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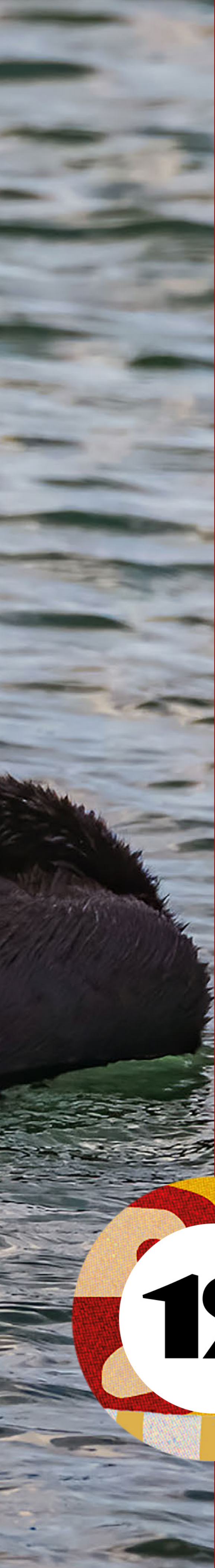

Chapter 12

CONCLUSIONS

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FIVE KEY TAKEAWAYS

The previous 11 chapters provide an extensive review of the available data and scientific literature relevant to the consideration of a managed reintroduction of sea otters to coastal Oregon. There are, of course, a great many questions to address and issues to resolve before any final decision can be made as to whether such a reintroduction should be attempted. As emphasized in the introduction, the purpose of this feasibility study is not to make recommendations for or against any specific course of action, but rather to provide a useful resource document to aid resource managers and the various stakeholders who will be contributing to discussions and decisions about sea otter reintroduction. Each chapter of this feasibility study takes an in-depth look at a particular element or consideration relevant to the broader question of feasibility. Here, we summarize some of the most important takeaway messages that have emerged from this work.

1. Reintroductions are a successful conservation tool.

*The reintroduction of sea otters (*Enhydra lutris*) to their former habitats has been the single most important management action contributing to recovery from near extinction in regions of the eastern North Pacific. Approximately 30% of today's global sea otter abundance can be attributed to reintroductions to Southeast Alaska, British Columbia, and Washington. Reintroductions have increased species viability, helped recover genetic diversity, and improved gene flow throughout populations in the regions north of the geographic break between the Washington and California populations. Previous reintroductions, even those that failed, can provide practical and logistical lessons that will improve the chances of success.*

While some previous sea otter reintroductions were unsuccessful, including to the Pribilof Islands and to the Oregon coast in the 1960s, the lessons learned from past reintroduction efforts—both successful and unsuccessful—have led to insights into the demographic, behavioral, and ecological factors important to success (Chapter 2). A review of these previous efforts, including the most recent reintroductions to San Nicolas Island and Elkhorn Slough in California, reveals some strategies that may improve the chances of success for future reintroduction efforts (Chapter 9).

Potentially important future genetic consequences could result from reintroducing sea otters to Oregon. Based on historical records, it appears that sea otters once occurred throughout most of the Oregon coast, although there are outstanding questions about the relative densities of sea otters in Oregon. Three published genetic analyses of tissue samples from midden sites suggest that Oregon sea otter populations

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historically represented a "genetic hybrid zone," with ancestors that genetically resembled both southern and northern sea otters.

The current distribution of sea otters in the northeast Pacific (Figure 4.1) features a large break between southern sea otters in California and northern sea otters in northern Washington. This break has eliminated gene flow between the two regions and thus limited the potential recovery of genetic diversity, especially for southern sea otters. Reestablishing sea otters in Oregon could reestablish such a genetic hybrid zone, aiding in the recovery of genetic diversity by restoring the mixing of northern and southern sea otters and restoring the potential for gene flow to the largest remaining gap in sea otter distribution within their current range.

2. Reintroducing sea otters to Oregon is likely to succeed with appropriate considerations.

A spatially explicit population model developed specifically for evaluating potential sea otter reintroductions to Oregon shows that a reintroduced population (or populations) of sea otters is likely to be viable, assuming sufficient numbers of animals are released to appropriate habitats. However, there is a high degree of uncertainty associated with the outcome of any one reintroduction scenario. This model, when combined with an analysis of habitat suitability, suggests several areas likely to support a successful reintroduction, mostly along Oregon's southern coast. The model also suggests that multiple release locations may be more effective than a single release site. The population model used in this feasibility study can guide alternate reintroduction strategies, including determining the appropriate numbers, demographic structure, sequencing, and location of reintroduced populations.

The most critical resource for a sea otter population's survival is access to sufficient and suitable prey. The sea otter's diet is determined largely by the type of habitats in which it forages, which include rocky reefs (where kelp forests can occur) and unconsolidated substrate, or soft sediments, with the latter further divided into outer coast areas versus protected estuaries. Suitable prey species can occur in all these habitats, though their abundance and productivity can differ. In addition to habitats with adequate prey, sea otters tend to select habitats that offer protection from adverse environmental conditions and/or predators, such as kelp forests and estuaries. These two variables—adequate prey species and access to protected habitats—are crucial factors in assessing different areas with respect to their potential suitability for a reintroduced sea otter population.

Of outer coast habitats in Oregon, it appears that areas in the southern half of the state have a higher abundance of preferred habitat features and prey populations (especially urchins): in particular, the reef complexes near Port Orford (Blanco Reef, Orford Reef, and Redfish Rocks) and Cape Arago (Simpson Reef).

3. Estuaries may be an important reintroduction environment.

In addition to nearshore ocean habitats, several estuaries in Oregon may offer suitable habitat for a founding sea otter population. Using estuarine release sites could increase the potential for the successful establishment of a population center, especially when close to a suitable nearshore ocean habitat (e.g., Coos Bay or Yaquina Bay).

Recently, sea otters have been shown to exert strong indirect influences on the abundance of seagrass in estuaries (in one California estuary, the recovery of sea otters resulted in a 600x increase in seagrass abundance). This influence has broad implications for the diverse species assemblages that rely on healthy estuaries. An experimental release of rehabilitated juvenile sea otters into Elkhorn Slough in central California demonstrated the potential for a successful release of sea otters into an estuary. Specifically, it appeared that a small number of juveniles released into an estuarine environment were more likely to remain in place and contribute to an established population than the same number released to the outer coast. Moreover, it was easier to monitor them within an enclosed estuary and recapture them for further rehabilitation and later re-release if necessary. Thus, reintroducing sea otters to an estuary may be a viable alternative (or complementary addition) to reintroduction to an outer coast habitat.

Three larger estuaries in Oregon appear to have an optimal combination of prey resources (clams, crabs) and resting habitats (eelgrass beds and tidal creeks), suggesting they could support viable sea otter populations: Tillamook Bay, Yaquina Bay, and Coos Bay. Of these, the latter two have the additional advantage of proximity to outer coast reefs and kelp beds that could provide alternative habitats for establishing sea otter populations.

4. The return of sea otters will have many direct and indirect effects.

As a keystone species, sea otters have inordinately strong effects on the nearshore ecosystems they inhabit. Impacts associated with sea otter recovery include both direct effects on prey species—some of which, such as Dungeness crab, currently support commercially important fisheries—as well as indirect effects throughout the nearshore or estuarine environment mediated through ecological interactions. Many indirect ecosystem effects are beneficial, including increases in kelp forests and eelgrass beds that, in turn, increase finfish and invertebrate species that rely on kelp and seagrass, overall biodiversity and productivity, and carbon capture and fixation. The impacts of sea otters on some shellfish species can have negative social and economic effects.

The top-down effects of sea otters discussed in Chapter 5 include direct influences on their macroinvertebrate prey, including some shellfish species of commercial and social consequence. Importantly, sea otters also have significant indirect influences on other species and ecological processes. The most well-known sequence of indirect effects occurs through what we refer to as the *otter-urchin-kelp cascade*. Via this pathway, sea otters limit the abundance of herbivorous sea urchins. In turn, the abundance and persistence of kelps and other macroalgae can flourish because fewer urchins are feeding. More macroalgae subsequently affect numerous other species and ecological processes. Sea otters are characterized as a *keystone species* because of this phenomenon.

The sea otter's powerful and diverse top-down influences result in both costs and benefits to human societies. The direct effect of sea otter predation can lead to conflicts with existing shellfisheries in areas of sea otter recovery and thus are generally perceived as negative. These direct effects also tend to be the easiest to quantify and the first to be documented, in part because sea otter diets have the highest proportion of commercially valuable species during the initial stages of recovery. In contrast, indirect effects of sea otter recovery are more difficult to quantify but often result in changes perceived as positive, such as the otter-herbivore-kelp pathway previously mentioned, enhanced biodiversity overall, increases in some nearshore finfish species, reduced wave energy, the protection of shorelines from erosion, and increased carbon sequestration by kelp and seagrass. It is important to consider the full suite of ecological effects and not focus on only those perceived to be positive or negative.

5. Socioeconomic factors and regulatory issues must be considered.

While the biological and ecological factors summarized above are critical for determining whether to undertake a species reintroduction effort, social and economic considerations and legal and regulatory issues must also be weighed. Outreach and engagement with a broad array of stakeholders and community groups likely to be impacted are essential to ensure that reintroduction decisions address all the relevant socioeconomic factors and have a broad base of support.

Social and Economic Considerations

In Oregon, the invertebrate species fished commercially or recreationally that could be affected by sea otter recovery include the following: Dungeness crab, red rock crab, razor clams, butter clams, gaper clams, littleneck clams, cockles, mussels, ghost shrimp, and red and purple sea urchins. For some fisheries (e.g., urchin dive fisheries), there is good reason to project a substantial negative impact from sea otter recovery. However, in the case of others (e.g., crab, shrimp), it is far from clear whether there would be a negative impact or how substantial such an effect would be. In the case of Dungeness crab, negative impacts were found to be associated with sea otter recovery in some parts of Alaska. Conversely, in California, no measurable impacts were associated with sea otter recovery, and in fact, there has been a positive correlation between sea otter recovery and crab landings. Further research on the potential for fisheries conflicts is warranted, especially for Dungeness crab because of the economic scale of this fishery.

The socioeconomic costs and benefits associated with the indirect effects of sea otter recovery are often more difficult to measure than those for direct effects, as they involve complex suites of interactions with other species. In cases where indirect effects have been measured, they have often been associated with increases in primary producers (plants), including kelp and seagrass, and many of the associated knock-on effects (such as increases in finfish populations and stabilizing and protecting shorelines), most of which are perceived as positive.

A comprehensive tabulation of the monetary costs and benefits associated with sea otter recovery, including both direct and indirect effects, can be challenging. A recent attempt to do so in British Columbia analyzed a broad array of socioeconomic changes attributable to sea otter recovery on the west coast of Vancouver Island. It found a net positive economic impact (Gregr et al. 2020).

However, monetary considerations are not the only way to measure human values. Communities based around fishing activity provide people with many important nonmonetary values. In the case of Indigenous Peoples, subsistence shellfisheries often provide cultural and economic value. At the same time, the return of sea otters to the ecosystem may have cultural importance. Any assessment of the socioeconomic impacts of sea otter recovery should therefore provide a comprehensive accounting of the relevant communities' social values, including both monetary and nonmonetary variables.

Chapter 11 provides a brief overview of some of the stakeholder concerns and views that have been previously expressed about this subject (in Oregon and in other regions). However, we recognize that this summary barely scratches the surface and is no substitution for a formal and comprehensive outreach program.

Regulatory Considerations

Reintroducing a marine mammal protected by international, federal, state, and tribal laws requires careful consideration, planning, and documentation of legislation, including acquiring multiple permits (see Chapter 8). Internationally, permits are required for trade between countries. In the United States, sea otters are managed at the federal level by the U.S. Fish and Wildlife Service and are protected under the Marine Mammal Protection Act. The southern sea otter subspecies and the Southwest Alaskan stock of the northern sea otter subspecies are listed and regulated as threatened under the Endangered Species Act (ESA), thus requiring federal permits. A reintroduction of sea otters from non-ESA-listed stocks within the United States, such as sea otters in Southeast (SE) Alaska or Washington, would require the least regulatory oversight, legal documentation, and permitting. However, even for these non-ESA-listed source populations, a reintroduction would require extensive documentation and permits under federal law, as well as careful adherence to state laws and regulations, local ordinances, and tribal laws. Thus, any future reintroduction proposals should factor in the necessary effort and time required for consultation and permit acquisition.

Logistical Considerations

In addition to the legal documentation and permitting requirements, many other logistical considerations need to be addressed in any future reintroduction proposals. Selecting a suitable source population is the first of these considerations. As discussed above, this decision involves demographic and genetic questions as well as legal and permitting issues.

Alternative reintroduction strategies should be considered, such as

1. a single *hard release* of animals to a suitable habitat location on the outer coast;
2. a *soft release* to an outer coast location, whereby animals are initially held for some time in net pens to accommodate them to the new location;
3. a single hard release of animals to a suitable estuarine habitat;
4. a single soft release to a suitable estuarine habitat;
5. sequential soft reintroductions of small groups of sea otters over several years into an estuary, with the potential for the recapture, rehabilitation, and re-release of animals that do not appear to be thriving initially, an approach successfully used in Elkhorn Slough, California (Mayer et al. 2019); or
6. any of the above methods (or a combination) used at multiple, geographically distinct locations to achieve more than one founding node of population growth, as was the case for the SE Alaska reintroduction.

The ORSO sea otter population model (Chapter 3) can be used to help evaluate and compare these alternative release strategies in terms of their potential for success and future population growth.

In addition to identifying source populations and release strategies, additional logistical considerations include

1. sea otter capture methods;
2. the selection of the appropriate sex and age composition of captured animals (to maximize the founding population's reproductive potential as well as the likelihood of animals remaining in their new habitats);
3. animal holding, care, and transport methods;
4. pre-release ecosystem monitoring and surveys used to help identify suitable release sites as well as for before-after comparison studies to evaluate ecosystem impacts;
5. tagging and post-release monitoring of reintroduced sea otters; and
6. recapture and rehabilitation methods for animals failing to adapt to new habitats.

Health and Welfare Considerations

Perhaps the most substantial health threat to sea otters living along the Oregon coast is domoic acid (DA) intoxication. Its presence in shellfish has been recognized as a potential human health threat for well over a decade, a concern mostly directed toward the acute intoxication of shellfish consumers. Chronic, low levels of DA have been shown to be a driver of cardiac disease in sea otters (Moriarty et al. 2021), which can have population-level consequences.

A second health threat of great concern, but one with uncertain potential in Oregon, is shark-bite trauma. Shark bites are a significant cause of mortality for southern sea otters. Although the white shark (which is known to occur off the Oregon coast) has been accepted as the primary source of injury and death in California, the broadnose sevengill shark is present in high numbers in Oregon's coastal, offshore, and estuarine systems and may also be a potential sea otter predator.

In addition to DA exposure and shark-bite mortality, several infectious diseases could have population-level impacts on the reintroduction program and, in the case of density-dependent diseases, may increase over time as sea otter numbers increase (Tinker et al. 2021). They include contagious diseases such as morbillivirus infections, noncontagious infectious diseases such as sarcocystosis and toxoplasmosis, and bacterial infections and toxicosis associated with nutrient-rich or contaminated freshwater inputs to coastal habitats. Such diseases may significantly impact small populations in localized areas, especially those associated with river mouths or estuaries in watersheds strongly influenced by agricultural or urban activities.

In addition to all the above, the effects of climate change will impact the health and welfare of all sea otter populations through direct impacts of oceanographic parameters and sea level rise, along with indirect effects that include changes in prey species, pathogen distribution, and animal movements.

Other animal welfare considerations relate to sea otter capture, transportation, acclimation, and release in Oregon. During these activities, close attention must be paid to individual animal nutrition, comfort, health, social structure, and stress relief.

CONCLUSION

Restoring a population of sea otters on the Oregon coast is feasible if steps are taken to account for ecological, habitat, logistical, economic, and social factors highlighted in this feasibility study. There appear to be no insurmountable ecological, habitat, physiological, logistical, or regulatory barriers to restoring a population of sea otters in Oregon.

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