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Chapter 9

IMPLEMENTATION AND LOGISTICAL CONSIDERATIONS

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Based on a review of the translocation history of the sea otter (*Enhydra lutris*; refer to Chapter 2) and our current combined knowledge and experience with the capture, holding, and transport of sea otters, we have prepared an analysis of two general strategies for reintroducing sea otters to the waters of Oregon. One follows the strategy employed by all but one historical reintroduction. It consists of the simultaneous release of groups of animals into vacant but previously occupied exposed or semi-protected coastal habitats (Jameson et al. 1982). The other strategy follows a recently-described procedure of sequentially reintroducing single or small groups of sea otters over several years into an estuary (Mayer et al. 2019).[1] We wish to emphasize that these two strategies are not mutually exclusive, and a combination of the two may be most appropriate.

For each strategy, we offer the underlying rationale and discuss the pros and cons. Presenting alternative strategies is intended to provide a broad range of possibilities to consider. We begin by describing factors that should be considered when selecting a release site, followed by a review of alternatives for selecting source or donor populations. The protocols may differ for capture/holding, transport, and to some extent, release and monitoring, depending on release strategies and source population alternatives. Those differences and similarities will be presented and discussed in each release strategy and source population alternative.

Various factors require consideration in evaluating the potential suitability of release sites for successfully reintroducing sea otters into Oregon, either along the open coast or into estuarine habitats. They include (a) suitable and appropriate habitats, (b) the availability of appropriate and sufficient prey, (c) access to suitable resting habitats, either protected waters or canopy-forming kelps, and (d) refuge from disturbance or sources of injury or mortality. We will briefly consider each of these habitat requirements in the discussion below as it relates to potential sea otter release strategies. A more comprehensive assessment of habitat suitability is provided in Chapter 6 of this study.

The present distribution and abundance of sea otters in the coastal North Pacific suggest that all coastal habitat types less than about 50 m in depth represent potential habitats for sea otters. At the same time, there is a growing body of evidence that suggests that all habitat types do not support equal densities of sea otters. It has generally been regarded that exposed rocky reef habitats support greater densities than open-coast soft-sediment habitats (Kenyon 1969, Riedman and Estes 1990), with reported densities in rocky habitats in California more than five times greater than along sandy shorelines (Laidre et al. 2001, Tinker et al. 2021). However, relatively high densities of sea otters can also be found in mixed-substrate habitats, particularly along complex shorelines that provide sheltered habitats, including bays,

1 The published example of estuarine release occurred in Elkhorn Slough, an estuarine habitat in California that was already occupied by sea otters, although they were mostly male otters and had a density well below the local carrying capacity. Therefore, this example might reflect a different outcome than a similar release to an unoccupied estuary in Oregon.

lagoons, sounds, and estuaries. Examples of such include Kachemak Bay, Prince William Sound, Izembek Lagoon, and Glacier Bay in Alaska, as well as Barkley Sound in British Columbia (Bodkin 2015). Sea otter densities along high-energy, sandy shores typical of much of Oregon and Washington are generally lower than densities in other coastal habitats (Kone et al. 2021, Tinker et al. 2021) and may represent a less-preferred habitat type.

It should be recognized that even in these less-preferred habitats, high sea otter densities may be achieved during the process of colonization due to elevated prey abundances achieved during the otters' absence. These high otter densities may subsequently decrease as the highest-quality prey become depleted. It is also worth noting that there is historical evidence from the fur harvest records that sea otters may have been relatively less abundant along the Oregon coast than either further north or south (Ogden 1941), although a more recent analysis by Kone et al. (2021) suggested that Oregon coastal habitats could still support over 4000 sea otters.

Our primary goal in this chapter is to identify options for reintroducing sea otters to Oregon that will maximize the potential for the successful establishment of a self-sustaining population (Chapter 3) while minimizing potential human–otter conflicts over competition for marine resources (Chapter 7) and potential threats from human activities.

GENERAL STRATEGIES

Open Coast: Traditional Open-Coast Release Site(s) With On-Site, Short-Term Holding Pens

Historically, most sea otter reintroductions were comprised of animals captured, transported, and released into exposed or semi-protected coastal ocean habitats where sea otters had occurred historically but had been absent for decades, sometimes up to a century or more (see Chapter 2). In part, this approach resulted from the fact that the only sea otters that survived the maritime fur harvest occurred in small groups living along open, exposed coastlines, where human harvest may have been somewhat restricted. This strategy of exposed capture locations in early reintroductions was thus largely predicated on where surviving populations persisted, which created the perception of sea otters as an "exposed open coast" species. What is less clear from historical information and published accounts is the rationale used to determine exactly where translocated sea otters would be released. In most cases, if not all, logistics based on methods of transport appear to have dictated feasible release locations.

Despite the failure of the initial reintroduction of sea otters to Oregon, suitable habitat for sea otters exists over much of the Oregon coast, although not all habitats in Oregon should be considered equivalent (Jameson 1975, Kone et al. 2021). Much of the north coast of Oregon consists of exposed sandy beach habitats that are likely to support low densities of sea otters. Prevailing thought and literature consider rocky reefs with canopy-forming kelps to be preferred habitats, supporting relatively high densities (four to six otters per km2) of sea otters (Laidre et al. 2001, Tinker et al. 2021). Additional habitats include exposed, unconsolidated substrates (sand or cobble shores) and protected estuarine habitats. Kone et al. (2021) suggested that the Oregon coast could support about 4500 sea otters (a range of 1742–8976), with most of them along the outer coast in rocky reef habitats but with more than 650 occurring in estuaries. Spatial and temporal variation in the potential densities of otters that could be supported in each area is likely related to differences in prey availability and productivity, as well as differences in access to sheltered habitat (e.g., kelp beds, nearby estuaries) for resting and pup rearing. Based on other reintroductions and examples of sea otter recovery, achieving carrying capacity in Oregon will be a prolonged process, as sea otters demonstrate high fidelity to small home ranges and affinity to conspecifics. Elsewhere in this study, more detailed analyses are provided on the dynamics of population growth and recovery (Chapter 3) and habitat suitability along the Oregon coast (Chapter 6).

Perhaps the primary lesson to be learned from the history of past reintroductions is that a relatively small percentage of sea otters are likely to stay or become quickly established near where they are released (see Chapter 2). This scenario was the case in the initial Oregon release but also in all other open-coast release attempts (excepting perhaps portions of Southeast [SE] Alaska), despite the presence of abundant and preferred prey and proximity to established kelp beds. It may be possible to improve the retention of sea otters near release sites through temporary holding in large anchored net pens, although this technique has not been fully demonstrated. Animals at San Nicolas were initially held in anchored net pens in an attempt to achieve improved retention, but deteriorating sea conditions required premature release. Any open-coast "soft release" of sea otters using net pens is likely to be exposed to harsh and unpredictable sea conditions and, thus, should be carefully considered.

It also seems likely that prior reintroductions to outer rocky coasts consisted of animals that had strong affinities to the home ranges they were removed from, although there is little data on age and sex composition in most reintroductions. This likelihood is evident from the rapid diminishment in abundance post-release and from the resighting of marked animals that returned to original capture locations in an experimental relocation within California (Odemar and Wilson 1969) and again later during and following the San Nicolas Island translocation (Rathbun and Benz 1991, Rathbun et al. 2000, Carswell 2008). Evidence of a similar trend in post-release movements was presented in SE Alaska. Southern reintroductions diminished in numbers while, in the north, numbers increased, and population growth occurred shortly after the final reintroduction (Pitcher 1989, Esslinger and Bodkin 2009). It may be possible to improve retention through the selection of juvenile sea otters before they establish home ranges or establish long-term social bonds. Such an approach has proven feasible in estuarine habitat through the surrogate rearing of stranded pups in California (Mayer et al. 2019) but has not been tested in open coastal or unoccupied habitats.

The general strategy that has proven most successful in establishing open-coast sea otter populations has been the release of large numbers of individuals at multiple release sites over several years. This approach is best exemplified in the reintroduction of 403 sea otters over five years into six separate areas of SE Alaska (Esslinger and Bodkin 2009) that ultimately resulted in three or possibly four distinct populations across coastal SE Alaska. Annual rates of increase by 1987–1988, about 20 years after the final reintroduction, averaged about 20% per year, and total abundance had approached 5000 sea otters (Pitcher 1989, Tinker et al. 2019a). It is possible that the loss rate to emigration or mortality in the SE Alaska reintroductions may have been less than in the more southern efforts, as animals dispersing from one release site may have encountered otters from another release. It is also possible that a high reproductive output of animals at some release sites compensated for lower survival at others, thus explaining early increases in regional abundance. Unfortunately, a lack of detailed post-release animal tracking in SE Alaska makes it impossible to assess either of these hypotheses with certainty.

Estuarine: Longer-Term Temporary Estuarine Holding Facility at Release Site

Broadly defined, estuaries are partially enclosed and protected bodies of water that interface the ocean's seawater with the freshwater draining the continents. Such habitats occur throughout the sea otters' range in the North Pacific. Because no populations that occupied estuaries survived the fur harvest, early work describing sea otter habitats (Barabash-Nikiforov 1947/1962, Kenyon 1969) focused on open coastal habitats, largely failing to recognize estuaries as important to sea otters. However, archeological evidence obtained from estuaries in Oregon and Washington (Moss and Losey 2011) and San Francisco Bay (Broughton 1994) identified the sea otter as a predominant marine mammal in estuarine habitats, establishing estuaries as suitable and historically important habitats (Silliman et al. 2018).

As sea otters have expanded their distribution through recolonization and translocation, we find they have occupied such habitats as they have encountered them (Kvitek and Oliver 1988). These include small estuaries, such as Clam Lagoon on Adak Island in the Aleutian archipelago (Tinker and Estes 1996); Izembek Lagoon, one of Alaska's largest estuaries (384 km2) on the Alaska Peninsula; Orca Inlet in Prince William Sound (Bodkin et al. 2002, Coletti 2006); and Glacier Bay in SE Alaska, which supports in excess of 10,000 sea otters (Tinker et al. 2019a). As sea otters have expanded their range in California, they too have occupied the estuaries in Morro Bay and Elkhorn Slough (Hughes et al. 2019), and Hughes et al. (2013) describe the role of sea otters in restoring the health of eelgrass beds in this estuary. Most recently, the Monterey Bay Aquarium, with assistance from collaborators, merged the complementary objectives of the rescue and rehabilitation of stranded juvenile sea otters with the reintroduction of those animals into underutilized habitat in the Elkhorn Slough within Monterey Bay (Mayer et al. 2019). This work in Elkhorn Slough provides an example of a previously unused strategy for releasing reintroduced sea otters that potentially increases the low retention rate observed in most open-coast releases.

Estuarine habitats clearly can provide suitable and abundant prey as well as adequate resting and pupping habitats (Eby et al. 2017, Espinosa 2018, Hughes et al. 2019). In addition, in some situations, they can provide refuge from some large marine predators, such as killer whales (Estes et al. 1998) and possibly large sharks (Tinker et al. 2016). The recognition of estuaries as important sea otter habitat and the success in supplementing an estuarine population using small numbers of rehabilitated juveniles should both be considered in reintroducing sea otters to the coast of Oregon.

The details of the Elkhorn Slough reintroduction are important, and distinctions from releases on the open coast require consideration. First, Elkhorn Slough had already been occupied by sea otters for several decades at the time that the reintroduction of juveniles began. However, the number of preexisting otters was well below carrying capacity (Tinker et al. 2021), and they were mostly males with no intrinsic reproduction (Mayer et al. 2019). This example suggests that the presence of sea otters where releases occur may provide incentive for newly released individuals to remain. If this is true, then efforts to establish some presence of sea otters at a proposed release site may be facilitated by the enclosed nature of the estuary compared to the open coast, perhaps using net pens or other enclosures as a temporary measure to encourage residence. Second, it must be noted that the success of the Elkhorn Slough reintroduction required the recapture of most animals for health or behavior reasons—some up to four times (Mayer et al. 2019). Thus, the ability to recapture animals that display stress or aberrant behaviors may be essential when translocating surrogate-raised pups. Recapture is much more feasible in the protected waters of an estuary compared to the open coast. It may be possible that a captive population in a large, enclosed area within an estuary might mimic this situation.

DEMOGRAPHIC CONSIDERATIONS

Establishing the number, source, age, and sex composition of sea otters, as well as release sites in Oregon, will be critical in formulating a reintroduction plan. A web-based tool for evaluating many of these variables has been developed as part of this feasibility study (ORSO, the Oregon Sea Otter Population Model) and is described in Chapter 3 (also see Appendix A). To demonstrate the feasibility of a proposed reintroduction plan, we somewhat arbitrarily considered a target of achieving an average population abundance of 200 animals after 30 years, with a 90% probability of at least 50 individuals by this time. Using the ORSO web app, we showed that this might be achieved using a strategy of two release sites—one open-coast site near Port Orford and one estuary site in Coos Bay—with an initial introduction of 50 animals near Port Orford and 25 individuals in Coos Bay and with supplementary additions of three juveniles per year for 10 years following the initial release.

Another possible release strategy could entail successive reintroductions with close monitoring of numbers, movements, and age and sex compositions to determine when and where subsequent releases occur. This recurrent strategy would continue until the desired founding population size, distribution, and growth rate is achieved. Such a strategy could (and should) incorporate a range of inputs and considerations from a broad base of relevant stakeholders and community groups.

We note that there are several demographic and logistical considerations that should factor into a decision of one versus multiple release locations. Clearly, there would be greater logistical and financial costs associated with multiple release sites, which argues in favor of a single location. On the other hand, multiple release sites might act as an insurance policy against the failure of one of the releases, thereby reducing the overall failure risk of the reintroduction program.

Perhaps more important for the long-term success of a reintroduction is the fact that having two or more "nodes" of population growth can greatly increase the overall rate of population recovery due to the combination of local density-dependent population regulation and the limited potential for range expansion in sea otters (Tinker 2015). This phenomenon is perhaps most clearly demonstrated by the rapid recovery rate in SE Alaska, which was facilitated by having several spatially distinct nodes of population growth resulting from multiple release sites (see Chapter 2 and Chapter 3 of this study; Bodkin 2015, Tinker et al. 2019a). The demographic consequences of multiple nodes of population growth may be even more dramatic in the case of a narrow, "one-dimensional" coastline such as Oregon or California, where the rate of population growth and range expansion is constrained by the linear configuration of habitat (Tinker 2015). At the same time, the potential for more rapid growth and colonization must be weighed against the potential social and economic impacts at the different prospective release locations (see Chapter 7).

SOURCE POPULATION CONSIDERATIONS

Several options exist for source populations for reintroduction to Oregon, including SE Alaska, Washington, and California. Each, singularly or in combination, will entail consideration of existing state and federal law (Chapter 8), implications for source populations and their management (Chapter 3), population genetics (Chapter 4), and logistical factors. In the following paragraphs, we primarily consider the logistical considerations but include relevant information on the history and biology of source populations wherever beneficial. Note that because of legal complexities associated with transporting sea otters across international boundaries, we do not consider British Columbia sea otters as a likely source population despite their abundance (> 8000) and proximity to Oregon. Other than these administrative challenges, we note that sea otters from British Columbia would seem to be highly suitable as a source for reintroduction to Oregon.

Sea otters that reside in Washington would appear to provide the most immediate source for an open-coast reintroduction to Oregon based on their abundance, proximity, and state-protected status and based on the assumption that the State of Washington and the U.S. Fish and Wildlife Service (USFWS) would be cooperative. Washington sea otters currently number approximately 3000 individuals and occupy about 100 km of the coastline south of Cape Flattery. Their long-term rate of change is approximately 10% annually (Jeffries et al. 2017), a rate reduced from the early years of recolonization (Bodkin et al. 1999) but continuously positive. Annual removals of 100 individuals would represent approximately 3% of the population and 33% of the annual growth increment in the Washington population, sufficient to have a measurable impact on growth but probably not sufficient to cause a decline (see Chapter 3 for a more in-depth analysis). Transporting animals captured in Washington would be relatively straightforward and consist primarily of transport by air-conditioned vans or trucks from a port such as La Push to temporary holding facilities in Oregon (see below) via interstate highway.

It is also likely that the habitats occupied by sea otters in Washington most closely resemble those that sea otters will experience in Oregon. However, sea otters in Washington presently occupy habitats that are often exposed to sea surface conditions that render capture difficult and possibly hazardous to both otters and humans. This situation could result in a prolonged effort to capture the targeted number of animals. In addition, the proximity of a release site to animals captured in Washington may serve to encourage sea otters to return to their home range. The potential for this latter eventuality is speculative but suggested by some prior translocation efforts within their established range in California (Odemar and Wilson 1969).

It is possible that the State of Alaska would be another willing donor of sea otters to a reintroduction effort into Oregon. SE Alaska likely supported 30,000–40,000 sea otters as of 2020, occupying thousands of kilometers of coastline (Tinker et al. 2019a): Annual removals of 100 animals would have no measurable effect on population viability at the regional scale and would be sustainable at a subregional scale depending on the specific capture locations (see Chapter 3). Transporting a large number of sea otters to Oregon from Alaska would entail additional effort, requiring the use of air transport and thus additional costs. However, the abundance of sea otters and the protected nature of the habitat occupied in SE Alaska would likely entail reduced capture effort and risks, possibly offsetting higher transportation costs. It may also be possible, based on population abundance and distribution, to target and capture mostly subadult sea otters in SE Alaska from habitats that are qualitatively similar to the habitats at proposed release sites in Oregon, thereby maximizing the potential for the retention of animals near release sites. Further, the State of Alaska may be more likely to support sea otter removals to support the Oregon effort if they help achieve local resource management objectives (e.g., removing sea otters from localized areas that support valuable shellfish resources for subsistence or commercial fisheries). If so, a multistate collaboration could increase the availability of crucial resources needed to implement the capture and translocation of animals.

Based on long-term positive rates of increase in abundance, animals residing in Washington and SE Alaska appear to have readily adapted to the habitats, prey assemblages, and environments along those coastlines. It is expected that animals from either source would encounter similar conditions in Oregon, although Oregon and Washington share more similar, open coastlines with relatively little coastline complexity compared to SE Alaska. One additional difference between Washington and SE Alaska is that SE Alaskan (and British Columbian) otters originated from two donor populations, Amchitka Island and Prince William Sound, in the Gulf of Alaska. This mixing of donors resulted in increased genetic diversity, the highest measured for any extant sea otter population (Larson et al. 2002, Larson et al. 2012). To some extent, this two-donor approach restored genetic diversity lost as a consequence of the population bottlenecks induced by the maritime fur trade (Bodkin et al. 1999, Larson et al. 2015). Thus, the use of SE Alaska as a source population might best achieve the goal of maximizing genetic diversity near the southern end of the sea otter distribution (Chapter 4).

Given the ESA listing and demographic status of sea otters in California, taking a large number of animals annually (≈ 100) from the population—a number adequate to establish a viable population in Oregon—would likely have measurable negative impacts on the California population's conservation and recovery, depending on where the captures were conducted (see Chapter 3). However, depending on the preferred release strategy, a case could be made for including some sea otters from California based on at least two considerations.

First, sea otters that resided historically in Oregon, or at least the southern half of the state, appear to have been more closely related genetically to southern sea otters (see Chapter 4). As a result, including a genetic component of California sea otters in Oregon would likely aid in the recovery of lost genetic diversity that resulted from the maritime fur trade. This would theoretically provide future benefits to sea otters in both California and those further north, as Oregon could become a bridge reuniting the long-fragmented sea otter species (Larson et al. 2012, Larson et al. 2015, Wellman et al. 2020). In turn, this connection may eventually benefit sea otters isolated in California by restoring some portion of their lost genetic diversity. Inserting a California genetic component into an Oregon reintroduction could be accomplished through a relatively small number of animals contributing to an Oregon reintroduction. On the other hand, mixing source populations would also add considerable legal and administrative complications (refer to Chapter 8). It is perhaps worth noting here that a regionally coordinated strategy that might achieve the same genetic benefits while avoiding some of the legal complications could involve pairing an Oregon reintroduction using a northern sea otter source with a northern California reintroduction using a southern sea otter source, thereby allowing for future mixing of these genetic stocks.

The second consideration relates to the potential inclusion of surrogate-raised stranded pups in an Oregon reintroduction strategy. Such a strategy would partly depend on the number of stranded sea otter pups that can be accommodated in existing long-term facilities in California and Oregon. Assuming that the methods described by Mayer et al. (2019) of using surrogate females to rehabilitate and prepare stranded sea otters for release into the wild would achieve similar success in Oregon, using such juveniles could relieve the strain of surplus strandings in California, which sometimes requires sea otter pups and juveniles to be euthanized. If an estuarine release strategy is employed in all or in part in Oregon, those surrogate-reared and rehabilitated pups would (a) help reduce euthanasia of sea otters in California, (b) demonstrate a mechanism for stranded pups in other U.S. and possibly Canadian populations to contribute to the Oregon population, (c) aid in the recovery of lost genetic diversity within sea otters, potentially across much of their range in the eastern Pacific, and (d) potentially improve the retention rate of reintroduced sea otters in Oregon beyond that expected based on past translocation efforts.

In the following text, we present options for the capture, transport, holding, and release of animals into the coastal waters of Oregon. This effort would be sizeable but not insurmountable and would require cooperation from state and federal governments and their agencies that have management responsibility for sea otters. It would also require consideration of the many potential and reasonably anticipated implications for source populations and the social, economic, cultural, and ecological effects in Oregon that are considered elsewhere in this study.

CAPTURE

There are three different methods used to capture living sea otters: (1) with handheld dip nets on land or in water, (2) with tangle nets set near concentrations of sea otters, and (3) with diver-operated traps from below the sea surface (Wild and Ames 1974, Ames et al. 1986). We will discuss the benefits and liabilities associated with each method. It should be recognized that the capture of sea otters is highly regulated, requiring federal and, in some cases, state permits. Permittees are required to establish knowledge, skill, and experience in the safe capture and handling of sea otters. The potential for the sea otter's injury or death exists during capture, although the probability varies among methods (discussed below). Additionally, capture and handling present the potential for serious injury to those involved in capturing sea otters. No one should attempt to capture or handle a sea otter without appropriate training, experience, and permitting.

Dip Nets

Large, commercially available *dip nets* can be used to capture sea otters either hauled out on land (rare) or on the sea surface. In general, capturing sea otters on the water is restricted to naïve, juvenile sea otters that fail to evade capture. Capture is usually attempted from a small (17–20 ft ; 5.18–6.10 m) skiff with a 50–100 hp outboard motor and with a team of two people, one operating the vessel and another on the bow with the long-handled dip net.

Because juveniles occasionally loosely aggregate in open water, individuals can be rapidly approached and occasionally simply dipped out of the water before they dive. If they do dive, and the sea surface is relatively calm, they can be followed as they swim underwater either visually or by tracking the air bubbles that are released as they descend and float to the surface (this is a technique developed by Aleuts to hunt the sea otter, although without the outboard motor). If the otter does not dive too deep, they may be followed visually or as they ascend while swimming to gain a breath. Once an animal is captured, they are brought aboard the vessel and placed in a net bag within a *capture box* that can be used for transport (Figure 9.1). This technique has been successfully used to capture sea otters for research purposes as well as in translocation to San Nicolas Island.

One advantage to dip-netting is that the equipment is rather simple and requires only two people. It may also have the advantage of targeting relatively young sea otters that may be more likely to remain near their translocation site. In California and Alaska, typical weights of dip-netted sea otters were approximately 15–25 lb (6.80–11.34 kg; often recently weaned pups), and if juvenile sea otters are a target age group, some individuals may be captured this way.

Figure 9.1. Capture box used for the short-term holding and transport of sea otters to and from the capture site.

There are at least three potential disadvantages to dip netting. One is that the catch rate can be relatively low, perhaps zero to four animals per day per team under good conditions. The second disadvantage is the method can be stressful to the otter if pursued for more than a few minutes, and in rare circumstances, collisions with the capture vessel may occur, with the risk of serious injury or death possible. Third, the method requires relatively calm seas and clear waters where resting sea otters can be observed from afar and followed underwater while being chased.

Tangle Nets

Floating *tangle nets* represent the tool most likely responsible for a large majority of sea otter captures during translocations and for research in the 20th century. Tangle nets are typically 330 ft (100.58 m) long, about 9–15 ft (2.74– 4.57 m) deep, constructed of #15 monofilament line with a 9.25 in. (23.50 cm) stretch mesh size, and commonly adapted from commercial king salmon fishing gear. Nets are kept afloat with a "cork-less" foam core float-line with a 1.5 in. (3.81 cm) diameter along the length of the net and a #20 lead-core lead line. It is important that the lead line be heavy enough to sink and light enough so that a sea otter that becomes tangled below the surface can easily return to and remain at the surface. Research Nets Inc. of Redmond, Washington, has made most, if not all, nets used for sea otter captures over the past 30 years, and we recommend that organizers of future capture efforts talk with Research Nets Inc. to benefit from their expertise.

The nets are set in proximity to aggregations of sea otters at rest or in areas where sea otters are known to forage or travel between resting and foraging locations. Typically, one to three nets are set at a time, depending on the density and distribution of otters, the types of habitats and sea conditions, and the number of people available to tend the nets. Nets are typically anchored at one end with a scope of 3-5 to 1 with a chain and rode line. A large float is on one or both ends, and the nets are usually set in waters from 20–60 ft (6.10– 18.29 m) deep in or adjacent to canopy-forming kelp beds where sea otters are known to rest (Figure 9.2). In some instances where tide and current dictate, the net may be anchored at both ends but with consideration of tidal change to permit the net to float continuously. Where sea otters are abundant, nets might be deployed only during daylight hours and be watched continuously by a shore-based observer(s) with a telescope. Where densities are low and sea conditions allow, nets may be allowed to remain overnight but should still be checked periodically.

Figure 9.2. Illustration of the deployment of a tangle net for sea otter capture.

Tangle nets can be highly efficient in capturing sea otters under conditions where they are abundant. It might be expected under the right conditions to safely capture five to 10 sea otters per net per day. However, where they are in low density, one might go days without capturing a single animal. It is important to have local knowledge of the abundance, distribution, and behavior of sea otters in areas where nets will be deployed; reconnaissance is essential for efficiency and for the safety of both the otters and the capturers.

While nets can be highly effective under a range of conditions, they also present several risks. Foremost is the ability to safely access and remove animals that become entangled. There have been instances where adverse sea conditions have prevented researchers from getting to their nets, and animals have remained entangled for extended periods. Often, more than one animal becomes entangled at a time, and multiple animals entangled may act aggressively toward one another. Occasionally, an animal that is free may behave aggressively toward a tangled animal. It is therefore essential that the nets are monitored continuously and that the net-tending crew are able to access their nets rapidly at any time.

Another potential hazard lies in the net or lead line becoming entangled with the bottom or some other feature that prevents a tangled animal from coming to the surface. In this case, the animal is likely to drown within a few minutes. High-current areas provide yet another opportunity for tangled sea otters to drown in a net that remains submerged because the current is stretching and holding the net below the surface.

Yet another potential for a tangle-net hazard is an unexpected encumbrance of the net with debris, algae, or other substances. In a protected bay in Prince William Sound, a tangle net became so saturated with diatoms that much of it sank. Only because the crew was in proximity were they able to bring the net to the surface and release an animal submerged for several minutes. It usually takes a crew of three to operate one to three nets when they are deployed and retrieved daily. However, it is not unusual for these nets to become laden with seagrass or kelps that may take many hours to clean and prepare for resetting, and there is also the risk of bycatch of fishes, birds, and other mammals. These incidences can result in injury or death to the bycatch, with the potential for serious injury to those tending the nets when a sea lion or fur seal is tangled.

For the reasons stated above, only those with extensive experience with floating tangle nets should employ them to capture sea otters, and even then, not all risk can be eliminated. Compared to SE Alaska or British Columbia, the Washington coast probably provides the least amenable habitat, environment, and access to capturing sea otters with tangle nets.

Figure 9.3. Scuba diver operating an underwater propulsion device with a Wilson trap.

Wilson Traps

In large part because of the risk presented by floating tangle nets, in 1972, the State of California experimented with a diver-held device to capture sea otters from below in what would come to be known as the *Wilson trap* (Figure 9.3). The original device consisted of a large, lightweight aluminum frame into which a net, opened at one end, was attached with a purse line (Ames et al. 1986). The frame and net were attached to a long pole that a team of divers carried as they swam to a position beneath a resting sea otter. They would then swim up to the otter, whose initial reaction to the disturbance would be to dive into the trap. The trap would immediately be closed by the purse string, entrapping the otter, and the dive tender would soon pick it up.

While early efforts with the trap proved feasible, in many cases, the otter would be disturbed by the divers' exhaust bubbles and easily avoid capture. Over the years, several modifications and improvements have been made to the Wilson trap technique, making it the preferred capture method in many cases. These improvements include a shift to oxygen rebreathers (a closed-circuit scuba system) that remove the scent and disturbance created by divers' bubbles; waterproof very-high-frequency (VHF) radios that allow spotters to communicate with the divers; and the replacement of the wooden rod with a battery-powered underwater propulsion device that extends the range and speed of the divers. Under average to good capture conditions—including abundant animals and clear and calm seas—expected capture rates by a team of three to four should be approximately three to six animals per day.

Regardless of the method of sea otter capture, it is essential that once a sea otter is captured, it be placed in a container that will restrain its escape, protect captors from injury, and provide a safe environment for transport and temporary holding. Over the years, a capture box designed to hold any sea otter has proven to meet these needs (Figure 9.1). It is constructed of marine-grade plywood and fitted with a sliding lid and holes for drainage and air or water exchange. It can hold ice to keep animals cool. A frame of tubular polyvinyl chloride (PVC) can be placed on the bottom to keep the sea otter off the bottom of the box, thereby reducing the potential for soiling the fur. If animals are required to be held for any period of time before or during transport, the capture boxes can be placed in the water and secured to a vessel or platform, allowing for an adequate breathing area above the waterline for the otter to float so that water can flow through the drainage holes. An otter in a capture box that has been set in this "*soaking position*" has ample room to rest or groom inside the box, thus aiding in thermoregulation and maintenance of pelage integrity.

TRANSPORT AND HOLDING

Planes, trains, boats (from large ships to small skiffs), trucks, helicopters, and humans have all been used to transport sea otters for reintroductions, with runways, rail tracks, roads, and anchorages playing a role in determining where they might be released. Transport, beyond capture, depends on locations, distances, and available logistics. In this section, we discuss the advantages and disadvantages of the modes of transport likely to be used in a translocation in Oregon.

Small, trailered skiffs, 5–7 m in length, are required for each of the capture methods described above. Solid-hull and rigid-hull inflatables, powered by 50–150 hp outboard motors and generally center consoled, are typically employed. Adequate space is needed for two to four people and capture equipment that might include nets, dive equipment, and at least two capture boxes. The 17 ft and 20 ft (5.18 m and 6.10 m) center-console Boston Whaler skiffs have been used for much sea otter research requiring capture using each of the methods described above, as have the extremely seaworthy rigid-hull inflatables available today. These capture skiffs provide initial transport of captured animals to shore or designated transport skiffs for further transport.

Early efforts at sea otter translocation revealed the critical need throughout holding and transport for captured animals to be kept cool and to retain the ability to maintain the thermal integrity of their fur. Aboard the capture or transport vessels, this can be accomplished by periodically placing the capture box (with the otter inside) into the water while the box is secured to the side of the vessel, ensuring there is room in the box for the otter to groom its fur at the surface (this is often referred to as "soaking" the captured animal). Extended travel, beyond an hour or two, may require individual sea otters to be moved into a standard, large animal kennel with a raised platform that helps the sea otter maintain a clean pelage. It is critical that the sea otter retain the ability to thermoregulate body temperature throughout holding and transport. Ice is often added to the holding container to aid in thermoregulation, and close monitoring of the animal's health status and body temperature during transport (by a qualified veterinarian or animal husbandry specialist) is strongly recommended. For some recent captures, tiny subcutaneous Passive Integrated Transponders ("PIT tags") with thermal recording capability have been implanted into animals after capture; these allow veterinary staff to obtain an internal temperature reading from an animal from a few meters away using a PIT tag reader. Transport from initial holding facilities to release site facilities will be by truck and aircraft or vessel, depending on distances and logistics.

Holding facility requirements depend on release strategies. If sea otters are to be accumulated for group release, they will require holding facilities capable of supporting the intended number of animals for each release. In the San Nicolas Island translocation, several days to weeks were required to capture the desired number of animals, which were transported from the capture location by air-conditioned van to holding facilities at the Monterey Bay Aquarium.

Adequate holding facilities will be required for any future Oregon reintroduction, either near capture or release locations or possibly both. If sea otters are to be held at the release site, large floating *net pens* suitable for holding the number to be held, with platforms above the water level and suitable for hauling out, will be required (see Figure 9.4).

A surrogate-raised rehabilitation strategy will require holding and acclimatization facilities at either capture or release locations. Ideally, a long-term holding facility at the release site will aid in raising the retention of released individuals and facilitate the sea otters' recapture when needed. It may be advisable to acquire the capacity to hold adult female sea otters at the release site to rear juvenile sea otters under rehabilitation for release.

Figure 9.4. Photos of floating net pens for holding sea otters at a release site.

Note. TOP: A view of a floating net pen deployed for testing in Monterey Bay. BOTTOM: Releasing a captured sea otter into a floating net pen deployed at San Nicolas Island. Photos courtesy of Colleen Young (California Department of Fish and Wildlife) and Mike Kenner (U.S. Geological Survey).

RELEASE

Based on evidence from the earliest (Barabash-Nikiforov 1947/1962) and latest (Mayer et al. 2019) reintroduction case studies, it may be possible to increase retention near the release site by providing for prolonged acclimatization to the habitat and prey populations, which may be facilitated by allowing for recapturing and holding individuals as necessary. It appears likely that the development of socialization and relations among individuals could be important for achieving some level of cohesion between animals that will likely improve retention rates at or near the release site. If stranded, rehabilitated sea otters form a component of or the core of a reintroduction in Oregon, a single individual or small groups of individuals may come from one or more captive sea otter institutions. They will require a holding facility at (or near) the release site to provide local acclimatization and bond development between individuals from different sources. Such a release strategy may also require the capacity to recapture animals as needed, most likely using dip nets.

MONITORING

Post-release monitoring of reintroduced sea otters has proved to be a critical component of success in recent reintroductions (Rathbun et al. 2000, Carswell 2008, Mayer et al. 2019, Becker et al. 2020). Monitoring can be increasingly challenging the further the animals move from the release site and the more erratic those movements. However, the use of remote sensing tags on each individual can help locate animals that move even long distances. Implanted VHF telemetry tags (Williams and Siniff 1983) have a long history of use for tracking sea otters, although these tags are costly and relatively invasive to apply. GPS-enabled flipper tags are currently under development by the U.S. Geological Survey and the U.S. National Aeronautics and Space Administration (J. Tomoleoni, pers comm) and may provide a less-invasive and cheaper alternative in the near future.

In addition to telemetric monitoring, visual monitoring is valuable, as it allows for assessments of individual health and status (e.g., determining if animal pelage looks well groomed). But visual monitoring may be more difficult for animals released on the open coast compared to those released in estuaries (assuming that animals stay within the estuary). Frequent monitoring, daily or multiple times per day, can improve the reintroduction's chances of success, particularly if recapture is required. Full-time teams of two to four trained and experienced observers may be required for initial monitoring.

Depending on movements and the degree of retention near release sites, intensive monitoring capabilities may be required throughout the duration of releases. On-call aircraft with VHF tracking capabilities and staff capable of VHF and visual tracking from vehicle-accessible coastal locations will likely be required if reintroduced animals move as expected. Note that there is a well-developed methodology and extensive literature on VHF tracking of tagged sea otters in coastal environments (Ralls and Siniff 1990, Siniff and Ralls 1991, Ralls et al. 1995, Bodkin and Ballachey 1996, Tinker et al. 2006, Tinker et al. 2019b, Becker et al. 2020). Aerial tracking is effective, especially if some animals cannot be accounted for by ground-based teams and are believed to have moved greater distances. Aerial tracking of marine species is expensive and does entail safety considerations. Float-equipped aircraft may provide increased margins of safety for pilots and observers if tracking occurs more than a few kilometers offshore.

DATA NEEDS

The primary data need before a reintroduction is the assessment of appropriate and adequate food and habitat resources (see Chapter 6). Such assessments depend on the habitat available and where sea otters become established, which may or may not be close to the area they are released. Although it is prudent to assess food resources and resting habitat in the area around the release site, the possibility that otters may move to a different location must be recognized. So, rapid assessments of food and habitat at new locations may need to be made.

It is likely that recreational and commercial fisheries will provide some data on prey species availability for various clam, sea urchin, and crab species that are also part of sea otter diets. However, much of the otters' diet will include taxa that are not part of any commercial fishery, including species such as shore crabs, kelp crabs, other echinoderms, snails, worms, chitons, and limpets. Habitat resources can also be assessed using geospatial (geographic information system, or GIS) data layers, including bathymetry, substrate type, kelp canopy cover, and shoreline contours (to identify areas of complexity that may offer shelter and high-quality prey habitat). Published and unpublished research may provide further data on habitat and community-level data important in evaluating the potential to support sea otter populations (e.g., Kone et al. 2021, Tinker et al. 2021).

Another data need relates to the status of the ecosystem before and after the reintroduction, allowing for informed assessments of ecological and socioeconomic impacts (Chapter 5 and Chapter 7). Previous translocations and natural recolonizations provide extensive examples of the power of experimental manipulation, or before-after contrasts, in understanding the effects of reestablishing sea otters into their historically occupied habitats (e.g., Estes and Palmisano 1974, Duggins 1980, Estes et al. 1982, Estes and Duggins 1995, Bodkin et al. 1999, Watson and Estes 2011, Hughes et al. 2013, Markel and Shurin 2015, Burt et al. 2018). To the extent possible, pre-treatment sampling of biological communities at or near selected reintroduction sites should be carefully designed and considered for implementation. Existing monitoring programs should be leveraged wherever possible. Some examples might include descriptions of communities, species, and ecological relations expected to be influenced by reintroducing a long-absent predator. Published data from other established and recolonizing sea otter populations can provide an excellent reference for the types of changes to be expected. Monitoring studies aimed at detecting changes in sea otter behavior, physiology, and population dynamics in newly established populations can also provide insights into population status and ecological impacts. In addition to long-term monitoring studies, comparative studies that utilize a *space for time substitution* (i.e., comparisons of sites that differ in terms of the duration of sea otter occupation used as a proxy for longitudinal data from a single site that becomes occupied by sea otters and changes slowly over time) have been shown to be a powerful approach for elucidating ecological dynamics associated with sea otter recovery (Rechsteiner et al. 2019).

SUMMARY AND CONCLUSION

Several strategies can be considered regarding the implementation of reintroducing sea otters to the Oregon coast. These include options for both source populations, release locations, and specific animal attributes. Likely source populations of sufficient numbers include Washington and SE Alaska. Sea otters from California may be considered to supplement animals from northern populations, which would potentially benefit the conservation and recovery of southern sea otters as well as establish a genetic bridge between California and northern subspecies. Evidence from historical reintroductions suggests that multiple introductions may improve the probability of establishing a successful population.

Although sea otters can be expected to eventually occupy all nearshore habitats within their range, not all habitats will support equivalent densities. In general, shallow, high-relief rocky habitats that support canopy-forming kelp canopies may be preferred. High densities of sea otters also occur in many estuarine and shallow soft-sediment habitats throughout their range. The selection of release locations should take into consideration habitat preferences, but sites that allow for access to both exposed and sheltered shorelines (or estuaries) may increase the potential for success. It is critical to realize that in past translocations, sea otters have often not remained where they were released but have become established many kilometers from release sites.

Although not explicitly demonstrated, the sex and age composition of reintroduced sea otters may be important to success. There is reason to suspect that younger animals may not have well-established home ranges that they will try to return to and, so, may be more likely to become established at or near the release site. It is also possible that a sex ratio biased toward females will contribute to the reproductive potential of the founding population. The ORSO application (Chapter 3) can be used to evaluate the likely effects of varying the age/sex ratio of the founding population.

A variety of capture methods are available that can contribute to achieving the desired abundance and age/sex composition. These include dip nets, tangle nets, and scuba-operated Wilson traps. Appropriate care and monitoring of captured animals' health status during transport and holding is critically important, and intensive post-release animal monitoring will also help ensure success.

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