are litigation-sensitive and thus unavailable to us. For these reasons, we provide only a brief and preliminary overview of this event. Much of this information was provided through personal communications from A. DeGange (U.S. Fish and Wildlife Service, Anchorage, Alaska) and G. VanBlaricom (U.S. Fish and Wildlife Service, Santa Cruz, California). A review of the effects of the Exxon Valdez oil spill on sea otters is presented in Bayha and Kormandy (1990).

Effects of the Exxon Valdez spill on the population and ecosystem of the sea otter are largely unknown, and they are likely to remain so. Although numerous studies had been conducted on sea otters in Prince William Sound, the size and distribution of the population in the area influenced by the spill was poorly known. Limited surveys were conducted in several areas before and after they were affected by spilled oil, but due to the imprecision of sea otter counts and the ability of sea otters to move long distances over short periods, these surveys may be impossible to interpret. Even so, there are several general points to be made about the effects of oil on sea otter populations there (Bayha and Kormandy 1990). First, contrary to initial expectations, local populations were not exterminated over large areas of coastline, even at sites that were very heavily affected. However, many animals died. Eight hundred seventy-eight carcasses were recovered from the area during the response phase of the spill (through 15 September 1989); most of these were killed by oil. An additional 135 animals died during capture and rehabilitation efforts. Thus, at least 1,013 sea otters died as a result of the spill, and the number could be much larger. The known causes of mortality were briefly discussed earlier in this section.

One of the main efforts associated with the Exxon Valdez spill was to capture and rehabilitate oiled wildlife. Most of this effort was directed toward sea otters. Many people were involved and the estimated cost for sea otter rehabilitation alone was $18.3 million. Otter rehabilitation facilities were constructed at several sites. Three hundred sixty-one sea otters were brought to the rehabilitation centers, where they were cleaned and cared for; about 45% of these animals were found to be either unoiled or only lightly oiled. One hundred ninety-seven were eventually released back into the wild, 45 of which were instrumented with surgically-implanted radio transmitters for study. These studies are ongoing, but preliminary results indicate that an unexpectedly high number of animals have died or are missing.

Finally, the Exxon Valdez spill confirmed the fears of many that spilled oil could not be cleaned up or contained. The weather was clear and calm for 2 to 3 days following the spill, so that conditions were ideal for containment. Nonetheless, the oil was not contained and probably could not have been contained with available equipment and technology. Furthermore, most of the spilled oil was never cleaned up and probably never can be. The long-term effects of the oil on the environment of the northern Gulf of Alaska remain to be seen.

Review of Sea Otter Reintroductions in North America

Introduction

As mentioned earlier, sea otters were exterminated along the North American coast from Prince William Sound to central Baja California, except for the remnant population in central California. During the 1960's and early 1970's, in collaboration with various State and Provincial wildlife management agencies, the Alaska Department of Fish and Game attempted to facilitate recovery by reintroducing small numbers of sea otters into areas that otherwise might not have been recolonized for decades or centuries. From 1965 to 1972, 708 sea otters captured at Amchitka Island and in Prince William Sound, Alaska, were reintroduced into unoccupied habitat in Alaska, Canada, Washington, and Oregon (Jameson et al. 1982). In most cases, sex ratios of the initial populations were approximately 2:1, favoring females. In 1969, 17 sea otters captured at Cambria, California, were released about 72 km north into occupied habitat within the sea otter's range. In 1988-89, 19 sea otters were captured at Shell Beach and released at Moss Landing. In 1987, reintroduction of sea otters from central California to San Nicolas Island, in the southern California Bight, was initiated. This project is ongoing. Figure 36 shows the locations of capture areas and reintroduction sites from Alaska to California and indicates the status of each reintroduced population. Results of each reintroduction effort are summarized in Table 11.

Alaska

The first five sea otter reintroductions were attempted in 1951, 1955, 1956, 1957, and 1959. In each of these early instances, otters were captured at Amchitka Island and transported to various sites in Alaska. All of the early reintroductions failed. Most of the relocated otters died in captivity during transport or immediately following release. Death resulted primarily from hypothermia, because the fur of captive animals became soiled and matted during transport and handling (and consequently lost its insulative properties). Therefore, failure of the early reintroductions was due to inadequate transport facilities and insufficient knowledge of the importance of keeping the otters' fur clean (Kenyon and Spencer 1960; Kenyon 1969).
On 20 May 1959, seven otters (four females and three males) captured at Amchitka were released at St. Paul Island in the Pribilof Islands. All the otters appeared to be in good health immediately following the release, and subsequent sightings were made near St. Paul Island until spring 1961. However, the relocated population did not survive and reproduce, probably due to its small initial size or to mortality from winter sea ice, which limits the northern extent of the species' range (Schneider and Faro 1975).

In 1968, 55 sea otters captured at Amchitka Island were released at St. George Island in the Pribilof Islands. The St. George population eventually became extinct. During a 1977 survey of the area, only three otters were sighted. Little or no reproduction appears to have taken place within the relocated colony, and no pups have been observed since the 1968 relocation (Jameson et al. 1982). In 1971 and 1972, the sea ice extended unusually far south, to the north side of Unimak Island (Schneider and Faro 1975), and may have reduced or eliminated the population at the Pribilof Islands. It is uncertain whether subsequent sightings are remnants from the reintroduction or animals that dispersed northward from southwestern Bristol Bay. Seven otters were seen at St. George Island by A.L. Sowls during summer 1988, and local residents claim that up to 30 otters are present (A. DeGange, U.S. Fish and Wildlife Service, Anchorage, personal communication).

From 1965 to 1969, 412 otters (89% captured at Amchitka, 11% from Prince William Sound) were reintroduced to various sites in southeastern Alaska (Fig. 37). These efforts were successful, and the sea otter population in southeastern Alaska is currently well established and increasing in size and range. From 1975 to 1987, the southeastern Alaska population increased about eightfold (K.W. Pitcher, Alaska Department of Fish and Game, unpublished data). In a 1988 survey of southeastern Alaska, 4,500 otters were sighted between the Barrier Islands near Dixon Entrance to the south, and north of Cape Spencer (Pitcher, unpublished data). The total population in southeastern Alaska probably contains 5,000 or more sea otters. The ratio of pups to older otters was 1:5. Johnson et al. (1983) reported that there seemed to be excellent sea otter habitat for future population expansion and predicted that the populations should increase 4- to 5-fold during the 1990's. This population has increased at a rate of 17.6% annually (Estes 1990a).

**British Columbia**

From 1969 to 1972, 89 sea otters were reintroduced to the Bunsby Islands in British Columbia: 29 in 1969, 14 in 1970, and 46 in 1972. Of the relocated otters, 33% were captured at Amchitka Island, and the remainder were from Prince William Sound (Cameron 1972; MacAskie 1975). Bigg and MacAskie (1978) suggested that the high postrelease mortality that took place during the 1969 relocation occurred due to soiled pelage incurred during transport—the otters were not kept in holding pens before release and were therefore unable to feed or adequately groom and clean their fur before being liberated.

During a 1977 aerial survey, Bigg and MacAskie (1978) sighted 70 sea otters at the Bunsby Islands (55 otters) and Bajo Point (15 otters), including several pups (although they did not specify the number of pups observed). The populations seemed unchanged in 1978 (Breen et al. 1982). Based on the 1977–78 surveys, Farr and Bunnell
Table 11. *Number of sea otters (Enhydra lutris) reintroduced into unoccupied habitat in Alaska, Canada, Washington, Oregon, and California, and the size of reintroduced populations during the most recent survey.*

<table>
<thead>
<tr>
<th>Reintroduction site</th>
<th>Release location</th>
<th>Capture site</th>
<th>Number of otters released</th>
<th>Year of reintroduction</th>
<th>Total number reintroduced</th>
<th>Otters counted during most recent survey (year)(^b)</th>
<th>Ratio of pup: independent(^c)</th>
<th>Status of reintroduced population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pribilof Islands</td>
<td>St. George</td>
<td>Amchitka</td>
<td>55</td>
<td>1968</td>
<td>55</td>
<td>3 (1977)</td>
<td>0:100</td>
<td>Uncertain</td>
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<tr>
<td>(Alaska)</td>
<td>Island</td>
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<td>1966</td>
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<td>1968</td>
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<tr>
<td>British Columbia</td>
<td>Bunsby Islands</td>
<td>33% from Amchitka;</td>
<td>29</td>
<td>1969</td>
<td>89</td>
<td>380 (1987)</td>
<td>Some pups observed</td>
<td>Established</td>
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<td>67% from Prince</td>
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<td></td>
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<td>30</td>
<td>1970</td>
<td>46</td>
<td>1972</td>
<td>1972</td>
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<tr>
<td>Washington</td>
<td>Point Grenville</td>
<td>Amchitka</td>
<td>29</td>
<td>1969</td>
<td>59</td>
<td>211 (1989)</td>
<td>8:100</td>
<td>Established</td>
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<tr>
<td>La Push</td>
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<td>Amchitka</td>
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<td>Amchitka</td>
<td>30</td>
<td>1970</td>
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<td>Oregon</td>
<td>Point Orford</td>
<td>Amchitka</td>
<td>29</td>
<td>1970</td>
<td>93</td>
<td>1 (1981)</td>
<td>0:100</td>
<td>Extinct</td>
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<td>Amchitka</td>
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<td>Amchitka</td>
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<td>1971</td>
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\(^a\) Sources of data: Jameson et al. 1982; Johnson et al. 1983\(^d\); Jameson, unpublished data; Bigg and MacAskie 1978; Pitcher 1987\(^e\) and unpublished data; MacAskie 1987; Rathbun et al. 1989\(^f\).

\(^b\) Total includes pups.

\(^c\) Number of pups sighted varies according to time of year.

\(^d\) In southeastern Alaska, otters were released at various sites along the exposed west coasts of Yakobi, Chichagof, Baranof, and Prince of Wales islands. Otters were released at Yakuttal Bay and Cape Spencer on the Alaska mainland.
(1980) estimated that the population contained 70–120 animals. In 1984, MacAskie (1984) found that the population in British Columbia had split into two main groups, which together contained an estimated 345 individuals; 370 otters were counted in a 1987 survey (MacAskie 1987). From these data, Estes (1990a) estimated that the British Columbia sea otter population increased at 17.7% annually.

Since the relocations to British Columbia, sea otters have been sighted as far northwest of the reintroduction site as 320 km (to the Queen Charlotte Islands and northern mainland) and 220 km southeast along the Vancouver Island coast. However, sightings extralimital to the main British Columbia population may represent sea otters from reintroduced populations in southeastern Alaska and western Washington, since these reintroduction sites are located about the same distance away from these areas as are the Bunsby Islands (Bigg and MacAskie 1978).

**Washington**

From 1969 to 1970, 59 sea otters were relocated from Amchitka Island to Washington. In 1969, 29 sea otters were released at Point Grenville; at least 16 died within 2 weeks of the reintroduction (Jameson and Kenyon 1977*; Jameson et al. 1982). Most of the mortalities occurred among otters whose fur became soiled in transit (Farr and Bunnell 1980). A second reintroduction of 30 otters was made to La Push in 1970. During a 1983 survey of the Washington coast, 52 otters (including 4 pups) were sighted, from the Destruction Islands in the south to the
Bodieh Islands in the north. The Washington population was again surveyed in 1985, during which 65 animals were counted (Jameson et al. 1986), of which 5 were dependent pups. A 1987 survey recorded 90 sea otters, including 12 dependent pups. More than 200 otters were counted during a 1989 survey (Jameson, personal communication), although some of these were in a large group offshore in an area that had not been examined in previous surveys. The small proportion of pups (8%) observed in the Washington population during the 1983 survey probably reflects the fact that the survey was conducted in September, when most pups had been weaned (Jameson, unpublished data). Jameson et al. (1986) reported that from 1977 to 1983, the average rate of population growth was 18.3% and predicted that the population should contain >160 otters by 1990. Estes (1990a) estimated that the Washington population increased at 20.6% annually from 1978 to 1987, a rate similar to that of other increasing populations in Alaska and British Columbia.

Jameson et al. (1982) speculated that the sea otters relocated from Amchitka might have been better adapted for survival in northern waters. Because Oregon and Washington lie within a transitional zoogeographic province between the Aleutian and California provinces (Ekman 1953), the more southerly habitat may have been less than suitable for otters originating from the Aleutian Islands. However, the reason for failure of this relocation effort is, in fact, unknown.

Oregon

In 1970 and 1971, 93 sea otters from Amchitka Island were released in Oregon in three relocations: 29 at Port Orford in 1970, 24 at Port Orford in 1971, and 40 at Cape Arago in 1971. From 1972 to 1974, 21–23 otters were sighted during surveys of the Oregon coastline; pup-to-independent otter ratios varied from 1:20 to about 1:3. The Oregon populations declined dramatically after 1975 (Jameson 1975; Jameson et al. 1982). In a 1981 survey, only one otter was sighted (Jameson et al. 1982). Sea otters have not been seen since, and the population is considered extinct (Jameson, personal communication).

Eleven sea otter mortalities (including one stillborn pup) were recorded in the Oregon population (Jameson and Kenyon 1977; Jameson et al. 1982). Although little postrelease mortality was documented, it is possible that the incidence of mortality immediately following the two 1971 translocations was high. High postrelease mortality caused by exposure and thermoregulatory distress may have resulted from an unseasonal storm, which prevented the otters from recuperating (by cleaning their fur and feeding) in holding pens; instead, the animals were released directly into open water from their carrying cages (Jameson 1975).

Jameson and Kenyon (1977) and Jameson et al. (1982) suggested that failure of the Oregon reintroductions may have been due to emigration, mortality, or habitat unsuitability. Several sightings were made considerable distances from the Oregon introduction sites. In 1972, 4–5 otters were observed 204 km north of Cape Arago in June, and 3 otters were reported 290 km north of Cape Arago in August; the same otters could have been involved in both sightings (Jameson et al. 1982).

California

In 1969, the California Department of Fish and Game relocated 17 sea otters, captured and tagged near Cambria, to Big Creek, located about 72 km north of Cambria. This relocation differed from those discussed previously: the California otters were released a fairly short distance from the capture site and into habitat already occupied by sea otters. In addition, whereas the other relocations were done to expand the otter's range, this one was done to limit it. The relocations in California took place during January, April, July, and August. At least 30% (5) of the relocated sea otters returned to the capture site at Cambria within 9 months of their release (Wild and Ames 1974). On 25 September 1969, the first relocated otter was observed off Cambria (Odemar and Wilson 1969b). On 12 October 1969, four otters released at Big Creek were sighted 6 km south of Cambria. According to Wild and Ames (1974), it is likely that the proportion of otters that returned to the capture site was greater than indicated by the five otters actually sighted.

Another translocation of California sea otters from the southern to the northern part of their current range was conducted in 1988–89 by Doroff et al. (1989), who investigated the movement patterns of the translocated animals. Sea otters from the southern part of the range were captured and moved, because animals in this area may be at higher risk to oil spills if the proposed oil development in the Santa Maria basin takes place. If an oil spill occurred in this area, attempts would be made to capture, clean, and relocate oil-contaminated otters; therefore, the movements of such relocated otters after release in the northern part of the range are of interest; if they return to their capture site, they may risk oil recontamination.

Doroff et al. (1989) captured 19 sea otters at Shell Beach and released them at Moss Landing during 3 periods: 9 during 17–20 May 1988, 6 during 18–19 January 1989, and 4 during 27 April–2 May 1989. A 60-day radio-transmitter tag was attached to each otter's hindflipper. One of the otters was a juvenile female, and the rest were juveniles, subadult, or adult males. Nine of the otters were released soon after being moved to Moss Landing, while the remaining 10 were held in a flotation
pen at Moss Landing harbor for 48 h to determine the effect of such containment on homing behavior.

All otters detained in the holding pen remained between Monterey and Point. Año Nuevo for the entire study. Yet 56% (five) of the nine otters not held returned to the Shell Beach capture site, about 291 km south of Moss Landing, traveling this distance in an average of 12 days (range = 7–21 days). The remaining four otters moved southward only once during the monitoring period. Four of the otters that returned to Shell Beach immediately moved north to Soquel Point (an area inhabited primarily by males, 27 km north of the Moss Landing release site) before returning to Shell Beach.

After being released without being held for 48 h, one adult male (captured 17 May 1988) moved 27 km north to Soquel Point where he remained for 6 days; he was found back at Shell Beach 7 days later. Interestingly, after 34 days, he returned to Soquel Point, and was last located 28 days later near Cayucos, 250 km south of Soquel Point. After the expiration of his radio-transmitter, the otter was again sighted 3 times at Soquel Point, identified by his hindflipper tags; the last sighting was 12 May 1989.

One old adult male died during the monitoring period, and two old adult males were found dead after the study ended, at Half Moon Bay (116 km north of Moss Landing) and San Gregorio Beach (100 km north of Moss Landing); causes of all three deaths were unknown. This translocation experiment indicates that holding sea otters for a period of time before they are released influences homing behavior, possibly making them less likely to return to their capture site.

The 1969 and 1988–89 California experiments demonstrated that relocations across continuous rocky substrates–kelp forest habitat (apparently preferred by sea otters) could not effectively prevent otters from dispersing from the release site and traveling back to the original capture site (Wild and Ames 1974). However, other factors such as the age of animals, presence of territorial males, and seasonal movements of males to and from the range peripheries (Jameson 1989), may have influenced attempts to relocate male otters to a specific area within the established range in California. Doroff et al. (1989) pointed out that all five otters that returned to their Shell Beach capture site were released in spring (late April to mid-May).

Jameson et al. (1982) suggested that sea otters (especially adults) have an affinity for a specific home range. Those most likely to return to their capture site when relocated to an unfamiliar area, therefore, may be the adult otters. Jameson (1989) found that some adult males near San Simeon, California, returned to the same territories for 6 consecutive years. Jameson et al. (1982) suggested that subadult otters, especially males, may be more likely to remain at the relocation site due to their tendency to disperse to new areas from their natal site. In many species of mammals, it is the juveniles, particularly

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**Fig. 38.** San Nicolas Island translocation zone, where the relocated population of California sea otters is protected. Sea otters in the management zone are to be removed and transported back to the sea otter range north of Point Conception.
juvenile males, that disperse from the natal area seeking reproductive opportunities (Murray 1967; Gaglii 1971; Hamilton and May 1977; Horn 1978). In the California sea otter population, evidence suggests that juvenile males tend to disperse a greater distance from the natal area than juvenile females (Ralls et al. 1984; Riedman et al. 1985; Jameson, unpublished data). However, Doroff et al. (1989) found that 30% (3) of their sample of 10 subadult males returned to their capture site within their monitoring period.

San Nicolas Island

In August 1987, the U.S. Fish and Wildlife Service began a major effort to reintroduce sea otters to San Nicolas Island in the southern California Bight (Fig. 38). This effort is ongoing. Unlike all previous sea otter reintroductions, this project included an intensive follow-up study of the fate and behavior of the relocated otters (Rathbun et al. 1989). As of June 1990, 137 animals had been moved to San Nicolas Island (U.S. Fish and Wildlife Service 1990). Each of these animals was marked with color-coded flipper tags, and some were instrumented with radio transmitters. By June 1990, 15 animals were known to have remained at San Nicolas Island. Of the other translocated animals, 30 returned to the mainland, 9 died from human-related causes (including capture stress), 3 were recaptured and returned to their original capture site (after they swam into the “no-otter” zone near the southern California mainland), and 80 were unaccounted for (Rathbun et al. 1989). Adult (1.8 kg) seem to be more likely to return to their capture sites than do subadults and juveniles. Eight pups were born on San Nicolas Island; of these, one was weaned, three are still with their mothers, and the fate of the remaining four is unknown (U.S. Fish and Wildlife Service 1990). The success or failure of this project is still undetermined.

Summary and Conclusions

Failure of all efforts to reintroduce sea otters in the 1950’s was principally due to a high mortality that occurred during and immediately after transportation to the release site. Mortality in transit was caused by thermoregulatory distress resulting from soiled and matted fur, which lost its insulative properties when the otters were released into open water. During subsequent attempts, this problem was largely resolved by preventing the animals from becoming soiled in transit and by placing them in holding facilities containing clean seawater before release allowing the animals to feed and to clean and groom their fur.

From 1965 to 1972, attempts to reestablish populations of sea otters into unoccupied habitat were successful in southeastern Alaska, British Columbia, and probably Washington. Reintroductions to Oregon and to the Pribilof Islands in Alaska failed. The reasons some attempts succeeded and others failed are largely unknown, although postrelease dispersal has occurred in all the relocation efforts (Estes et al. 1989); failure of the reintroduction to St. George Island in the Pribilof Islands may have been due to mortality caused by unseasonal winter sea ice in the area (Kenyon 1969; Jameson et al. 1982).

The Oregon reintroduction probably failed because of emigration from the release area coupled with a high mortality rate. Some degree of habitat unsuitability for the transplanted Amchitka otters may possibly have promoted the decline in the Oregon population (Jameson et al. 1982), although there is no evidence for this. The reintroductions to southeastern Alaska, British Columbia, and Washington apparently succeeded because of the larger number of otters relocated (although the Oregon reintroduced population was larger than the one to Washington and comparable in size to the British Columbia population), immigration of otters from other populations, or highly suitable habitat available at the reintroduction site (Jameson et al. 1982).

Based on the results of previous reintroduction efforts for sea otters, Jameson et al. (1982) concluded the following: (1) Soon after release, the number of sea otters at a reintroduction site may decline substantially; (2) emigration probably is the main cause of the decline; (3) it is difficult to predict specific locations where the relocated populations will become established, although it is possible to reintroduce otters to a general area; and (4) the successful reintroduction of sea otters into unoccupied habitat probably will require a fairly large nucleus population. Jameson et al. (1982) suggested that relocation of 25–30 otters annually over 3–5 years would be necessary to ensure adequate growth of the reintroduced population.

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