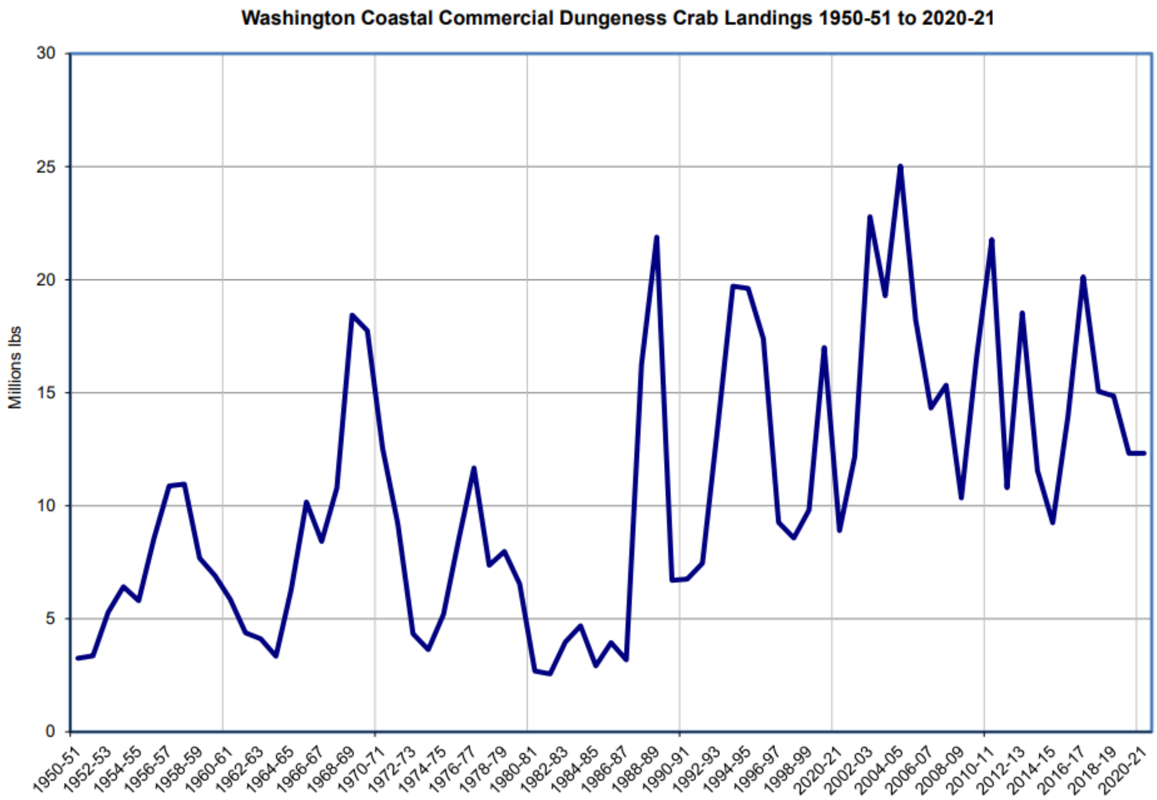


Figure 4.8. Commercial Dungeness crab landings Statewide in Washington in millions of pounds, 1950 through 2021. Source: Washington Department of Fish and Wildlife.

There are two bits of anecdotal information that suggest the possible negative influence of sea otters on a local level. One is the observation that Destruction Island, an area traditionally known as a good crabbing ground and used as a pre-opening testing area for Dungeness crab season, has been discontinued as a test area by the Washington Department of Fish and Wildlife (WDFW) because they can no longer find legal-sized crabs there, which appears to be correlated with increasing numbers of sea otters in the area (D. Ayres, pers. comm. 2021). The other indication that sea otters may be having a localized effect is based on information received from Tribes. Unlike other crabbers, Tribal fishers cannot move to other areas where crab may be more plentiful, thus they are most likely to be negatively affected by highly localized reductions in abundance of Dungeness crab. The Quinault Indian Nation has indicated that losses to sea otter predation at their usual and accustomed fishing area near and around Destruction Island is threatening the viability of Dungeness crab there, as well as razor clams, and the Makah Tribe also commented on reductions of these species in this area (see APPENDIX A. Tribal Perspectives).

Drawing loosely from these data, in Washington the association between areas occupied by sea otters and landings in the Dungeness crab fishery appears to manifest in decreased catch at the local level, but on a Statewide-level landings continue to increase and no negative economic impact has been observed on the fishery as a whole. Fishery effort continues to increase as well (D. Ayres, pers. comm. 2021). Based on these observations, there appears to be no net economic impact to non-tribal fishers who have the capability of redirecting their crabbing effort along the coast. Fishers restricted to crabbing in a limited geographic area, such as particular Tribal members, are likely to experience direct negative impacts as a result of locally reduced abundance of shellfish.

The razor clam fishery is the largest recreational shellfish fishery in Washington. In the fishery adjacent to catch area 59A-2, which is occupied by sea otters, the razor clam management beach at Kalaloch has had very little non-tribal harvest opportunities for several years due to a lack of small juvenile clams surviving to harvestable size. The four other razor clam management beaches, adjacent to catch areas 60A-1 and 60A-2, are on Washington's central and south coast where sea otters do not occur. In contrast to Kalaloch, these have all had strong or record numbers of razor clams in recent years. There is no direct evidence of high levels of sea otter predation on razor clams at Kalaloch, but managers suspect sea otters are at least one of the likely causes of the loss of adult clams at this formerly productive beach (D. Ayres, pers. comm. 2021). The Quinault Indian Nation describes sea otters as exerting excessive predation pressures on razor clams at Kalaloch Beach, as well as Dungeness crab and other shellfish species. The potential impact of sea otters on the traditional razor clam fishery in the vicinity of Destruction Island and Kalaloch Beach was also noted by the Makah Tribe (see APPENDIX A. Tribal Perspectives).

4.2.1.2.6. Economic impacts of ecosystem services and other considerations, including non-monetary values

Many of the potential economic impacts that may be experienced as the result of sea otter reintroduction are not typically perceived in monetary terms and are therefore easy to overlook, or if considered are addressed only in qualitative terms (Loomis 2006, Martone et al. 2020); the value of ecosystem services often falls into this category. The worth of ecosystem services can be substantial and any comprehensive economic evaluation that professes to present a fair accounting of all costs and benefits to be weighed in a decision must take the full value of such services into consideration. Non-monetary values such as cultural, experiential, or existence values must be valued and accounted for as well. While ecosystem services associated with sea otters benefit everyone, the potential costs to local fisheries are borne by a small percentage of the population. The quantification of ecosystem services would thus inform the consideration of possible economic impact offset measures that could potentially transfer some of the benefits gained to those who may experience direct costs (see 5.2.1.5). As we noted earlier, such a task requires specialized economic expertise and resources beyond our capacity in this Assessment, but here we identify some categories of ecosystem services that should be valued and assessed in a future economic analysis to inform the consideration of sea otter reintroduction and the exploration of possible measures to reduce associated economic impacts.

4.2.1.2.6.1. Increased capacity for carbon sequestration and other ecological effects

Increasing the capacity for carbon capture and storage is a primary focus of efforts to fight the negative impacts of climate change. The work of Wilmers et al. (2012) evaluated the contribution of the sea otter-urchin-kelp trophic cascade to the storage and flux of atmospheric carbon. They found that the

Giant kelp forest, California. Photo by Kelly Moore, NPS.

indirect positive effects of sea otters on kelp through increased biomass and net primary productivity resulted in a significantly greater capacity for the ecosystem to capture carbon in the tissues of kelp and transport it to the deep ocean where it is stored in sediments (note that this calculation requires an assumption that sea otters are present at ecologically effective densities). The authors calculated that the net primary productivity (NPP) in systems with otters was 12 times greater than that in systems without otters (and therefore little kelp). To put this into perspective, if only 1% of the annual increase in NPP due to sea otters was transported into the deep ocean, this would represent sequestration of carbon equivalent to the annual emissions from 100,000 cars. If 50% of the NPP was transported, the values would be equivalent to carbon emissions from 5 million cars. From an economic perspective, the numbers are impressive as well. At the 1% sequestration level, the yearly economic worth of the carbon sequestered would have been valued at from $6 million to $21 million on the European Carbon Exchange; estimates at the 50% level ranged from $294 million to $1060 million.[19]

Wilmers et al. (2012) suggest that the substantial economic value of sequestered carbon realized through the indirect effects of sea otters could be used to offset economic losses that could manifest as a result of sea otter reintroduction; this is an intriguing idea that we explore further in sections 5.2.1.6.3 and 6.3.2.4. Although there has been some debate as to whether kelp may capture and store carbon over the long term as efficiently as seagrasses and other angiosperm-based systems (mangroves, salt marshes, and seagrasses are considered some of the most highly efficient carbon sinks on the planet; Duarte et al. 2005, Nellemann et al. 2009, Fourqurean et al. 2012), recently it has been suggested that kelp systems may possibly even surpass these systems in carbon sequestration capabilities (e.g., (Krause-Jensen and Duarte 2016, Krause-Jensen et al. 2018, Macreadie et al. 2019). As sea otters may have positive indirect effects on both kelp and seagrasses, either or both systems could potentially serve as a basis for calculating the value of carbon sequestration contributed by sea otters in a specific area.

Carbon sequestration benefits resulting from changes in local biomass as a result of sea otter mediated trophic cascades was one of several ecosystem services valued by Gregr et al. (2020) as well (results summarized in 4.1.4.5). This innovative work lays out a method for quantifying the projected net change in biomass resulting from restoring sea otters to an ecosystem where they are currently absent using a trophic model calibrated with local data, and then quantifying the effects of that change on several categories of ecosystem services. Model calibration was based on comparable sites with sea otters either present or absent on the outer coast of Vancouver Island, British Columbia. For their study area, they estimated the value of carbon sequestration in terms of unconsumed surplus production transported to deep ocean storage as a net benefit of CA $2.2 million per year based on European Union

[19] The authors based yearly values on December 2012 futures on the European Carbon Exchange, converted to US dollars using the exchange rate at the time (Wilmers et al. 2012)

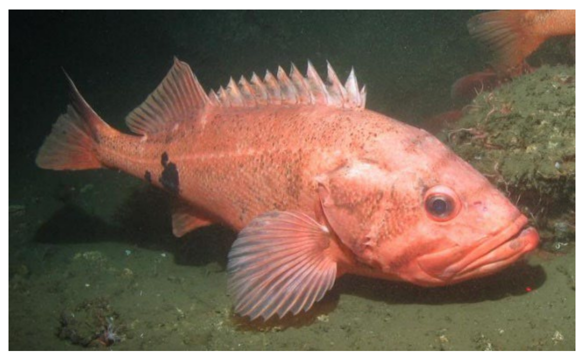
carbon prices [in US dollars, approximately $1.6 million].[20] The authors note differences in estimates of standing stock densities between their study and that of Wilmers et al. (2012), which result in the carbon sequestration valuation of Gregr et al. (2020) yielding a lower dollar value; they clarify that their estimate is conservative and may be considered a lower bound estimate of value.

Other ecosystem services that have ecological benefits as well as potential to address issues associated with climate change that may merit valuation include localized reductions in ocean acidification and buffering of physical wave action, which reduces coastal erosion (see section 4.1.4.6).

The range of sea otters represents a very small proportion of the earth's surface. It is important to recognize that their potential impact in reducing levels of atmospheric carbon indirectly through positive indirect effects on kelp biomass is very high proportional to the surface area they cover, but the contribution of sea otters alone cannot make a significant contribution to addressing climate change on a global scale. At the local level, they provide the potential for a significant increase in long-term carbon sequestration potential, and this is important as all such changes are cumulative and collectively they are necessary to achieve measurable reductions in greenhouse gases. Expectations must be tempered by the reality that if sea otters are reintroduced populations are likely to remain small and patchily distributed for a very long time, thus positive effects will be localized.

4.2.1.2.6.2. Impacts on finfish fisheries

Finfish fisheries are likely to benefit from the positive indirect effects of sea otters to both kelp and seagrass systems, since these areas provide important nursery habitat for many commercially important species of finfish (see 4.2.1.1.2) (Reisewitz et al. 2006, Markel and Shurin 2015). Through the trophic model described above, Gregr et al. (2020) quantified the potential economic benefit to the finfish fishery from sea otters in British Columbia and found a predicted economic gain worth CA $9.4 million per year (U.S. $6.9 million). Similar to their estimate for carbon sequestration, the authors stress that this should be considered a conservative (low bound) estimate.



Blackspotted rockfish. Photo NOAA Southwest Fisheries Science Center.

Groundfish fisheries are one of the largest fisheries by both volume and revenue in both California and Oregon (ODFW 2019*a*, California SeaGrant 2021). The term "groundfish" is a Federal management category for a diverse group of fisheries that includes more than 100 managed species such as rockfishes, flatfishes, sablefish, lingcod, and others. Many of these are the finfishes that would benefit from the indirect positive effects of sea otters on kelp and seagrass systems.

Although the effects of sea otter mediated restoration of kelp or seagrasses are positive for finfishes, these benefits are not necessarily experienced throughout the groundfish fisheries because many of these fisheries occur in deeper waters off the continental shelf. Benefits to commercial fisheries are

[20] Converted to U.S. Dollars using Bank of Canada exchange rate on date of publication of Gregr et al. 2020. The authors used 2018 exchange rates, however, so U.S. dollar values should be viewed for general comparative purposes only.

most likely to be realized in the nearshore groundfish fisheries. For example, most of Oregon's nearshore commercial groundfish fishery is on the south coast where the rocky reefs have significant kelp beds. While the nearshore commercial groundfish fishery may benefit, and this benefit is important, this fishery is relatively small, representing about 3% of the value of Oregon's groundfish fisheries (D. Fox, pers. comm. 2021).

4.2.1.2.6.3. Economic impacts on tourism and associated visitor services

In the economic assessment of Gregr et al. (2020), introduced above, the economic worth of ecotourism associated with sea otters eclipsed the projected benefits from all other ecosystem services considered – gains from ecotourism were nearly four times as great as the benefits from carbon sequestration and increased value of finfish combined. Potential revenue from tourism was projected to be worth on the order of CA $41.5 million per year (US $30.5 million). Estimates of increased tourism revenue were based on a survey and choice experiment resulting in a combination of willingness-to-pay for a wildlife tour, increased proportion taking a wildlife tour, and predicted number of visitors to Vancouver Island (Martone et al. 2020). The authors make note of similar observed benefits of sea otters to the tourism industry in southeast Alaska as well.

In the details of the economic evaluation of the impact of sea otters on the tourism industry on Vancouver Island, Martone et al. (2020) found that individual willingness to pay for a high chance of seeing otters was not far behind that for whales, which is the number one factor for tourists choosing a wildlife tour. The value of willingness to pay for the chance of seeing sea otters was estimated at CA $115 million annually (US $94.5 million)[21]. Interestingly, wildlife tour operators significantly underestimated the value of willingness to pay for the chance to see sea otters.

To assess the potential economic benefits of southern sea otters expanding their range to the coast of Santa Barbara, California, (Loomis 2006)[22] demonstrated three different methods to assess and monetize non-market values. The application of value transfer and benefit transfer approaches allowed the author to estimate the recreational tourism values and existence values of sea otters (the inherent value in knowing something exists, even if you don't necessarily get to see it or experience it), as well as calculate costs to commercial fishing from the presence of otters. Lower bound calculations for the recreation benefits and costs to commercial fishing were based on an estimated 117 otters moving to the Santa Barbara Coast (presumed to occur after elimination of the "no otter" zone associated with the San Nicolas Island translocation effort; see 2.4.1.2), whereas existence value calculations also considered an additional 79 otters at San Nicolas Island itself (196 otters total).

The calculated loss to the commercial shellfish fishery (only urchin, crab, and spiny lobster fisheries were included) was $610,242 per year in ex-vessel revenues, and estimated total job loss over 10 years ranged from 24 to 26.5 jobs.

Considerations that go into the calculation of recreational tourism value include increased economic benefits associated with wildlife viewing opportunities and businesses, such as wildlife tours or bay cruises and kayak rental businesses, as well as indirect benefits from increased tourism (spending for lodging, restaurants, and other visitor services). The valued added or direct tourism related income was $69,700 per otter; a conservative lower bound estimate was $13,200 per otter. These value-added

[21] Converted to U.S. Dollars using Bank of Canada exchange rate on 8 October, 2021.
[22] All dollar values reported are now 15 years old, so estimated amounts would be greater in 2021 dollars.

coefficients were then used to calculate the direct aggregate sea otter tourism income for Santa Barbara and Ventura Counties. The lower bound estimate of minimum direct county annual income was $1.5 million, with an upper bound of $8.2 million; applying the California State multiplier for tourist-related industries yielded estimates ranging from $3.9 million to $18.86 million in annual income. Tourism employment is associated with tourism spending, and also benefits from sea otters. Loomis (2006) calculated that from 62 and 326 jobs would be added to Santa Barbara and Ventura counties as a result of sea otter-related tourism over a period of 10 years. With standard economic multipliers, these numbers are even higher, from 142 to 750 total jobs.

Nonmarket values of sea otters (viewing or existence values) were calculated using a contingent valuation method (CVM). For nonmarket values, this survey method designed to elicit the monetary amount a household would be willing to pay to achieve some gain in resource quantity or quality. Of particular interest here is the breakdown in the components of total nonmarket economic value for sea otters in terms of willingness to pay by household: 12% of the total economic value was *non-consumptive viewing value* – the proportion due to actually seeing otters in the wild off the coast; 23% of the total economic value was *option value* – the value of knowing you may be able to see otters in the wild off the coast someday; and 65% of the value was *existence value* – the value of just knowing that otters exist on the California coast. The estimated value of California households willingness to pay for sea otter populations ranged from $3.4 to $16.1 million.

Sea otter viewing and tour boats, Morro Bay, California. Photo by Lilian Carswell, USFWS.

4.2.1.2.6.4. Regulatory impacts

Additional economic impacts from the reintroduction of sea otters that merit consideration are potential costs to the commercial and recreational fishers that may stem from potential regulatory changes that could be imposed to protect sea otters. For example, to reduce the potential for incidental take of sea otters by drowning in nets, in California shallow water set gillnet fisheries were moved further offshore, out of the range of sea otters. If such a change were to occur in Oregon, there could be opportunity costs associated with that change for fishers. Trap regulations could also be considered to prevent or reduce the incidental entrapment of sea otters in crab or finfish traps, which may have some associated costs.

Also in the regulatory realm is the potential for increased administrative costs or delays that could be associated with ensuring compliance with the MMPA or ESA through authorizations for activities such as in-water construction projects. We estimate that the incremental costs attributed to sea otters would be relatively minimal, however, as in most cases it is likely that the presence of seals or sea lions would trigger the need for MMPA authorization regardless. This is not to minimize the time and effort required for MMPA authorizations, but merely to say that it is unlikely that any such effort would be attributable solely to the presence of sea otters; this could of course vary by location, so such costs may warrant consideration depending upon potential reintroduction sites and whether other marine mammals occur at that location.

State agencies could incur additional costs for responding to the public or taking enforcement actions related to sea otters, and these costs would be above and beyond those currently expended on seals and sea lions. Departments of Fish and Wildlife could be called upon to manage fishery interactions with sea otters, State Police could be called to respond for enforcement actions, and State Parks could be required to manage human interactions with sea otters (e.g., all shoreline areas in Oregon are managed by the Oregon Parks and Recreation Department). Although it is not possible to estimate precise costs, it is reasonable to assume that States will incur costs associated with the management of sea otters and associated resource uses.

Additional costs due to required ESA authorizations could be possible if southern sea otters were used as source animals, although the implementation of an experimental population rule under section 10(j) of the ESA, as recommended in this Assessment, could reduce or eliminate most administrative burden associated with a species reintroduced under that authority such that any costs would be minimal.

4.2.1.2.6.5. Impacts on cultural, spiritual, and existence values—Other values

We have identified here many of the potential economic gains and losses that may be stem from the reintroduction of sea otters, and in some cases non-market values have been monetized to establish equivalencies for comparison. But as Gregr et al. (2020) point out, “the value of tourism, finfish, and invertebrates are not necessarily culturally equivalent to different communities.”

Existential qualities such as existence values, cultural or spiritual importance, and tradition or lifestyle are challenging to quantify and evaluate in a way that ensures they receive consideration comparable to that of traditional market values. But these values are deeply meaningful to people and they should factor into any equitable cost/benefit analysis. For some people, the strength of their cultural or spiritual beliefs, personal existence values, or devotion to tradition may very well outweigh the monetary considerations in question. For these reasons, we recommend that any future socioeconomic assessment on the impact of sea otter reintroduction include the equitable consideration of these non-monetary values.

4.2.1.3. Summary of needs for socioeconomic impact assessment

As noted above, the Elakha Alliance has an economic impact study underway to assess the potential economic effects of sea otter reintroduction in Oregon. It is not yet available, so we cannot comment on the potential adequacy of their study to reduce the economic uncertainties we have identified in this document. However, we do know that their study is limited in geographic scope to the Oregon coast, so at a minimum additional work will be needed to evaluate the economic impacts of sea otter reintroduction to northern California, which is also under consideration in our Assessment.

We have recommended (as has the Elakha Alliance) the development of a comprehensive socioeconomic analysis of sea otter reintroduction by experts in the field. Given the time and resources we had available, here we have attempted only to identify and describe some of the important economic considerations that should be included in such an assessment, but clearly additional data and rigorous evaluation of potential impacts specific to northern California and Oregon are needed, and many uncertainties remain.

A thorough socioeconomic evaluation will be far more accurate if we narrow the scope of the analysis to target specific geographic areas. It is not possible to do a meaningful analysis at a scale as large as the entire coast of Oregon or all of northern California. The identification of several potential reintroduction sites for evaluation and comparison would enable a detailed and far more informative economic analysis that looks at benefits and costs on a local scale, and allow us to focus on the particular cities, ports, businesses, fisheries, communities, and individuals most likely to experience the positive and/or negative effects of a reintroduction. Conducting a socioeconomic analysis at a finer scale would also provide for the identification of any disparities in the distribution of projected costs or benefits, and allow the development of possible mechanisms to ameliorate those inequities (see 5.2).

4.2.2. Stakeholder Perspectives

The genesis of the directive to develop this Assessment lies in the recognition of the sea otter's critical influence on the structure and function of the Pacific nearshore marine environment and appreciation of the ecosystem benefits that might be realized from restoring the sea otter as a keystone predator. But this perspective is not necessarily shared by all, and some coastal users are reticent at the thought of bringing sea otters back to an environment they have not inhabited within our lifetimes. Here we introduce a small sample of stakeholder perspectives on the potential for sea otter reintroduction.

4.2.2.1. U.S. Fish and Wildlife Service Stakeholder Interviews

To gather information on stakeholder perspectives specific to the consideration of reintroducing sea otters to northern California and Oregon, the Service conducted a series of one-on-one interviews with individuals from a spectrum of key stakeholder groups in those regions. For the purpose of these interviews, we defined stakeholders as those most likely to be directly affected by sea otter reintroduction or who have previously raised concerns and perceive themselves to be at risk from a reintroduction. The stakeholders we spoke with can be classified into six general groups: commercial shellfish fishers (crabbers, urchin divers); seafood supply chain/processors; recreational and charter fishers; port managers; conservation interests; and tourism/recreation interests (including wildlife viewing tours and visitor's associations). Table 4-3 provides a breakdown of the number of stakeholders we spoke with ("interviewees") in each group. We note that our pool of interviewees does not represent a random sample from each of these stakeholder groups but reflects those stakeholders who were willing and available to speak with us. Due to these limitations, the goal of these conversations was not to obtain every single perspective among all stakeholders, but rather to gather a diversity of opinions that may be present among stakeholders in Oregon and northern California. We do not claim that the opinions expressed by these individual interviewees should be viewed as representative of all members of the stakeholder groups identified here.

Table 4-3. U.S. Fish and Wildlife Service stakeholder interviews: number of interviewees by category and State.

Stakeholder group	California	Oregon
Commercial Shellfish Fishers	3	6
Recreational/Charter Fishers	3	2
Seafood Supply/Processors	3	3
Port Managers	1	2
Conservation Interests	2	3
Tourism and Recreation	1	3
Total	13	19

Many of these interviews were facilitated by the California Ocean Science Trust, a non-profit science organization engaged by the Service to assist with facilitation and information gathering for this portion of our report, as well as to develop scientific guidance for incorporating socioeconomic considerations into any possible future considerations related to sea otter reintroduction. We looked to the Ocean Science Trust for assistance based on their strong history of working in a collaborative framework to integrate sound science with policy and management decisions. U.S. Fish and Wildlife Service staff conducted some additional interviews directly as well, particularly with commercial fishers. Our goal was to be able to synthesize for Congress the full range of viewpoints, concerns, and questions from these constituencies to inform future discussions surrounding sea otter reintroduction, as well as to develop recommendations for addressing questions surrounding the feasibility of reintroduction.

This summary of stakeholder feedback from our initial interviews represents a small sample of constituents and is only the beginning of what the Service intends to be a robust stakeholder engagement process, should consideration of reintroduction continue past this report. We note in particular that we were unable to gather feedback from casual recreational shellfishers (e.g., clammers) or coastal residents who may not be associated with a particular interest group or other sector represented here. Input from Tribes was invited separately and is presented in section 4.2.3; the full text of their communications is provided in Appendix A. We also asked the States of California and Oregon if they would like to comment on the consideration of sea otter reintroduction; a summary of their responses are provided in section 4.2.4 and full text is in Appendix B.

Interviews were held either by videoconference or by telephone. The interview format was informal and conversational, and although we did not ask a specific prescribed set of questions to each interviewee, we did use several questions to prompt discussion and ensure that we heard the views of each stakeholder on the same general topics. Prompt questions included: What is your reaction to the concept of restoring sea otters to the Pacific coast? Do you see any potential benefits of a reintroduction? Do you see any potential negative effects of a reintroduction? What would a successful reintroduction look like to you? Could you foresee a future condition in which you might coexist with sea otters long-term? If so, what would that condition be?

We heard from people representing a wide range of experiences and viewpoints, but the primary suggestions, concerns, interests, and requests for further information that we gathered from our conversations can be distilled into several common themes, as follows.

4.2.2.1.1. Summary of Stakeholder Perspectives

4.2.2.1.1.1. Need for a clear management plan prior to reintroduction

The single most commonly mentioned concern across all stakeholder categories was the need to have a comprehensive management plan in place prior to the release of any animals. Most interviewees called for advance contingency planning – stakeholders desired a solid backup plan to address problems if the reintroductions did not go as expected. For some this meant setting a clear threshold for determining success or failure of the reintroduction, so as to know when further investment was no longer needed. For others – primarily representatives associated with shellfisheries -- this meant setting a cap on the number of animals and having the ability to manage the population if the sea otter population exceeded that cap. Many of the interviewees, especially those from Oregon, specifically identified the Marine Mammal Protection Act as an impediment to management of sea otters in the future and pointed to the present inability to effectively manage sea lions as an example of the constraints imposed by that law. Some of the interviewees from California expressed distrust of the Federal government to effectively manage sea otters, and specifically pointed to the failure of the zonal management program associated with the translocation of sea otters to San Nicolas Island as an example. Those who voiced fears of unintended consequences, particularly with regard to potentially negative impacts on shellfish fisheries, felt it was risky to proceed with a reintroduction without the authority or capacity to assert population control measures should those impacts be realized.

Nearly all interviewees acknowledged appreciation for the known ecosystem benefits of sea otters as well as their general appeal, and many offered suggestions as to conditions under which they might consider reintroduction to be acceptable. Some pointed to the history of sea otter population control (e.g., culling) by indigenous peoples as an example of a successful approach on a local level that allowed for the coexistence – albeit spatially separated -- of sea otters and viable shellfish fisheries (e.g., Goldman 2021, Slade et al. 2021). Several stakeholders concerned about potential negative impacts on shellfish fisheries offered that they might be amenable to a reintroduction of a small number of sea otters, but only on the condition that some mechanism was in place to control the numbers if they exceeded a certain limit. Some suggested that as a compromise to allow reintroduction the public might have to be willing to accept the culling of sea otters if their numbers rose too high,[23] even as they acknowledged that this was an undesirable outcome and bound to be unpopular.

Many of the interviewees, particularly those associated with recreational fisheries, conservation, tourism, and recreation, were pleased at the prospect of a reintroduction and viewed it as a proactive step toward enhancing ecosystem resiliency, as well as restoring the sea otter to its rightful place in the coastal environment. Several individuals from these constituencies also identified the importance of

[23] Authorizing culling under the Marine Mammal Protection Act would be extremely challenging.

having a solid management plan in place prior to any translocations occurring. They generally did not share concerns regarding potential negative impacts to shellfish fisheries and did not view limiting sea otters numbers as likely to be necessary, but they stressed the importance of everyone knowing in advance what actions will be taken under certain situations, so that there would not be any surprises or last-minute scrambles to try to address unforeseen circumstances.

Many of the stakeholders who expressed support for sea otter reintroduction were sensitive to the dependence of many small coastal communities on fishery resources and the apprehensions that many would feel at the return of sea otters, even if they themselves did not think that significant negative impacts were liable to occur.

4.2.2.1.1.2. Possible negative impacts on shellfish resources

Sea otter eating crab. Photo by David Ledig, Bureau of Land Management.

All interviewees who made their living in commercial shellfish fisheries or associated industries (seafood processing and supply chain, ports) expressed misgivings over the idea of reintroducing sea otters and what it might mean for their livelihoods and their culture. The high quantities of shellfish consumed by sea otters and their potential to reduce or eliminate shellfish resources were the primary sources of concern. Many of those interviewed brought up the example of sea otters reintroduced to southeast Alaska, pointing out that they now number in the tens of thousands and have significantly impacted the Dungeness crab fisheries in that region. Several of the fishers from Oregon explained that they had experienced firsthand the loss of Destruction Island in Washington as a lucrative and dependable crabbing ground after sea otter numbers increased. Fishers from northern California voiced concerns over potential impacts to already depleted and collapsed abalone and red sea urchin fisheries, adding that reintroducing a voracious predator into a degraded kelp forest ecosystem would be detrimental to the recovery and survival of red abalone and red sea urchins. Fishers were proud of the sustainable management of the Dungeness crab fishery, and voiced doubt that it would remain so once sea otters began indiscriminately eating crabs of any size or sex and in any season. Several interviewees mentioned the "trickle down" effects to coastal economies should negative impacts result from declines in shellfish fisheries, and from Dungeness crab in particular, as that fishery allows for much of the seafood processing operations to continue year-round.

These stakeholders wanted a better understanding of how many sea otters were likely to be introduced and what kind of population growth and expansion could be expected. They asked for more specific and data-driven analyses of the projected effects of sea otter populations on Dungeness crabs, red sea urchins, red abalone, and oyster farms, based on the experiences from areas where sea otters occur or have recolonized. Several of those interviewed were familiar with recent studies from California that showed no negative effects on Dungeness crab catch in association with sea otters (Grimes et al. 2020, Boustany et al. 2021) but expressed skepticism at the results. Some noted that the geographic area where those studies occurred is at the southern end of the Dungeness crab's range and wondered whether greater impacts would be observed in an area where Dungeness crab are more plentiful.

Several interviewees representing commercial fishers mentioned that the timeframe of potential impacts was unimportant to them; even if they did not personally experience any negative effects on the fishery, they wanted to ensure that the fishery survived for future generations. The culture and tradition of the fisheries for crab, urchins, and abalone was of intrinsic worth to many of these stakeholders, and several shared that they felt the value of their culture was being overlooked. Some fishers specifically mentioned the research of Gregr et al. (2020) as an example of how the value of fisheries to those who make their living by it is dismissed, by implying it is unimportant in the scheme of things when compared to potential gains from sea otters and ecotourism.

The majority of all interviewees expressed appreciation for sea otters and acknowledged both their known positive effects in terms of kelp restoration and ecosystem function as well as their charismatic appeal but felt these potential benefits did not outweigh the potential impacts and they saw no compelling reason to reintroduce them. Many of the stakeholders questioned why recolonization by sea otters had not already occurred and stated that they would be more accepting of a natural range expansion. A few stakeholders, especially those associated with the urchin fishery, stated that they could see no benefit whatsoever to reintroducing sea otters.

4.2.2.1.1.3. Cumulative impacts on fisheries

Many of the stakeholders representing fisheries interests or ports mentioned the hardships and management challenges that were already being experienced by both commercial and recreational fishers. These stakeholders cited to negative impacts on the abundance of target species as a result of climate change (warming water temperatures, hypoxia, acidification) as well as an accumulation of regulatory constraints on where or how they can fish. Specific examples cited by Oregon fishers include recent changes to the depth limits for the Dungeness crab fishery intended to reduce whale entanglement in fishing gear and fishing prohibitions and harvest restrictions within marine reserves and marine protected areas. There were concerns that additional geographic restrictions might accompany the future development of offshore wind power, currently under consideration for the Oregon coast. This set of stakeholders viewed the reintroduction of sea otters as yet another setback to their ability to conduct business. Interviewees from Oregon expressed apprehensions about the potential for accidental harm or mortality to sea otters from entanglement or entrapment in fishing nets or pots, and whether that might result in penalties, additional gear restrictions, or both; interviewees from California cited to restrictions they had already experienced, such as setting nets further offshore. There were also concerns about additional restrictions or regulatory requirements that might result from the presence of yet another marine mammal that could delay in-water construction projects or interfere with shipping. This group felt that they were already over-regulated, and that sea otters would only further complicate matters.

Stakeholders from other constituencies, especially individuals from conservation interests, recreation, and tourism, stressed that ocean resources are a public trust, and that the fishers who utilize these public resources for private gain are regulated to ensure the sustainability of those resources for the benefit and enjoyment of all. Some of these interviewees cited the example of marine reserve areas in Oregon and pointed out that despite opposition to the establishment of these areas and claims by fishers that they would result in economic harm, negative impacts have not been realized. Several interviewees acknowledged the concerns voiced by commercial shellfish fishers but asserted the opinion that the potential for negative impacts, especially to the Dungeness crab fishery, was likely low. They noted that at most some localized impacts were possible. Some shared the opinion that shellfish fisheries have been artificially inflated by the absence of sea otters, and that some adjustments in harvest might be expected over time as the system is restored to its natural equilibrium, but if sea otter populations grew and expanded slowly this could be accommodated through gradual reductions in permits granted.

4.2.2.1.1.4. Kelp forest restoration and ecosystem resiliency

Southern sea otter eating purple sea urchin. ©Joe Tomoleoni, used with permission.

The majority of interviewees were familiar with the well-established keystone predator role of sea otters in rebuilding and maintaining resilient kelp ecosystems through control of urchin populations and understood the rationale behind sea otter reintroduction as a strategy to restore kelp forests on the northern California and Oregon coasts. Most stakeholders representing recreational and charter fisheries, tourism, conservation interests, and some port managers expressed support for reintroducing sea otters to restore the integrity of the nearshore marine community and realize the many ecosystem services provided by sea otters. The potential for sea otters to rein in the explosion of purple sea urchin populations and thereby contribute to the restoration of the kelp forests that have experienced dramatic losses in recent years was of particular interest. Some recreational and charter fishers were appreciative of the beneficial effects that sea otters would have on finfish species that they focus on, including salmon, lingcod, and especially rockfish. Some stakeholders expressed appreciation for the indirect benefits of sea otters on the resiliency of kelp forest ecosystems, which would enhance the ability of these systems and associated species to respond to the impacts of climate change.

Multiple stakeholders from commercial and recreational fisheries and conservation interests – particularly in northern California – questioned whether sea otters would have the restorative effects hoped for in kelp forests that had been reduced to urchin barrens. These interviewees believed that sea otters would ignore non-gravid purple sea urchins and instead prey on crabs or other shellfish, leaving the kelp deforestation issue unaddressed. These concerns were generally followed up by further concerns of sea otters impacted recovering abalone and red sea urchins. They suggested that sea otters might be capable of maintaining function in the ecosystem over the long term once the initial causes of kelp collapse had been addressed, but not now while the ecosystem is already degraded.

4.2.2.1.1.5. Tourism and wildlife viewing benefits

Sea otters were recognized by nearly all stakeholders interviewed as being charismatic animals that hold strong appeal for many people. Stakeholders representing tourism, recreation, conservation interests, and some ports felt there would be benefits to coastal communities due to the presence of sea otters. These stakeholders believed that sea otters would be a strong draw for visitors to the coast, which could result in economic gains to businesses in the hospitality industry (restaurants and lodging) as well as tour operators, especially those specializing in wildlife viewing tours or kayak rental operations. A few of the Oregon charter fishers felt there could be some added appeal for their customers, many of whom come from out of State; these fishers felt that the presence of sea otters would add to the authentic wild nature of the Oregon coast experience.

4.2.2.1.1.6. Existence value

Many of the stakeholders representing tourism, recreation, and conservation interests were excited at the prospect of restoring sea otters and "making the ecosystem whole again." Some interviewees mentioned a sense of personal satisfaction in knowing that progressive actions were being considered to return a species that had been eliminated through anthropogenic causes to its rightful place in the marine environment. They also mentioned that this was the type of non-monetary value that often gets overlooked in evaluating actions such as reintroductions.

The importance of assessing non-monetary values was also mentioned by stakeholders in the fisheries groups, who felt that the cultural or worth of the fishery to their personal sense of tradition was not sufficiently valued.

4.2.2.2. Other stakeholder concerns and perspectives

The Elakha Alliance Draft Feasibility Study presents an overview of stakeholder concerns and perspectives regarding sea otter reintroductions, including a report from a stakeholder meeting addressing conflicts with shellfish fisheries in southeast Alaska (USFWS 2020). They also review an unpublished 2019 report on stakeholder opinions specific to the potential reintroduction of sea otters to Oregon (Curran et al. 2019; Appendix E provides the report in its entirety), which we briefly summarize below. For a good discussion of the importance of stakeholder engagement in these processes and more detail on these other reports, we refer readers to Chapter 11 of the Elakha Alliance Draft Feasibility Study: https://www.elakhaalliance.org/feasibility-study/chapter-11-stakeholder-concerns-and-perspectives/. For an excellent review of the history of stakeholder concerns and perspectives related to southern sea otters in California, we recommend Carswell et al. (2015) and for British Columbia, Burt et al. (2020).

For the purposes of comparison with the outcome of our stakeholder interviews, here we present a very brief synopsis of the survey results from Curran et al. (2019). Surveys asking a series of questions designed to gauge general perceptions related to the possibility of reintroduce sea otters to the Oregon coast were sent to the following stakeholder groups: Elakha Alliance Board members, environmental advocacy groups, staff from Pacific shellfish advocacy and research organizations, board members of Oregon's Ocean Policy Advisory Council, local governments on marine policy issues, commissioners for Oregon's Department of Fish and Wildlife Commission, the Oregon Trawl Commission, the Oregon Salmon Commission, and the Oregon Dungeness Crab Commission. A total of 49 stakeholders responded to the survey.

Despite the differences in methodology, many of the results from the survey administered by Curran et al. (2019) are quite similar to those from our stakeholder interviews (4.2.2.1.1). The most common negative outcomes perceived were harm to fisheries or reductions to certain sea otter prey species (n = 15) and loss of access to marine areas as a result of Federal, State and local regulations related to sea otters (n = 4). For positive outcomes, most frequently cited was the improvement in nearshore marine ecosystem health and the restoration of a balanced ecosystem (n =27), followed by increased tourism (n =24) and positive impacts on kelp (n = 23). Overall, a majority of respondents (88%) supported reintroducing sea otters to Oregon to some degree; 2% were somewhat opposed; and 10% strongly opposed reintroduction. Commercial fishers were the only group with less than a majority expressing some degree of support for reintroduction.

Additionally of interest from this survey is information regarding attitudes toward potential source populations. The majority of respondents indicated that the genetic similarity of reintroduced sea otters to those that occurred on the Oregon coast prior to their extirpation was moderately to extremely important (n=47). Nearly half of respondents (46%) favored the concept of using a combination of wild-captured sea otters and rehabilitated stranded pups as a source for any reintroduction, and a similar proportion (52%) indicated they were concerned over potential losses that might be experienced by the founding population (7% were extremely concerned). Finally, the degree to which the reintroduction program might contribute to the conservation needs of other sea otter populations was important to the majority of respondents (89%) (Curran et al. 2019).

4.2.3. Tribal Perspectives

We invited all federally-recognized Tribes on the coasts of northern California, Oregon, and Washington to share their perspectives on the potential reintroduction of sea otters. We received responses from six Tribes: one in northern California, three in Oregon, and two in Washington. Tribes within the area under consideration for sea otter reintroduction in California and Oregon were generally supportive, with some advocating strongly for the effort. Tribes outside of the area of consideration in Washington were not supportive or even opposed. For a full understanding of the perspective of each Tribe, we direct the reader to the full text of their communications to the Service in Appendix A.

The Wiyot Tribe in northern California expressed appreciation for the sea otter as a key ecological predator that helps to maintain healthy kelp forests by controlling sea urchins, and was hopeful that reintroduction could help to restore kelp forests within Wiyot ancestral lands and along the west coast. They also noted the historical value of sea otters to the Tribe as an important food and pelt resource. The Wiyot characterized the idea of reintroduction as exciting and hopeful, and expressed support.

The Coquille Indian Tribe of Oregon expressed cautious support for the concept of reintroduction, but also voiced some concerns and a need for better understanding of the potential ecological and economic impacts of reintroduction. They describe their Tribe's historical use of coastal resources, and note that the sea otter is culturally significant to them as a traditional food resource and for its pelt. The Coquille Indian Tribe describes the importance of the sea otter as a keystone species and its fundamental role in maintaining ecological balance and function in the coastal ecosystem, in particular the restoration of kelp forests. They note that kelp beds contribute to supporting species of importance to the Tribe, including herring (which in turn support salmon), and that long-term all coastal flora and fauna may benefit from the restoration of the sea otter as a native species. However, they also express caution regarding the environmental changes that are being witnessed in coastal systems, and want to better understand the implications of sea otter reintroduction in terms of potential depredation on other at-risk culturally significant species. They also stated the need for better understanding of the potential impacts on the Oregon coast economy, particularly the commercial and recreational shellfish fisheries.

The Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw River Indians (CTCLUSI) in Oregon expressed strong support for the return of sea otters to the Oregon coast. They describe a feeling of kinship with the sea otter, as what was once an important part of the ocean environment and the lives of coastal Indian people. They acknowledge that if successful, the reintroduction of sea otters may ultimately impact commercial, sport, and subsistence gathering of shellfish and affect associated businesses. Furthermore, they anticipate resistance from those who feel fishing opportunities will be reduced. Despite this, the CTCLUSI specifically articulate the desire to once again see healthy populations of sea otters and their positive effects on kelp ecosystems through reduction of unbalanced sea urchin populations, and are highly encouraging of a reintroduction effort.

The Confederated Tribes of the Siletz Indians (CTSI) in Oregon expressed vigorous support for the re-establishment of a viable sea otter population to the Oregon coast, and described the concept as exciting and encouraging. They describe the great importance of the sea otter to the CTSI as an essential keystone species with both ecological and cultural significance, and point to its critical role in terms of enhancing the resiliency of kelp forests as well as creating the conditions for the establishment of those forests, creating a nutrient base for the food chain, and providing nursery habitat for numerous species. They additionally described the formerly continuous distribution of sea otters along the Oregon coast, and the importance to genetic diversity of restoring connectivity between the northern and southern populations. The CTSI describe their deep commitment to the protection, enhancement, and restoration of western Oregon habitats and resources, and view the reintroduction of sea otters as a significant opportunity to have a positive impact on the nearshore marine ecosystem. They describe the sense of loss at the absence of the sea otter on the Oregon coast, and encourage reintroduction for cultural and ecological reasons, to build resilience against climate change effects, and to restore the lost historical connection with sea otters for all of the people of Oregon.

The Quinault Indian Nation in Washington expressed opposition to the idea of reintroducing sea otters, and cited the lack of understanding and consideration by Federal agencies of unintended and adverse consequences. They describe the history of tribal peoples actively maintaining balance in coastal ecosystems to protect kelp forests and all species that are important to them for trade, cultural use, and subsistence. While acknowledging the sea otter's keystone role to support kelp systems and in turn fish, crab, and shellfish, they also expressed concern over potentially severe ecological, social, and economic consequences of sea otters if not managed. In particular they cite to the reintroduction of sea otters to Washington State without involvement or consent of tribal co-managers, and describe losses to Dungeness crab and razor clams that threaten the viability of these species for commercial, cultural, and subsistence use for their communities. They state that laws and regulations intended to protect marine mammals prevent native peoples from exercising their cultural means of removing sea otters to restore and maintain ecological balance. The Quinault Indian Nation expressed concern that the reintroduction of sea otters off the Oregon coast will result in their expansion northward into southern Washington, which would affect their tribal treaty rights and interests, and stated the need for consultation before any decisions are made.

The Makah Tribe in Washington acknowledged the benefits to coastal ecosystems of reintroducing sea otters, but argued strongly for consideration of how populations will be managed once they become established. They provide several specific examples of negative impacts of sea otters on shellfish resources, including from their own experience with a sea urchin fishery in Neah Bay. The Makah describe a fishery that once supported a number of families in their community but that became economically inviable after sea otters colonized the area. They also describe impacts to the Dungeness crab and razor clam fisheries for the Quinault and Quileute Tribes in Washington, as well as reductions in various shellfish fisheries including chiton, sea cucumber, Dungeness crab, red urchin, and geoduck clams experienced by communities in southeast Alaska. They state that any plan to introduce sea otters back into the ecosystem will not be complete without considering that historically balance was maintained by tribal hunting of sea otters, and that such a plan could again allow sea otters to provide important ecological benefits without incurring the soecioeconomic impacts to coastal communities that have been observed where sea otter populations are unmanaged. They discourage the consideration of reintroducing sea otters to Oregon and northern California if a plan to manage the sea otter population cannot be established.

4.2.4. State Perspectives

We invited the State Departments of Fish and Wildlife for California and Oregon to share their perspectives on the potential reintroduction of sea otters to the Pacific coast. The California Department of Fish and Wildlife declined to provide a formal position statement at this time. The Oregon Department of Fish and Wildlife (ODFW) shared their views with us; their letter is provided in full in Appendix B.

In short, ODFW voiced their support for studying the feasibility of reestablishing sea otters in Oregon. They particularly encouraged a transparent study on the ecological effects of reintroduction as well as social effects on Tribes, coastal communities, recreational and commercial fishing industries, other ocean users and economies. ODFW acknowledged the potential positive effects of sea otters on the marine ecosystem as well as their significant cultural meaning for Tribal Nations, and stressed need for additional information regarding the potential ecological and social effects to determine the suitability of reintroducing sea otters to Oregon.

4.2.5. Summary of Socioeconomic Feasibility

The potential socioeconomic impacts of restoring sea otters to northern California and Oregon represents the greatest uncertainty with regard to the feasibility of reintroduction. For this reason, we carry socioeconomic impacts over for consideration in our Risk Assessment (section 5).

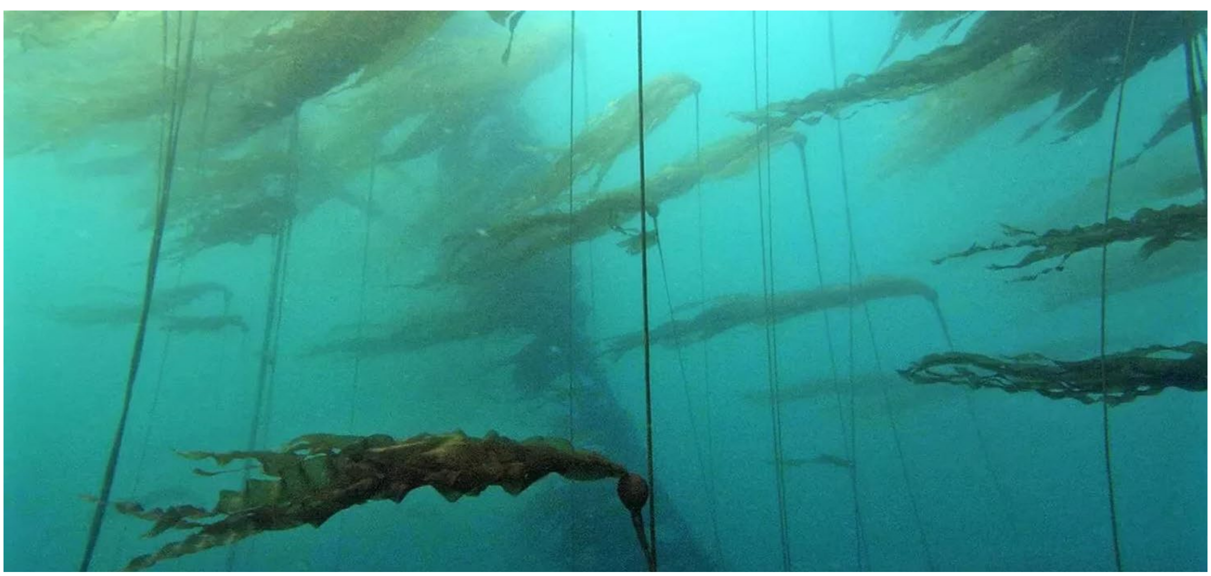
Here we have identified those factors, both positive and negative, that require further evaluation to inform the continued consideration of sea otter reintroduction. We also identify areas of particular concern or interest based on feedback from stakeholder groups. We note that the factors identified here may not necessarily be all inclusive, and additional considerations may be identified for incorporation into any future analysis.

Potential negative impacts or concerns include:

- Economic impacts resulting from potential reduction in commercial and Tribal shellfish harvest in areas of overlap, including but not limited to red sea urchins, Dungeness crab, and clams
- Economic impacts from potential losses to oyster aquaculture operations
- Economic impacts from potential reduction in shellfish available to recreational users, including Dungeness crab, red abalone, and clams
- Additional time and administrative effort required to comply with regulatory requirements due to the presence of sea otters, such as the requirement to secure additional authorizations under the MMPA for marine construction projects
- Regulatory restrictions that may be imposed to avoid harm to sea otters, e.g., prohibitions or restrictions on fishing net set areas
- Lack of authorization for incidental take in the course of commercial fishing operations under the Marine Mammal Protection Act (applies only if southern sea otters are utilized for reintroductions)
- Impacts on other species of cultural importance to Tribes
- Impacts to cultural values of traditional shellfish fishers

Potential positive impacts or opportunities identified include:

- Recognition of the sea otter's keystone role in the ecosystem and restoration of ecological balance, especially to kelp systems
- Ecosystem services that combat the negative effects of climate change as a result of increased biomass and productivity of restored kelp forests and seagrass beds, including:
    - Increased capacity for carbon sequestration
    - Reduced ocean acidification on a local level
    - Physical protection from coastal erosion
- Benefits to finfish fisheries (commercial, recreational, Tribal) from provision of nursery habitats and increases in abundance and diversity of species such as rockfish, cod, herring, and salmon
- Economic gains from increased ecotourism dollars to coastal communities, including, e.g., wildlife viewing charters, kayak rentals, hospitality industry, photography
- Benefits to recreational users (e.g., recreational divers) from increased biodiversity of the nearshore marine environment
- Re-establishment of connectivity and enhanced gene flow, diversity for sea otter populations
- Deepfelt cultural value and traditional significance to California and Oregon Tribes
- Existence values –inherent satisfaction in knowing sea otters have been restored to their native ecosystems within their historical range; atonement for near-extinction due to the fur trade
- Designation as an experimental population under section 10(j) of the Endangered Species Act provides an opportunity to remove prohibitions that might impede public acceptance (applies only if southern sea otters are considered as a source)



Bull kelp. NPS photo.

4.3. Legal Feasibility

Here we briefly review the relevant statutes, regulations, and permit requirements or authorizations that may be relevant to the reintroduction of sea otters under various potential scenarios. We begin with a review of the Federal laws that would apply under all circumstances (Marine Mammal Protection Act, National Environmental Policy Act, Coastal Zone Management Act, Magnuson-Stevens Fishery Conservation and Management Act, and Animal Welfare Act), and subsequently address those laws or requirements that would apply only under special circumstances (e.g., involving sea otter source populations listed under the Endangered Species Act). Legal requirements and authorizations may differ depending on whether source animals are captured from the wild or supplied by a rehabilitation facility, listed under the Endangered Species Act, or considered depleted under the Marine Mammal Protection Act, as well as other considerations. We additionally briefly review the role of the States that could serve as sources of founder animals for reintroductions.

Additional requirements would apply if sea otters were to be sourced from outside of the United States (e.g., from British Columbia, Canada) and would add further layers of complexity to what is already an involved and protracted regulatory process. As we have determined that there is no shortage of animals within the United States that would serve as appropriate sources for reintroduction, we do not consider international import of sea otters in this Assessment; therefore, in this section we do not discuss CITES (Convention on International Trade in Endangered Species) or other authorities that would be involved in the international movement of sea otters.

Table 4.3-1 at the end of this chapter provides a summary of all Federal authorizations that we estimate would be applicable for various activities related to sea otter reintroduction; however, which of these would ultimately be required will depend upon the specific circumstances of any reintroduction.

4.3.1. Marine Mammal Protection Act of 1972, as amended [16 U.S.C. § 1361 et seq.]

The Marine Mammal Protection Act (MMPA) was enacted on October 21, 1972. This legislation was innovative in that it focused on preserving marine ecosystems, and particularly on the role of marine mammals in maintaining ecosystem function. Section 1361 of the MMPA sets forth the findings and declaration of policy behind the statute, which specifically stipulate that marine mammal species or stocks "should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part."

As directed by Congress,the primary objective of the MMPA is that marine mammal management should be to maintain the health and stability of the marine ecosystem and, when consistent with that objective, to maintain optimum sustainable populations of marine mammals. The MMPA defines an optimum sustainable population (OSP) [24] as "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." The statute further declares that "measures should be immediately taken to replenish any species or population stock which has already diminished below that population."

[24] See section 3 of the MMPA, 16 U.S.C. § 1362, for all definitions.

The MMPA gives jurisdiction over the sea otter to the Secretary of the Interior as administered by the Service.[25] The MMPA also created the Marine Mammal Commission as an independent advisory agency to provide review of actions taken under the Act and make recommendations for implementation (16 U.S.C. § 1401 et seq.).[26]

As marine mammals, all sea otters of the United States are protected under the MMPA. Southern sea otters (subspecies *E. l. nereis*) and the southwest Alaska Distinct Population Segment (DPS) of northern sea otters (*E. l. kenyoni*) are also federally protected under the Endangered Species Act of 1973, as amended (ESA; 16 USC 1531 et seq.). It is important to note that the ESA protections are independent of, and additive to, MMPA protections (this is discussed further below). The protections of the MMPA apply to all marine mammals subject to U.S. jurisdiction, regardless of whether those marine mammals are listed under the ESA. However, for species or stocks considered "depleted" and/or "strategic" under the MMPA, additional protections and special conservation considerations apply. As defined by the statute, any species or population of marine mammal listed as threatened or endangered under the ESA is considered *depleted*. Further any marine mammal species or stock listed under the ESA or otherwise designated as depleted under the MMPA is considered a *strategic stock.*[27] In addition to a stock or species being considered depleted by virtue of it being listed as threatened or endangered under the ESA, it may also be considered depleted if it is below its OSP level.

The MMPA includes a prohibition of unauthorized take of marine mammals in U.S. waters and by U.S. citizens on the high seas. *Take* under the MMPA means:

> to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.

The term *harassment*, as applied to activities other than those for military readiness or Federal scientific research, is further defined under the MMPA as any act of pursuit, torment, or annoyance, which —

1. has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or
2. has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

[25] As specified in 16 USC 1362, section 12(A), the Secretary of the department in which the National Ocean and Atmospheric Administration (NOAA) is operating [currently Commerce] holds authority for all members of the order Cetacea (i.e., whales, dolphins, and porpoises) and members of the order Pinnipedia other than walruses (i.e., seals and sea lions). All other marine mammals (i.e., sea otters, walruses, manatees, dugongs, polar bears) fall under the authority of the Secretary of the Interior via the Service.

[26] Among other things, the Commission is to make recommendations to the Secretary and other Federal officials on steps needed for the protection and conservation of marine mammals and to further the policies of the MMPA. Federal officials that do not follow any Commission recommendation are required to provide the Commission with a detailed explanation of the reasons for non-adoption.

[27] Strategic stocks may also refer to any marine mammal stock for which the level of direct human-caused mortality exceeds the potential biological removal level, or which is declining and likely to be listed as a threatened species under the ESA within the foreseeable future.

A marine mammal *stock* is defined in the MMPA as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that can interbreed when mature.

Direct take (e.g., intentional killing) of a marine mammal is prohibited, with the exception of narrow purposes specified in the MMPA, such as defense of self and others; subsistence and the creation and selling of authentic native articles of handicrafts and clothing by certain Alaskan coastal natives; or as otherwise authorized under section 104 of the MMPA. Exceptions to the take prohibitions of the MMPA may be provided by a variety of specific exemptions, authorizations, or permits. For example, direct (i.e., intentional) take of marine mammals may be permitted for the purposes of scientific research or activities that enhance the survival or recovery of a species. The capture of sea otters for the purpose of reintroduction would constitute direct take and would therefore require authorization under the MMPA (see 4.3.1.1, below).

Incidental take under the MMPA is take that is accidental or unintentional. Under section 101(a)(5) of the MMPA, take that is incidental to an otherwise lawful activity other than commercial fishing may be authorized if it occurs in a specified geographic area and involves only a small number of marine mammals; will not have more than a negligible impact on the species or stock under consideration; and will not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses by coastal-dwelling Alaska Natives.[28] Taking is subject to the requirement that it will occur by means that have the least practicable impact on marine mammals. Authorization for non-commercial fishery activities such as construction projects, scientific research projects, oil and gas development, and military exercises may be in the form of either an Incidental Harassment Authorization (IHA) or a Letter of Authorization (LOA) under an Incidental Take Regulation, depending on the type of take anticipated; incidental harassment authorizations cannot authorize lethal take.

The incidental take of marine mammals during commercial fishing operations is addressed separately under section 118 of the MMPA (and 101(a)(5)(E) for ESA-listed species) (16 U.S.C. § 1387). Owners of U.S. vessels or foreign vessels with valid fishing permits issued in accordance with section 204(b) of the Magnuson-Stevens Fishery Conservation and Management Act that have obtained the necessary authorizations and meet the requirements of section 118 of the MMPA are not subject to penalty for incidental take of marine mammals that may occur in the course of their fishing operations. Fishing vessel owners also have a duty to report any incidental injury or mortality of a marine mammal that may occur as a condition of this authorization. A separate, additional authorization under MMPA section 101(a)(5)(E) is required for the incidental taking of marine mammals listed as endangered or threatened under the ESA.

An additional, important caveat is that "California sea otters" are explicitly excluded from coverage under the commercial fisheries incidental take authorizations in both sections 101(a)(5)(E)(vi) and 118(a)(4). In other words, authorization of incidental take of California sea otters (i.e., southern sea otters) in the course of commercial fishery operations cannot be provided under sections 101(a)(5)(E)(vi) and 118(a)(4) of the MMPA, regardless of where those otters occur or their ESA listing status. (These provisions of the MMPA pertain only to southern sea otters, and they operate independent of the otter's listing status under the ESA. Therefore, these provisions would remain in effect even if the southern sea otter is no longer listed as a threatened species under the ESA. These provisions would also apply if southern sea otters were translocated outside of California).

[28] The terms "negligible impact," "small numbers," and "unmitigable adverse impact" are defined in the Code of Federal Regulations at 50 C.F.R. § 18.27.

It is worth noting lessons learned from another law that was passed specific to the southern sea otter, Public Law 99-625 (PL 99-625). PL 99-625 was intended to provide for the translocation of southern sea otters associated with the effort to establish an additional population at San Nicolas Island, detailed earlier in this document in section 2.4.1.2., and it included provisions for zonal management. As described in Box 4.1, the Service advises against any future attempts to manage sea otters in this manner.

Section 109 of the MMPA (16 U.S.C. § 1379) retains management authority for all marine mammals at the Federal level and prohibits State enforcement of State laws or regulations relating to the take of marine mammals, unless management authority is transferred to the State by the Secretary [of the Interior or Commerce]. This section also provides a procedure whereby States may request the transfer of management authority; however, no State currently possesses this authority. Management authority for all marine mammals thus remains vested with the U.S. Fish and Wildlife Service or the National Oceanic and Atmospheric Administration (NOAA), depending upon the marine mammal species in question.

4.3.1.1. Permits or authorizations required or allowed under the MMPA

Because all sea otters are protected under the MMPA, the capture, holding, handling, transport and ultimate introduction back into the marine environment would constitute direct take and require authorization under the MMPA. Such authorization would be required regardless of whether wild sea otters are captured for translocation or animals from a captive holding or rehabilitation facility are reintroduced to the wild. Authorizations to non-Federal parties are issued by the U.S. Fish and Wildlife Service's Branch of Permits in the Division of Management Authority, a part of the International Affairs Program. The Federal permit required under the MMPA for the capture, transport, or release of wild sea otters for the purposes of establishing a new population would be accomplished through Application Form 3-200-43, as sea otter reintroductions would be for the purpose of enhancing the survival or recovery of a species or stock under section 104(c)(4) of the MMPA. The reintroduction of animals from a rehabilitation facility within the U.S. for the purpose of establishing a new population would similarly need such a permit[29]. If the source animals are from a population listed under the ESA, additional authorization would be required under that statute (see ESA, below). In practice the Division of Management Authority issues permits that combine authorizations under both the MMPA and ESA when addressing ESA-listed marine mammals. The issuance of an enhancement permit under the MMPA requires notice in the Federal Register and an opportunity for public comment, as well as consultation with the Marine Mammal Commission.

Once released into new areas, reintroduced sea otters would receive the full complement of protections afforded all marine mammals under the MMPA. Permits could be authorized to allow some exceptions to the protective measures of the MMPA, such as direct take for the purposes of scientific research. Additionally, the Service may authorize any take that might occur that is not directed at the sea otters themselves (i.e., incidental take) through either an IHA or LOA issued under incidental take regulations

[29] The transport and release of captive-held animals for individual welfare purposes, such as stranded sea otters that are released back into the wild by permitted rehabilitation facilities, is usually accomplished through a Letter of Authorization.

BOX 4.1. PUBLIC LAW 99-625 AND ZONAL MANAGEMENT OF SEA OTTERS

Public Law No. 99-625 ("PL 99-625;" November 7, 1986) is a Federal law that was passed for the express purpose of providing for the translocation and establishment of an experimental population of southern sea otters in California. The passage of PL 99-625 was necessary because, at the time, the MMPA authorized "take" of sea otters for limited purposes (e.g., scientific research), but there was no provision to authorize take for the purpose of enhancing the survival or recovery of a marine mammal species or stock. A new law was needed to allow for the purposeful capture, transport, and release of southern sea otters in an attempt to establish an experimental population to increase the range and redundancy in populations of the species. Furthermore, public acceptance of any endeavor to establish a new population of sea otters required some mechanism to address concerns over potential conflicts with fisheries. The Service used this law to translocate southern sea otters to San Nicolas Island, the most remote of southern California's Channel Islands, beginning in 1987.

PL 99-625 specified that, "The Secretary [of the Interior] may develop and implement, in accordance with this section, a plan for the relocation and management of a population of California sea otters from the existing range of the parent population to another location." Further, the law required that any such plan identify both a translocation zone (to which the sea otters would be moved) and a management zone (*aka* the "no otter" zone). The intent of the management zone was to contain the experimental population within the translocation zone, and to prevent, as much as possible, conflicts with fishery resources. The law required the Service to use all feasible non-lethal means and measures to capture any sea otter found within the management zone and return it to either the translocation zone or to the range of the parent population.

The translocation program initiated under PL 99-625 ended in 2012 (77 FR 75266; December 12, 2012). The final rule terminating the program stated that attempts to limit natural range expansion of the sea otters was disrupting their normal seasonal patterns of movement and hindering recovery. Furthermore, the rule concluded that capturing and moving sea otters out of a "no otter" management zone had proven ineffective as a long-term management action, largely because of the difficulties inherent in sea otter capture, the ability of sea otters to return rapidly to the management zone, and elevated mortality associated with the holding, transport, and release of sea otters. Ultimately the program was deemed incompatible with the recovery goals for the southern sea otter, and zonal management was abandoned.

Although PL 99-625 is still law, based on our experience with zonal management, the Service advises against any attempt to claim or pledge that sea otters will stay within any specific geographic area, or commit to the indefinite capture and removal of sea otters, as a means of addressing any stakeholder concerns that may arise regarding a possible future reintroduction.

pursuant to the provisions of section 101(a)(5) of the MMPA (except for incidental take that occurs in the course of commercial fishing operations, which is addressed separately; see below). Incidental take authorizations may be approved if the take would be of small numbers, has no more than a "negligible impact" on the species or stock, and does not have an "unmitigable adverse impact" on the availability of the species or stock for subsistence uses. IHAs and incidental take regulations (as well as LOAs) must first be noticed in the Federal Register and are subject to public comment.[30]

Incidental take of marine mammals in the course of commercial fishing operations is handled differently and is covered through the issuance of Marine Mammal Authorization Certificates[31] for permitted commercial fishers on an annual basis (MMPA Section 118, 16 U.S.C. §1387). As noted earlier, the southern sea otter[32] is specifically excluded from this exemption program. The issuance of Marine Mammal Authorization Certificates does not require notice in the Federal Register, and there is no associated public comment period.

4.3.2. The National Environmental Policy Act of 1970, as amended [42 U.S.C. § 4321 et seq.]

The National Environmental Policy Act (NEPA) requires all Federal agencies to assess the environmental and related social and economic effects of their proposed actions prior to making decisions and provide opportunities for public involvement through review and comment. This obligation applies to all major Federal actions--those implemented, funded, licensed, or authorized (permitted) by a Federal agency. NEPA is not required at the stage at which a project is merely contemplated or considered, but comes into play if the project proceeds to the formal proposal stage.

Because all sea otters are protected under the MMPA, as discussed above, permit(s) issued by the Service would be required to capture, move, or release animals for reintroduction. Should the reintroduction involve any ESA-listed sea otter, additional authorization under the ESA would be required. Since any action that is authorized (permitted), implemented, or funded by a Federal agency is considered a Federal action, any proposed authorization under the MMPA or ESA from the Service would trigger review under NEPA.

Under NEPA, some categories of actions have been predetermined as not having significant environmental effects and, so long as no extraordinary circumstances apply, do not require further evaluation under the law (43 CFR 46.205, 46.210, 46.215). Such actions are known as *categorical exclusions*. If, however, the effects of the action *may* have a significant effect on the environment, agencies are required to prepare either an Environmental Assessment (EA) or Environmental Impact Statement (EIS). An EA may first be prepared to determine whether a proposed Federal action will significantly affect the environment; if so, a more extensive EIS is required. If not, a Finding of No Significant Impact (FONSI) ends the NEPA process.

An EIS is required if an activity *will* result in significant effects to the environment. An EIS provides a detailed evaluation of the proposed action and alternatives. The public, other Federal agencies, and

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[30] For more information on incidental take authorizations -- https://www.fws.gov/ecological-services/species/ITA.html
[31] For more information on marine mammal authorization certificates https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-authorization-program
[32] The MMPA uses the term "California sea otter."

outside parties (e.g., State agencies, Tribes) may provide input into preparation of an EIS through a scoping process, and then comment on the draft EIS when it is completed. Public information meetings or public hearings may be a part of the EIS process. After a final EIS is prepared, a Federal agency will prepare a public record of decision ("ROD"). The ROD states the agency's decision and includes other required discussions and findings pursuant to the Council on Environmental Quality's NEPA regulations.

In short, the requirements of NEPA do not apply to the consideration of sea otter reintroduction unless and until a Federal agency action is formally *proposed* that will authorize, implement, or fund activities related to that reintroduction. Consideration of an application for or proposed issuance of any Federal permits required under the MMPA, as discussed above, would serve as one such trigger. Any Federal permits or similar activities involving animals listed under the ESA would also require NEPA review, as would any proposed establishment of an experimental population under section 10(j) of the ESA as part of the reintroduction process, which would require a formal rulemaking (see section 4.3.6, below).

4.3.3. Coastal Zone Management Act of 1972, as amended [16 U.S.C. § 1451 et seq.]

The Coastal Zone Management Act (CZMA) was passed in response to the challenge of managing growth and development in the coastal zone.[33] Administered by NOAA, the law provides for the management of the nation's coastal resources, including the Great Lakes. The stated purpose of the CZMA is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and future generations." The CZMA establishes three national programs: the National Coastal Zone Management Program, the National Estuarine Research Reserve System, and the Coastal and Estuarine Land Conservation Program. Of these three programs, the National Coastal Zone Management Program is relevant to sea otter reintroduction.

Section 307 of the CZMA is commonly referred to as the *Federal consistency* provision. This provision calls for consistency between Federal activities and State management programs. It requires that each Federal agency activity within or outside the coastal zone that has reasonably foreseeable effects on any land or water use or natural resource of the coastal zone be consistent to the maximum extent practicable with the enforceable policies of a State's federally approved coastal management program. Similar to the other statutes addressed here, Federal actions include any activities the Federal agency may authorize (permit), implement, or fund.

An "enforceable policy," as defined by the CZMA (section 304), refers to "State policies which are legally binding through constitutional provisions, laws, regulations, land use plans, ordinances, or judicial or administrative decisions, by which a State exerts control over private and public land and water uses and natural resources in the coastal zone." To comply with the CZMA, the Federal agency must provide a *consistency determination* in the form of a certification that the proposed action is consistent with any such enforceable policies to the relevant State agency; this applies to any applicant for a required Federal permit or license that may affect any land or water use or natural resource of the coastal zone. The certification is made available for public notice and comment, and the State must notify the Federal agency if it concurs with or objects to the agency's certification. State review of consistency

[33] Defined in section 304 as "the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches."

determinations are generally coordinated among affected State agencies. The CZMA would require a consistency determination for any permits issued related to the reintroduction of sea otters on the Pacific coast of the United States.

4.3.4. Magnuson-Stevens Fishery Conservation and Management Act, as amended [16 U.S.C. 1801 et seq.]

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens or Act) is the primary law that governs marine fisheries management in U.S. Federal waters. First enacted in 1976, the overarching goal of the Act is to provide for the long-term biological and ecological sustainability of marine fisheries. Magnuson-Stevens is a sweeping law that includes, among many diverse measures, provisions to prevent overfishing, rebuild overfished stocks, and conserve and manage important habitats for the conservation and management of fishery resources. Relevant to our discussion is the declaration in the Findings section of the Act that "One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats" (16 USC 1801 §(a)(9)).

The Magnuson-Stevens Act includes a provision that encourages the protection, conservation, and enhancement of *essential fish habitat*, defined as *"*those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (§ 1802(10)). Areas of essential fish habitat (EFH) are identified and geographically delineated in fishery management plans (FMP) for managed fish species and may be designated for assemblages of species or life stages using an ecosystem-based approach to management (50 CFR 600 Subpart J). On the west coast, EFH is identified for federally managed fish stocks in FMPs developed by the Pacific Fishery Management Council. Within the potential range of the sea otter on the contiguous west coast of the U.S., EFH is identified in FMPs for coastal pelagic species, Pacific Coast salmon, Pacific coast groundfish, and possibly highly migratory species as well. Habitat areas of particular concern (HAPC) are subsets of EFH that are considered high priority areas for conservation, management, or research because they are important to ecosystem function, sensitive to human activities, stressed by development, or are rare. HAPC in the groundfish FMP that could be affected by sea otters include kelp forests, seagrass beds, estuaries, and rocky reefs. HAPC of relevance in the salmon FMP include estuaries and marine and estuarine submerged aquatic vegetation (which includes kelp and seagrass).

Consultation under section 305(b) of Magnuson-Stevens is required if a Federal agency has authorized, funded, or implemented all of part of a proposed activity that will take place in or adjacent to EFH and if the activity will adversely affect that EFH. An adverse effect can be any direct or indirect physical, chemical, or biological alteration to the EFH, and can include: changes to waters or substrate; species and their habitat; other ecosystem components; and the quality or quantity of EFH (see 50 CFR §600.810).

The determination as to whether an action will adversely affect EFH is up to the Federal action agency. If a Federal agency determines that an action will not adversely affect EFH, and NOAA Fisheries agrees, no consultation is required. If, however, the Federal agency determines that their proposed activity will adversely affect EFH, the agency must notify NOAA Fisheries in writing and submit an EFH assessment. NOAA Fisheries then provides EFH conservation recommendations, and the action agency responds with a description of how they intend to proceed with the action. The implementing regulations for EFH consultation can be found at 50 CFR 600, Subpart K.

EFH consultations are typically combined with existing environmental review procedures, such as those required under NEPA and the ESA. EFH consultation may be required in association with the reintroduction of sea otters if the Service (or any other Federal agency that may be involved) determines that any proposed associated activity, such as the issuance of a permit, will result in adverse effects to EFH.

4.3.5. Animal Welfare Act [7 U.S.C. 2131 et seq]

The Animal Welfare Act (AWA), passed into law in 1966, authorizes the Secretary of Agriculture to promulgate standards and other requirements governing the humane handling, care, treatment, and transportation of certain animals. The U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) is the regulating authority for the AWA. Subpart E of the AWA implementing regulations at 9 CFR, Part 3 stipulates the minimum standards for humane handling, care, treatment, and transport of marine mammals, including sea otters (9 CFR §§ 3.100 through 3.118). These standards would set the minimum requirements for the holding and transport of any sea otters that would be involved in any reintroduction effort.

The animal welfare regulations proscribe detailed standards for transport enclosures and maintenance of appropriate environmental conditions during handling and transport of marine mammals to ensure their health and safety (e.g., appropriate ranges of temperature or humidity). Marine mammals must be transported in acceptable primary enclosures that conform to specific safety requirements (e.g., for sanitation, air flow, and emergency veterinary access), and facilities or conveyances must be strictly temperature-controlled within a certain range; in the case of animals such as sea otters, other appropriate safeguards such as adding ice to enclosures or the use of fans may be used to maintain the animal at an appropriate temperature. Animals are required to be accompanied by a licensed veterinarian, employee, or other attendant knowledgeable and experienced in the area of marine mammal care during transport, and any transport of greater than 2 hours duration requires a veterinarian-approved transport plan. Animals must be moved as expeditiously as possible and there are limits on holding and transport times to ensure the safety of the animals.

Transport plans for the movement of sea otters must be reviewed and approved by USDA APHIS for conformance with the AWA. Certificates must accompany all animals transported attesting that transport enclosures conform to the standards in 9 CFR § 3.113. Marine mammals in transport must additionally be accompanied by a health certificate signed by the attending veterinarian stating the animal was examined within the prior 10 days and found to be in acceptable health for transport.

4.3.6. The Endangered Species Act of 1973, as amended [16 U.S.C. § 1531 et seq.]

The Endangered Species Act (ESA) was passed in response to concerns over the loss or growing diminishment of fish, wildlife, and plant species that Congress recognized as having “esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people” (section 2(a)). The stated purpose of the ESA is to conserve endangered and threatened fish, wildlife, and plant species and to provide a means whereby the ecosystems upon which they depend may be conserved (section 2b). Furthermore, Congress specifically called upon all Federal departments and agencies to seek to conserve endangered species and threatened species and to utilize their authorities in furtherance of the purposes of the ESA (sections 2(c) and 7(a)(1)). The ESA is administered by the Service and NOAA Fisheries (also known as National Marine Fisheries Service).

Species may be listed as either *endangered* or *threatened* under the ESA. *Endangered* is defined as a species in danger of extinction throughout all or a significant portion of its range (section 3(6)). A *threatened* species is defined as likely to become endangered within the foreseeable future throughout all or a significant portion of its range (section 3(20)). Some protections under the ESA vary depending on whether a species is listed as endangered or threatened. For the purposes of the ESA, Congress defined the term *species* to include any species, subspecies, variety (for plants), and for vertebrate animals only, distinct population segments (DPS) (as defined by Interagency Policy Regarding the Recognition of Distinct Population Segments Under the ESA, 67 FR 4722, February 7, 1996) (section 3(16)).

One of the primary protections afforded listed animals under section 9 of the ESA (Prohibited Acts) is the prohibition against "take." The term *take* under the ESA has a more expansive definition than take under the MMPA[34]. Section 3(19) of the ESA defines take to mean

> to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Section 9(a)(1) prohibits certain actions involving endangered species, including take, import and export, and sale or delivery in interstate and foreign commerce, while section 10 of the ESA authorizes the Secretary to permit these otherwise prohibited activities for scientific research or for enhancing the propagation or survival of endangered species, or permit take incidental to otherwise lawful activities. These prohibitions under section 9 and the exceptions to these prohibitions under section 10 may be extended to threatened species under section 4(d) of the ESA.[35]

As noted earlier, there are two populations of sea otters that are listed under the ESA: the southern sea otter was listed as threatened in 1977 (42 FR 2965; January 14, 1977), and the Southwest Alaska DPS of the northern sea otter was listed as threatened in 2005 (70 FR 46366; August 9, 2005). (The Southwest Alaska DPS under the ESA is the same entity as the Southwest Alaska stock under the MMPA). Both of these populations, listed as threatened species, have special prohibitions in place: the southern sea otter is extended the same protections as endangered wildlife through application of 50 CFR §17.31 (42 FR 2965, January 14, 1977), and the Southwest Alaska DPS has a 4(d) rule that provides some exceptions to the take prohibitions for cultural exchange and limited import/export of native articles of handicrafts and clothing that were derived from sea otters legally taken for subsistence purposes by Alaska Natives (71 FR 46864, August 15, 2006). No other subspecies or DPSs of sea otters are listed under the ESA. As discussed above, all sea otters are protected by the MMPA, irrespective of their status under the ESA. There are many aspects to the ESA; here we concentrate only on those facets potentially germane to the issue of sea otter reintroduction.

[34] As a reminder, the MMPA definition of *take* is "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal" (section 3(13)).

[35] In 1978, pursuant to section 4(d) of the ESA, the Service issued a "blanket rule" that automatically extended to threatened species the prohibitions and exceptions thereto under ESA sections 9 and 10, respectively, unless a species-specific 4(d) rule was issued. However, the 1978 rule was rescinded in 2019. Currently, 4(d) protections are put in place via species-specific 4(d) rules.

4.3.6.1. Interagency Cooperation (Consultation) – Section 7

Section 7(a)(2) of the ESA requires that each Federal agency shall, in consultation with and with the assistance of the Service, ensure that any action authorized, funded, or carried out by that 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 designated critical habitat. In practice this is commonly referred to as "section 7 consultation" or just "consultation." The requirement to consult with the Service under section 7 applies to Federal agencies, and the proponent of an activity is referred to as the *action agency*.

As the issuance of one or more Federal permits would be required to accomplish the reintroduction of sea otters, as discussed above, that Federal agency action would trigger consultation under section 7 of the ESA. The first question in such a consultation is whether the proposed agency action *may affect* any listed species or designated critical habitat (this refers to any effect, whether positive or negative). If there is no effect, there is no need to consult. If there may be an effect, the next question is whether that action is *likely to adversely affect* the listed species or critical habitat. If the action is *not likely to adversely affect* any species or critical habitats, the action agency makes a determination in writing to the Service that its action is not likely to adversely affect any listed species or critical habitats; this is considered a type of *informal consultation*. If the Service agrees with the action agency determination, informal consultation concludes with a letter of concurrence from the Service. If the action is *likely to adversely affect* any listed species or critical habitats, *formal consultation* is initiated, which concludes with the issuance of a Biological Opinion (BiOp) and an accompanying Incidental Take Statement if incidental take is anticipated by the Service to assist the action agency in avoiding or minimizing any adverse impacts from the proposed action[36]. If the Service itself is the agency taking the action[37], then *intra-Service consultation* is required, as the Service must ensure that its own actions do not jeopardize the continued existence of any listed species or adversely modify critical habitats, and it may need to consult with NOAA/NMFS to analyze impacts to species/critical habitat under NMFS' jurisdiction.

For a sea otter reintroduction, there would be at least one and possibly two factors that would trigger formal consultation under section 7. The first is that even if the reintroduction were to involve sea otters from a population that is not listed under the ESA (e.g., from Washington or southeast Alaska), the Service would still need to consider whether issuing a permit to allow the introduction of unlisted sea otters or activities associated with the reintroduction may affect any *other* listed species or critical habitat within the action area (i.e., the geographic area where the effects of the action may extend). As a hypothetical, such a consultation might consider whether the introduction of unlisted sea otters may affect listed salmonids, marbled murrelets, or sea turtles or their critical habitats if these listed species or their critical habitats occur within the proposed action area, and walk through the consultation process, as described above. If any reintroduction were to be proposed using sea otters from an ESA-listed population, such an action would require additional scrutiny under section 7 to ensure the action does not jeopardize the continued existence of the listed sea otters themselves (see Table 4-4, below).

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[36] The situation becomes more complicated if the Service determines that a proposed action may result in jeopardy to the species, or destruction or adverse modification of critical habitat. But such cases are rare, and we will not go into further detail here.

[37] Which it would be if the action under review were the issuance of permits under the MMPA and/or the ESA. It is also possible that the Service would carry out or fund the reintroduction activities, which would also trigger intra-Service consultation.

4.3.6.2. Reintroduction as an Experimental Population – Section 10(j)

Section 10(j) of the ESA (Experimental Populations) provides authority to release a listed species in an area outside of its current range and to designate that population as *experimental*.[38] This *experimental* designation, which is done via notice and comment rulemaking[39], allows for greater discretion in the application of the take prohibitions under section 9 of the ESA than would otherwise apply. Promulgating a "10(j) rule" for the reintroduction of a listed species is not mandatory, but it can help to alleviate public apprehensions about possible restrictions or penalties that could otherwise result from the release of a fully protected ESA-listed species., The Service has used section 10(j) to reintroduce listed species for the purposes of recovery. Whooping cranes (*Grus americana*; 58 FR 5647, January 22, 1993), black-footed ferrets (*Mustela nigripes*; 59 FR 42696, August 18, 1994), and California condors (*Gymnogyps californianus*; 61 FR 54044, October 16, 1996) are some of the more familiar examples of listed species that have been successfully re-established as experimental populations through the use of 10(j) rules. All experimental populations are identified in 50 CFR §§ 17.84-17.86 and listed as special rules in 50 CFR § 17.11(h).

Under section 10(j), the Service may authorize the release of an endangered species or a threatened species outside its current range (but within its probable historic range, absent a finding that the primary habitat of the species has been unsuitably and irreversibly altered or destroyed), upon a finding that the release will further the conservation of the species (50 CFR §17.80-81). The experimental population must also be wholly separate geographically from existing nonexperimental populations of the same listed entity. The 10(j) rule must clearly delineate geographic boundaries that define the experimental population. A determination is also required as to whether the experimental population is *essential* or *nonessential.* An essential population is defined as "essential to the continued existence of the species." A nonessential experimental population can make a meaningful contribution to the recovery of the listed species, but the future of the listed species is not dependent upon the survival of the experimental population.

Members of experimental populations are treated as having threatened status under the ESA, with two important differences that apply if the experimental population is determined to be nonessential (section 10(j)(2)(C)). For one, solely for the purposes of ESA section 7 (Interagency Cooperation; see 4.3.6.1 above), a nonessential experimental population is treated as if it is proposed for listing[40] unless it occurs within a National Wildlife Refuge or National Park. Second, section 10(j) specifically stipulates that critical habitat shall not be designated for a nonessential experimental population. All experimental populations established to date under section 10(j) of the ESA have been deemed nonessential. Treatment of the experimental population as a threatened species is the key to the regulatory flexibility that experimental populations provide. As discussed above, the take prohibitions of section 9 of the ESA do not apply to threatened species unless extended by the Service under section 4(d), which provides the discretion to adopt any regulations that are necessary and advisable to provide for the conservation

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[38] Section 10(j) of the ESA also requires that any experimental population be determined as either *essential* or *nonessential*, as explained below.

[39] The criteria and procedures for establishing an experimental, nonessential population are provided by regulations at 50 C.F.R. § 17.81 (see also 49 FR 33885; August 27, 1984).

[40] Under the ESA, the consultation requirements of section 7(a)(2) do not apply to species proposed for listing; instead, the conferencing requirements of section 7(a)(4) apply for actions that are likely to jeopardize proposed species. See discussion under section 7 of the ESA – Interagency Cooperation (section 4.3.6.1).

of a threatened species, including prohibitions on take. Therefore, the usual ESA section 9 prohibitions do not apply to 10(j) populations, and instead the Service crafts take prohibitions or exemptions that are found to be necessary and advisable for the conservation of the species on a case-by-case basis for each experimental population in aa 10(j) rule. In many cases, such rules exempt all incidental take of the species (i.e., any non-intentional “take” of the species in the course of otherwise lawful activities is not considered a violation of the ESA).

This designation can greatly reduce concerns on the part of stakeholders over the potential reintroduction of an ESA-listed species. If all incidental take is exempted from the prohibitions of the ESA, there is no need to apply for incidental take permits associated with a nonessential experimental population, and no fear of possible penalties for incidents of inadvertent incidental take. The lack of critical habitat additionally contributes to the lessening of perceived regulatory burdens associated with a nonessential experimental population. Finally, for the purposes of section 7 consultation (explained in 4.3.6.1 above), since the experimental, nonessential population is treated as “proposed to be listed,” the section 7(a)(2) consultation requirements for a listed species do not apply.[41] As noted, if the experimental population occurs within the National Wildlife Refuge System or the National Park System, it is treated as threatened and the requirements under section 7(a)(2) may apply.

It is important to note that the regulatory flexibilities that can be afforded through a 10(j) rule apply only to the ESA. The MMPA does not have any provisions analogous to the ESA’s section 10(j) experimental designation. If a reintroduction were to use sea otters sourced from an ESA-listed population, such as the southern sea otter, a 10(j) rule could potentially exempt incidental take under the ESA, but incidental take prohibitions (and all other protections) under the MMPA would remain.

NEPA compliance is also required to establish an experimental population under section 10(j) of the ESA. If listed animals are contemplated as part of sea otter reintroduction, a single NEPA process can include consideration of both the reintroduction and the establishment of an experimental population. That evaluation must take into account potential impacts of the action on any donor population(s) of sea otters that are used as the source of individuals for the reintroduction.

4.3.6.3. Permits or Authorizations Required under the ESA

Permits would be required under section 10(a)(1)(A) of the ESA (permits for threatened or endangered species) for any capture, handling, and/or transport of listed sea otters in the course of any reintroduction effort as well as for any follow-up veterinary care, surveys, or monitoring that could involve take of the listed species. Recovery permits are issued under ESA section 10(a)(1)(A) to authorize take as part of activities intended to foster the recovery of listed species. For endangered species, these permits can allow acts otherwise prohibited under section 9 for scientific purposes or to enhance the propagation or survival of the affected species or authorize incidental take that is accidental and not the purpose of an otherwise lawful activity. For threatened species, unless subject to specific section 4(d) rules that exempt take from the Act’s prohibitions, permits can allow the above acts but also may be issued for special purposes consistent with the ESA. The issuance of these permits is subject to publication in the Federal Register and opportunity for public comment. ESA permits for enhancement for sea otters are handled by the Service’s Division of Management Authority and would be bundled together with any permits required under the MMPA.

4.3.7. State Authorities

As discussed above (section 4.3.1), under section 109(a) of the MMPA, States are prohibited from regulating actions relating to the take of marine mammals, unless authority has been transferred to the State. Thus, States cannot require permits for "take" of sea otters. This is codified in 16 USC § 1379:

> (a) State enforcement of State laws or regulations prohibited without transfer to State of management authority by Secretary. No State may enforce, or attempt to enforce, any State law or regulation relating to the taking of any species (which term for purposes of this section includes any population stock) of marine mammal within the State unless the Secretary has transferred authority for the conservation and management of that species (hereinafter referred to in this section as "management authority") to the State under subsection (b)(1).

At the present time, no State holds this authority, and management authority for marine mammals remains solely at the Federal level. Hence, to the extent that take of marine mammals is regulated by the Federal government, an authorization from the State for any take associated with translocation activities would not be required. As a best practice, however, the Service would coordinate with our State partners on any actions related to sea otter reintroduction in the affected States, including consideration of State laws or authorities that might apply.

Here we briefly review sea otter populations in each State that are most likely to be considered as future sources of individuals for potential reintroduction (see section 4.1.3).

Alaska – At the present time, all stranded sea otter pups brought into care facilities in Alaska are immediately deemed non-releasable, as sufficient resources are not available to raise these animals in captivity to prepare them for successful repatriation into the wild. Sea otter pups from facilities in Alaska thus could not be considered as a potential source of individuals for reintroduction. If capture and translocation of adult sea otters are considered, the large population of sea otters in southcentral or southeast Alaska might be a potential source. However, there are potential logistical difficulties due to the distance that would be involved in safely transporting the animals.

California – California could serve as a potential source of a limited number of surrogate-raised southern sea otter pups for reintroduction within their historical range. Many southern sea otter pups strand each year along the California coast, and the Monterey Bay Aquarium has operated a successful program using non-releasable females as surrogates to rear pups for release to the wild. Unfortunately, the capability of those females to rear more than a few pups per year has meant that a significant percentage of stranded pups must be deemed non-releasable and placed in other zoos and aquariums or, as a last resort, euthanized. Monterey Bay Aquarium is currently the only facility in the State permitted to surrogate-raise otter pups, but there is a Federal review underway to allow two additional facilities to operate surrogacy programs. Even with these new facilities, capacity and other resource constraints will limit the number of surrogate-raised southern sea otter pups ready for release each year, although three facilities could likely accommodate all of the pups that strand each year for potential reintroduction or placement without any further need for euthanasia of excess pups.

California could also serve as a source of wild-captured southern sea otters for translocation, presuming that a relatively small number of sea otters (± 100 animals) would be removed from local populations determined to be at carrying capacity within the central portion of their current range to minimize any negative effects on the founder stock.

Washington – Northern sea otters in Washington could serve as a source of founder animals for translocation presuming reintroduction is within the historical range of the species; we do not contemplate the translocation of northern sea otters into northern California. The capture and removal of wild sea otters from Washington would be similar to that contemplated for California, wherein a relatively small number of animals (± 100 sea otters) would be removed from a local population estimated to be at carrying capacity to minimize any negative effects on the founder stock.

Table 4-4. ***Summary of Federal permits or authorizations that would likely be needed to implement a reintroduction of sea otters.*** *This table represents our best estimate of the various Federal authorizations that might be required to implement a reintroduction of sea otters. The final requirements, however, will depend upon the specific circumstances of any reintroduction that may be proposed as well as the laws and regulations in effect at that time.*

Law or Authority	Purpose/Trigger	Permit/Process	Mechanism/Outcome	Responsible Agency
MMPA	Direct take of sea otters for recovery purposes (capture/handling/transport/ release)	Enhancement of Survival Permit	MMPA Sec. 104(c); Form 3-200-43	Division of Management Authority, USFWS
MMPA	Post-release surveys and monitoring or care	Research	MMPA Sec. 104(c); Form 3-200-43	Division of Management Authority, USFWS
MMPA	If live, captive-held sea otters transported within U.S.	Movement of Captive-held Marine Mammals	Form 3-200-87	Division of Management Authority, USFWS
NEPA	Proposed Federal action that significantly affects the environment (MMPA and ESA permit issuance or possible 10(j) designation, as applicable)	Scoping/EIS with public comment	Record of Decision	Ecological Services, USFWS
CZMA	Proposed Federal action must be consistent with enforceable policies of State coastal management programs	Consistency determination with public comment	Certification of consistency	USFWS
Magnuson-Stevens	Ensure no adverse effects to Essential Fish Habitat	Consultation with NOAA Fisheries	EFH Assessment, if needed	USFWS

Law or Authority	Purpose/Trigger	Permit/Process	Mechanism/Outcome	Responsible Agency
Animal Welfare Act	Ensure safety and health of sea otters during transport and holding	Transport plan, authorizations	Approval of transport plan; veterinary certificates; certificates of compliance with safety standards	USDA APHIS
ESA	Direct take (capture/handling/transport/ release)of listed sea otters for recovery purposes	Enhancement Permit	ESA Sec. 10(a)(1)(A); NEPA and ESA Sec. 7 also required	Division of Management Authority, USFWS
ESA	For actions involving northern sea otters only, ensure proposed Federal action (MMPA and ESA permit issuance, as applicable) does not jeopardize any other ESA-listed species or critical habitat	Consultation with the Service or NOAA Service for incidental take authorization, if needed	ESA Sec. 7 No effect; *or* Not likely to adversely affect (letter of concurrence); *or* Likely to adversely affect (biological opinion [BiOp])	USFWS, or NOAA; if USFWS is issuing the permit to itself, intra-service consultation is required
ESA	For actions involving southern sea otters, ensure proposed Federal action (MMPA and ESA permit issuance, as applicable) does not jeopardize the southern sea otter or any other ESA-listed species or critical habitat	Intra-Service consultation for southern sea otter; consultation with the Service or NOAA Service for incidental take authorization, if needed for other listed species	ESA Sec. 7 No effect; *or* Not likely to adversely affect (letter of concurrence); *or* Likely to adversely affect (BiOp)	Ecological Services USFWS, or NOAA, depending on species affected; if USFWS is issuing the permit to itself, intra-service consultation is required
ESA	Designate reintroduced population of southern sea otters as experimental, non-essential [*optional*]	Proposed rule with public comment	ESA Sec. 10(j); rulemaking required; NEPA and ESA Sec. 7 required	Ecological Services, USFWS

In all cases, securing the necessary permits and authorizations can be a lengthy process, and any future reintroduction effort should take this into account for planning purposes. For example, under the MMPA, the must notice all permit applications and public comment periods in the Federal Register, and permit applications must undergo review by the Marine Mammal Commission. Processing marine mammal permits can take a year or more.

4.3.8. Summary of Legal Feasibility

The reintroduction of sea otters is legally feasible. Some of the laws relevant to potential sea otter reintroductions offer opportunities to ease the process from a regulatory standpoint, such as the designation of experimental populations for federally listed sea otters under section 10(j) of the ESA. Other laws have provisions that may pose regulatory hurdles to sea otter reintroduction or be a source of contention depending on the particular reintroduction scenario under consideration. None of these issues are insurmountable or would prevent reintroduction.

The following are the key considerations that we have identified with regard to the legal feasibility of reintroduction:

- The MMPA specifically exempts "California" (southern) sea otters from the potential authorization of incidental take in the course of commercial fishery operations. If southern sea otters are considered as source individuals for reintroduction, commercial fishers who operate within or adjacent to reintroduction sites may have concerns about liabilities or penalties for unintentional take that may occur.

- The MMPA does not have any provision for experimental populations analogous to that of section 10(j) of the ESA, thus there is no avenue for providing regulatory flexibility or relaxing of the incidental take prohibitions under the MMPA for any reintroduced population of sea otters, regardless of ESA listing status. While it is possible incidental take authorizations may not be required under the ESA for a 10(j) population, incidental harassment authorizations or incidental take regulations and associated letters of authorization would still be required under the MMPA.

- Some stakeholders have expressed interest in management of sea otters if they exceed a certain population threshold in the future. Options to authorize direct take of marine mammals under the MMPA are limited.

- The express exemption from the take moratorium for subsistence purposes under section 101(b) of the MMPA is specific to certain Alaskan coastal natives. For any tribal issues relevant to the geographic area under consideration in this Assessment, we recognize our obligation to conduct meaningful government-to-government consultation and collaboration with Tribes, as detailed in Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, signed November 6, 2000.

- If a listed population of sea otters is contemplated as a potential source of individuals for reintroduction, an additional rulemaking to establish the reintroduced population as an experimental population under section 10(j) of the ESA is advisable to alleviate public concerns over take prohibitions that might otherwise be associated with an ESA-listed species. Such a designation (assuming the reintroduced population is determined nonessential) would also remove the requirements for critical habitat designation and section 7 consultation, although conferencing pursuant to section 7(a)(4) would still be required.

4.4. Estimated Costs

Reintroduction of a species requires logistical and financial considerations. In this chapter, we estimate the costs of a potential reintroduction, including those associated with gathering baseline habitat data, capture and transport, long term monitoring of the reintroduced sea otters and their habitat, and emergency response and stranding. We are budgeting using a 10-year timeline that incorporates the national 5-year inflation rate of 2.62% (https://www.usinflationcalculator.com/inflation/current-inflation-rates/). Below, we present a budget for each anticipated component of reintroduction. For the transport component, we provide several sample budgets, as the costs vary significantly depending on transport mode and distance. Finally, we present four reintroduction scenarios to compare the costs associated with various capture locations and source populations. We present these scenarios for comparison and are not prioritizing one method over another and or endorsing any particular technique or scenario. Detailed tables for each budget are provided in Appendix C.

4.4.1. Habitat assessment

Gathering baseline information on potential habitat is a fundamental need for assessing the feasibility of reintroducing sea otters. The estimated budget includes 3 years of pre-reintroduction baseline data collection and 10 years monitoring associated with intertidal, subtidal, and offshore surveys along the northern California and Oregon coast. For this budget, we estimated the costs associated with 6 intertidal and subtidal monitoring sites for 10 years, based on the assumption that surveys would occur at 3 sites proposed for reintroduction and 3 sites not proposed for reintroduction, for comparison. In addition to intertidal and subtidal work, our budget includes an offshore study focused on Dungeness crab abundance, to occur at least once every 10 years. Additional information regarding the three types of habitat monitoring can be found below.

Intertidal monitoring would be conducted along rocky coastlines and would include benthic and algal biodiversity surveys. Sites would be accessed by road or by foot and monitoring procedures would follow well established protocols such as those compiled by Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). The budget includes a contract with a specialized agency that would conduct the fieldwork and data processing using 4 staff over 11 to 15 days per year.

Subtidal monitoring requires more complex logistical components and experienced divers. Because the Oregon coast can be unpredictable in terms of ocean conditions, and because access points are few and far between, the costs to conduct this type of work will be high relative to some places in California, for example. Our budget assumes monitoring at 6 subtidal sites where benthic, algal, and fish surveys would be conducted. The proposed budget includes a contract for 5 people to conduct fieldwork and data processing, working up to 17 days (includes weather days), and a chartered boat. The first year of intertidal and subtidal surveys will be more expensive due to the start-up costs of planning and setting up the long-term sites.

Finally, our budget includes baseline offshore surveys that will provide information regarding the distribution and abundance of Dungeness crabs. For the purposes of budget estimation, we assumed one large-scale survey would occur every 10 years, although smaller, more frequent surveys may also be considered as an alternative. The proposed budget includes contracting a local fisher person to assist with a pot survey of Dungeness crabs. The survey would be conducted from a single boat over 30 days to set at least 100 crab pots/site using 3 biologist and 2 boat crew. The budget includes rental of the boat and appropriate equipment.

Benthic surveys should continue beyond the 10 years noted here. However, in the future, reevaluation of the intervals at which they continue to occur may be appropriate (for example, subtidal monitoring could change to monitoring once every 3 years instead of every year). Habitat assessment is estimated to cost $1,881,428 over the 13-year period (*Table C-1*).

4.4.2. Captures

Wild-captured individuals are one potential source for a reintroduced sea otter population. There are 3 different capture methods that are suitable for sea otters (see Chapter 9 of the EAFS at https://www.elakhaalliance.org/feasibility-study/chapter-9-implementation-and-logistical-considerations/ for a more detailed explanation of the three different methods). For this budget, we only included the tangle net and dive method using Wilson traps captures. We excluded dip netting as it can be difficult to execute, is very time consuming, and can be hard on the animal.

Tangle nets and dive method techniques have advantages and disadvantages. For example, dive methods require highly trained professionals to conduct the capture. However, this method can target specific individuals of interest, in particular, different sex and age classes and avoid animals not of-interest. The tangle net method requires less specialized training, less equipment and typically cost less than dive methods. However, it does not allow for targeting specific sex or age classes. In addition, there is a higher risk of by-catch in the nets or injuries to the animals.

For this budget exercise, we estimated 16 capture days with a target of capturing 35 individuals per year. This is based on recent capture events in Alaska, using both tangle nets and divers, and represents a plausible timeframe and target number of individuals. Included in the costs are personnel salaries, which vary based on the method of capture; veterinarian services, which include monitoring, tag implantation surgeries, and conducting baseline health assessments (blood work, pathology, etc.); instrumentation and marking of individuals (VHF, Life History Tags and/or GPS flipper tags); and associated equipment for the specific type of capture (dive gear, boats, nets, etc.). These estimates do not include holding individuals beyond the day of capture.

A generalized breakdown of the of the two capture techniques are as follows. For dive methods, a capture crew of 9 people (4 specialized divers and 5 assistants for scouting, boat driving, handling, monitoring, lab assistance, etc.) and 2 veterinarians where included. Surgical supplies (including drugs), instrumentation and monitoring equipment (for example, Very High Frequency (VHF) tags, radio telemetry receivers, base stations for Life History Tags, etc.), dive equipment, and a capture boat are included in the cost as well.

The tangle net method includes a capture crew of 7 people (two 3-person capture crews and 1 assistant) and 2 veterinarians. Surgical supplies, instrumentation and monitoring equipment remained the same under both scenarios. Capture equipment such as nets and two capture boats were also included in the total cost.

Retention, survival, and recruitment rates from the captured and released individuals should be assessed yearly. For this budgeting exercise, we do not extend the capture budget beyond 5 years since evaluation of success should be conducted to determine whether or not to continue to supplement the re-introduced population with wild-captured individuals. We also did not include costs for potential recapture due to the high degree of variability associated with location, source population, and other logistical variables.

The location of capture was not factored into this capture budget. Rather, for simplicity, travel costs were based on per diem rates in Seaside, Oregon. A research ship was included in the total estimate. This model has proven successful in sea otter capture operations in Alaska as the vessel can be based near the location of capture and can house the capture crew and a surgical laboratory. Additional costs associated with different potential capture areas (i.e., central California, Washington, and Alaska) will be discussed further in *Transportation (4.4.4)* and *Holding (4.4.5)* sections below.

Captures estimates vary based on methodology and range from $3,205,875 (tangle net) to $4,190,308 (diver) to capture 175 animals over the 5-year period (*Table C-2*), or approximately $18,300 to $23,900 per animal.

4.4.3. Surrogate-reared juveniles

Stranded sea otter pup, USFWS photo.

Stranded southern sea otter pups from California that are surrogate-reared are another potential source of individuals that could be used for reintroduction. We estimated the annual operational costs of caring for, rearing, and releasing surrogate raised individuals, without including the capital and related costs of building and permitting the specialized facilities required to hold sea otters. The operational costs were based on the Monterey Bay Aquarium, an established facility with a successful track record for doing this work and has the existing physical and staffing capacity to rear and release up to 5 surrogate-raised sea otter pups per year. The costs associated with the surrogacy program include: (1) salaries and benefits for staff caring for rescued animals and the resident adult sea otters who act as surrogate mothers, (2), costs associated with supporting and maintaining the health and wellbeing of all involved sea otters (including veterinarian care, food, instrumentation, and some post-release monitoring travel and boats), and (3) facility operations and maintenance. The costs illustrated are operational in nature and do not include the substantial capital expenditures associated with facility design, construction or retrofitting, and maintenance. If additional facilities become available, the costs to raise pups may differ dependent on existing facilities and locations. Surrogate raised pups are estimated to cost $16,897,906 to raise 50 animals over the 10-year period (*Table C-3*), or approximately $337,958 per animal.

4.4.4. Transportation

There are various methods of transportation that can be used to transport sea otters from the capture site to the reintroduction site. However, animal welfare should be top priority when considering the preferred method of transport. The transport mode will influence the number of people involved (from 1 on smaller helicopters to 6 on research vessels). It will also influence the total time in transit, which will impact whether or not animals will need to be fed during transit or have access to additional ice/water. Depending on the distance to the reintroduction site, intermittent holding facilities may be needed to hold animals until an accumulated number of captured individuals can be transported all at once (for example, if animals were captured in Alaska and flown to Oregon). Holding facilities related to this example, and others, will be discussed in the *Holding* section below.

Because sea otters may be captured in one of several locations and transported by one of several modes, cost estimates for post-capture transport vary significantly. In this section, we present a subset of options that include various locations and three of four possible transport modes; fixed wing aircraft, helicopter, and research vessels. However, we are not suggesting these are the preferred methods and/or locations.

Example 1. Animals are captured near La Push, Washington, and driven to Newport, Oregon. We estimated 2 vehicles would be needed, including a rented refrigeration truck. Total time on the road would take 7-8 hours and a crew of at least 4 people, including one veterinarian and 1 veterinarian technician. Food and water/ice would need to be supplied. We also assumed that only short holding times would occur near the capture site (1-2 days maximum), and a total of 6 different trips (with an average of 5-6 sea otters per trip) would be required.

Example 2. Animals are captured near Monterey Bay, California and flown to San Francisco Bay, California using a Eurocopter AS350 helicopter. We estimated total flight time would be approximately 30 minutes, with one biologist and one pilot per flight. A total of 6 individual transportation crates would fit in the helicopter at one time. Ice and/or a frozen towels could be included in the crate but no food would be needed. A total of 6 flights would occur, with very little holding time (less than a day).

Example 3. Animals are captured in southeast Alaska (Gustavus, AK) and shipped to Newport, Oregon using a larger (≥115 ft) research vessel. We estimated the total transit time would be at least 6 days, weather dependent, and would include at least 6 people, including two veterinarians. Food and water would need to be supplied. Due to the transit time and costs, one trip could be made with the entire load (35 individuals) of animals. This would require animals to be held in Alaska until the entire capture effort was completed under this scenario.

Transportation estimates vary based on distance and mode and range from $95,129 (research vessel from central to northern California; not included in the examples, above) to $1,302,353 (research vessel from southeast Alaska to central Oregon) over the 5-year period (*Table C-4*).

4.4.5. Holding

There are two occasions for which individuals may be held in captivity. Pre-transport holding would occur after capture and before transportation to a new site. This may occur if a set number of individuals needs to be captured before a mode of transportation is considered efficient (for example, waiting for multiple individuals before making a flight vs. flying the single individual that was captured the same day). Post-transport holding may occur after the transportation occurs and the animal is brought to the new site. Experienced veterinarians suggest holding wild individuals post-transport for 2-3 weeks to monitor individual health and allow the animal to regain thermo-regulatory integrity. This allows individuals to be closely monitoring and recaptured if any health problems arise. While practical consideration may determine the actual duration of holding, we assume a 2-3 week holding period for the purpose of budget estimates.

Holding times vary based on distance to the proposed reintroduction site, mode of transportation, source population, and post capture health (surrogate reared individuals may not require post release holding). For this budget exercise, the holding facility costs are based on elements in the Emergency Care and Rehabilitation of Oiled Sea Otters guide (William, and Davis, 1995). This budget includes a floating octagon pen (divided into 8 smaller pens), food (including food storage), food prep and equipment, 24-hour personnel including at least 1 veterinarian, and other associated equipment needs such as personal protective clothing and recapture equipment.

Holding estimates vary based on mode of transportation and range from $2,034,772 (post-transport only) to $3,657,247 (pre-transport and post-transport) over the 5-year period (*Table C-5*).

4.4.6. Land-based monitoring

There are many different forms of monitoring that might be conducted once individuals are released at the reintroduction site(s). Here, we subdivide monitoring into land-based, boat-based, and aerial-based monitoring and include a budget for each. The most appropriate type of monitoring may depend on where animals are located (accessibility), as well as weather and seasonal distribution of individuals.

Monitoring sea otters from shore. Photo by Michele Zwartjes, USFWS.

This budget is for 10 years of monitoring released individuals for location and demographic data (survival, recruitment) and conducting foraging observations. Two different locations with a staff of 4 technicians and 1 part time lead biologist were included in the budget. Housing, two vehicles, and associated monitoring gear (computer tablets, spotting scopes, fuel, telemetry equipment, etc.) were included. The costs are highest during the first and sixth year of monitoring due to vehicle purchase.

Land-based monitoring is estimated to cost $3,488,133 over the 10-year period (*Table C-6*).

4.4.7. Boat-based monitoring

Depending on the location of the animals, boat-based monitoring may or may not be a viable option. Boat-based monitoring efforts would collect the same information as land-based surveys, including collecting location and demographic data and conducting foraging observations. Our budget assumes that boat-based monitoring would occur at one location. We budgeted for 2 boats and associated equipment (trailers, motors, electronics, etc.), maintenance, and storage needs. Our budget also includes 3 technicians, training, housing, telemetry and recording equipment. The initial year is highest due to the purchase of two new boats. The budget also reflects one boat replacement after 8 years. In addition to monitoring efforts, this budget includes equipment that could be employed for boat-based rescues, either for health or oil spill response reasons.

Boat-based monitoring is estimated to cost $3,172,893 over the 10-year period (*Table C-7).*

4.4.8. Aerial-based monitoring

There are a number of different types of aerial surveys that could be conducted. This budget includes three different types, including post-release monitoring, periodic monitoring, and yearly population estimate surveys. Aerial-based methods are limited to gathering location and some demographic data.

We budgeted post-release monitoring surveys to be flown every other week for 5 months along the entire coast to look for individuals that may have moved out of the reintroduction area. This work would include a smaller single-engine fixed wing aircraft conducting radio tracking with 1 technician.

Following the intensive 5-month survey period, additional periodic aerial monitoring surveys may be needed to find individuals that moved out of a specified area or are missing. For this budget exercise, we estimated that an additional 4 flights per year would be conducted along the entire coast to search for missing individuals. The cost estimate is based on the same set up and staff as the post-release monitoring surveys.

Aerial surveys for population estimates should be conducted once a year to determine population trends and distribution. The methods of surveys may change through time as technology develops. However, for this scenario, we budgeted for both observer and camera-based survey methods. The initial start-up costs are largely influenced by the camera and software equipment. The estimated budget is for a twin-engine aircraft, surveying the entire coastline from northern California (Pigeon Point) to the Washington/Oregon border. We estimate it will take 16 days, including weather days, and will require 3 people (2 observers and a data recorder). Travel costs, including trainings, and associated gear (computer tablets, emergency equipment, personal protective equipment, etc.) are also included. Subsequent surveys will be less expensive since the camera equipment will not be purchased again.
All aerial-based monitoring (post release surveys, periodic surveys, and population estimates) is estimated to cost $4,557,533 over the 10-year period (*Table C-8*).

4.4.9. Postmortem program

Efforts should be made to recover the carcasses of reintroduced animals and a full necropsy assessment (pathology, histology, and ancillary testing) should be conducted, at least during the initial reintroduction phase. This will provide managers information about causes of mortality in the population. The actual cost will depend on the number of animals reintroduced. For the budget exercise, we estimated 10 necropsies will be conducted per year. This estimate includes the logistical costs associated with picking up the carcass in the field, shipping it to specialists such as those at the U.S. Geological Survey National Wildlife Health Center in Madison, Wisconsin; salary for a technician to prepare the slides; and payment to various labs for the pathology and histology analyses and reports.

If the population begins to grow, a sea otter stranding program should be considered in Oregon to respond to dead and injured animals. The California Department of Fish and Wildlife already has a system in place to respond to and conduct necropsies on sea otters in California. However, additional resources will be needed to cover northern California. The Oregon program could follow a similar program to the Alaska Marine Mammals Management Program, which includes one full time biologist acting as the stranding coordinator who conducts outreach and coordinates response when animals become stranded. This program may not need to be started until several years after reintroduction given the relatively few animals in the population. The budget includes one full time biologist, stranding equipment, and travel costs.

Postmortem program costs are estimated to be $1,098,071 over the 10-year period (*Table C-9*).

4.4.10. Oil spill response program

Prior to reintroduction, an oil spill response program should be developed. The California Department of Fish and Wildlife already has a program in place and is prepared to respond to potential reintroduction areas in northern California. Consequently, we do not discuss the oil spill response budget needed in California. In Oregon, however, there is currently no oil spill response program in place for marine mammals. The initial budget includes a full-time biologist for the first 2 years to develop plans and purchase appropriate equipment including rehabilitation pens, mobile trailer(s), safety equipment, and training individuals to respond to spills. Our budget is based on the mobilization equipment used in Alaska. It is assumed that equipment would be acquired during the first three years after reintroduction. Note this budget is only for oil spill preparedness. During an actual oil spill, costs are borne by the responsible party.

The oil spill response program is estimated to cost $4,615,996 over the 10-year period (*Table C-10*).

4.4.11. Four potential reintroduction scenarios

The locations and source populations for a potential reintroduction have not yet been identified. Since these factors are influential in the cost of reintroduction, we present four scenarios that represent a range of reintroduction options and their estimated costs. These scenarios are examples, presented for the purpose of comparison, and are not ranked in any particular order. In addition, these examples only include capture or rearing, transportation, and holding; costs associated with long term monitoring are not included in the budget below since these costs remain the same regardless of location or source population. For simplicity, estimates are provided for a single year.

4.4.11.1. Wild captures from northern Washington to central/southern Oregon (Scenario 1)

For this example, we budgeted 35 wild sea otters captured near La Push, Washington using divers and flown to Newport, Oregon using a twin-engine fixed wing such as an Aero Commander. Captured animals would be held in captivity 1-2 days prior to being transported to Oregon and held for 3 weeks at the reintroduction site before they were released. Total estimated costs for capture, transport, and holding is $1.44 million dollars for one year.

4.4.11.2. Wild captures from northern Washington to central/southern Oregon with additional supplement of surrogate reared sea otters (Scenario 2)

For this example, we budgeted the same capture, transport, and holding times as Scenario 1 with 35 wild sea otters. However, we added 5 surrogate reared sea otters that would be transported from Monterey Bay, California to Newport, Oregon in an Aero Commander and held for 3 weeks at the reintroduction site prior to release. Total estimated costs for capture and surrogate raised sea otters, transport (both wild and surrogate reared), and holding is $3.02 million dollars for one year.

4.4.11.3. Surrogate sea otters reared from Monterey Bay, California to Northern California (Scenario 3)

Five surrogate raised pups from Monterey Bay, California will be transported via helicopter (Eurocopter AS350) to San Francisco Bay, California and released with intense monitoring efforts for up to two weeks to ensure acclimation. Total estimated costs for surrogate reared sea otters, transportation, and costs associated with intense monitoring is roughly $1.65 million dollars for one year.

4.4.11.4. Wild captures from southeast Alaska to central/southern Oregon (Scenario 4)

For the final example, we estimated the costs of capturing 35 wild sea otters in southeast Alaska, holding them in Alaska for 16 days (the entire capture field season), flying them to Newport, Oregon in a twin-engine fixed wing plane (CASA C212), and holding them for 3 weeks at the reintroduction site before releasing. Total estimated costs for capture, transport, and holding is roughly $1.69 million dollars for one year.

4.4.11.5. Summary

The actual costs of reintroducing sea otters are uncertain and will vary based on the source population, distance to reintroduction, capture techniques, transportation methods, and number of sea otters captured annually. This budget serves to demonstrate the scope of the project and provides a framework for managers to compare the different scenarios. Our budget is inclusive and is not limited to the anticipated contributions of U.S. Fish and Wildlife Service. Rather, the expenses we describe here may be shared across agencies and organizations.

Based on the four scenarios above, we estimated that the total cost of sea otter reintroduction will range from $26 million to $43 million dollars over a 13-year period (*Table C-11*). This estimate includes 3 years of pre-release habitat evaluation, long-term habitat monitoring, acquisition of sea otters (wild caught for 5 years and/or surrogate reared for 10-years), population monitoring (10 years), postmortem, and oil spill response programs. Although monitoring efforts will need to continue beyond 10 years, we do not include those costs here. The scenarios presented above are for demonstration only and are not endorsed. Additional evaluation by managers will be required before selecting an appropriate approach.

5. RISK ASSESSMENT

The IUCN Guidelines (IUCN/SSC 2013) recommend an assessment of risk as an important companion to the assessment of feasibility to gauge the viability of reintroduction as a conservation option. All reintroductions incur some level of risk that the effort will fail, or that the reintroduction may result in unintended consequences. As defined by the IUCN, risk is a function of the probability of a risk factor occurring combined with the severity of its impact. Factors such as a probability of unacceptable ecological impacts or negative impacts on human interests can increase the level of risk. The total “risk landscape” is the product of multiple considerations, including the number of risk factors at play, the degree of uncertainty as to whether the risk factor will occur, and the severity of the impacts.

It is important to recognize that lack of information does not imply lack of risk. When data are scarce, a qualitative risk assessment may be required. If time allows, gathering additional data for analysis can improve the accuracy of a risk assessment and provide a greater likelihood for a successful outcome. In the present case, we have already identified that we lack sufficient data to understand the probable socioeconomic impacts of sea otter reintroduction in northern California and Oregon (see section 4.2). Given the importance of this particular factor in understanding the potential consequences of reintroduction in terms of impacts on human interests, one of the primary outcomes of this Assessment is the recommendation for a rigorous expert analysis of potential socioeconomic impacts to more fully inform the evaluation of overall reintroduction feasibility (see sections 6.3.2.1, 6.4.3).

Here we present our initial identification of the risk factors associated with the potential reintroduction of sea otters to northern California and Oregon that may require further evaluation in any future analysis. For each of these risk factors we consider the relative probability of that factor occurring and the anticipated severity of the impact, to the degree that we have data to inform that discussion; where we have few data, we merely identify those factors that require further consideration. We emphasize that we consider this to be a purely preliminary and cursory assessment of risk, and in all cases we recommend a more detailed analysis through a structured process that allows for the explicit assignment of probabilities and values for each of these factors, as discussed further in the Summary, below.

5.1. Risk Factors

5.1.1 Risk to Source Populations

We anticipate minimal risk to any potential source populations from the removal of individuals. Specific local populations under consideration as sources for translocations are estimated to be at carrying capacity, and removal of the small numbers of individuals contemplated for the purposes of achieving reintroduction has been evaluated and found to have negligible effects on the viability of those populations (Tinker et al. 2021; see Chapter 3 of the EAFS at https://www.elakhaalliance.org/feasibility-study/chapter-3-population-and-demographic-considerations/). This evaluation applies to both potential source populations of southern sea otters and northern sea otters (see 4.1.3).

5.1.2 Risk to Founding Populations

5.1.2.1 Initial losses

If traditional translocations are contemplated (using the capture, transport, and release of wild sea otters from another population), initial losses of up to 90% of those individuals may be possible based on our experience with past reintroductions (see 2.4.1). This is a conservative estimate, as improved understanding of transportation and handling techniques, dispersal behaviors, and the optimal demographic composition of potential founding populations should reduce the degree of loss in future efforts (e.g., Carswell 2008, Tinker et al. 2021). Nonetheless, we know that such losses are not outside the realm of possibility and the public should be prepared to expect an initial high level of dispersal and/or mortality during the establishment phase of the reintroduction. An early assessment of stakeholder perspectives by Curran et al. (2019) suggested that concern over these initial losses can be high (see 4.2.2.2).

Alternatively, a reintroduction may take advantage of surrogate-reared, stranded pups for release into estuary environments as juveniles, as was demonstrated at Elkhorn Slough in California (see 2.3.1). Use of this strategy resulted in a significant increase in the proportion of released individuals remaining at the release site, and if used should reduce public concerns over initial levels of mortality or loss of reintroduced individuals. Release into an estuary environment would also reduce risks associated with predation by white sharks and would provide release animals with shelter from severe weather conditions as well as allow for easier recapture and treatment of released animals, if needed (e.g., if animals were observed having difficulty securing sufficient food resources), thereby reducing the risk of loss of individuals. The risk to the founding population that would be associated with this strategy is that it has never been attempted in an area that is not already occupied by sea otters, so it is unknown whether a similarly high level of retention could be expected if the juveniles were to be released in an estuary without an already established population of sea otters. This risk could be reduced by attempting small-scale experimental reductions using surrogate-reared juveniles with close monitoring of individuals and applying the principles of adaptive management, as needed. Risk might be further reduced by combining the release of surrogate-reared juveniles with the release of a small number of wild-captured sea otters, a scenario evaluated by Tinker (2021); this approach would likewise benefit from implementation as a small-scale experiment subject to monitoring and adaptive management. We propose consideration of such small scale, experimental reductions as one of the next steps if consideration of reintroduction continues (see 6.3.1.2 and 6.4.5).

5.1.2.2 Threat factors

There are several potential threat factors that may act on the newly established populations of sea otters. The evaluation of these threats and the probability of their occurrence should be one of the factors considered in the selection of any future reintroduction sites. We do not have sufficient information to conduct a formal evaluation of most of these threats at this time, but threat factors to new populations of sea otters in northern California and Oregon that have been identified include the following:

5.1.2.2.1 Threats from the effects of climate change

Threats from the effects of climate change include the northward expansion of juvenile white sharks along the coasts of northern California and Oregon as a result of warming ocean waters and the associated potential for shark bite mortality; possible reductions in benthic invertebrate prey species as a result of changing environmental conditions (e.g., from ocean acidification, hypoxia, or domoic acid); domoic acid intoxication; and reductions in kelp habitats as a result of warming ocean conditions.

Uncertainties with regard to whether the nearshore marine systems of northern California and Oregon will be suitable to support a reintroduced population of sea otters due to the negative effects of climate change are often raised as a risk factor for the new population. But the threat posed by the effects of climate change is not limited to any future reintroduced population of sea otters – one or more of the negative impacts of climate change described here already pose a threat to sea otters throughout their range. For this reason, we view 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 these increased stressors. It is our position that the establishment of additional populations of sea otters across a broader range of different environments through reintroduction will reduce the risk to the species or subspecies associated with climate change.

5.1.2.2.2 Oil spills

Oil spills remain one of the primary threats to sea otter populations and have occurred within the geographic range of the potential reintroduction area. For example, the *New Carissa* oil spill in 1999 resulted in the release of up to 140,000 gallons of fuel oil and diesel in two separate groundings near Coos Bay and Waldport, Oregon; and the *Tristan* oil spill in 2001 released an estimated 21,000 gallons of fuel oil off the Oregon coast from Coos Bay to Florence. In California, significant oil spills within the range of the southern sea otter include the *Cosco Busan* spill in San Francisco Bay (2007), and the *Kure* and *Stuyvesant* spills (1997 and 1999) in Humboldt Bay.

Sea otter killed in oil spill. USFWS photo.

Although oil spills pose a significant risk to sea otters, as with the risks posed by climate change, this risk would not be limited to a newly reintroduced population. We consider the establishment of additional populations of sea otters across a broader geographic range to be one of the most important conservation actions to reduce the risk posed to the species or subspecies by oil spills. Nonetheless, the risk of oil spills should be an important factor in considering the selection of potential reintroduction sites. In addition, to further reduce the risk to any population that may be reintroduced to Oregon, our Assessment calls for the establishment of oil spill response capabilities in Oregon since no such program yet exists in the State to care for wildlife that may be affected (see section 4.4.10). The California Department of Fish and Wildlife has a well- established program in place to deal with oiled wildlife through the Office of Spill Prevention and Response.

5.1.2.2.3 Incidental take in fishing gear

Accidental entanglement in shallow water set gillnets or trawl nets and entrapment in crab pots, finfish traps, or other fishing gear can result in mortality of sea otters from drowning, and there is a history of mitigation measures to reduce this risk for the southern sea otter in California that will be informative for analyzing this risk factor (USFWS 2021). Although Kone et al. (2021) assessed the degree of spatial overlap between suitable sea otter habitat and various fishery types in Oregon, there has been no detailed analysis of the amount and type of fishery gear deployed within the usable depths of sea otter habitat or the potential for incidental take of sea otters within the geographic scope of this Assessment. This will be an important risk factor that will require detailed evaluation and consideration of potential mitigation mechanisms, and also poses some degree of additional socioeconomic risk (see 5.1.5.4).

5.1.2.2.4 Human disturbance

Human activities can negatively affect sea otters, whether through disturbance that may interfere with essential behaviors or foraging (e.g., recreational boating), or through accidental mortality (e.g., propeller strikes). The potential for a reintroduced population to be affected by human activity will be an important risk factor to assess in association with specific areas considered for releases. Some preliminary work has already been done in this regard (e.g., San Francisco Bay, Rudebusch et al. 2020; coastal areas in Oregon, Kone et al. 2021), but additional analysis is needed for some important areas that may be under consideration as potential reintroduction sites (e.g., estuaries in Oregon; Kone et al. 2021).

5.1.2.2.5 Intentional take

The intentional killing of sea otters has been known to occur, particularly in areas where there has been a high degree of conflict with shellfish fisheries. In California, sea otters that have been shot continue to be found on occasion. It is hoped that collaborative efforts with stakeholders to develop a reintroduction and management plan would reduce the degree of such a threat in northern California and Oregon, should reintroduction be considered. However, the risk of the deliberate killing of sea otters seen as unwelcome competitors for a resource of economic value cannot be dismissed.

5.1.3 Risk of Inaction

In the initial stages of considering whether reintroduction is a viable or acceptable conservation option, the IUCN Guidelines suggest that one of the alternatives to be considered is the “no action” alternative (see Figure 1-1). What if we simply chose to wait for sea otters to recolonize on their own?

Recall that by the time they received legal protections in 1911, sea otters had been entirely extirpated from the Pacific coast between Prince William Sound, Alaska, and Point Sur, California (Figure 2.4). Many decades later, sea otters remained absent from southeast Alaska, British Columbia, and Washington and exist in those areas today due to translocations that occurred in the late 1960s and early 1970s. The formerly recovered population in southwest Alaska suddenly declined by more than 50% in the 1990s, likely due to a sudden shift in predation by orcas, leading to the listing of that population under the ESA (Estes et al. 1998, Doroff et al. 2003, USFWS 2005). Had reintroductions elsewhere in the historical range of the subspecies not taken place earlier, some areas, such as Amchitka, may not have been able to provide important redundancy to the northern sea otter. Inaction can also pose a risk to viability.

The gap between southern sea otters in central California and northern sea otters in north/central Washington is roughly 1,500 km (930 mi) in length (see Figure 2.6). As discussed earlier (see, e.g., 2.1.3, 2.4.2), sea otters exhibit a high degree of site fidelity and range expansion is generally slow; in California, range expansion of the southern sea otter population has not been observed in the past 20 years, and some range contractions have even occurred (Lafferty and Tinker 2014, USFWS 2021). Although individual northern sea otters occasionally swim from Washington southward into Oregon, most likely pioneering young males seeking mating opportunities, there are no other sea otters within dispersal distance for them to meet up with to establish a new population along the Oregon coast. The same is true for individual southern sea otters that may disperse on occasion north of Pigeon Point in California. Thus sea otter populations remain absent from this considerable expanse of the Pacific coast. Based on our understanding of sea otter range expansion, it is highly unlikely that this gap will be reduced without active intervention for many, many decades to come.

There is risk in simply waiting for natural range expansion to bridge this gap in the sea otter's historical range, particularly for the threatened southern sea otter. One source of risk is the diminished genetic diversity in the southern sea otter (see 4.1.3.1), which lessens the ability of the subspecies to respond to changing environmental conditions. Enhancing genetic diversity of the southern sea otter by providing the opportunity for occasional genetic exchange with northern sea otters would improve its adaptive potential in the face of climate change (e.g., Weeks et al. 2011, Larson et al. 2021). Northern sea otters may also benefit, as southern sea otters may carry genes that would benefit the ability of northern sea otters to respond to changing ocean conditions (see section 4.1.3.1). Natural range expansion to reestablish the historical connectivity between these subspecies is unlikely to occur within a timeframe that would give sea otters an adaptive advantage in responding to the effects of climate change, although environmental changes are already occurring rapidly and expected to worsen, so this will remain a challenge.

The more immediate source of risk is the lack of redundancy in populations of the southern sea otter. As long as the bulk of the southern sea otter subspecies remains isolated in one concentrated stretch of coast, it is vulnerable to catastrophic events, such as a large oil spill, that could effectively eliminate the source population. The risk of such an unforeseen event, even if extremely unlikely in any one year, poses a significant threat to the southern sea otter while waiting for the population to expand on its own and further natural expansion of the population is currently limited by shark bite mortality (USFWS 2021; see section 2.4.3.3). We therefore conclude there is risk associated with inaction, and that this risk is greatest for the threatened southern sea otter due to diminished adaptive capacity and a lack of redundancy in populations.

5.1.4 Ecological Risk

For the most part we do not anticipate any negative effects to the ecology of the nearshore marine environment of northern California or Oregon as a result of sea otter reintroduction. On the contrary, we expect a substantial benefit to biodiversity and ecosystem resilience. Sea otters are native to these ecosystems, and the species that inhabit this environment have co-evolved over tens of thousands or even millions of years together, with sea otter records in Oregon and California dating to the Pleistocene (Riedman and Estes 1990). Although environmental and ecological changes have occurred over the 100+ years that sea otters have been absent, observations of prey species in areas that have been recolonized by sea otters demonstrate that they continue to exhibit the adaptive behaviors in response to otter predation that enable coexistence (e.g., Lee et al. 2016). From an ecological perspective, areas within the historical range of sea otters that have become reoccupied have consistently demonstrated improved conditions in terms of increased overall biodiversity, ecosystem function, and even enhanced genetic diversity of associated species (e.g., Estes and Palmisano 1974, Estes and Duggins 1995, Reisewitz et al. 2006, Hughes et al. 2013, Estes 2015, Markel and Shurin 2015, Lee et al. 2016, Burt et al. 2018, Estes and Tinker 2021, Foster et al. 2021), thus clearly meeting one of the primary objectives of reintroduction.

The exception may be species that have been severely depleted due to other causes and may be particularly vulnerable to further perturbations that might impede or prevent population recovery. The Oregon Department of Fish and Wildlife has identified red abalone (see, e.g., 4.2.1.2.3.2) and native Olympia oysters (*Ostrea lurida*) as native species whose recovery could be negatively affected by excess predation by sea otters should the range of a reintroduced sea otter population overlap with the occurrence of these species (D. Fox, pers. comm. 2021).

One of the fundamental assumptions underlying the reintroduction of sea otters to restore ecosystem function and resiliency function rests upon the consistently predictable indirect effects of the sea otter-urchin-kelp trophic cascade (e.g., Estes et al. 2013, Estes 2015). There have been some questions as to whether the recovery of the kelp system will be as predictable or effective in areas where the majority of urchins are in a condition that provides little energetic return for foraging sea otters. As discussed in section 4.2.1.2.5, we anticipate that the trophic cascade will play out as expected if sea otters are reintroduced into areas characterized by urchin barrens, as demonstrated by the observed recovery of kelp forests in other urchin-dominated areas subsequently recolonized by sea otters (e.g., Estes and Palmisano 1974, Estes and Duggins 1995, Watson and Estes 2011). There is, however, some risk that the intended ecosystem benefits may not be realized as quickly as hoped for, as such systems tend to undergo a series of small-scale phase shifts resulting in a mosaic of kelp or urchin-dominated areas before ultimately transitioning into a more resilient yet dynamic kelp-dominated state (Watson and Estes 2011).

It is also important to recognize that such transitions may not occur until sea otter populations become established, and that suitable habitat to support systems such as kelp forests (and sea otters) occurs in a patchy, discontinuous mosaic along the coast (see, e.g., Figure 4.1 for Oregon). There should be no expectation that kelp forests will recover or become established in other than rocky nearshore areas that historically supported kelp systems, or that either kelp forests or sea otters will someday occur continuously along the coast. Additionally, the capacity for sea otters to contribute to the enhancement of kelp recovery will naturally be limited by the extent to which reintroduced otter populations grow and expand. As we forecast that the growth and expansion of reintroduced sea otter populations will take place gradually over decades (see e.g., 5.1.5.1 and 5.1.5.2, below) it should similarly be anticipated that the ecological benefits associated with sea otter recolonization will be realized over a long period of time.

5.1.5 Socioeconomic Risk

In our evaluation of socioeconomic feasibility, we identified the uncertainty around the severity and scope of the potential negative impacts of reintroduced sea otters on shellfish fisheries as the greatest area of risk in our Assessment (see 4.2.5). Additional risks were identified as the result of regulatory uncertainty. As specific potential reintroduction sites and/or reintroduction scenarios (e.g., which animals may be used as founders) are as yet unknown, it is impossible to conduct any site-specific analyses, which injects considerable uncertainty into the assessment of this risk factor. Furthermore, we note that the evaluation of socioeconomic risks would benefit from the structured decision making and stakeholder engagement process and comprehensive socioeconomic impact assessment we recommend in section 6.4. Here we offer our preliminary assessment of a few of the primary perceived risks that we have heard identified through our stakeholder interviews (see 4.2.2.1.1), with the caveat that we recommend further detailed and expert evaluation of all of these questions.

5.1.5.1 Risk from populations reaching projected carrying capacity

One of the primary concerns identified by many Oregon stakeholders is the risk that sea otters reintroduced to Oregon will grow to many thousands of individuals and deplete shellfish resources, resulting in the collapse of the commercial Dungeness crab fishery. As evidence for why they believe this might occur, some individuals have pointed to the carrying capacity estimates produced for Oregon by Kone et al. (2021). Based on observed densities of sea otters in California, the authors predicted sea otter densities and abundance at carrying capacity for the outer Oregon coast and all estuaries based on available habitat, including bathymetry, benthic substrate, kelp cover, and net primary productivity. They predicted that Oregon could support a total of 4,538 sea otters (range 1,742 to 8,976; 95% CI) at carrying capacity.

Although we understand why this number may induce concerns, it is important to put it into context — this number is the maximum number of sea otters all available habitats could collectively support across the entire Oregon coast if all were occupied. It is unclear if and when sea otters could reach this carrying capacity, but we do not anticipate a reintroduced population of sea otters reaching this maximum within the foreseeable future as sea otter population growth and range expansion, especially in linear habitats, is a slow process. The population of southern sea otters in California, for example, has been growing since the early 1900s from a founder population of fewer than 50 animals, has recolonized only an estimated 13% of their historical range, and remains at less than 20% of the estimated carrying capacity for the State[42] (USFWS 2021). Specific to Oregon, the EAFS presents a population projection from application of the ORSO model for the Port Orford area, which is considered to represent some of the best potential sea otter habitat on the Oregon coast. If 100 otters were reintroduced with supplementary additions of 3 subadults per year for 10 years, after 25 years the mean projected population size would be 176 otters (range 172 to 181; 95% CI) (Tinker 2021). Projections run with multiple reintroduction sites resulted in an approximate doubling of projected population estimates. Therefore, assuming success, reintroduction scenarios utilizing reasonable numbers of animals released would most likely result in a few hundred sea otters in Oregon over the coming decades, not thousands.

5.1.5.2 Risk that high levels of population growth experienced in southeast Alaska will occur in northern California and Oregon

The prospect of reintroduced sea otters growing to approximate the high densities observed in southeast Alaska, resulting in significant impacts to shellfish fisheries, is another perceived risk that has come up in multiple stakeholder interviews (4.2.2.1.1). As discussed earlier in this document (see 2.4.2), there are several reasons that we consider this to be unlikely. For one, although technically suitable

[42] This 20% figure is calculated based on the projected carrying capacity for southern sea otters based only on habitats within the California border and does not include the additional carrying capacity throughout the remainder of the subspecies' historical range, thus even 20% is an overestimate of the proportion of carrying capacity reached by southern sea otters after more than 80 years of population growth.

habitat spans the coasts of northern California and Oregon, habitat modeling clearly demonstrates significant differences and geographic discontinuities in potential sea otter densities along that extent (Kone et al. 2021, Tinker et al. 2021; see section 4.1.2, Figures 4.2 and 4.3). As sea otters are highly social animals, groups of otters would be patchily distributed and likely remain concentrated in disjunct areas of high-quality habitat. Secondly, we believe it is reasonable to anticipate that sea otters reintroduced to the coasts of northern California and Oregon are more likely to exhibit growth rates similar to those of sea otters in central California. This is because the spatial configuration of habitat within the sea otters' usable depth range along the coastline of northern California and Oregon is narrow and approximately linear, far more similar to the coastline of central California than the highly complex coastline of southeast Alaska. This factor, in combination with the high degree of spatial structuring of sea otter populations (high site fidelity and short dispersal distances, especially for reproductive females; Tinker et al. 2008, Tinker 2015), is expected to result in slow rates of range expansion and overall population growth. When coastal habitats occur in a narrow, linear configuration, such as in California, it means that only sea otters at the terminal ends of the range have unoccupied habitat within dispersal range. Animals throughout the rest of the population eventually become resource limited, which limits production of emigrating recruits to the periphery (Tinker 2015).

In contrast, in southeast Alaska and British Columbia, where the habitat consists of shallow bays, islands, and complex matrices of inland channels, or Washington, which is characterized by numerous emergent offshore rocks (in the north) and a broad, shallow sandy shelf (in the south), most sea otters can disperse in multiple directions and find suitable foraging habitats within reasonable distances, so a small fraction of the population is resource limited (Tinker 2015, Davis et al. 2019, Hale et al. 2019). This difference in habitat configuration results in very different expected population growth rates over the long term at regional scales (Tinker 2015, Davis et al. 2019). Recovering or translocated populations of northern sea otters in southeast Alaska, British Columbia, and Washington all exhibited growth rates of up to 17 or 20% annually during the early stages of recovery (Estes 1990, Bodkin 2015; see 2.3.2) For the California mainland, the highest observed growth rate for any 5-year period since the early 1980s, when comparable trend data first became available, is 7.6% per year (range 6.6 to 8.6; 95% CI) (USFWS 2021).

To quantitatively evaluate potential differences in foraging habitat available to sea otters in southeast Alaska versus our area of consideration in northern California and Oregon, we ran a GIS exercise to calculate the area, in acres, of foraging habitat available to sea otters in each of these areas. We additionally calculated foraging area off the coast of Washington for comparison. We calculated area at three depths: from 0-25 m (0 to 82 ft), the depth at which the vast majority of foraging dives take place; at 25-40 m (82 to 131 ft), the next range of most preferred foraging habitat; and from 40 to 100 m (131 to 328 ft), depths which can be utilized by sea otters on occasion, but are used only infrequently (see section 2.1.1). We calculated areas for the California coast north of San Francisco, the entire coast of each Oregon and Washington, and specifically calculated the area identified as the range of the southeast Alaska stock of sea otters, as provided by the Service's Environmental Conservation Online System (https://ecos.fws.gov/ecp/species/2884). We used gridded bathymetric datasets from GEBCO 2021[43] to calculate the area within each depth range. The results are presented in Figure 5.1. Within preferred foraging depths of 0 to 25 m, sea otters in southeast Alaska have more than 5 times as much area available to them as on the Oregon Coast, and 2.5 times as much as northern California. Ratios were similar within the mid-range, and are even higher at the maximum depths of up to 100 m. Although not all of this area is potentially suitable sea otter habitat, it is clear that southeast Alaska can

[43] (https://www.gebco.net/data_and_products/gridded_bathymetry_data/).

support far greater densities of sea otters than could ever occur on the coasts of northern California or Oregon because they have a vastly greater area of potential foraging habitat for sea otters.

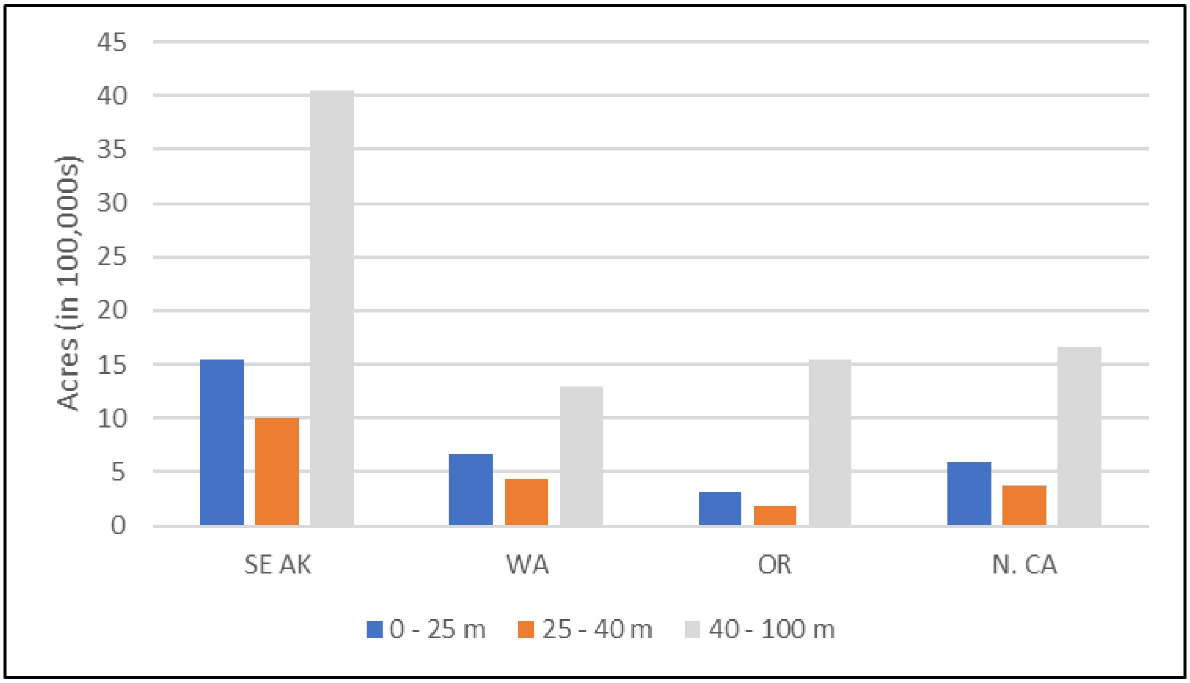

Figure 5.1. Comparison of area within suitable foraging depths for sea otters in southeast Alaska compared to the coasts of Washington, Oregon, and northern California. 0-25m is most preferred, 25-40 m is next most used, and up to 100 m least.

For all of these reasons, we do not expect the same levels of high population growth on the coasts of northern California and Oregon that have been observed in southeast Alaska and other areas that offer large expanses of shallow foraging habitats with complex geography, such as British Columbia. However, we caution that this comparison of growth rates does not apply to estuaries, as there are few estuaries in California occupied by sea otters that offer data for comparison (the releases of rehabilitated pups into Elkhorn Slough do not allow for an estimate of the natural rate of population growth that would occur without these continuous augmentations) and growth rates for a population reintroduced into an estuarine environment in either northern California or Oregon could be higher (e.g., see Hughes et al. 2019). In addition, we note the variability in change of population growth rates for reintroduced populations. Although many have shown relatively high growth rates at or near the maximum intrinsic growth rate soon after the establishment phase and then leveled off at a much lower rate, some populations have demonstrated little to no growth for decades and then suddenly accelerated (e.g., San Nicolas Island; see 2.4.1.2). Finally, although we have exercised our best professional judgment in evaluating the scientific evidence to develop an informed opinion as to what is most likely to occur, we acknowledge that much uncertainty remains, and predicting the specific outcomes of any translocation events with certainty is impossible.

5.1.5.3 Risk of negative economic impacts to shellfish fisheries

The greatest socioeconomic risk from a reintroduction of sea otters is the potential for significant negative impacts to shellfish fisheries. As discussed at length in section 4.2, these fisheries are an important part of the economy for many small coastal communities and individuals within the geographic scope of the area considered in this Assessment, and can represent a significant portion of the State's shellfish economy as well. Some formerly productive shellfish fisheries that developed in the absence of sea otters have been observed to decline dramatically following reoccupation of the area by sea otters, in some cases closing altogether (e.g., Larson et al. 2013, Carswell et al. 2015, Hoyt 2015, Polasek et al. 2018), while others continue to be productive despite the presence of sea otters. There are multiple factors that may determine the ultimate outcome; for this reason, further information gathering and focused analysis are required once a suite of potential reintroduction options and sites have been determined.

We agree with the analyses of Estes et al. (2021) and Kone et al. (2021) that the fisheries most likely to be impacted are those for red sea urchins and clams, whereas the potential effects on Dungeness crab are more nuanced. Impacts to clam fisheries and the Dungeness crab fishery have the potential to affect recreational and Tribal as well as commercial ocean users, and recreational fisheries for both clams and Dungeness crabs may experience impacts in bay or estuarine environments as well as on the coast (although most species of clams are more commonly harvested in bays or estuaries). Since the bottom of most bays or estuaries will be within the foraging depths of sea otters, recreational crabbing or clamming in those areas may not remain viable should a large sea otter population become established there. Consideration of reintroduction sites, whether coastal or estuarine, will need to factor in these potential impacts to multiple ocean users. Oyster farms in bay or estuary sites will also be a source of risk. Reopening of the recreational red abalone fishery on the coast could be negatively affected by sea otter reintroduction if there should be spatial overlap in occurrence.

The Dungeness crab fishery is in many respects the linchpin of the seafood industry on the Pacific coast, and multiple aspects of the economy depend upon it. From 2007/2008 through 2018/2019, most (87-96%) of the Dungeness crab landed in the commercial fishery in Oregon come from waters within the maximum foraging depth of sea otters (100 m; 331 ft), and about 35-48% of the catch comes from areas shallower than 40 m (D. Fox, pers. comm. 2021). There is thus potential for significant overlap between commercial crab harvest and sea otter foraging depths. Yet several lines of evidence suggest the Dungeness crab fishery may be more resilient to the reintroduction of sea otters than other shellfish fisheries – including little spatial overlap between high suitability otter habitat and crabbing grounds in Oregon (Kone et al. 2021), the lack of demonstrable economic impact on the fishery in California (Grimes et al. 2020, Boustany et al. 2021), the availability of deepwater refugia off the coasts of northern California and Oregon due to the relatively narrow continental shelf, and the observed continuing increases in statewide commercial Dungeness crab harvest in Washington despite the growing sea otter population there (see 4.2.1.2.5). However, observations from Washington also suggest that one potential outcome of re-establishing a sea otter population is that crab catch may decrease locally while remaining unaffected on a larger scale. If a similar pattern were to be observed in northern California and Oregon, there would be relatively little risk to the economy overall, but there could potentially be significant localized impacts on particular communities or individual fishers. Since the majority of legal crab are harvested every season, movement from one crabbing ground to another is likely to increase competition between individual fishers for the finite harvestable resource available (Richerson et al. 2020; D. Fox, pers. comm. 2021).

The reported impacts of sea otters on Dungeness crab fisheries have been variable and given the high potential overlap of the fishery with sea otter foraging depths and the economic importance of the fishery, the potential effect of sea otters on Dungeness crab within the geographic focus area of our Assessment requires careful and thorough study, as well as consideration of methods to reduce risk.

As noted above in the discussion of ecological risk (5.1.3), the realization of potential ecological benefits from the reintroduction of sea otters will not be immediate and widespread. Although the ecosystem in the immediate area where sea otters take up residency will benefit, it will take time for a reintroduced population of sea otters to gradually expand their range and spread those benefits further into the mosaic of discontinuous suitable habitats along the coast. The potential negative effect of sea otters on shellfish resources would be expected to follow a similar pattern: socioeconomic impacts are unlikely to be immediate or widespread but will more likely remain highly localized and limited to those areas where nascent reintroduced populations of sea otters become established, at least for the foreseeable future.

5.1.5.4 Risk of economic losses due to restrictions or prohibitions on fishing gear

Another source of socioeconomic risk stems from potential regulatory restrictions that could follow the re-establishment of a sea otter population to avoid entanglement or entrapment in fishing gear, which can lead to injury or mortality of sea otters. In California, depth restrictions were put into place for use of gill or trammel nets, and their use was prohibited altogether in some areas, to avoid death or injury of sea otters. State regulations were also promulgated to require the use of sea otter exclusion rings on live fish traps along the central California coast (USFWS 2021).

Similar restrictions or closures in Oregon could potentially have negative economic impacts on some fisheries by limiting the areas available to them for fishing, although if such restrictions or closures were relatively localized (only in areas where sea otters occur) and the fishers in question are relatively mobile, these impacts could be minimized. Other than crab pots, the primary fishing gear in Oregon that could pose an entanglement risk is bottom trawl and purse seine, currently fished for squid. These are fished in localized areas in the nearshore environment, primarily over sandy bottom habitats. In some years there is a seine fishery for herring in Yaquina Bay. Overlap of these fisheries with sea otters would depend upon where reintroduced sea otters would become established.

5.1.5.5 Risk to non-monetary values

Finally, we note that although at least one recent evaluation determined that the restoration of sea otters results in a net economic benefit overall in spite of losses to shellfish fisheries (due to the greater economic value from ecosystem services and tourism; Gregr et al. 2020), such a high-level approach overlooks the potentially significant adverse impacts to individuals who may rely upon these fisheries for their livelihood, for recreational or subsistence purposes, or for other non-monetary values. This is a source of socioeconomic risk that should not be overlooked, and we make recommendations here for potentially ameliorating any such impacts to individuals (see 5.2, below).

5.1.6 Legal risk

The greatest source of legal or regulatory risk that we have identified, voiced by some stakeholders, is the constraint on the ability to directly manage sea otters, such as if they exceed a certain population threshold. According to the IUCN Guidelines (IUCN/SSC 2013), in the case of unintended consequences, the best course of action may be to simply remove the translocated population (though the guidelines acknowledge this may be possible only at very early stages after establishment). However, as discussed elsewhere in this document (see 4.3.1.1), the MMPA's prohibitions on take, except in limited circumstances, presents challenges to authorizing removal once sea otters are reintroduced. This creates a strong incentive to ensure that all aspects of any potential reintroduction are thoroughly examined and that any reintroduction plan and post-reintroduction management and monitoring plan be developed in collaboration with all key stakeholders involved in a meaningful, structured process.

If southern sea otters are used as source animals, an additional source of regulatory risk to the feasibility of the action may be opposition from commercial fishers due to the inability to authorize incidental take of southern sea otters in the course of commercial fishing operations (see section 4.3.1.)

5.1.7 Financial risk

Adequate and reliable funding to support reintroduction efforts and associated monitoring for the duration of the reintroduction effort is essential; lack of adequate funding has been identified as one of the primary causes of reintroduction failures (Berger-Tal et al. 2019). There is some financial risk associated with this element of potential reintroduction, as the source of funding for any future effort has not yet been identified. Furthermore, assuming Federal funds may be involved, such funds are subject to the vagaries of congressional appropriations and thus subject to change on an annual basis. Inadequate or inconsistent funding for activities associated with a reintroduction (i.e., for necessary research prior to reintroduction, implementation, or monitoring post-reintroduction) would pose a risk to the success of the reintroduction effort and would mean that any mortalities of individuals incurred in the course of that effort would have been for naught.

5.2 Measures to minimize or offset potential negative impacts and reduce risk

We have identified what we consider to be the primary risks associated with the reintroduction of sea otters, based on both our own analysis as well as stakeholder interviews and other sources of information regarding stakeholder perspectives or attitudes (e.g., Curran et al. 2019, Larson and Tinker 2021). These risks, as well as any others that may be identified as the assessment of a potential reintroduction continues, require further scrutiny and careful evaluation for consideration in future decision processes.

To promote continued constructive dialogue regarding possible sea otter reintroduction and enhance the likelihood of success of such an undertaking, here we suggest some possible ways to reduce the risks we have identified in the course of developing this Assessment. These concepts require further development and evaluation to determine whether they may be viable and are not necessarily within the purview of the Service to accomplish alone. However, we provide them here to indicate possible avenues for further consideration, to spark creativity in problem-solving, and to point to the potential for collaboration with entities whose participation may be required to achieve these solutions.

5.2.1 Recommendations to reduce risk

5.2.1.1 Evaluate threats prior to selection of reintroduction sites

Conduct site-specific evaluations of risk prior to selection of potential reintroduction sites, to include factors such as evaluation of prey sufficiency, risk of shark bite mortality, risk of oil spills, exposure to environmental contaminants or domoic acid, and potential for conflicts with human activities (e.g., shipping, commercial or recreational fisheries) (see 6.3.1.3, 6.3.1.4). The evaluation of conflicts with anthropogenic activities that would be associated with the potential reintroduction of sea otters into San Francisco Bay conducted by Rudebusch et al. (2020) provides a helpful framework for such an assessment.

5.2.1.2 Consider experimental releases of surrogate-reared stranded juveniles and/or small numbers of translocated wild captured sea otters into estuaries to increase potential for success and minimize risk to released individuals.

Estuaries can provide high quality habitat for sea otters (Hughes et al. 2019*b*) and releases of surrogate-reared juveniles into estuarine environments have been demonstrated to greatly reduce the number of individuals lost to immediate dispersal (Mayer et al. 2019; see 2.4.1.3). This approach has resulted in a high level of retention of the released animals, with most (81%) settling within 10 km (6 mi) of the release site (Becker et al. 2020). However, all of the prior releases of surrogate-reared juveniles have occurred in areas that already had established sea otter populations (or at least male groups) (Mayer et al. 2019, Becker et al. 2020); whether similarly high levels of retention of released animals would occur in an estuarine environment that does not already have sea otters present is unknown. We recommend an adaptive management experimental approach focused on small scale reintroductions (see, e.g., Wilson et al. 2020) at one or two carefully selected estuary locations to test whether releases of surrogate-reared juveniles would be successful in an area without an established recipient population of sea otters.

Alternatively, an experimental approach could be used to test whether a small number of translocated wild captured otters of the appropriate age and sex composition introduced into an estuary environment would increase the likelihood of retention compared to past translocations, all of which involved moving animals to open coastal environments. A third experimental design could test the release of a small number of wild captured otters in combination with releases of surrogate-raised juveniles; all would be extremely informative in testing new and promising reintroduction strategies.

If successful, either of these strategies may serve as a viable alternative to more traditional translocations that can result in the loss of a high proportion of animals released (see 5.1.2.1). The enhanced retention of reintroduced animals in an estuary would not only reduce the levels of potential mortality that can result from a traditional translocation, but would also reduce the number of animals requiring capture, transport, and release for initial population establishment. Release into estuary environments could additionally preserve greater opportunity for recapture of the released animal, if need be; reduce the vulnerability of sea otters to shark bite mortality; and, if a population were to become established, could provide a more accessible wildlife viewing opportunity for the public and increase economic gains from ecotourism, if this were deemed desirable. Small-scale experimental pilot studies could also be used to further test potential soft release techniques, such as holding pens, to improve retention and further increase success.

5.2.1.3 Provide mechanisms, assistance to commercial and recreational fishers to reduce potential for accidental take of sea otters in traps

Sea otters may be trapped and drown in finfish or crab traps. The risk of mortality can be reduced by the use of slightly modified trap openings or exclusion devices. For example, Hatfield et al. (2011) concluded that reducing the typical 4-inch fyke opening height of Dungeness crab traps by one inch (to 3 inches) would exclude nearly all diving sea otters while not significantly affecting the number or size of harvested crabs. Requiring modified fykes or exclusion rings on crab or finfish traps would reduce the risk of accidental entrapment of sea otters. Exploring avenues to provide exclusion rings to crabbers or fishers free of charge would increase the likelihood of usage and reduce economic impacts.

5.2.1.4 Provide mechanisms, infrastructure assistance to oyster farmers to reduce potential losses to sea otters

Explore avenues to provide assistance to oyster farmers if a bay or estuary with oyster farms present is considered for releases or is located within general dispersal distance of a reintroduction site. Research may be required to determine methods or mechanisms for preventing or discouraging sea otters from gaining access to cultured shellfish.

5.2.1.5 Explore aquaculture opportunities that could offset economic losses to shellfish fisheries

Experience has shown that profitable commercial fisheries for red sea urchins, abalone, and possibly some clams are incompatible with sea otter populations in the immediate area. The development of aquaculture opportunities in areas that support these shellfish fisheries and that are also within the range of a potential reintroduced sea otter population could provide a viable alternative to offset the potential loss of these fisheries and could even provide additional economic gains to local communities or Tribes that host the siting and operation of these facilities. Aquaculture operations have been established for abalone (https://www.montereyabalone.com/our-story; Monterey Bay Abalone 2021, NOAA 2021) , urchins (https://www.urchinomics.com/; Urchinomics 2021), and clams (https://www.fisheries.noaa.gov/west-coast/aquaculture/commercial-shellfish-aquaculture-west-coast; NOAA 2021). Although not all of these programs may have yet reached the point of being commercially viable on a large scale, all have successfully demonstrated that aquaculture for these shellfish is possible.

5.2.1.6 Explore establishment of one or more programs to compensate commercial and subsistence shellfish fishers for sea-otter-induced losses with sea otter-induced gains to different segments of society

If one or more reintroduced populations were established, either on the outer coast or in estuaries, they would likely remain small for many years, possibly decades, and have inconsequential effects on most shellfish fisheries. At some point, however, depending on their location, the sea otter population(s) could grow to a size/density that would have detectable negative effects on shellfish fishing locally or regionally. Local benefits arising from ecotourism and benefits due to existence value could begin to be realized soon after the establishment of a small, core population. Benefits arising from sea otter-induced ecosystem changes (resilience to some of the consequences of climate change, finfish fishery benefits, and carbon sequestration benefits) would likely be realized later, on approximately the same time scale as impacts to shellfish fisheries. A cost-benefit analysis of sea otter recovery in British Columbia found that benefits outweighed losses by a factor of seven (Gregr et al. 2020).

Although the exact benefit-cost ratio will differ to some extent depending on the area, it is extremely unlikely that costs resulting from a reintroduced population would outweigh benefits. Compensation mechanisms could be established now that would allow for the future distribution of some portion of the benefits accrued by other segments of society from sea otter reintroduction(s) to shellfish fishers if/when they begin to experience losses. Limits on issuance of shellfish fishing permits to new entrants by the State(s) could be used in conjunction with compensation programs to reduce competition between fishers remaining in the fishery. Because of the likely lag time between initial reintroductions and eventual measurable effects on most shellfish fisheries, these limits could be imposed gradually over a long period of time.

5.2.1.6.1 Ecotourism, climate resilience, and existence value benefit distribution (Sea Otter Stamp)

Any reintroduced sea otter population, if visible or otherwise accessible to the public, is expected to enhance local businesses connected to ecotourism (kayak and boat rental establishments, hotels, restaurants, gas stations, etc.). If a reintroduced population achieved a size/density where ecological changes (increased kelp and/or seagrass) occurred, local communities would also benefit from increased resilience against the effects of climate change that are brought about by increased kelp and/or seagrass (e.g., reduced shoreline erosion due to sea level rise and increased storm intensity, local reductions in ocean acidification). A reintroduced sea otter population also has existence value for other members of society who may never see it, simply from knowing that it exists. Purchase of a Sea Otter Stamp (modeled loosely on the Duck Stamp https://www.fws.gov/birds/get-involved/duck-stamp.php) could generate funds, a portion of which could be used to compensate shellfish fishers if/when they begin to experience losses due to a reintroduced sea otter population. Purchase of a Sea Otter Stamp would acknowledge the ecotourism, climate resilience, and existence value provided by a reintroduced sea otter population. Purchase would be voluntary, though municipalities in proximity to a reintroduced sea otter population could conceivably mandate the purchase of a Sea Otter Stamp for businesses benefiting from ecotourism and/or improved climate resilience to ensure that compensation for affected shellfish fishers would be available.

5.2.1.6.2 Finfish fishery benefit distribution

If a reintroduced population were established in an area with rocky substrate that could anchor kelp, decreases in the availability of some commercially targeted or subsistence-harvested shellfish would be expected to occur at the same approximate geographic scale and during the same approximate time frame as increases in many commercially targeted or subsistence harvested finfish. Ecosystem modeling and statistical analyses could be used to estimate sea-otter-related gains and losses to local fishers. A fishing organization that represents both finfish fishers and shellfish fishers could develop a mechanism to distribute some portion of the benefits accrued by finfish fishers to shellfish fishers experiencing losses as a result of reintroduction.

5.2.1.6.3 Carbon offset revenue distribution

If a reintroduced population achieved a size/density where ecological changes (increased kelp and/or seagrass) occurred, carbon sequestration would occur in the form of blue carbon: in standing biomass of kelp and seagrass, through deposition of some proportion of kelp in the deep sea, and through deposition via seagrass roots in estuarine sediments. Rigorous validation could establish the amount of carbon sequestered as an indirect result of sea otter reintroduction. Carbon offsets could be sold to customers seeking to mitigate their climate impacts, facilitated by a carbon offset broker. A portion of the revenues could be used to compensate shellfish fishers experiencing losses as a result of reintroduction. The nonprofit Ocean Foundation has developed a blue carbon calculator, Seagrass Grow (https://oceanfdn.org/projects/seagrass-grow/), that translates the value of carbon capture and sequestration of seagrass into carbon offset values and provides an innovative and useful model of how this type of program could work.

5.3 Summary

We have identified the potential for negative economic impacts to shellfish fisheries as the greatest source of uncertainty with regard to socioeconomic feasibility (4.2.5) and the greatest risk associated with a reintroduction (5.1.4.3). On the other hand, recolonization by sea otters is associated with substantial economic benefits in other sectors, including significant revenue from ecotourism and other socioeconomic values such as ecosystem services and positive effects on finfish fisheries. Given the socioeconomic importance of the shellfish fishery to multiple user groups in terms of both economic and cultural values and the potential severity of unintended adverse impacts, we recommend further study on the probable impacts of sea otter reintroduction on the shellfish fishery in northern California and Oregon (5.1.4.3; see sections 4.2, 6.3.2.1, and 6.4.2). The use of a facilitated structured decision making framework is recommended to allow for the explicit assignment of probabilities and values for each of the risk factors considered. The use of such a framework ensures that the logic, value judgments, and gaps in data or understanding are transparent for all, and provides a constructive avenue for engaging key stakeholders in the decision process.

Suitable habitat for sea otters occurs in a patchy mosaic along the coasts of northern California and Oregon, such that should sea otters be reintroduced and become established in this area they will be distributed discontinuously along the shoreline. Based on our knowledge of sea otter site fidelity and range expansion in linear habitats, we anticipate that population growth and expansion along the coast will take many years if not decades (see 2.4.2, 5.1.5.1, 5.1.5.2). This means that any negative economic impacts that may result from the reintroduction of sea otters are unlikely to be widespread but will more likely remain localized, at least for the foreseeable future. It also means that some of the positive outcomes from sea otter reintroduction may likewise remain localized and experience a time lag before realization. The net positive in this scenario is that with sufficient advance planning it provides time for adjustments and adaptation to minimize any potential negative impacts that may be anticipated, should consideration of reintroduction continue.

6. CONCLUSIONS, RECOMMENDATIONS, AND NEXT STEPS

6.1 Conclusions: Assessment of conservation benefits, feasibility, and estimated cost of sea otter reintroduction

According to the principles of the IUCN Reintroduction Guidelines, the objective of any reintroduction must be intended to yield a measurable conservation benefit; that benefit may be recognized as an improvement in the conservation status of a population or a species, or it may stem from the restoration of natural ecosystem functions or processes (IUCN/SSC 2013). The IUCN Guidelines further elevate the relative importance of ecosystem function in assessing conservation benefits, noting that "while species conservation remains a priority for conserving biodiversity, reintroduction needs to be undertaken in the context of the conservation and restoration of habitats and ecosystem services" (IUCN/SSC 2013, Annex 1).

6.1.1 Conservation benefits to the species

Based on our assessment as summarized in this report, we conclude that there would be multiple substantial benefits to the species from a reintroduction of sea otters to their historical range in northern California and Oregon. These benefits would stem from the improved conservation status of the species rangewide, and depending on the reintroduction scenario, could benefit the federally-listed southern sea otter in particular, as follows:

- Range expansion of the southern sea otter has been stalled for the past 20 years. Although population growth in the southern sea otter has been slow, the single recovering population has grown to the point that it has become resource-limited in the center of its range and further range expansion to the north and south appears to be limited by shark attacks. Reintroductions in the northern extent of its historical range would assist the subspecies to achieve the range expansion that is a key objective for the recovery of the southern sea otter.
- The establishment of additional population(s) of the southern sea otter, which is currently concentrated primarily in one single, large population on California's central coast, would create desirable redundancy in populations that would enable the subspecies to survive a catastrophic event, such as a large oil spill or disease outbreak.
- Reintroduction of the southern sea otter to northern California and/or south to central Oregon would re-establish the historical transition zone between northern and southern sea otters that once existed on the Oregon coast. Restoring the opportunity for occasional genetic exchange between these subspecies that are currently entirely isolated from each other would benefit the southern sea otter by:
  - Rebuilding genetic diversity in the southern sea otter that has been diminished as result of past population bottlenecks; and
  - Increasing the southern sea otter's adaptive capacity to respond to changes in environmental conditions, including the effects of climate change.
- Increased population redundancy, restored genetic connectivity, and range expansion as a result of reintroduction(s) would all contribute to the recovery of the southern sea otter and set the stage for the delisting of the subspecies under the Endangered Species Act.

- On a global scale, the reintroduction of sea otters to the coasts of northern California and Oregon would contribute to restoring populations of the species to a vast gap in what was once its worldwide range spanning the North Pacific Rim.

6.1.2 Conservation benefits to the ecosystem

Based on our assessment as summarized in this report, we conclude that there would be multiple substantial biological and ecological benefits to the nearshore marine ecosystem from a reintroduction of sea otters to their historical range in northern California and Oregon. These benefits would be realized as a consequence of the ecological effects of the sea otter as a keystone predator and its positive indirect effects on habitat and ecosystem services (see section 2.1.4 and 4.1.4). The restoration of sea otters to areas where they have long been absent has been observed to result in increased cover, productivity, and ecosystem services of kelp forests and seagrass beds (in estuarine environments), with potential benefits including, but not limited to:

- Increased nursery habitats for many species of finfish (including rockfish, salmon, and herring) ultimately benefitting finfish fisheries
- Increased nursery habitats for crabs and other invertebrate species, especially in estuaries
- Overall increases in biodiversity and biomass in the nearshore marine ecosystems
- Increased capacity for carbon sequestration
- Local reductions in ocean acidification
- Protection from coastal erosion through reductions in wave energy
- Greater ecosystem resiliency to climate change

6.1.3 Fulfillment of the purposes of the ESA and MMPA

Recovery of the southern sea otter would fulfill a primary purpose of the Endangered Species Act: to conserve endangered species and threatened species, and to conserve the ecosystems upon which they depend.

Recovery of the southern sea otter would fulfill a primary purpose of the Marine Mammal Protection Act: to restore a species that has diminished to the point that it has ceased to be a significant functioning element of the ecosystem of which it is a part, and to maintain the health and stability of the marine ecosystem.

6.2 Feasibility and costs of a potential reintroduction

We consider something to be feasible if it is practicable or achievable. Feasibility may also be defined as capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors. **Based on our evaluation of biological, socioeconomic, and legal feasibility as detailed in section 4 of this Assessment, we conclude that the reintroduction of sea otters to northern California and Oregon is feasible.** The ultimate success of such an endeavor, however, would require focused effort and creative solutions to overcome some challenges, particularly in the socioeconomic sector.

6.2.1 Cost estimates of various potential reintroduction scenarios

A translocation should not proceed without assurance of funding for all essential activities over an adequate period of time; the latter should be determined by reference to the schedules laid down in the IUCN Guidelines, section 4 (IUCN/SSC 2013).

The actual costs of reintroducing sea otters are uncertain and will depend on the specifics of each reintroduction effort. In the case of translocation, these costs will vary based on the source population, distance to reintroduction site, capture techniques, transportation methods, and number of sea otters captured annually. Based on the reintroduction scenarios discussed in section 4.4, we estimated that the total cost of sea otter reintroduction will range from $26 million to $43 million dollars over a 13-year period. This estimate includes pre-reintroduction habitat evaluation (3 years), acquisition of sea otters (wild captured for 5 years and/or surrogate reared for 10 years), habitat monitoring (10 years), population monitoring (10 years), and postmortem and oil spill response programs. Although monitoring efforts will need to continue beyond 10 years, we do not include those costs here. The scenarios presented in section 4.4 are for demonstration only and are not endorsed. Tables with the breakdowns for each element can be found in Appendix C.

6.3 Recommendations

To promote continued constructive dialogue regarding possible sea otter reintroduction and enhance the likelihood of success of such an undertaking, here we make several recommendations to address key concerns or uncertainties identified in the course of developing this Assessment for further consideration (see sections 4 and 5 for discussion of key uncertainties and risks addressed here).

6.3.1 Recommendations to reduce biological or ecological uncertainty or risk

6.3.1.1 Integrate ORSO and Sea Otter Integrated Population Model (IPM)

To more accurately forecast sea otter population growth and expansion in northern California and Oregon under different reintroduction scenarios, the integrated population model (IPM) for California (Tinker et al. 2021b) and ORSO model for Oregon (Tinker et al. 2021c) should be modified to allow population forecasting across the two regions, as there is the potential for interaction between animals released depending upon the distance between release sites. This factor will also be a consideration in evaluating the potential for population connectivity and gene flow.

6.3.1.2 Conduct experimental pilot studies on release of surrogate-reared sea otters and/or small numbers of translocated wild captured sea otters into estuaries in unoccupied historical range

As described in section 5.2.1.2, above, experimental pilot studies should be considered at one or two carefully chosen sites to test whether surrogate-reared, rehabilitated southern sea otters will successfully establish in an area that lacks an existing sea otter population, or whether release of a small number of translocated wild captured sea otters may be more successful if released into an estuary environment (or some combination thereof). If successful, these methods may serve as a viable alternative to more traditional translocations that can result in the loss of a high proportion of animals released. In addition, such pilot studies could be used to assess site selection criteria (e.g., prey availability, habitat suitability, anthropogenic risk), and allow for evaluation of the success of the site and methods used before proceeding at a larger scale or at other locations, if deemed necessary and desirable.

6.3.1.3 Assess threats at potential reintroduction sites

A baseline threats assessment should be conducted to evaluate risk to reintroduced sea otters in areas of suitable habitat under consideration for as potential reintroduction sites (5.2.1.1). Such an assessment should include an evaluation of shark-bite risk along the northern California and Oregon coast. Shark-bite trauma is the most significant primary cause of mortality to southern sea otters and has been shown to cause population level effects. Gathering information on the spatial or temporal overlap of white sharks and sevengill sharks in areas of reintroduction consideration may influence selection of potential sites for reintroduction. Similarly, an evaluation of potential conflicts with human activities or other anthropogenic sources of risk (e.g., oil spills) and exposure to environmental threats (e.g., contaminants, domoic acid) will be an important consideration in the selection of possible reintroduction sites.

6.3.1.4 Evaluate prey availability at potential reintroduction sites

Prior to final selection of any reintroduction sites, areas under consideration will require ground truthing to ensure that sufficient prey are available to sustain a reintroduced population of sea otters.

6.3.1.5 Evaluate potential effects on at-risk species

Evaluation of possible reintroduction sites should include consideration of the potential impacts of a reintroduced sea otter population on native species that have been depleted due to other causes, such as red abalone or Olympia oysters, and are thus sensitive to excess predation pressure that may impede their recovery.

6.3.2 Recommendations to reduce socioeconomic uncertainty or risk

6.3.2.1 Conduct comprehensive socioeconomic impact assessments targeted to potential reintroduction sites

The greatest uncertainty in our feasibility assessment is the degree of possible economic impact of reintroduced sea otters on shellfish fisheries and associated industries (e.g., seafood processors). This is an issue of critical importance to many stakeholders and likely represents the greatest impediment to the success of a reintroduction effort.

A robust economic impact assessment is needed to thoroughly understand the probable effects of sea otter reintroduction to northern California and Oregon. To be most accurate, such an analysis will first require the identification of likely reintroduction sites to allow for geospatial analysis of potential impacts to specific fisheries. In Oregon it would make sense to use the areas of greatest habitat suitability identified by Hodder et al. (2021) and Kone et al. (2021), and in California, Tinker et al. (2021), as a starting point for a site-specific economic evaluation. Projected sea otter numbers, distribution, and foraging depths/local bathymetry are also important factors in such an analysis. Therefore, this assessment will additionally require narrowing the universe of potential reintroduction scenarios for evaluation (see 6.4.5, below).

A thorough economic impact assessment will not be limited to impacts on shellfish fisheries and associated industries but will consider potential impacts on other economic sectors as well, such as finfish fisheries, maritime vessels and ports, offshore energy development, ecotourism, cultural and existence values, and ecosystem services. Potential impacts to State resource management agencies should be evaluated. Economic impacts may be either positive or negative, and all must be considered. Expertise from resource economists as well as social scientists will be required to inform a comprehensive economic impact assessment that takes all of these factors into account.

Incorporating into this assessment a calculation of the potential value of the full range of ecosystem services provided by sea otter restoration would have the added benefit of informing the development of a compensation program that could offset economic losses that may be experienced (see 6.3.2.4).

6.3.2.2 Consider non-monetary values

Where appropriate, incorporate socioeconomic factors into key decisions along with biological considerations. For example, the selection of potential reintroduction sites might be based on a multi-variate structured decision making model that includes consideration of factors such as economic impacts (potential for resource conflicts or ecotourism) and non-monetary values (e.g., wildlife viewing, existence values, cultural values of indigenous peoples and fishers) to further narrow the suite of options once an initial assessment has been completed based on essential biological and ecological factors such as habitat suitability and prey availability.

6.3.2.3 Consider assistance to mariculture businesses, as needed

Consider the development of a subsidy program or Extension service to provide mariculturists with the materials or infrastructure necessary to grow oysters or other shellfish such as abalone or red sea urchins in such a manner as to deter potential sea otter predation.

6.3.2.4 Explore novel approaches to minimizing inequities in socioeconomic impacts

Explore the development of economic incentive or compensation models to facilitate socioeconomic equity and/or minimize or offset economic or other costs associated with sea otter reintroduction (5.2.1.6). For example, research the potential development of a carbon offset market, based on carbon sequestration values provided by sea otters via the indirect restoration of kelp and/or seagrass biomass or other ecosystem services. Sales of carbon credits could be used to compensate individuals or businesses that may experience negative economic impacts as a consequence of sea otter reintroductions. The success of this concept would depend upon the scale of benefits that could be accrued as well as time to realization of those benefits. Sales of a "Sea Otter Stamp," similar to the Service's Duck Stamp, are another possible avenue to generate revenue for compensation programs. All of the ideas presented in this Assessment are purely exploratory at this point and would require further development and evaluation.

6.3.3 Recommendations to reduce legal or regulatory uncertainty or risk

6.3.3.1 Advance development of adaptive management plan

Develop a clear adaptive management plan prior to reintroduction, should a decision be made to proceed; this plan must account for and describe how the U.S. Fish and Wildlife Service will deal with unexpected outcomes and should be developed with input from all key stakeholders, including the public, States, and Tribes. Stakeholders from across the spectrum of constituencies identified the need for forecasting potential problems and having a solid plan in place to address them ahead of time, rather than scrambling to find solutions after the fact (see 4.2.2.1.1.1).

As a part of any management plan, the IUCN Reintroduction Guidelines recommend an "exit strategy" that may require the removal of individuals should a reintroduction fail to meet its stated objectives or cause unanticipated harm. In light of the MMPA's moratorium on take, with very limited, prescribed exceptions, authorization of take associated with the removal of marine mammals after reintroduction could prove very challenging, and the public should be fully informed of this legal constraint. Other means of addressing unanticipated outcomes must therefore be clearly identified in the adaptive management plan.

Adequate funding and capacity to implement all necessary post-release monitoring and management must be identified and secured to ensure reintroduction success.

6.3.3.2 Explore avenues to authorize incidental take in the course of commercial fishing operations for southern sea otters

If southern sea otters are considered for reintroduction to Oregon, explore possible legal avenues for authorizing incidental take from commercial fishing operations. Such authorization would reduce apprehensions from fishers about possible penalties for inadvertent violation of the MMPA in the course of normal operations and could increase public acceptance of a reintroduction. Measures should also be developed and implemented to reduce the likelihood of incidental take of sea otters from commercial fishing operations (see section 5.2).

6.3.3.3 Avoid consideration of zonal management or lethal control

We advise against any consideration of zonal management (capture and relocation) as provided under PL 99-625, and we additionally advise against providing assurances regarding the specific geographic area that sea otters will occupy subsequent to their release. Transparency is key. Stakeholders must be presented with mortality and movement information based on experience with prior translocations and the Service must acknowledge the uncertainties associated with any reintroduction.

We advise against any consideration of lethal control of sea otters. The majority of stakeholders from all key constituencies expressed the desire to avoid lethal control, even if it were legally possible.

6.3.3.4 Consider use of experimental population designation if ESA-listed sea otters are used as a source

If listed southern sea otters are considered as a potential source for reintroductions, we recommend consideration of a regulatory rulemaking to designate an experimental population under section 10(j) of the ESA to provide maximum regulatory flexibility and lessen concerns about penalties or restrictions that might otherwise be associated with the presence of a listed species.

6.4 Next steps

Having concluded that the reintroduction of sea otters to the contiguous Pacific coast of the United States, and more particularly, to northern California and Oregon, is feasible, here we recommend the next steps for action should consideration of reintroduction continue.

6.4.1 Initiate facilitated structured decision making and stakeholder engagement process

Ultimately the decision as to whether to proceed with reintroduction requires the careful consideration of both risks and benefits; this requires assessing the probabilities that different outcomes may occur (either quantitatively or qualitatively) and placing values on those outcomes. A structured decision making framework, working with an experienced, neutral facilitator, is best suited for this process. We suggest convening a series of facilitated structured decision making workshops with key stakeholders, agency representatives, and scientific experts. The goal of these workshops would be to engage in collaborative problem-solving regarding the uncertainties or data gaps identified and to explore reintroduction options that might present an acceptable level of risk to all parties and increase the likelihood of success of a reintroduction effort. Workshops should incorporate the principles of evidence-based conservation policy development, which relies on the incorporation of science, expertise, values, and local knowledge into a transparent decision analysis framework. For example, collaborative work with key stakeholder groups could be used to identify those reintroduction sites that would maximize the likelihood of reintroduction success while minimizing negative socioeconomic impacts (6.4.2), craft an economic incentive/benefits distribution or compensation model that would provide for socioeconomic equity in a reintroduction effort, or explore other options that may increase the success of a reintroduction effort.

6.4.2 Develop criteria for selection and evaluation of potential reintroduction sites

Further evaluation of the acceptability of sea otter reintroduction as a conservation strategy requires that specific reintroduction sites be identified. Facilitated structured decision making workshops (6.4.1) should be used to help develop criteria for selection and evaluation of potential reintroduction sites, working with panels of scientists and experts in sea otter biology and habitat as well as stakeholders and agency representatives. Narrowing the focus of feasibility assessment to specific reintroduction sites will allow for gathering specific baseline information (6.4.4) as well as enhance accuracy of the socioeconomic impact assessment (6.3.2.1, 6.4.3).

6.4.3 Conduct targeted comprehensive socioeconomic impact assessments

Initiate a rigorous socioeconomic impact study that considers the full range of negative and positive effects of sea otter reintroduction, including ecosystem services, as described in sections 6.3.2.1 through 6.3.2.5. Potential reintroduction sites must first be identified to provide for greater accuracy in projecting the possible localized impacts of a reintroduction (6.4.2).

6.4.4 Complete baseline assessments needed for evaluation of reintroduction sites

Evaluate specific sites identified as having highly suitable habitat available for sea otter reintroduction (e.g., from ORSO and IPM for California) for additional factors that may influence reintroduction site selection, including prey availability, shark-bite risk, anthropogenic threats (e.g., human activities, oil spills), and overlap with commercial and recreational fisheries (6.3.1.3, 6.3.1.4).

6.4.5 Plan experimental pilot studies for reintroduction of surrogate-reared juveniles and/or small numbers of translocated adult sea otters into estuary habitats

Develop plans for pilot studies and/or small-scale experimental reintroductions to assess the viability of using surrogate-reared southern sea otter pups and/or small numbers of translocated adult sea otters into estuary environments as a source for the establishment of new populations (6.3.1.2).

6.4.6 Model reintroduction scenarios for northern California and Oregon combined

Integrate the population growth and expansion models that are currently separate for California and Oregon such that simulations can forecast outcomes for the continuous northern California to Oregon coast, including the potential for interaction between reintroduced populations (see 6.3.1.1).

6.5 Summary

Our preliminary evaluation indicates that reintroduction of sea otters to northern California and Oregon is feasible from a biological and ecological perspective and would produce conservation benefits to the species and the nearshore marine ecosystem, as well as a broad range of ecosystem services. Sea otter reintroduction is feasible from a legal standpoint as well, although a few regulatory adjustments may be desirable to increase the likelihood of public acceptance and thus success of the effort.

The greatest challenge to the success of sea otter reintroduction is at the socioeconomic level. We conclude that reintroduction is feasible from a socioeconomic perspective but this is the area of greatest risk associated with reintroduction due to uncertainties regarding the potential for negative economic consequences on shellfish fisheries. Sufficient data are not available at this time to inform the consideration of these questions at the site-specific level for northern California and Oregon since specific reintroduction sites have yet to be identified. Our preliminary evaluation suggests that reintroduced sea otter population(s), once established, will initially be small in size and take many years to grow and expand, such that any impacts are likely to remain localized for the foreseeable future. We recommend the completion of a comprehensive socioeconomic study/economic impact assessment to determine the probability and scope or magnitude of all socioeconomic impacts, positive or negative, that may stem from the reintroduction of sea otters to northern California and Oregon.

The actual costs of reintroducing sea otters are uncertain and will vary based on the source population, distance to reintroduction site, capture techniques, transportation methods, and number of sea otters captured annually. We evaluated a range of plausible reintroduction scenarios for the purpose of estimating the potential scope of costs. Based on the scenarios considered, we estimated the total cost of sea otter reintroduction will range from $26 million to $43 million dollars over a 13-year period.

Returning to the original question: is reintroduction a viable conservation option? Our Assessment indicates that reintroduction is feasible and would result in significant benefits to the species and the ecosystem, but that additional work is needed to reduce uncertainty in the area of risk, particularly with regard to the potential socioeconomic impacts of sea otter reintroduction.

Sea Otter Reintroduction Assessment – Summary Conclusions

Feasibility Assessment	***Conclusion***	***Comments***
Biological Feasibility	Feasible	Additional baseline evaluations of potential reintroduction sites needed; experimental pilot studies recommended
Socioeconomic Feasibility	Feasible	Reintroduction will result in both benefits and costs; further evaluation required to reduce risk/uncertainty
Legal Feasibility	Feasible	No legal constraints preclude reintroduction; some regulatory changes may be desirable
Risk Assessment	***Conclusion***	***Comments***
Biological Risk	Risk of inaction	Waiting for natural range expansion poses a risk to the southern sea otter from diminished adaptive capacity and lack of redundancy in populations
Socioeconomic Risk	Uncertainty with regard to severity and scope	Additional evaluation required to determine whether the degree of risk associated with the uncertainty of socioeconomic impacts, in particular with regard to shellfish resources, may be reduced to an acceptable level once specific reintroduction sites are identified and a rigorous socioeconomic impact assessment is completed
Legal Risk	Low risk	Lack of authorization for incidental take in commercial fisheries for southern sea otter and limited options for management of all sea otters under MMPA may increase public resistance to reintroduction
Costs	***Timeframe***	***Comments***
$26-$43 million total	13 years	3 years of baseline assessments + 10 years implementation and monitoring, based on a range of plausible scenarios

This concludes our assessment of the feasibility and cost of reintroducing sea otters to the contiguous Pacific coast of the United States. We emphasize that this report is not to be read as a stand-alone document but as a companion to the Elakha Alliance Feasibility Study (EAFS), available at https://www.elakhaalliance.org/feasibility-study/. This report is intended to complement and supplement, not replicate, the compilation of the best available scientific information provided in the EAFS. This is not a decision document and does not represent or predetermine any proposal for action.

Southern sea otters resting in Morro Bay, California. Photo taken from shore with a 400mm zoom lens and cropped; Lilian Carswell, USFWS.

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Glossary

Angiosperm	flowering plants; used in this document to differentiate marine plants such as seagrasses from kelps, which are algae. Algae contain chlorophyll but lack the true stems, roots, leaves, and vascular tissue of flowering plants
Autotroph	*aka* primary producers. Autotrophs do not need a living source of carbon or energy and are the primary producers in a food chain, such as plants or algae that produce complex organic compounds using carbon dioxide and light energy for photosynthesis. Autotrophs are at the bottom of the food chain.
Apex predator	a predator at the top of a food chain or food web, without natural predators
Bathymetry	the measurement of water depth at various places in a body of water
Benthic	of, relating to, or occurring on the ocean floor
Biodiversity	biological diversity in an environment as indicated by numbers of different species of plants and animals
Biotic	of, relating to, or caused by living organisms
Carbon sequestration	the process of capturing and removing carbon (usually in the form of carbon dioxide) from the atmosphere to stable storage through physical, chemical, or biological processes
Carrying capacity	the maximum number of individuals of a particular species that the environment in a certain area can sustain over time, considering both biotic and abiotic resource limitations (e.g., food resources, space).
Demographics	factors that influence population growth or decline including population size, density, age structure, fecundity (i.e., birth rates), mortality, and sex ratio
Ecosystem	the complex of a community of organisms and its abiotic environment functioning as an ecological unit
Endangered	as defined under the Endangered Species Act, a species in danger of extinction throughout all or a significant portion of its range
Equilibrium density	the carrying capacity for a specific area
Estuary	a water passage where the tide meets a river current
Experimental population	a special designation under section 10(j) of the Endangered Species Act that can apply to a population of a threatened or endangered species prior to reestablishing it in an unoccupied portion of its former range, and can be used to reduce potential regulatory burdens or restrictions
Finfish	a true fish as distinguished from a shellfish
Fishers	a person who catches fish for a living or for sport; used as a gender-neutral term for the more traditional "fisherman." As used in this document, it does *not* refer to the mustelid *Pekania pennanti*.
Fyke	the funnel opening of fish or crab traps
Genetic diversity	the variation in the genetic composition among individuals
Gravid	pregnant or full of eggs
Groundfish	fish that live and feed near the bottom
Historical range	the geographical area historically occupied by the species
Home range	an area traversed by an animal in its normal activities of food gathering, mating, caring for its young
Homeothermy	having a body temperature that is constant and largely independent of the environmental temperature

Homing	to return to one's native area or place of origin
Hypothermic	a below normal body temperature
Hypermetabolism	metabolism at an increased or excessive rate
Hypoxia	a deficiency of oxygen reaching the tissues of the body
Incidental take	unintentional take that results from activities that are otherwise lawful
Intertidal	the zone between high tide and low-tide marks
Intrinsic rate of increase	the maximum per capita growth rate for a population
Keystone species	a species of plant or animal that produces a major impact (as by predation) on its ecosystem and is considered essential to maintaining optimum ecosystem function or structure
Macroinvertebrates	any animal lacking a backbone and large enough to see without the aid of a microscope (such as a crayfish or crustaceans)
Mesopredator	a predator that ranks in the middle of a food chain or food web
Morphometric	using measurements of the form of an organism
Mustelid	animal in the carnivorous family of mammals, Mustelidae; includes otters as well as wolverines, badgers, skunks, weasels, ferrets, minks, fishers, and others
Net primary production	the rate at which energy is stored in the organic matter of plants or algae through photosynthesis, less the amount lost to cellular respiration
Pathogen	an agent that causes disease, especially a virus, bacterium, or fungus
Polygyny	a mating pattern where an animal has more than one mate
Recruitment	the process of adding new individuals to a population or to a specific segment of that population through reproduction, immigration, and stocking
Redundancy	the ability of a species to withstand catastrophes, measured by the number and distribution of populations relative to the scale of relevant catastrophic events
Resiliency	the ability of a species to withstand environmental stochasticity (normal year to year variation in environmental conditions), periodic disturbances within its normal range of variation and demographic stochasticity (normal variation in demographic rates such as mortality and population growth rate)
Shellfish	an aquatic invertebrate animal with a shell such as a mollusk (i.e. oyster) or crustacean (i.e. crab)
Site fidelity	the tendency to return to a previously occupied area
Socioeconomic	relating to or concerned with the interaction of social and economic factors
Stock	the Marine Mammal Protection Act defines a "stock" as a group of marine mammals, of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature
Subspecies	a category in biological classification that ranks immediately below a species and designates a population of a particular geographic region genetically distinguishable from other such populations of the same species and capable of interbreeding successfully with them where its range overlaps theirs
Subtidal	lying below the low-tide mark but still shallow and close to shore
Surrogate	as used in this document one who acts or serves as a substitute mother
Take	under the Marine Mammal Protection Act, 'take' means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal; under the Endangered Species Act, 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Thermal conductance	a measure of the ability of a body to conduct heat
Threatened	as defined under the Endangered Species Act, a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range
Transition zone	as used in this document, that area within a latitudinal cline or gradation in genetic characteristics within a single species that gradually transitions from one subspecies to another
Trophic	Of or relating to feeding or nutrition. The trophic level of a species refers to its position in a food web or food chain
Trophic cascade	The indirect effects of a predator at the top of the food chain or food web on species at lower, non-adjacent trophic levels, which ultimately result in rebalancing the ecological relationships of numerous species.
Urchin barrens	Collapsed kelp ecosystems, where herbivorous sea urchins that normally subsist on drift kelp have become so numerous that they have overgrazed all or most of the standing kelp, resulting in a desert-like underwater landscape dominated by sea urchins and devoid of kelp.
Weaning	to accustom an animal to take food otherwise than by nursing

APPENDIX A. Tribal Perspectives

We invited all federally-recognized Tribes on the coasts of northern California, Oregon and Washington to share their perspectives on the feasibility of reintroducing sea otters to the Pacific coast. We received responses from six Tribes; their responses are summarized in section 4.2.3 of this document. Here we include, with their permission, the full text of the letters received from five of the Tribes (the sixth Tribe provided their feedback by email; that email is summarized in section 4.2.3 but is not duplicated here).

COQUILLE INDIAN TRIBE

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October 14, 2021

Michele Zwartjes
US Fish and Wildlife Service
michele_zwartjes@fws.gov

RE: Comments of the Coquille Indian Tribe on Possible Sea Otter Reintroduction

Dai s'la! I am the Chairperson of the Coquille Indian Tribe. Thank you for the opportunity to provide some initial feedback on the possible reintroduction of Sea Otters to the Oregon Coast. I understand that these comments will be considered as you evaluate the feasibility of reintroduction steps that you might or might not approve.

The Coquille Tribe historically occupied, traded, fished, hunted and gathered resources throughout Southwestern Oregon, including the coast. The Sea Otter, known as *Elakha* to our people, is culturally significant to us as it was used as a food resource and for its pelt.

We consider the Sea Otter to be, among other things, a traditionally important regulator of species balance on the Coast, an indicator of environmental crises, and a keystone species that is fundamental to the sound working of our coastal ecosystem.

Expansion of the sea otters' range into Oregon may be the best solution to its species diversification and long-term survival. Should sea otters be re-established on the Oregon coast, it is speculated that kelp forests will also re-establish to at least the extent they existed in 1912. Expanding kelp forests will provide new and much needed refugia and feeding habitat of various fish populations. Disappearing kelp beds contribute to reduced spawning habitats for herring, a species that provides 32-71% of the summer diet for chinook and coho salmon. (Forest & Ivy, 2002). With this in mind, native species restoration may ensure the long-term welfare of all coastal flora and fauna, including humans.

With that overall perspective, we do have some concerns over the possible restoration of Oregon's Sea Otter population. We are concerned about the unknown impacts it might have to other culturally and traditionally important species as well as our coastal economy. The ecological context on the Oregon coast is not the same as it was in the 19th Century. The Pacific Ocean is experiencing changes in water temperature and quality, and some of our traditional salmon runs are under severe threat. In fact, the Coquille Tribe declared an emergency for the Coquille River Fall Chinook just weeks ago.

We are witnessing the impacts of global-scale changes to our aboriginal lands. As guardians of these places, we see it as our duty to ensure that efforts are aimed at restoring a healthy ecological and economic balance to ensure the welfare of future generations.

We would like to better understand how any feasibility analysis will account for this changing ecological context. Sea Otters consume 25-30% of their body weight each day, so it is critical that their introduction does not result in depredation of resources needed by other at-risk culturally significant species. In addition, we also want to better understand the impacts of possible re-introduction of the sea otter to the Oregon coast economy, particularly the commercial and recreational shellfish fisheries.

Finally, we request information regarding how the Coquille Tribe might be able to compact with USFWS to assist any restoration effort.

For these reasons we request an opportunity to consult early and often with USFWS during the planning and development of the feasibility study. Our contact person for this effort will be: Helena Linnell (helenalinnell@coquilletribe.org). To facilitate scheduling any meeting, please contact Kay Collins (kaycollins@coquilletribe.org).

Thank you for the opportunity to submit these comments.

Masi,

Brenda Meade

Brenda Meade, Chairperson
Coquille Indian Tribe

Cc: Mark Johnston, Executive Director
Robin Harkins, NR Director
Kay Collins, Executive Management Coordinator

CONFEDERATED TRIBES OF
COOS, LOWER UMPQUA, AND SIUSLAW INDIANS
TRIBAL GOVERNMENT

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December 1, 2021

USFWS – Attn: Michelle Zwartjes

RE: Sea Otter Reintroduction Feasibility Assessment

Ms. Zwartjes

The history of the sea otter population in Oregon has many parallels with the history of the people of the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI). As such, we feel a kinship with what was once an important part of the ocean environment and of the lives of coastal Indian people.

We acknowledge that a successful introduction of sea otters may ultimately reduce economically important shellfish numbers, which would impact commercial, sport and subsistence gathering as well as associated businesses. It is expected that there will be resistance from the fishing public that feels their livelihoods or recreation will be negatively impacted. One just has to look at the push back against marine reserves in the Cape Arago area for an example of local sentiment on reductions of fishing opportunities. The Port of Coos Bay board of commissioners voted unanimously in 2012 to recommend to state government that there be no new marine reserves or marine protected areas established at Cape Arago.

Despite these challenges, CTCLUSI strongly supports the efforts to return sea otters to the Oregon Coast. We hope to one day see healthy populations of sea otters and their positive effects on reducing the unbalanced sea urchin populations that are impacting the health of kelp beds. We applaud your efforts and ask to be kept up to date on your progress.

Respectfully

Debbie Bossley

Debbie Bossley, Chair
Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians

Confederated Tribes of Siletz Indians
Tribal Council
P.O. Box 549 Siletz, Oregon 97380
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November 22, 2021

USFWS – Attn: Michelle Zwartjes

RE: Sea Otter Reintroduction Feasibility Study

Dear Ms. Zwartjes:

We appreciate the work that has been going into the sea otter reintroduction issues study directed to be conducted recently under legislative language in an amendment offered by Senator Merkley. We at the Confederated Tribes of Siletz Indians are excited and encouraged at the groundwork research, and report writing that is currently going on by both the USFWS and the Elakha Alliance to take into view all aspects of the eventual re-establishment of a viable sea otter population here on the Oregon Coast.

The Elakha Alliance (in its original form, as an effort under the Eco Trust org. umbrella) was founded by Siletz member and former Tribal Councilman Dave Hatch. His work on that effort to promote research into all things related to Sea Otter biology here on the Oregon Coast led to DNA research from shell midden samples of sea otter remains that indicated that the original Oregon population was a mix of (what we now consider to be) northern and southern sea otter population genetics. Though we now consider them somewhat distinct populations, at one time, it was a continuous, close-contact strand of populations, not 2 populations separated by great distances. The DNA research then, just pointed to the logical conclusion then that Oregon was a mixing ground for what we now call Northern and Southern genetics.

It is worthy of mention and emphasis really, that Dave's initial curiosity about Sea Otters was triggered by finding early 1900's maps of Kelp forests that existed at that time off the Oregon Coast and wondering why the kelp forest habitat in those mapped areas had shrunk significantly in the intervening years. His research into that cause and effect led him to the discovery that sea otters and an essential keystone species of great importance to us: ecologically, culturally, and have the job of not just maintaining that kelp forest habitat, but create the conditions for it to become established, thereby creating nutrient base for the food-chain, and nursery habitat for numerous ocean and anadromous species.

When Dave suddenly passed unexpectedly, it left us all in shock, the Elakha Alliance work stalled, and actually halted for a bit. After a respectful amount of time had passed, Bob Bailey, (active in many Oregon Coastal issues for a long time) approached our Siletz people and asked if there was any interest in the Elakha Alliance reorganizing and pushing that work forward. It was an easy decision for us to get onboard with those efforts. We have gladly provided Siletz Tribal funds to support symposiums organized by the Elakha Alliance, and currently have 2 Siletz Tribal members serving on the Elakha Alliance Board. One of those Siletz members serving on that Board is Peter Hatch, Dave's son.

The Confederated Tribes of Siletz is deeply committed to the protection, enhancement and restoration of our western Oregon habitats and resources – the nearshore ecosystem is one we can have an incredibly important positive impact on, with the reintroduction of Sea Otters to our coastline. The previous studies show that we can draw from both northern and southern source populations and to do otherwise would possibly be inappropriate, leaving part of our local sea otter genetic legacy unrepresented. Perhaps the release of Northern population. Northern animals released on the northern Oregon Coast, and southern animals to the southern Oregon Coast, and let them meet in the middle and blend genetics again, as they see fit.

We look at this as a common-sense endeavor to pursue, and look forward to doing our part to see it through. We vigorously support the restoration of sea otters to our coast, and the bolstered resilience of our nearshore ecosystem biodiversity that would result from it. We have been without that relative here to help take care of us for too long. We have place-names often derived from our ancestral place-names in our languages Otter Rock, Otter Point, etc. but no Sea Otters to be seen there. It is a loss to us and our sense of the world as it was given to us to care for.

If otter populations become over-abundant, there are regulations and management strategies that can be implemented to take care of that. Leading to more translocations to places where they are still absent, and which need their kelp enhancing benefits.

For all of the above reasons, cultural and ecological, to build resilience against climate change effects, to restore a connection of all of our people of Oregon to this extirpated species, we fully support action to bring sea otters back to our Oregon Coast.

Sincerely,

Delores Pigsley
Tribal Chairman

Quinault Indian Nation

POST OFFICE BOX 189 • TAHOLAH, WASHINGTON 98587 • TELEPHONE (360) 276-8211

November 17, 2021

Michele Merola Zwartjes, Ph.D.
Field Supervisor
Oregon Coast Field Office
US Fish and Wildlife Service
2127 SE Marine Science Drive
Newport, OR 97365

Re: Quinault Indian Nation comments on US FWS report to Congress on reintroduction of sea otters in Northern California and Oregon coastal areas.

Dear Dr. Zwartjes,

The Quinault Indian Nation (QIN) believes that reintroduction of sea otters (*Enhydra lutis*) along the Pacific coast of the contiguous U.S. states must be considered in the context of the environmental and social implications for interconnections between species, ecosystem functions and human communities. We request government-to-government consultation between co-managers so we can share concerns and perspectives prior to any decisions being made by the FWS regarding reintroduction of sea otters along the Oregon Coast.

Unfortunately, our experience with management by federal agencies responsible for administration of various federal statutes and regulations has demonstrated a lack of understanding and consideration of potential unintended and adverse consequences. Quinault and other tribal peoples harvested sea otters and other marine mammals for countless generations and understood the need for balance to protect kelp forests and other species that are important for trade, cultural use, and subsistence. Although sea otters are considered a "keystone" species that plays an important role in maintaining balance in the food pyramid and the environment of kelp forests that are important to fish, crab, and shellfish, without proper balance, the ecological, social, and economic consequences can be severe.

QIN reserved its rights to harvest many species of fish, shellfish, and animals in its treaty with the United States. By entering into the Treaty of Olympia, the United States assumed a trust responsibility to protect QIN's ability to exercise its reserved rights to fish, hunt, and gather. On August 6, 2021, Secretary of the Interior Deb Haaland signed a "Memorandum of Understanding regarding Interagency Coordination and Collaboration for the Protection of Tribal Treaty Rights and Reserved Rights." We expect that the U.S. Fish & Wildlife Service will honor the spirit and intent of this MOU which affirms the obligations of the United States in stating:

"Treaty-protected rights to use of and access to natural and cultural resources are an intrinsic part of tribal life and are of deep cultural, economic, and subsistence importance to tribes. Many treaties protect not only the right to access natural resources, such as fisheries, but also protect the resource itself from significant degradation. Under the U.S. Constitution, treaties are part of the supreme law of the land, with the same legal force and effect as federal statutes. Pursuant to this principle, and its trust relationship with federally recognized tribes, the United States has an obligation to honor the rights reserved through treaties, including rights to both on and, where applicable, off-reservation resources, and to ensure that its actions are consistent with those rights and their attendant protections. Accordingly, the Parties recognize the need to consider and account for the effects of their actions on the habitats that support treaty-protected rights, including how those habitats will be impacted by climate change."

QIN is a sovereign government with stewardship responsibilities and authorities to care for the environment and to protect the interests of future generations. As a co-manager of shared resources with extensive traditional knowledge and indigenous science which inform interactions of species and their environments, QIN has an essential role to play in making decisions that affect its rights and interests. A memo titled "Indigenous Traditional Ecological Knowledge and Federal Decision Making" released Nov. 15, 2021, by the Council on Environmental Quality (CEQ), Office of Science and Technology Policy, states, "*Where appropriate, ITEK (Indigenous Traditional Ecological Knowledge) can and should inform Federal decision making along with scientific inquiry*."

The reintroduction of sea otters in Washington State waters without involvement or consent of tribal co-managers led to a population explosion from 26 otters in 1977 to over 2,300 sea otters in 2019 with a large number of those in our usual and accustomed (U&A) fishing area near and around Destruction Island. This population explosion is leading to heavy predation losses that threaten the viability of Dungeness crab and razor clams, important species for commercial, cultural, and subsistence use by our communities.

Sea otters have demonstrated that they will relocate in response to prey availability. As prey become scarce, sea otters will move to avoid suffering malnutrition. In Washington State, sea otters have moved from the Strait of Juan de Fuca to the outer coast and steadily southward until they established a colony at Destruction Island. Recent research at the University of Washington estimates that in a "high movement" scenario, otters in Washington can expand their range by 2-5 km. per year. Sea otters are voracious feeders and already exerting excessive predation pressures on razor clams from the Kalaloch Beach area, a traditional harvest site co-managed by the QIN, the Hoh Tribe and Washington State and, on Dungeness crab and other shellfish species in the ocean waters south to Pt. Grenville.

Sea otters have few natural predators that are effective at controlling their populations. The ability of QIN and other native peoples to culturally remove them to restore and maintain ecological balance has been affected by the imposition of laws and regulations intended to protect marine mammals without consideration of potential effects on the environment and human communities.

The QIN does not support further introductions of sea otters to the south of our treaty-reserved U&A waters. Once established off the Oregon coast, we are concerned that their range will expand north based on current studies. The Biden Administration has announced that consultation with tribal governments would be required on matters affecting their rights and interests. It is our understanding that the FWS is in the process of preparing a report for Congress on the feasibility of reintroducing sea otters along the Pacific Coast to describe legal, technical, and economic impacts.

Although the current intent is to focus on the area of northern California and Oregon, QIN's interests can clearly be affected. Meaningful consultation and dialogue between co-managers is needed before decisions on sea otter reintroduction are made.

Thank you for the opportunity to comment,

Guy Capoeman, President
Quinault Indian Nation

MAKAH TRIBAL COUNCIL
P.O. BOX 115 • NEAH BAY, WA 98357 • 360-645-2201

October 29, 2021

Dear Dr. Zwartjes,

Thank you for inviting our feedback on the proposal to reintroduce sea otters on northern California and Oregon. We appreciate that you take tribal trust and consultation responsibilities seriously.

The desire to reintroduce sea otters is a noble idea. Our understanding is that the reintroduction of sea otters is proposed to help restore balance to coastal ecosystems in which sea otters were historically extirpated. A number of studies have found that the presence of sea otters influences the growth and distribution of kelp forests (Estes and Palmisano, 1974; Simenstad, Estes, and Kenyon, 1978; Markel and Shurin, 2015). Sea otters dramatically reduce the abundance of large invertebrates (Kvitek et al., 1992; Kvitek, Iampietro, and Bowlby, 1998), which can indirectly provide benefit to some fish such as kelp dwelling rockfish (Markel and Shurin, 2015).

Our concern is that any plan to introduce sea otters back to the ecosystem would not be complete if it did not also include returning sea otters primary predator of man back to the ecosystem. Often when individuals think of coastal ecosystems they forget that man is an integral component and has been since time immemorial (Simenstad, Estes, and Kenyon, 1978; Slade, Mckechnie, and Salomon, 2021). Hunting by man was in part to harvest the valuable fur, but also to protect shellfish resources and clam beds (Salomon et al., 2015; Slade, Mckechnie, and Salomon, 2021). Historically, tribes up and down the Pacific coast of the United States commonly consumed invertebrates such as abalone, urchin, and mussels. Evidence of the size distributions of the invertebrates they ate suggested an ecosystem that did not have sea otters at their maximum potential population densities (Kvitek et al., 1992; Kvitek, Iampietro, and Bowlby, 1998; Salomon et al., 2015; Slade, Mckechnie, and Salomon, 2021).

Introducing sea otters without a plan for how to control the populations once they are established will result in socioeconomic impacts for coastal communities in Oregon and Northern California. Here in Neah Bay, we had a sea urchin fishery that supported a number of families in our community. In the late 1990s, a large raft of male sea otters entered the Strait of Juan de Fuca where our fishery occurred and within a year our fishery was no longer economically viable (Laidre and Jameson, 2006). Our neighbors to the south, the Quileute and Quinault tribes, are currently experiencing reductions in their Dungeness crab fishery as the Washington sea otter population expands around Destruction Island (Jeffries et al., 2019). Communities on the Washington coast are watching with alarm as the sea otter range expands to the sandy shores south of Destruction Island where large tribal and recreational fisheries for razor clams occur. South of Destruction Island, sea otters are reported to be primarily consuming razor clams with the clams accounting for 65% of the otters diet (Hale et al., 2019). The lead author, Jessica Hale, has reported to our Marine Mammal Biologist that she has observed a single otter eat over 200 razor clams in a single hour. Conflicts between the sea otters and razor clam fishery have not yet been reported, but conflicts and reductions in opportunities to harvest razor clams should be expected as the sea otter population continues to grow on the southern portion of their Washington range.

Communities in southeast Alaska with expanding sea otter populations have experienced reductions to fisheries of chiton (Salomon, Tanape, and Huntington, 2007), sea cucumber, Dungeness crab, red urchin, and geoduck clams (Hoyt, 2015). In Southeast Alaska, Alaskan Natives do hunt some otters but are limited in the number they can harvest by restrictive management plans. As noted by Hoyt (2015) for southeast Alaska "… current shellfisheries cannot coexist with sea otters under existing management". The conclusion for southeast Alaska is likely for Oregon and northern California if the reintroduction plan does not include management measures for sea otter populations.

There are definitely potential benefits to the coastal ecosystems of Oregon and northern California by introducing sea otters. However, we argue that careful consideration is needed on how the populations will be managed once established. We believe that a plan to introduce otters that includes mimicking historic tribal hunting of sea otters (Salomon et al., 2015) could allow sea otters to provide important ecological benefits to coastal Oregon and northern California without incurring socioeconomic impacts to coastal communities observed elsewhere where sea otter populations are unmanaged. If a plan cannot be made that includes measures to manage the sea otter population, then we discourage the plan to introduce sea otters to Oregon and northern California.

If you have any questions on our letter then please contact our Marine Mammal Biologist, Jonathan Scordino, at jonathan.scordino@makah.com or by phone at (360) 640-0959. We also encourage you to read Salomon et al. (2015) which we have included with this letter.

Sincerely,

Timothy Greene, Sr.

Chairman

Makah Tribal Council

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APPENDIX B. State Perspectives

We invited the State Departments of Fish and Wildlife from within the focal area of this Assessment (California and Oregon) to share their perspectives on the feasibility of reintroducing sea otters to the Pacific coast. We received a response from the Oregon Department of Fish and Wildlife; the California Department of Fish and Wildlife declined to provide any formal comment at this time.

Oregon
Kate Brown, Governor

Department of Fish and Wildlife
Office of the Director
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Salem, OR 97302
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October 20, 2021

Michele Zwartjes
USFWS Field Supervisor
2127 SE Marine Dr
Newport, OR 97365

Dear Ms. Zwartjes,

Per your request letter of October 19, 2021, the Oregon Department of Fish and Wildlife (ODFW) supports the US Fish and Wildlife Service effort to study the feasibility of re-establishing sea otters in Oregon. We encourage a transparent and comprehensive study considering ecological effects of a reintroduction. The study must also consider social effects on tribes, coastal communities, recreational and commercial fishing industries, other ocean users and economies.

ODFW documents sporadic occurrences of sea otters along the Oregon Coast, but the population status is unknown. Re-establishment of sea otters to the Oregon portion of their former range may have positive marine ecosystem benefits. Sea otters also have significant cultural meaning for Tribal Nations.

Oregon values sea otters and lists them as a Watch List Marine Mammal in the Nearshore Strategy within the Oregon Conservation Strategy. The sea otter is also listed as a state threatened animal. However, additional information concerning potential ecological and social effects needs to be gathered before determining the suitability of re-introducing sea otters to Oregon.

We look forward to seeing your feasibility assessment.

Sincerely,

Curtis E. Melcher
Director

Copy Sheanna Steingass
Davia Palmeri
Michael Harrington
Bernadette Graham-Hudson
Caren Braby
David Fox

APPENDIX C. Budget Tables.

Table C-1. Estimated costs for habitat surveys associated with 6 intertidal and subtidal monitoring sites and 2 offshore surveys along the northern California and Oregon coast.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Grand Total
Intertidal surveys	$30,835	$22,612	$23,204	$23,812	$24,436	$25,077	$25,734	$26,408	$27,100	$27,810	$28,538	$29,286	$30,053	**$344,904**
Subtidal surveys	$74,389	$61,157	$62,759	$64,404	$66,091	$67,823	$69,600	$71,423	$73,294	$75,215	$77,185	$79,207	$81,283	**$923,830**
Offshore surveys	$266,952										$345,743			**$612,694**
Grand total	**$372,176**	**$83,769**	**$85,964**	**$88,216**	**$90,527**	**$92,899**	**$95,333**	**$97,831**	**$100,394**	**$103,024**	**$451,466**	**$108,493**	**$111,336**	**$1,881,428**

Table C-2. Estimated costs for capture of 35 animals over a 16-day field season using different capture methods. The need for continued capture beyond 5 years should be assessed based on retention, survival, and recruitment success. The first year of capture costs is highest due to purchase of boats and capture equipment.

Dive capture method	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$91,260	$93,651	$96,105	$98,623	$101,207						$480,847
Vet services/ baseline health assessment	$90,016	$92,375	$94,795	$97,279	$99,827						$474,292
Instrumen-tation/ marking	$341,984	$350,944	$360,139	$369,574	$379,257						$1,801,899
Equipment	$317,078	$268,318	$275,348	$282,562	$289,965						$1,433,271
Grand Total	**$840,339**	**$805,288**	**$826,387**	**$848,038**	**$870,257**						**$4,190,308**

Tangle net method											
Personnel	$13,793	$14,155	$14,525	$14,906	$15,297						$72,676
Vet services/ baseline health assessment	$90,016	$92,375	$94,795	$97,279	$99,827						$474,292
Instrumen-tation/ marking	$341,984	$350,944	$360,139	$369,574	$379,257						$1,801,899
Equipment	$273,440	$140,282	$143,958	$147,729	$151,600						$857,009
Grand Total	**$719,234**	**$597,756**	**$613,417**	**$629,488**	**$645,981**						**$3,205,875**

Table C-3. The estimated cost of surrogate raised sea otters is based on the operating budget of an established facility. These costs include all costs associated with raising the pups as well as caring for the adult surrogates. The current capacity for the surrogacy program is limited to one facility that can raise up to 5 individuals per year.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Grand Total
Grand Total	$1,500,000	$1,539,300	$1,579,630	$1,621,016	$1,663,487	$1,707,070	$1,751,795	$1,797,692	$1,844,792	$1,893,125	$16,897,906

Table C-4. Cost associated with transportation will vary depending on mode of transportation, distance to reintroduction site, number of trips, and transporter capacity. Several examples are provided below. Shaded rows correspond to examples provided in the text. Note the timeframe for this example follows that of wild captured animals (5 years). Additional calculations will need to be made if captures and surrogate transportation is needed beyond this timeframe.

La Push, WA to Newport, OR											
Truck/trailer	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$21,478	$22,040	$22,618	$23,211	$23,819						$113,165
Equipment	$12,995	$13,335	$13,685	$14,043	$14,411						$68,470
Grand Total	**$34,473**	**$35,376**	**$36,303**	**$37,254**	**$38,230**						**$181,635**
Helicopter (Eurocopter)											
Personnel	$10,350	$10,621	$10,899	$11,185	$11,478						$54,534
Equipment	$63,850	$65,523	$67,240	$69,002	$70,809						$336,424
Grand Total	**$74,200**	**$76,144**	**$78,139**	**$80,187**	**$82,287**						**$390,958**
Fixed wing (CASA C212)											
Personnel	$3,596	$3,690	$3,787	$3,886	$3,988						$18,946
Equipment	$30,339	$31,134	$31,950	$32,787	$33,646						$159,856
Grand Total	**$33,935**	**$34,824**	**$35,737**	**$36,673**	**$37,634**						**$178,803**

Large research vessel											
Personnel	$13,955	$14,320	$14,696	$15,081	$15,476						$73,527
Equipment	$23,684	$24,305	$24,942	$25,595	$26,266						$124,791
Grand Total	**$37,639**	**$38,625**	**$39,637**	**$40,676**	**$41,741**						**$198,319**

Monterey Bay, CA to Newport, OR

Truck/trailer	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Grand Total
Personnel	$21,867	$22,440	$23,027	$23,631	$24,250						$115,214
Equipment	$12,995	$13,335	$13,685	$14,043	$14,411						$68,470
Grand Total	**$34,862**	**$35,775**	**$36,712**	**$37,674**	**$38,661**						**$183,684**
Helicopter (Eurocopter)											
Personnel	$10,350	$10,621	$10,899	$11,185	$11,478						$54,534
Equipment	$82,800	$84,969	$87,196	$89,480	$91,824						$436,269
Grand Total	**$93,150**	**$95,591**	**$98,095**	**$100,665**	**$103,303**						**$490,803**
Fixed wing (CASA C212)											
Personnel	$3,644	$3,740	$3,838	$3,938	$4,042						$19,202
Equipment	$48,307	$49,573	$50,871	$52,204	$53,572						$254,527
Grand Total	**$51,951**	**$53,312**	**$54,709**	**$56,143**	**$57,614**						**$273,729**
Large research vessel											
Personnel	$19,130	$19,631	$20,145	$20,673	$21,215						$100,794

Equipment	$23,684	$24,305	$24,942	$25,595	$26,266						$124,791
Grand Total	**$42,814**	**$43,936**	**$45,087**	**$46,268**	**$47,480**						**$225,585**

Monterey Bay, CA to San Francisco Bay, CA											
Truck/trailer	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$21,478	$22,040	$22,618	$23,211	$23,819						$113,165
Equipment	$10,925	$11,211	$11,505	$11,806	$12,116						$57,563
Grand Total	**$32,403**	**$33,252**	**$34,123**	**$35,017**	**$35,934**						**$170,729**
Helicopter (Eurocopter)											
Personnel	$10,350	$10,621	$10,899	$11,185	$11,478						$54,534
Equipment	$51,791	$53,148	$54,541	$55,970	$57,436						$272,887
Grand Total	**$62,141**	**$63,770**	**$65,440**	**$67,155**	**$68,914**						**$327,420**
Fixed wing (Fairchild SA226)											
Personnel	$21,283	$21,841	$22,413	$23,000	$23,603						$112,141
Equipment	$37,291	$38,268	$39,271	$40,300	$41,355						$196,485
Grand Total	**$58,574**	**$60,109**	**$61,684**	**$63,300**	**$64,958**						**$308,626**
Fixed wing (Partenavia S.P.A. P68)											
Personnel	$10,350	$10,621	$10,899	$11,185	$11,478						$54,534
Equipment	$8,756	$8,986	$9,221	$9,463	$9,710						$46,135
Grand Total	**$19,106**	**$19,607**	**$20,120**	**$20,648**	**$21,188**						**$100,669**

Large research vessel											
Personnel	$8,780	$9,010	$9,246	$9,488	$9,737						$46,261
Equipment	$9,275	$9,518	$9,767	$10,023	$10,286						$48,868
Grand Total	**$18,055**	**$18,528**	**$19,013**	**$19,511**	**$20,022**						**$95,129**

Southeast AK to Newport, OR											
Fixed wing (CASA C212)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$2,017	$2,069	$2,124	$2,179	$2,236						$10,626
Equipment	$76,575	$78,581	$80,640	$82,753	$84,921						$403,470
Grand Total	**$78,592**	**$80,651**	**$82,764**	**$84,932**	**$87,157**						**$414,096**

Table C-5. Holding facilities may be needed after the animal is captured but not ready to transport and once the animal arrives at the reintroduction site. The length of time an individual is held during pre-transport varies on mode of transportation and distance to reintroduction site. Additionally, the length of time animals remain in a holding facility after transportation will be based on their health condition. This budget is for animals held 16 days prior to transportation (possible example in Alaska) and 21 days after transportation. The first year is the most expensive due to purchasing the holding pen equipment. Note the timeframe for this example follows that of wild captured animals (5 years).

Pre-transport	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$53,336	$54,734	$56,168	$57,639	$59,150						$281,027
Holding pen and equipment	$74,194	$22,172	$22,753	$23,349	$23,961						$166,429
Food and accessories	$223,008	$228,851	$234,847	$241,000	$247,314						$1,175,019
Grand Total	**$350,539**	**$305,757**	**$313,767**	**$321,988**	**$330,424**						**$1,622,475**

Post-transport	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Grand Total**
Personnel	$70,004	$71,838	$73,720	$75,652	$77,634						$368,848
Holding pen and equipment	$74,194	$22,172	$22,753	$23,349	$23,961						$166,429
Food and accessories	$284,591	$292,047	$299,698	$307,550	$315,608						$1,499,494
Grand Total	**$428,789**	**$386,057**	**$396,172**	**$406,551**	**$417,203**						**$2,034,772**

Table C-6. Post release land-based monitoring will be needed for gathering information on location, demographics (survival, recruitment) and foraging. This budget is based on conducting land-based monitoring at two different locations with a staff of 4 paid technicians and 1 part-time biologist. Similar to other estimates, the first year is the most expensive due to equipment purchases. Note that in year 6 of the project we anticipate purchasing a new vehicle.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6*	Year 7	Year 8	Year 9	Year 10	Grand Total
Personnel	$233,804	$239,930	$246,216	$252,667	$259,287	$266,080	$273,051	$280,205	$287,547	$295,080	$2,633,868
Vehicles	$113,140	$9,628	$9,880	$10,139	$10,405	$125,471	$10,957	$11,244	$11,539	$11,841	$324,245
Equipment	$45,057	$9,628	$9,880	$10,139	$10,405	$10,677	$10,957	$11,244	$11,539	$11,841	$141,369
Housing	$34,500	$35,404	$36,331	$37,283	$38,260	$39,263	$40,291	$41,347	$42,430	$43,542	$388,652
Grand Total	**$426,501**	**$294,590**	**$302,308**	**$310,229**	**$318,357**	**$441,491**	**$335,257**	**$344,041**	**$353,055**	**$362,305**	**$3,488,133**

Table C-7. Post release boat-based monitoring is another platform to gather information on location, demographics (survival, recruitment), and foraging. This budget is based on conducting boat-based monitoring at one location with a staff of 3 paid technicians. The initial costs are highest due to purchases of new equipment including 2 skiffs. A replacement of one skiff is noted in year 8.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8*	Year 9	Year 10	Grand Total
Personnel	$218,491	$224,215	$230,090	$236,118	$242,304	$248,653	$255,167	$261,853	$268,713	$275,754	$2,461,358
Boats and equipment	$519,823	$8,349	$8,568	$8,792	$9,023	$9,259	$9,502	$76,453	$9,750	$10,006	$669,525
Fuel/ storage/ docking	$3,818	$3,818	$3,918	$4,021	$4,126	$4,234	$4,345	$4,459	$4,576	$4,696	$42,010
Grand Total	**$742,132**	**$236,382**	**$242,575**	**$248,931**	**$255,453**	**$262,146**	**$269,014**	**$342,765**	**$283,040**	**$290,455**	**$3,172,893**

Table C-8. Three different types of aerial based surveys are included in the budget. They include population estimates, which are flown yearly along the entire coast of Oregon to Pigeon Point, CA using a twin engine aircraft; post-release monitoring, which are flights that occur every other week for 5 months after the sea otters were reintroduced using a single engine aircraft; and periodic surveys for missing individuals that could occur after the 5 month post release monitoring. The budget includes four periodic surveys using a single engine aircraft.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Grand Total
Population estimates	$386,703	$147,492	$151,356	$155,321	$159,391	$163,567	$167,852	$172,250	$176,763	$181,394	$1,862,090
Post release monitoring	$170,907	$175,385	$179,980	$184,696	$189,535	$194,500	$199,596	$204,826	$210,192	$215,699	$1,925,316
Periodic surveys	$68,363	$70,154	$71,992	$73,878	$75,814	$77,800	$79,839	$81,930	$84,077	$86,280	$770,127
Grand total	**$625,973**	**$393,031**	**$403,328**	**$413,895**	**$424,739**	**$435,867**	**$447,287**	**$459,006**	**$471,032**	**$483,373**	**$4,557,533**

Table C-9. Postmortem program includes conducting up to 10 full necropsies per year and starting up a stranding program in Oregon if the reintroduced population(s) grow. The stranding program would consist of one biologist with travel and equipment needs.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Grand Total
Necropsies	$21,908	$22,481	$23,070	$23,675	$24,295	$24,932	$25,585	$26,255	$26,943	$27,649	$246,794
Stranding program			$97,030	$99,572	$102,181	$104,858	$107,606	$110,425	$113,318	$116,287	$851,277
Grand Total	**$21,908**	**$22,481**	**$120,101**	**$123,247**	**$126,476**	**$129,790**	**$133,190**	**$136,680**	**$140,261**	**$143,936**	**$1,098,071**

Table C-10. Oil spill response budget is focused on Oregon given the lack of current infrastructure and staff. The first 3 years will focus on developing an oil spill response plan, building staff capacity, and purchasing response equipment.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Grand Total
Personnel	$88,208	$90,519	$23,223	$23,831	$24,455	$25,096	$25,754	$26,428	$27,121	$27,831	$382,467
Equipment	$850,000	$872,270	$895,123	$200,000	$205,240	$210,617	$216,135	$221,798	$227,609	$233,573	$4,132,366
Trainings	$8,980	$9,215	$9,457	$9,704	$9,959	$10,220	$10,487	$10,762	$11,044	$11,334	$101,162
Grand Total	$947,188	$972,004	$927,803	$233,536	$239,654	$245,933	$252,377	$258,989	$265,774	$272,738	**$4,615,996**

Table C-11. Estimated grand total based on 4 different reintroduction scenarios in no particular order. Details on the scenarios can be found in section 4.4.11.

	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Source animals, transportation, and holding costs	$6,867,490	$24,631,223	$18,583,526	$8,218,428
Habitat surveys	$1,881,437	$1,881,437	$1,881,437	$1,881,437
Land-based monitoring	$3,488,133	$3,488,133	$3,488,133	$3,488,133
Boat-based monitoring	$3,172,893	$3,172,893	$3,172,893	$3,172,893
Aerial surveys	$4,557,533	$4,557,533	$4,557,533	$4,557,533
Postmortem program	$1,098,071	$1,098,071	$1,098,071	$1,098,071
Oil spill response	$4,615,996	$4,615,996	$4,615,996	$4,615,996
Grand Total	**$25,681,553**	**$43,445,285**	**$37,397,588**	**$27,032,490**