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Sea Otter Rehabilitation Program
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INTERNATIONAL WILDLIFE RESEARCH

Sea Otter Rehabilitation Program: 1989 Exxon Valdez Oil Spill

Edited by

Terrie M. Williams[1] and Randall W. Davis[2]
International Wildlife Research

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Present address:

1. Naval Oceans Systems Center
   P.O. Box 997
   Kailua, HI 96734

2. Texas A & M University at Galveston
   Mitchell Campus
   P.O. Box 1675
   Galveston, TX 77553

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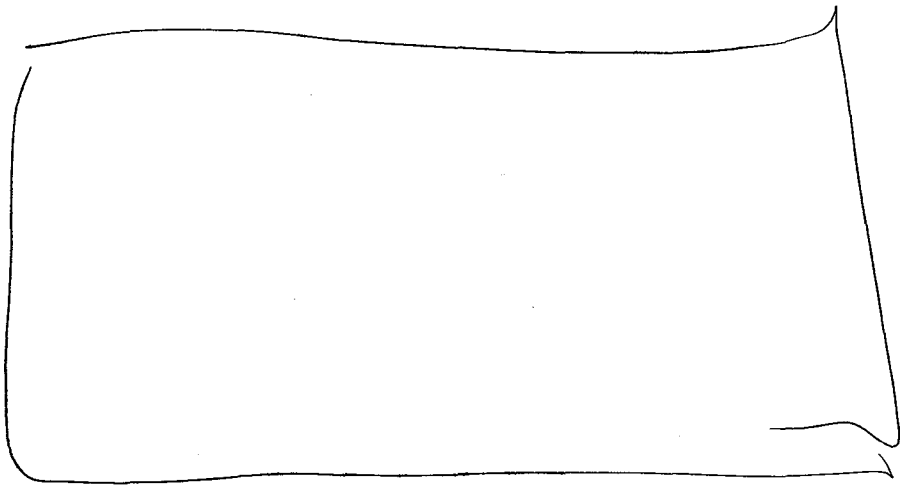

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List of Authors

Davis, Randall W., Ph.D	International Wildlife Research c/o Texas A & M University at Galveston Mitchell Campus P.O. Box 1675 Galveston, TX 77553
Hill, Kenneth A., D.V.M.	P.O. Box 1290, Cordova AK 99574
Hunter, Lee, Ph.D.	Redken Laboratories, Inc. 6625 Variel Ave. Canoga Park, CA 91303
Monahan, Thomas P.	Exxon Company USA Calais II Bldg, Third Floor 3301 C Street, Anchorage AK 99503
Osborn, Kent, D.V.M.	San Diego Zoological Society Pathology Department P.O. Box 551 San Diego, CA 92112
Schroeder, J. Pete, D.V.M	Naval Ocean Systems Center P.O. Box 997 Kailua, HI 96734
Tuomi, Pamela, D.V.M.	College Village Animal Clinic 2036 E. Northern Lights Blvd. Anchorage, AK 99508
Weltz, Fred	P.O. Box 982 Cordova, AK 99574
Williams, Terrie M., Ph.D.	International Wildlife Research c/o Naval Ocean Systems Center P.O. Box 997, Code 511 Kailua, HI 96734
Williams, Thomas D., D.V.M.	Aguajito Veterinary Hospital 1221 10th St. Monterey, CA 93940
Wilson, Riley K., D.V.M.	Arctic Animal Hospital 1600 East Tudor Road Anchorage, AK 99507

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The oil spill affected all of the communities around Prince William Sound, the Kenai Peninsula and Kodiak archipelago. Without exception, these communities supported the sea otter rehabilitation program. Our special thanks to the communities of Valdez, Seward and Homer for helping us to build the rehabilitation centers. We would especially like to thank the former mayor of Valdez, John Devens, the former mayor of Seward, Harold Geiseler, and city manager for Seward, Daryl Schaefermeyer. We are especially grateful to the Prince William Sound Community College for allowing us to use their facilities in Valdez. We would also like to thank the Girl Scouts of America, the Alaska Audubon Society, and the many other people throughout North America that sent towels to the rehabilitation centers.

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Executive Summary

Chapters 1 and 2

On March 25, 1989, one day after the Exxon Valdez oil spill, Exxon Company USA initiated a sea otter rehabilitation program at the request of the U.S. Department of the Interior. Randall Davis became Senior Director of the program. Rehabilitation centers were built in Valdez and Seward and a pre-release facility was built near Homer. From March 30 until September 15, 357 sea otters were treated at the three centers, and 225 (63%) were rehabilitated and released or rehabilitated in seaquariums. During this time, Exxon spent approximately $18,300,000, which fully funded the program. Historically, this ranks as the most expensive program to rehabilitate oiled marine mammals ever sponsored by a private company or government agency.

Construction of the Valdez sea otter rehabilitation center began on March 27, and the first otter arrived on March 30. The director was Terrie Williams. Four capture boats and a dedicated helicopter operated in Prince William Sound until late April. Oiled otters were captured with dip nets and tangle nets. Overall, the Valdez center treated 156 sea otters with a maximum of 64 in the facility at one time. Maximum staff size was 159.

A second rehabilitation center was opened in Seward in early May when the oil spill moved along the southern shore of the Kenai Peninsula. The director was James Styers. This facility treated 187 otters with a maximum of about 89 at one time. Maximum staff size was 98. Up to eight capture boats and a dedicated helicopter worked along the Kenai Peninsula through late July. Tangle nets were the primary method of capturing otters.

Temporary care facilities were built in Homer and Kodiak to stabilize oiled otters before they were sent to the Valdez or Seward rehabilitation centers. In May, a pre-release facility was built in Little Jakolof Cove near Homer to hold rehabilitated otters from Seward. The director was Nancy Hillstrand. This facility held up to 100 otters and employed a maximum staff of 63.

Establishing objective criteria to determine when capture operations should cease was difficult. In addition, the use of tangle nets along the Kenai Peninsula did not allow for the selective capture of oiled otters. As a result, many lightly oiled or unoiled otters were captured and taken to the Seward rehabilitation center. The USFWS ended capture operations in late July.

The USFWS, as the federal trustee for sea otters, completed a release strategy for rehabilitated sea otters in early July. One hundred and ninety seven rehabilitated otters were released into the wild and 37 (28 survived) were placed in seaquariums for health reasons or because they were young pups. Rehabilitated otters in Valdez were released in eastern Prince William Sound, and otters at the facilities in Seward and Homer were released along the Kenai Peninsula and in Prince William Sound. As part of a monitoring program administered by the USFWS, 45 otters received abdominal radio transmitters and were released in Prince William Sound. These otters will be tracked for 2-3 years.

The rehabilitation centers and the pre-release facility were closed in early September after the otters had been released. Work on a computerized database was transferred to the Exxon offices in Anchorage on September 15.

Chapter 3

The majority of the otters at the rehabilitation centers were females (55% in Valdez and 77% in Seward); 21% of the females were pregnant when they arrived. Average body weights for females were 18.8 kg and 22.8 kg in Valdez and Seward, respectively. For males, the average body weights were 19.5 kg and 28.8 kg for the two centers.

When otters arrived at the rehabilitation centers, they were evaluated based on their activity level, core body temperature and the degree of oiling. The latter was determined by examining the fur and by measuring total petroleum hydrocarbon concentrations in the blood. Almost 35% of the otters received at the centers were heavily or moderately oiled. The remainder were lightly oiled or unoiled. Preliminary results indicate that mortality was correlated with petroleum hydrocarbon concentrations in the blood. Typical medical disorders of oiled sea otters included hypothermia, hyperthermia, hypoglycemia (low blood sugar) and emphysema.

Oiled sea otters were medically stabilized and usually washed within 24 hours. Some very lightly oiled otters recovered without washing. Oiled otters were washed with a solution of Dawn™ dish washing detergent. Adequate rinsing and a thorough drying were essential. The cleaning process did not immediately restore the water repellency of the fur. Normal grooming and a gradual re-introduction into seawater usually resulted in full restoration of the fur in 7-10 days. In preliminary tests, squalane was applied to the fur to replace the natural oils (sebum) removed by the washing procedure. Further studies are required to determine whether this technique can accelerate restoration of the fur and shorten the rehabilitation process.

Chapter 4

Medical treatment began as soon as the oiled otters were sedated for washing. This included application of ophthalmic ointment to the eyes, oral administration of activated charcoal and a high caloric lipodextrose paste to heavily and moderately oiled otters, and fluid therapy if dehydration was suspected.

The treatment of pulmonary disorders such as emphysema and sinusitis was limited to supportive care and antibiotic therapy. Otters with gastro-intestinal disorders such as diarrhea and melena (blood in the stool) improved following an increase in dietary roughage. In severe cases of gastrointestinal bleeding, drug therapy was helpful. Anemia in heavily and moderately oiled animals often developed during the first week of captivity and required 1-3 months for recovery. Anemic otters were given supplemental vitamin B complex.

Some otters developed abrasions and pressure sores from resting on hard surfaces in the pens. A return to seawater (as soon as the fur was water repellent) was the most effective treatment. Seizures of unknown etiology were common during the first two weeks of the spill. In severe cases, the otters were given intravenous valium and Lactated Ringer's solution. Dextrose was added to the Ringer's solution (50 grams/liter) if hypoglycemia was diagnosed.

Because most of the rehabilitated otters were to be released, the introduction of domestic pet diseases (e.g. canine distemper and parvovirus) into the sea otter population was a concern. To prevent infection, domestic pets were not allowed in the rehabilitation centers. Despite preventative measures, the rehabilitation centers in Valdez and Seward were placed under quarantine for 1-2 weeks when disease was suspected. In both instances, tests verified the absence of domestic pet diseases. However, a herpes-like virus that is naturally present in the otter population was documented in some otters at the rehabilitation centers.

Chapter 5

Otters at the rehabilitation centers were fed a mixed diet composed primarily of shrimp, scallops, pollack fillets, squid, dungeness crabs, geoduck clams and mussels. Most of the food was obtained in bulk from commercial seafood processors.

Personnel cared for otters in the rehabilitation centers 24 hours a day. Each shift included a supervisor, otter monitors, food preparation staff, a pen cleaning crew, otter handlers, an on-site veterinarian and a veterinary technician. On admission into the rehabilitation centers, otters were assigned a number, and toe tags were attached to the hind flippers for

identification.

Safety, sanitation, good record keeping, and techniques to create a low stress environment for the otters and staff were emphasized when possible. Rehabilitated otters were placed in seawater pools or floating pens as soon as their health permitted. Grooming in seawater was essential for the restoration of the otter's fur. To reduce the stress of captivity, unnecessary handling was avoided, and otters were kept in groups of two or more animals. Young sea otter pups required constant attention to ensure their survival.

Chapter 6

Over 60% of the sea otters that were captured during the first three weeks of the spill died. After April 14, the mortality declined as the degree of oiling decreased and the oil weathered. Overall, mortality was 54% at the Valdez rehabilitation center and 20% at both the Seward and Homer facilities, respectively. The lower mortality in Seward resulted from the small number of heavily oiled animals that were received and the low toxicity of the weathered oil that impacted the Kenai Peninsula The pre-release facility in Homer received mostly rehabilitated otters from Seward and experienced a very low mortality.

Abnormalities were found in many of the organ systems examined during necropsy. Lung lesions were observed in almost 66% of the carcasses examined. Emphysema was frequently diagnosed in these otters. All but two of the emphysema cases were noted during the first six weeks of the spill, and only mild emphysema was observed in sea otters necropsied after this period. Over 55% of the necropsies revealed liver abnormalities, and 20% showed kidney and spleen abnormalities. Whether these lesions were caused by exposure to crude oil must await further histopathological and toxicological analysis.

Chapter 7

A detailed contingency plan, trained personnel, and well designed facilities are required for an effective sea otter rehabilitation program. To enable a rapid response, we recommend that rehabilitation facilities be established before an oil spill. Such facilities can be permanent or housed in trailers which can be stored. In either case, approximately 20,000 ft^2 of indoor space and an equivalent amount of outdoor space are required for a facility that can care for 100 otters at a time. Rehabilitated otters should be placed in a pre-release facility (large floating pens) until returned to the wild. An ideal rehabilitation facility would combine elements of a permanent facility, mobile triage units in trailers, and a pre-release facility. To create a low stress environment for the otters,

these facilities should be placed in natural settings. Stringent quarantine procedures should be instituted at the rehabilitation centers to avoid exposing the sea otters to domestic animal diseases.

Capture operations require good organization and communications. Equipment should be stockpiled, boats and aircraft identified, and capture personnel trained before a spill. Because capture and transport are stressful to otters, only trained personnel should be used. Tangle nets and dip nets are effective for capturing oiled otters. Captured otters should be transported to triage centers or rehabilitation centers within six hours. A Bell 212 helicopter is the most versatile aircraft for transporting caged sea otters.

Veterinarians must be prepared to treat pulmonary emphysema, hypothermia, hyperthermia, hypoglycemia, dehydration, stress and petroleum hydrocarbon toxicosis. Periodic blood sampling and comprehensive record keeping are essential for monitoring the progress of each otter during rehabilitation.

Further research is needed to improve rehabilitation facilities, cleaning methods, and husbandry protocols. Analytical tests are needed for: 1) quantifying the amount of oil on sea otter fur while animals are on capture boats, 2) determining petroleum hydrocarbon levels in the blood, and 3) screening for domestic animal diseases. With advance preparation and research, we can humanely and effectively care for oiled marine mammals while minimizing risks to the wild populations.

Introduction

The grounding of the T/V Exxon Valdez on March 24, 1989, released 11 million gallons of Prudhoe crude oil into western Prince William Sound. The oil slick eventually spread along the coast of the Kenai Peninsula, the Kodiak archipelago and the Alaska Peninsula adjacent to the Shelikof Straits. Sea otters are found throughout this area. place figure of sea otter distr

The fur insulation, food preferences and behavior of sea otters make this small marine mammal especially vulnerable to the effects of crude oil. Unlike pinnipeds and cetaceans which have a subcutaneous layer of blubber, sea otters rely on fur for thermal insulation in water. When oiled, the fur becomes clumped and loses the air layer that is normally trapped against the skin. Without this air layer, the fur loses 70% of its insulation, and the otter is subject to a lethal decrease in core body temperature (hypothermia) and death. One of the principal goals in rehabilitating oiled sea otters is to clean the fur and restore its insulating properties.

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A sea otter rehabilitation facility with trained personnel did not exist in Alaska at the time of the oil spill. At the request of the U.S. Department of the Interior and the U.S. Fish and Wildlife Service, Exxon built rehabilitation and pre-release facilities in Valdez, Seward and Homer. Each facility eventually had a capacity of about 100 otters and remained in operation until September 1989. In total, 357 otters were treated, of which 197 were released in Prince William Sound and along the Kenai Peninsula. An additional 37 otters were sent to seaquariums for health reasons or because they were too young to be released; 28 were still alive as of September 15, 1989. In total, 63% of the otters that entered the rehabilitation facilities survived.

During the first three weeks of the spill, many of the otters brought to the rehabilitation center in Valdez exhibited signs of petroleum hydrocarbon toxicity. Medical disorders included pulmonary emphysema, liver dysfunction, and anemia. Because sea otters spend much of their time resting, swimming, grooming and feeding on the surface of the water, systemic exposure to toxic petroleum hydrocarbons can occur through skin absorption, inhalation of volatile components, and ingestion. Although the primary route of absorption has not been determined, the natural history of sea otters makes all three avenues likely. As the oil weathered, new cases of petroleum hydrocarbon toxicity became rare.

This report is a chronicle of Exxon's Sea Otter Rehabilitation Program and documents the methods that were used to rehabilitate oiled sea otters. In Chapter 1, Davis provides a

short history of the otter rehabilitation centers and describes their design and operation. In Chapter 2, Hill, Weltz, Monahan and Davis describe the logistics of capturing and transporting otters to the rehabilitation centers.

The cleaning protocol, critical care and toxicological evaluation of oiled sea otters are described by T.M. Williams, Wilson, Tuomi and Hunter in Chapter 3. In Chapter 4, Wilson, Tuomi, Schroeder and T.D. Williams describe the medical problems of oiled sea otters and methods of treatment. The husbandry methods that were used at the rehabilitation centers are described by Tuomi in Chapter 5.

A description of necropsy procedures and a summary of postmortem observations are provided by Osborn and T.M. Williams in Chapter 6. The authors also discuss the incidence of mortality and possible factors that led to the death of sea otters in the rehabilitation centers.

The first six chapters document how the rehabilitation program was conducted during the oil spill. The process of rehabilitating oiled sea otters can be improved with the new knowledge we obtained during this oil spill and with advance preparation and training. In Chapter 7, T.M. Williams and Davis summarize the lessons learned from this experience and make recommendations for future sea otter rehabilitation programs.

Chapter 1. Facilities and Organization

Randall W. Davis, Ph.D.

I. A Concise History of the Sea Otter Rehabilitation Centers

A. Valdez

When the T/V Exxon Valdez ran aground on March 24, 1989, Paul Gates (U.S. Department of the Interior's Regional Environmental Officer for Alaska and Regional Response Team representative) was notified of the oil spill by the U.S Coast Guard (see section IV for details of the National Contingency Plan). According to an established procedure, P. Gates then notified Everett Robinson-Wilson, the U.S. Fish and Wildlife Service (USFWS) Response Management Coordinator. Pamela Bergmann (Regional Environmental Assistant for the U.S. Department of the Interior) and E. Robinson-Wilson traveled to Valdez at the request of P. Gates on March 24 (P. Gates, personal communication). At the recommendation of P. Bergmann, William Stillings (Exxon Company USA) asked Randall Davis (Sea World Research Institute) to organize and direct a sea otter rehabilitation program. R. Davis had been identified in the Alaska Regional Response Team's Wildlife Protection Guidelines as having expertise in cleaning and rehabilitating oiled sea otters. He and colleagues Terrie Williams, Jeanette Thomas and Ronald Kastelein had developed techniques to clean and rehabilitate oiled sea otters during a study for the Minerals Management Service in 1984 (Sea Otter Oil Spill Mitigation Study, MMS-86-0009).

On March 27, R. Davis arrived in Valdez and began designing a sea otter cleaning and rehabilitation facility at the Copper Basin Hall located at the Prince William Sound Community College (see Appendix 1 for a chronology of events at the rehabilitation centers). That same day, a severe storm spread the oil slick in a southwesterly direction toward Smith Island, Green Island and Knight Island, areas known to be used by sea otters (Figure 1.1). On March 28, Terrie Williams (Sea World Research Institute) and veterinarian Judy McBain arrived in Valdez and began organizing a washing room and veterinary clinic (see section IIA below). Marine mammal specialists throughout North America were contacted by telephone and asked to assist in the rescue effort. At the same time, volunteers were recruited to help with construction of the rehabilitation facility. The staff eventually grew to over 150 specialists and volunteers (see section III below).

The Valdez rehabilitation center received its first oiled sea otter from Smith Island on March 30. Two days later, 18

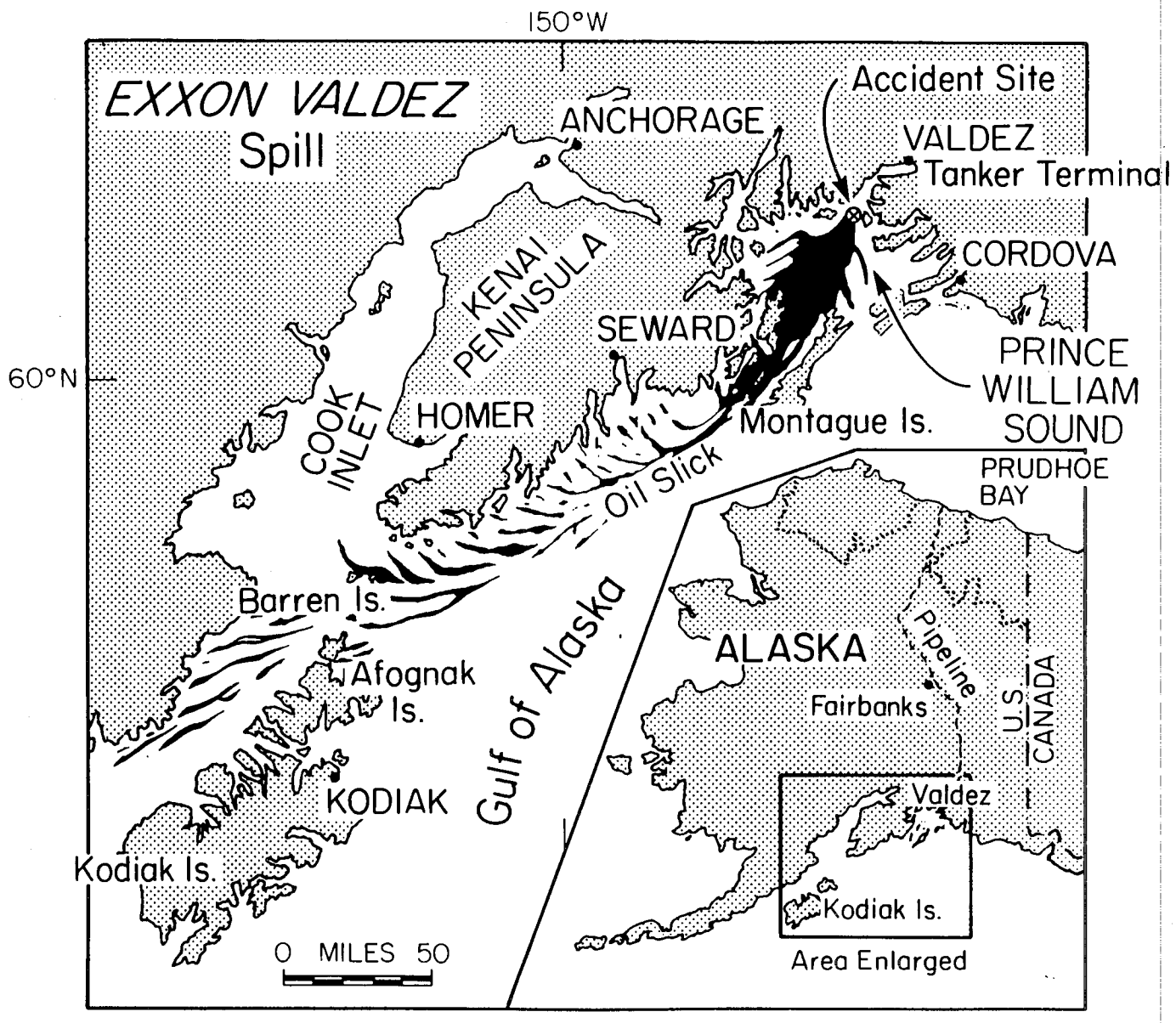


Figure 1.1 Geographical region affected by the oil spill.

otters arrived, the maximum number received in a single day. Oiled sea otters continued to arrive at an average rate of 10 per day until April 9, after which the new arrivals averaged only 1-2 per day until May 6. With indoor space for fewer than 20 animals, the number of otters arriving at the rehabilitation center rapidly exceeded its capacity. By April 5, we had received 73 otters of which 40 were still alive (Figure 1.2). Many of the otters that died exhibited toxic reactions to the oil (see Chapter 3). To relieve the overcrowded conditions and to help treat the most serious cases of oil exposure, six otters (one of which died in transit) were sent to Sea World in San Diego (April 2), six to the Point Defiance Aquarium in Tacoma (April 12) and six to the Vancouver Aquarium (April 17). At the same time, we began designing a larger rehabilitation facility.

The gymnasium at the Growden-Harrison Complex (formerly an elementary school and now part of the Prince William Sound Community College) was chosen for the new sea otter rehabilitation center (see section IIA for a description) on April 2. Construction contractors (Veco, Inc.) worked non-stop in order to complete the critical care facility in four days. However, we continued to clean oiled otters at the Copper Basin Hall until the new cleaning facility was completed in late April. We also established a pathology laboratory in a small salmon cannery (the Salmon Exchange) in Valdez in order to perform necropsies on otters that died in the facility.

On April 13, we began placing rehabilitated otters into floating pens located at the Valdez boat harbor. Of 122 otters that had been treated, 51 were still alive. On April 22, the rehabilitated sea otters were transferred to a salmon hatchery (the Solomon Gulch Hatchery), which was located across the bay from Valdez. This move was necessary because the three slips we were using for the holding pens were needed for fishing boats. At the Solomon Gulch Hatchery, the otters were held in two salmon raceways for the first month. Beginning on May 22, 65 otters were transferred from the raceways to the hatchery's large, floating salmon pen (the "octagon") located 300 m offshore. This floating pen was large enough to accommodate 180 otters and was available through the summer. The rehabilitated otters remained in this facility until they were released (see Section IE).

With most of the rehabilitated otters in floating pens awaiting release, we no longer needed the otter pens at the Growden-Harrison Complex. On June 1, we consolidated our operations and moved the rehabilitation center to vacant property adjacent to the pathology laboratory at the salmon cannery. The new facility, which included the Salmon Exchange building and three trailers from the Growden-Harrison Complex, was used for administration, otter food preparation, veterinary care and pathology (see section IIA).

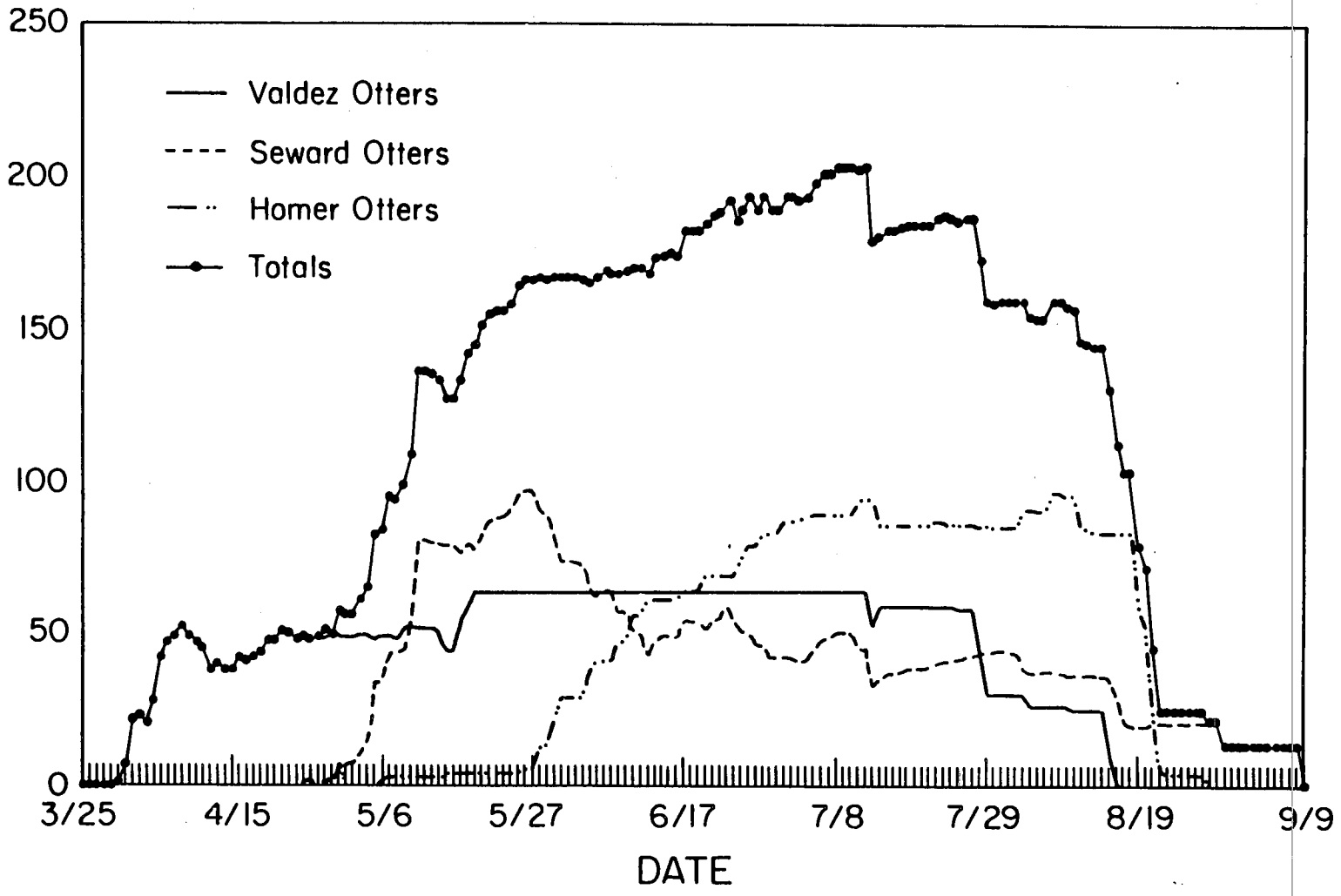


Figure 1.2 Comparison of the number of live sea otters in the rehabilitation centers.

The facilities at the Salmon Exchange were closed on August 18 after the otters were released. Overall, the Valdez rehabilitation center received 156 otters from the wild of which 63 survived, 85 died in Valdez, and eight died after being transferred to seaquariums. The maximum number of otters in the facility at one time was 65 (Figure 1.2).

Beginning in early June, sea otter biographical information, medical records, necropsy results and feeding records were entered into a computerized database at the Prince William Sound Community College. The computer group was moved to Exxon offices at the Royal Center in Valdez on August 29. When Exxon summer operations in Prince William Sound finished on September 15, the sea otter files and computer database were moved to Exxon offices in Anchorage for storage and completion of the remaining work.

B. Seward

By April 1, the southern edge of the oil spill had moved out of Prince William Sound and along the coast of the Kenai Peninsula (Figure 1.1). As a result, the USFWS asked Exxon to build a second rehabilitation center in Seward. At the recommendation of R. Davis, James Styers was selected as director of the new center by Alan Maki (Exxon Environmental Program Manager) on April 7. J. Styers immediately began organizing a staff, selecting a site and designing the facility (see section IIB for a description). However, difficulties in securing a lease agreement and uncertainty over the need for a second rehabilitation center delayed construction until April 21. Consequently, the first four oiled sea otters captured along the Kenai Peninsula between April 15-18 were sent to the Valdez rehabilitation center.

Seventeen oiled sea otters were captured from May 1-4 and temporarily held in cages at the Seward Bird Rehabilitation Center until the otter facility was opened on May 8. Two additional weeks were required to complete construction of the pools and floating pens in a seawater pond. From May 5-21, 91 otters were sent to the Seward center and seven pups were born. Until the facility reached its full capacity (about 80 otters) in late May, some otters continued to be held in cages at the Seward bird facility. To relieve the overcrowded conditions, 21 otters were transferred to the Valdez rehabilitation center from May 17-20, and the temporary holding facility at the bird center was closed. Otters continued to arrive at the Seward sea otter rehabilitation center at an average rate of one per day until July 31.

In early May, the USFWS recommended that Exxon build a pre-release facility at Little Jakolof Cove (see Section IC) to hold rehabilitated otters from the Seward center. The first otters were transferred from Seward to Little Jakolof Cove on May 28; 99

otters were eventually transferred to this facility from May 28-August 7. Overall, the Seward center received 187 otters of which 151 survived and 36 died; 21 of the 151 otters completed their rehabilitation at the Valdez center. A maximum of 97 otters were held at the Seward center at one time (Figure 1.2). This facility was closed on September 12 after the rehabilitated otters were released, transferred to the pre-release facility at Little Jakolof Cove or sent to the Point Defiance Aquarium.

C. Homer

A temporary holding facility for sea otters was started in Homer as a private effort by local resident Nancy Hillstrand. N. Hillstrand had worked as a volunteer at the Valdez rehabilitation center, then returned on April 9 to organize a holding facility at the Homer Junior High School; it had a capacity of about ten otters. Initially, otters that arrived in Homer from the Kenai Peninsula were stabilized before being flown to the rehabilitation centers in Valdez or Seward. The first oiled sea otter arrived at the junior high school facility on April 25. At the same time, N. Hillstrand began preparations for a large pre-release facility at Little Jakolof Cove and the Kasitsna Bay Research Center, which were located along the southern shore of Kachemak Bay (across from Homer).

On May 10, the Kenai Peninsula Borough began supporting the pre-release facility (see section IIC for a description) with oil spill clean-up funds that had been donated by Exxon. The primary purpose of this facility was to hold rehabilitated otters from the Seward center until the USFWS completed a release plan for the Kenai Peninsula. On May 15, the first six floating pens were placed in Little Jakolof Cove. At the same time, Exxon accepted direct financial responsibility for the project. The temporary holding facility at the Homer Junior High School was closed on May 23, and the three adult otters and one captive-born pup were transferred to the new pre-release facility. The first rehabilitated otters from Seward began arriving at Little Jakolof Cove on May 28. Of the 125 otters held at this facility, 99 came from the Seward Center and 14 came directly from the wild or were born to otters already in captivity. The maximum number of otters held at one time was 94 (Figure 1.2). This facility was closed on September 6 after the rehabilitated otters were released.

D. Kodiak

In addition to Homer, a temporary care facility was built at the National Marine Fisheries Service law enforcement center in Kodiak in late April. Otters from the Kodiak archipelago and the Alaska Peninsula were held for 1-2 days at this facility until they were flown to the Valdez or Seward rehabilitation centers. Jay Bellinger of the USFWS directed the operation and Vicky

Vanek, a local veterinarian, provided medical care.

E. Sea Otter Release

As the federal trustee for sea otters (Marine Mammal Protection Act of 1972), the USFWS was responsible for the disposition of rehabilitated otters. Because we were using temporary facilities which were not designed for wildlife rehabilitation, holding large numbers of sea otters was logistically difficult and posed additional health problems. As a result, the senior staff at the rehabilitation centers requested on several occasions that the otters be released as soon as possible.

On May 15, the first six rehabilitated sea otters from the Valdez center and a territorial male that entered the holding pen were released by the USFWS in Simpson Bay, Prince William Sound (Table 1.1). Biologists from the USFWS attached small radio transmitters to the hind flippers of these otters so that they could be tracked for several weeks. Information on their movements was used in preparing the release strategy for the remaining otters.

After prolonged deliberation and consultation with experts on sea otter management and biology, the USFWS completed the release strategy for the remaining otters in early July. In general, it called for otters captured in Prince William Sound to be released in the eastern (unoiled) part of the Sound, and otters captured along the Kenai Peninsula and around Kodiak Island to be released in unoiled areas of the Kenai Peninsula. The release strategy contained additional USFWS stipulations that up to 60 otters would have radio transmitters implanted in their abdomens and be released in Prince William Sound so that they could be tracked for 2-3 years (results from radio tracking will not be presented in this report). A pre-release blood sample was to be taken from each otter as part of a final health assessment.

Surgical implantation of radio transmitters in sea otters at the Valdez center was scheduled to begin on July 13. In the early morning hours before the USFWS surgical team arrived, unknown individuals cut the nets in the floating pens at the Solomon Gulch Hatchery. Thirteen of the 65 otters escaped, but five of these were recaptured. The individuals responsible and their motives for releasing the otters were never determined, but opposition to the planned surgeries was known to exist among some of the staff. Despite this incident, 23 otters at the Valdez center had transmitters implanted from July 13-17. Thirteen female otters (nine with transmitters) were released on July 27 in Sheep Bay, and 15 male otters (12 with transmitters) were released on July 28 in Nelson Bay, both of which are located in eastern Prince William Sound. On August 15 and 16, the remaining 25 otters were released in Nelson Bay and Sheep Bay; 22 of

Table 1.1 Disposition of sea otters from the rehabilitation centers at Valdez and Seward and the pre-release facility at Little Jakolof Cove.

DATE	NUMBER OF OTTERS	LOCATION RELEASED
4/02/89	1	SEAWORLD[1,4]
4/12/89	4	PT DEFIANCE AQ[1,5]
4/13/89	2	MONTEREY BAY AQ[1]
4/17/89	4	VANCOUVER AQ[1,6]
4/24/89	1	VALDEZ BAY[1]
5/15/89	7	SIMPSON BAY[1]
5/19/89	1	VALDEZ BAY[1]
6/12/89	1	KACHEMAK BAY[3]
6/17/89	2	LITTLE JAKOLOF[3]
7/13/89	8	VALDEZ BAY[1,7]
7/14/89	4	LITTLE JAKOLOF[3]
7/15/89	4	LITTLE JAKOLOF[3]
7/27/89	13	SHEEP BAY[1]
7/28/89	1	HERRING ISLAND, KACHEMAK BAY[3]
7/28/89	15	NF, NELSON BAY[1]
8/04/89	4	SEAWORLD[1]
8/05/89	1	LITTLE JAKOLOF[3]
8/11/89	10	LITTLE JAKOLOF[3]
8/13/89	2	LITTLE JAKOLOF[3]
8/15/89	6	NELSON BAY[1]
8/15/89	8	SHEEP BAY[1]
8/16/89	3	NELSON BAY[1]
8/16/89	8	SHEEP BAY[1]
8/16/89	7	SHEEP BAY[2]
8/17/89	7	TAYLOR BAY[2]
8/17/89	1	PICNIC HARBOR[2]
8/19/89	7	NORTH ARM NUKA BAY[3]
8/19/89	16	JAMES LAGOON, MCCARTY FIORD[3]
8/20/89	8	JAMES LAGOON, MCCARTY FIORD[3]
8/21/89	25	HARRIS BAY[3]
8/21/89	2	HERRING ISLAND, KACHEMAK BAY[3]
8/22/89	18	SOUTH SHORE, SHEEP BAY[3]
8/22/89	3	NELSON BAY[3]
8/22/89	4	HARRIS BAY[2]
8/30/89	4	LITTLE JAKOLOF[3]
9/11/89	13	PT DEFIANCE AQ[2]
TOTAL	225	

[1] Released from Valdez Center
[2] Released from Seward
[3] Released from Homer Center
[4] Does not include 4 otters that died in captivity
[5] Does not include 2 otters that died in captivity
[6] Does not include 2 otters that died in captivity
[7] One otter escaped on 7/13; recaptured on 7/14; escaped again 7/25

these received only flipper tags and two (a male and female) had abdominal radio transmitters.

Four rehabilitated otters at Valdez had chronic health problems including partial paralysis, blindness, and skin disorders. Because their survival in the wild was judged by the veterinary staff to be unlikely, these otters were sent to Sea World in San Diego on August 4.

In Seward, abdominal radio transmitters were surgically implanted in ten otters from July 15 to August 4; seven of these were released on August 16 in Sheep Bay in Prince William Sound and three were transferred to Little Jakolof Cove. Otters without radio transmitters were released in Taylor Bay (seven), Picnic Harbor (one) and Harris Bay (four) from August 17-22. On September 11, 13 orphaned sea otter pups, which were too young to be released (less than six months), were transferred to the Point Defiance Aquarium.

At the Homer facility, the USFWS gave permission to release one otter on June 12 and two pregnant otters on June 17 in Kachemak Bay. Similar releases were made on July 14 and 15 (four females with pups), July 28 and August 5 (one otter each day), August 11 (three females with pups and four females without pups), August 13 (two otters). On August 11, abdominal radio transmitters were surgically implanted in 12 otters; these 12 along with three otters that had received radio transmitters in Seward and five otters without radio transmitters were released in Sheep Bay and Nelson Bay in eastern Prince William Sound on August 22. From August 19-21, 57 otters without radio transmitters were released along the southern coast of the Kenai Peninsula in Nuka Bay, James Lagoon and Harris Bay. Of the remaining otters, two were released in Kachemak Bay (August 21) and four in Little Jakolof Cove (August 30).

F. Cost Analysis

From March 24 to September 15, 1989, Exxon spent approximately $18,300,000 to support the sea otter rehabilitation program (Figure 1.3). This amount was divided into the following categories:

Category	Amount	Percentage
1. Salaries for staff	$ 5,900,000	32%
2. Construction of rehabilitation centers	$ 4,200,000	23%
3. Boat and aircraft charters	$ 3,200,000	18%
4. Supplies and operations	$ 3,300,000	18%
5. Sea otter food	$ 950,000	5%
6. Aquariums and misc. costs	$ 750,000	4%
	$18,300,000	100%

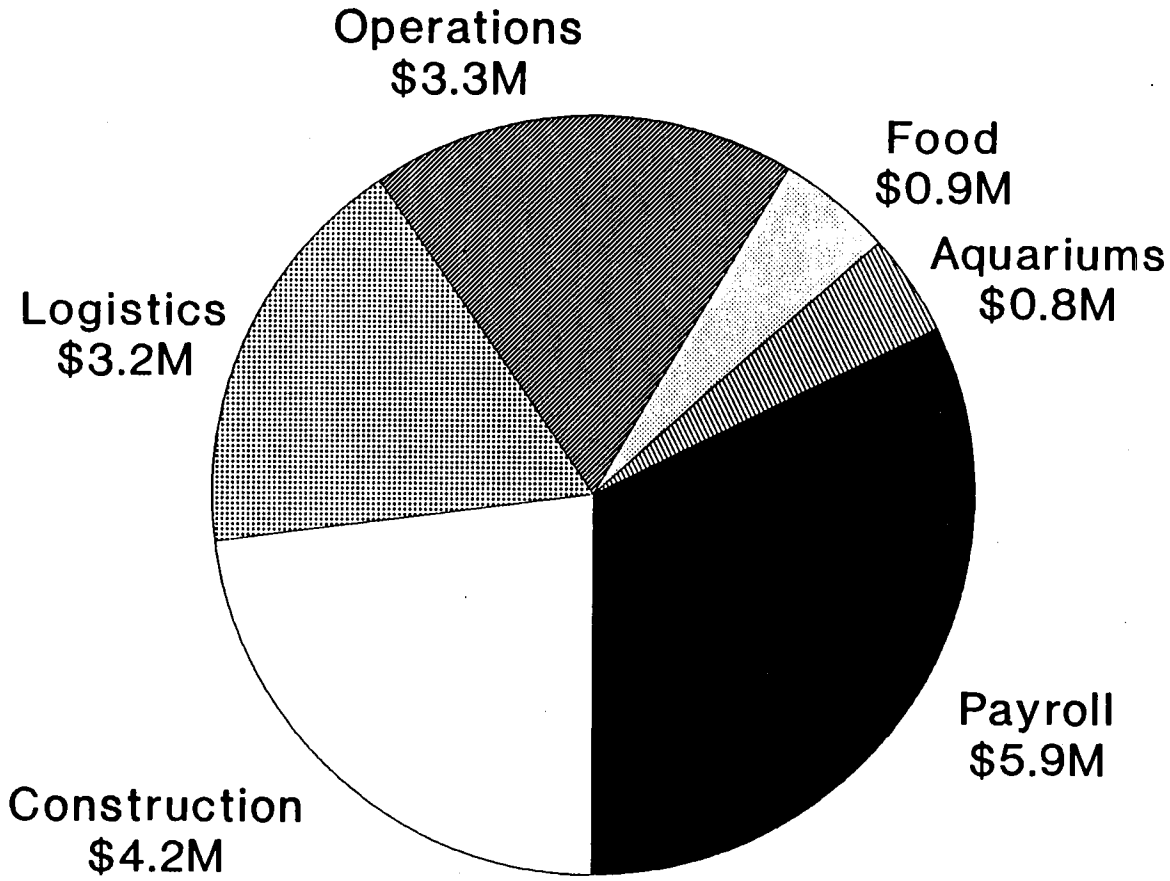


Figure 1.3 Cost analysis for the sea otter rehabilitation program.

Cost itemization:

1. Salaries included the staff at the three otter centers as well as contract personnel (Veco, Inc.) on the capture boats.

2. Construction costs included materials and contract labor costs to build the rehabilitation centers at Valdez and Seward, the pre-release facility at Little Jakolof Cove, and temporary care facilities at Homer and Kodiak Island.

3. Boat and aircraft expenses included 13 capture boats, a dedicated Bell 212 helicopter, and other aircraft for transporting sea otters.

4. Supplies and operations included costs for food, lodging, and transportation for the staff as well as various supplies, equipment, and lease expenses.

5. Sea otter food included a variety of frozen and fresh seafood.

6. Aquarium expenses included payments to Sea World, Monterey Bay Aquarium, Point Defiance Aquarium and the Vancouver Aquarium, all of which received otters for long term care.

II. Facilities

A. Valdez

The first sea otter rehabilitation center in Valdez was located in the Copper Basin Hall at the Prince William Sound Community College. Approximately 3,000 ft^2 were available for cleaning and holding sea otters; this space was divided into six rooms with connecting hallways and two lavatories. Several closets and one small room were used to store supplies. We shared two rooms with workers from the International Bird Rescue Research Center. One of the rooms served as a communications center, and the other room was used as a dining area by the staff.

Three cleaning stations (Figure 1.4) were installed in one room that had a kitchenette; this room also served as a small veterinary clinic. Each cleaning station consisted of a wooden stand and a 50 gallon plastic barrel that was cut length-wise to form a basin; wire screen (1 inch x 1 inch) was placed across the basin to support the otter while it was washed. The building's normal hot water supply was insufficient for cleaning three sea otters simultaneously, so an additional boiler was installed in a shed adjacent to the building. Eight holding pens were made from

plastic cargo totes (3 ft x 3 ft 2 ft deep) that could be filled with freshwater from a garden hose; although seawater would have been preferable, it was not available at the Copper Basin Hall. A small wooden bench (1 ft x 3 ft) in each tote provided a haul-out area. Waste water from the cleaning stations and totes drained through PVC pipes into a lavatory sewage line.

Food for the otters, including clams, fish fillets and crabs, was purchased from a wholesale seafood supplier (SeaHawk Sea Foods) in Valdez and stored in two chest freezers (50 ft^3 each). After thawing in a sink, the food was placed in plastic buckets with ice and distributed to husbandry personnel; each otter was then hand fed (see Chapter 5).

A separate room was used as a nursery for orphaned pups from the wild and pups that were born in captivity but whose mothers were unable to care for them. The pups rested on a water bed and were hand fed a formula developed at the Monterey Bay Aquarium (see Chapter 5 and Appendix 8).

To perform post-mortem examinations on sea otters that died in the facility, we rented a small salmon cannery (The Salmon Exchange) that was located near the Valdez boat harbor. The building (1500 ft^2) was divided into a salmon processing area, retail sales area, office, store room, walk-in freezer and lavatory. The salmon processing area, which had several large, stainless steel tables and sinks, was converted into a necropsy and pathology laboratory. Tissue samples for toxicology were stored in the freezer at -10°C (14°F).

The new rehabilitation center at the Growden-Harrison Complex was opened on April 6. It provided 6,200 ft^2 of indoor space for a critical care facility and an equivalent amount of outdoor space for pens and pools (Figure 1.5). Fifty-six holding pens were built in the gymnasium as part of the critical care facility; each pen could hold two otters. Three trailers (10 ft x 50 ft), which were placed next to the gymnasium, provided space for administration (400 ft^2), a veterinary clinic (250 ft^2), a clinical laboratory (100 ft^2), sea otter washing facilities (250 ft^2), staff dining area (250 ft^2), sea otter food preparation (150 ft^2) and a staff office (100 ft^2). A portable hot water system provided 60 gallons/minute for the washing facility and critical care unit (Figure 1.6).

Three cleaning stations and a veterinary clinic were built in the sea otter washing trailer (Figure 1.5). The clinic was used as an examination room and for storing drugs and medical supplies. An adjacent trailer housed the administrative offices for the rehabilitation center; this included secretarial staff, the personnel office, communications (telephones and FM base station), central files and photo copying. Also located in this trailer was a clinical laboratory for sea otter blood analysis.

The third trailer was used for sea otter food preparation, a staff lounge and a veterinary office. Frozen seafood was thawed in eight sinks under cold water and sorted on a large (2 ft x 10 ft) stainless steel counter. One pound portions were placed in plastic bags and stored on ice until delivered to the husbandry staff (see Chapter 5 for details). The staff lounge was used primarily for meals, which were catered three times per day. This eating area was separated from the animal pens to ensure good hygiene. Fifteen portable toilets and three outdoor sinks were provided for the staff.

The holding pens in the gymnasium were built in modules consisting of four plastic cargo totes that were separated with plywood partitions. A sliding door at the front of each tote could be removed to provide access to the otters (Figure 1.7). Each tote (3 ft x 3 ft x 2 ft deep) had a floor drain (2 in diameter) and a side-mounted overflow drain positioned 8 inches above the bottom of the tote; drains could be opened or closed independently. Each pair of pens shared a hot and cold freshwater supply that was regulated with a shower valve. A wire mesh rack in each tote prevented the otter from lying in dirty water and debris. When the otters had regained their ability to thermoregulate in water, the wire racks were removed and the totes were filled with freshwater to a depth of 8 inches (the height of the overflow drain). A small wooden bench (1 ft x 3 ft) mounted along one side of the tote provided haul-out space for the otter when the tote was filled with water.

Although these totes could be used as either dry pens or small pools, they had several problems. First, the plywood partitions did not allow adequate ventilation. This caused volatile ammonia from the urine to accumulate in the humid, stagnant air at the bottom of the tote. In addition, the floor drain was too small (it should have been 4-6 inches in diameter) and often become clogged with food which further contributed to the accumulation of ammonia. The humid air prevented the otter's newly cleaned fur, which had not yet regained its water repellent quality, from staying dry. This problem was partly remedied by increasing ventilation with fans.

Another problem with these pens was the shallow water depth, which prevented the otters from rolling and tumbling while grooming. As a result, the otters tended to groom the upper half of their bodies but neglected the lower half. Because normal grooming is essential for the full restoration of an otter's fur, this problem slowed the rehabilitation process. The confined space within the totes and the opaque, wooden walls (as opposed to netting) may have also altered normal grooming behavior and slowed the otter's recovery. Most otters became more alert and groomed more regularly after they were placed in outdoor pens with net walls. However, in early April the outdoor air temperature regularly fell below freezing, and many of the otters

with serious health problems were kept indoors until they could thermoregulate in the cold air.

The yard northeast of the gymnasium was used for the holding pens and seawater reservoirs (Figure 1.8). Two types of wooden pens were built; dry pens (Figure 1.9) and pens with a plastic tote swimming pool (Figures 1.10-1.12). Each of the 42 dry pens could hold one otter. However, because these pens did not allow the otters to groom in water, they were seldom used after an adequate number of pens with pools were built. Fourteen of the pens with pools could hold 1-2 otters (Figure 1.10 and 1.11), and four could hold 3-4 otters (Figure 1.12). Pools were plumbed for seawater from two plastic reservoirs (1000 gallons each; Figure 1.13) that were filled twice daily by a tanker truck. Overflow from the pools entered the sewage line. Animal waste from the dry pens was washed along a raceway and into a sump that was connected to a sewage line (Figure 1.14).

After the otters had recovered from the acute effects of oiling and had regained the water repellency of their fur, they were transferred to floating pens in the small boat harbor (Figures 1.15 and 1.16). The pens (20 ft x 20 ft x 8 ft deep) were constructed from PVC pipe (2 inch diameter) and herring net. An area (3 ft x 10 ft) on the dock adjacent to each pen was enclosed with plywood to provide haul out space; a small ramp led from the water onto the dock. An infra-red heat lamp was mounted at one end of the haul-out space so that otters could warm themselves. This design was suitable for holding otters several months. However, the otters were constantly exposed to noise and visual disturbance from harbor activities, and water quality was poor due to fuel contamination.

When the harbor slips were needed for fishing boats, we moved the otters to two salmon raceways at the Solomon Gulch Hatchery (Figure 1.17). The seawater raceways were approximately 10 feet wide, 60 feet long and 5 feet deep. Each one was partitioned with moveable net barriers (Figure 1.18) into 2-4 separate pens. A floating, plywood platform was placed in each section so that the otters could haul-out (Figure 1.19). A small wooden hut located next to each raceway provided shelter for the husbandry personnel.

In June, the sea otters were moved from the salmon raceways to an offshore salmon pen that provided more space for swimming and diving (Figure 1.20). This large, floating pen (about 200 feet in diameter) was octagonal in shape and consisted of 8 "pie shaped" sections. Each netted section was 15 feet deep and could hold 20-30 otters. Haul-out platforms were placed in each section. A small house in the center of the structure provided shelter for the staff. Two skiffs were used to transport personnel and supplies from the shore to the floating pen.

In addition to the otter rehabilitation center, we built a facility adjacent to the Copper Basin Hall in June for holding rehabilitated harbor seal pups (Figure 1.21). Pens with pools were salvaged from the otter center. One of the seawater reservoirs was converted into a large pool, where the seal pups were allowed to swim twice daily.

Facilities at the Valdez Sea Otter Rehabilitation Center

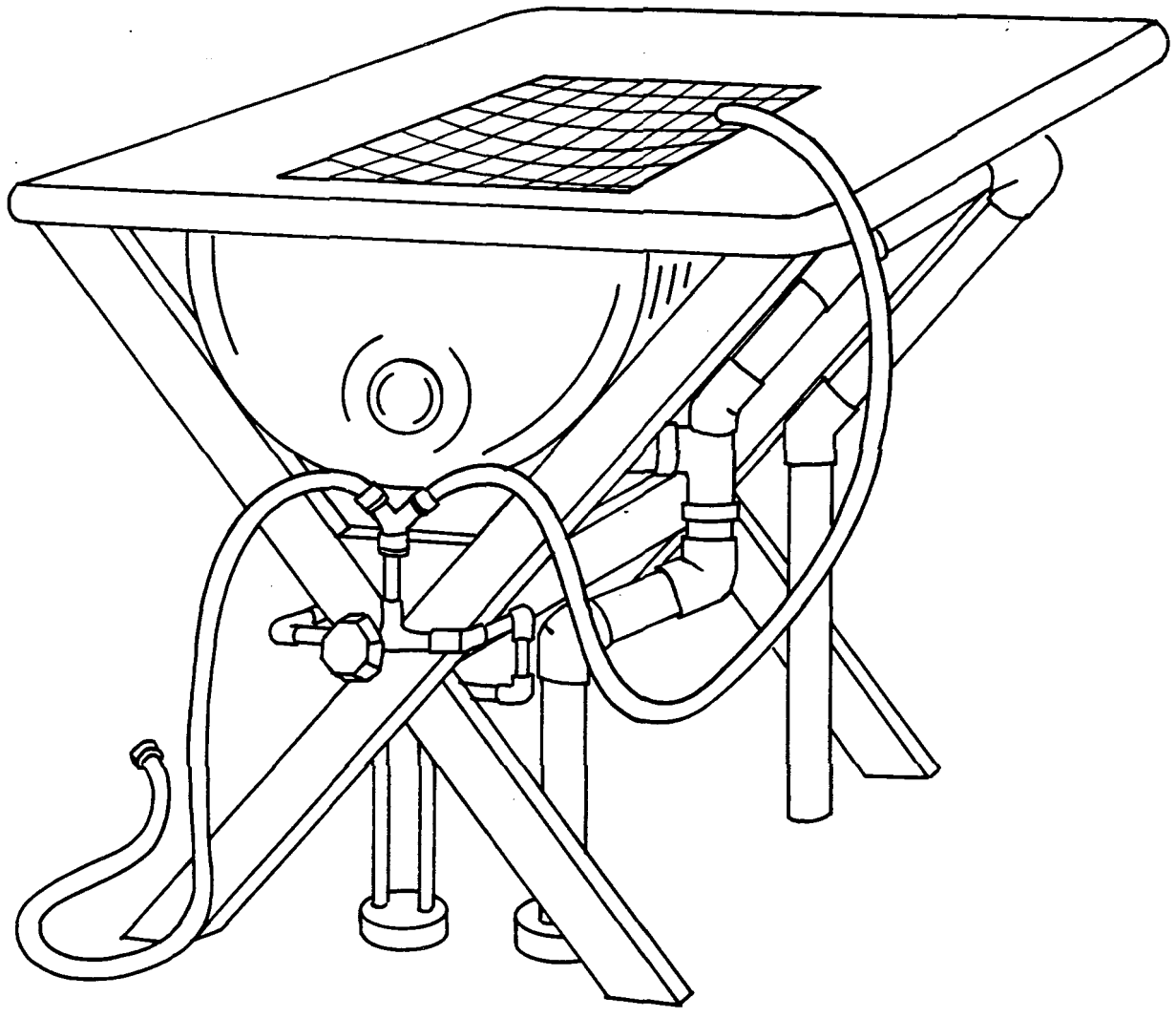


Figure 1.4 Table used to clean oiled sea otters. The sedated otter was laid on the wire or plastic screen during washing. Each table was plumbed with hot and cold fresh water. Water temperature was controlled with a mixing valve. The water fell into a plastic basin and drained into the sewer.

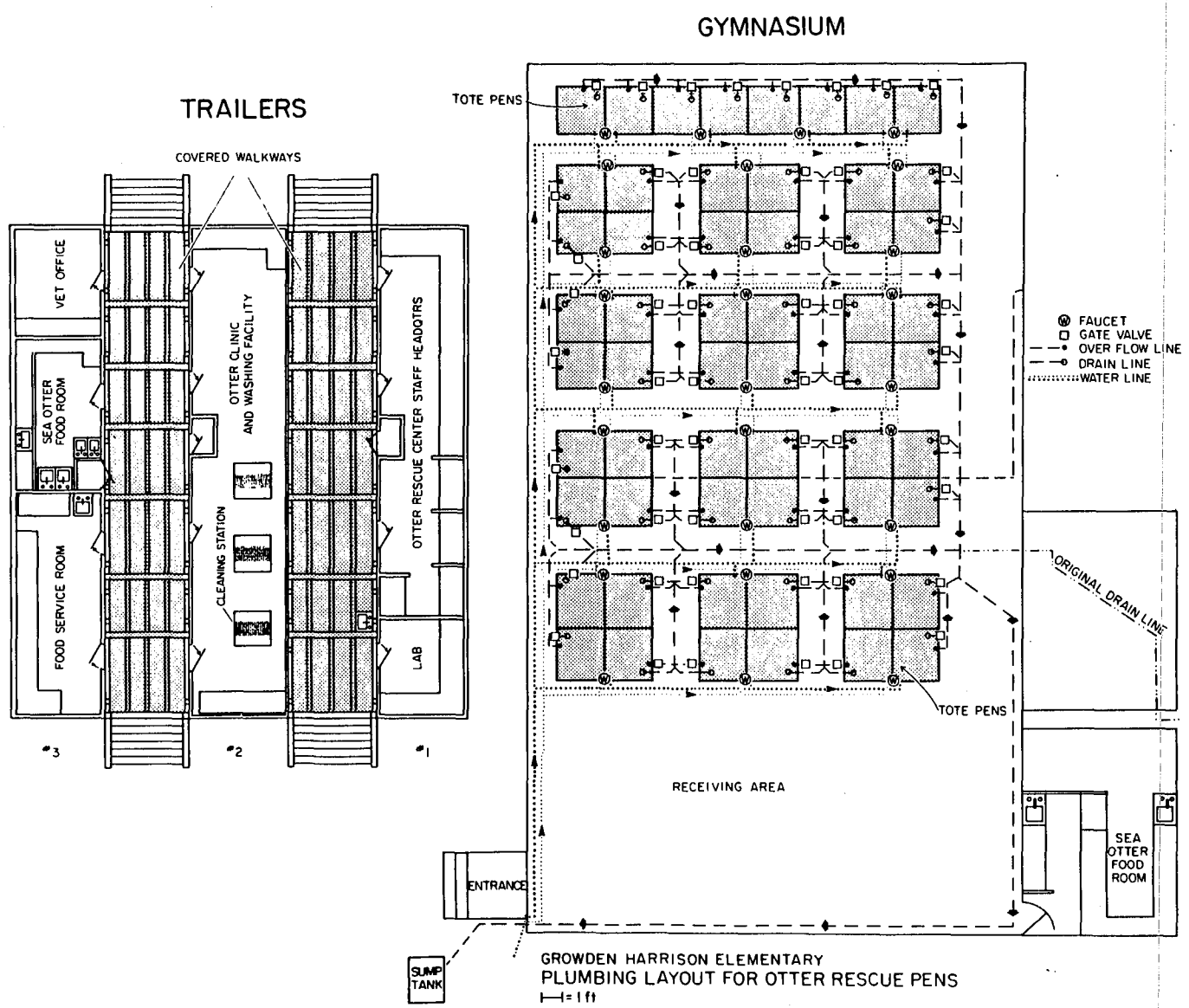


Figure 1.5 Floor plan for the Valdez sea otter rehabilitation center at the Growden-Harrison Complex. The critical care facility was located in the gymnasium. A veterinary clinic, otter washing area, food preparation area, staff lounge and administrative offices were located in three adjacent trailers.

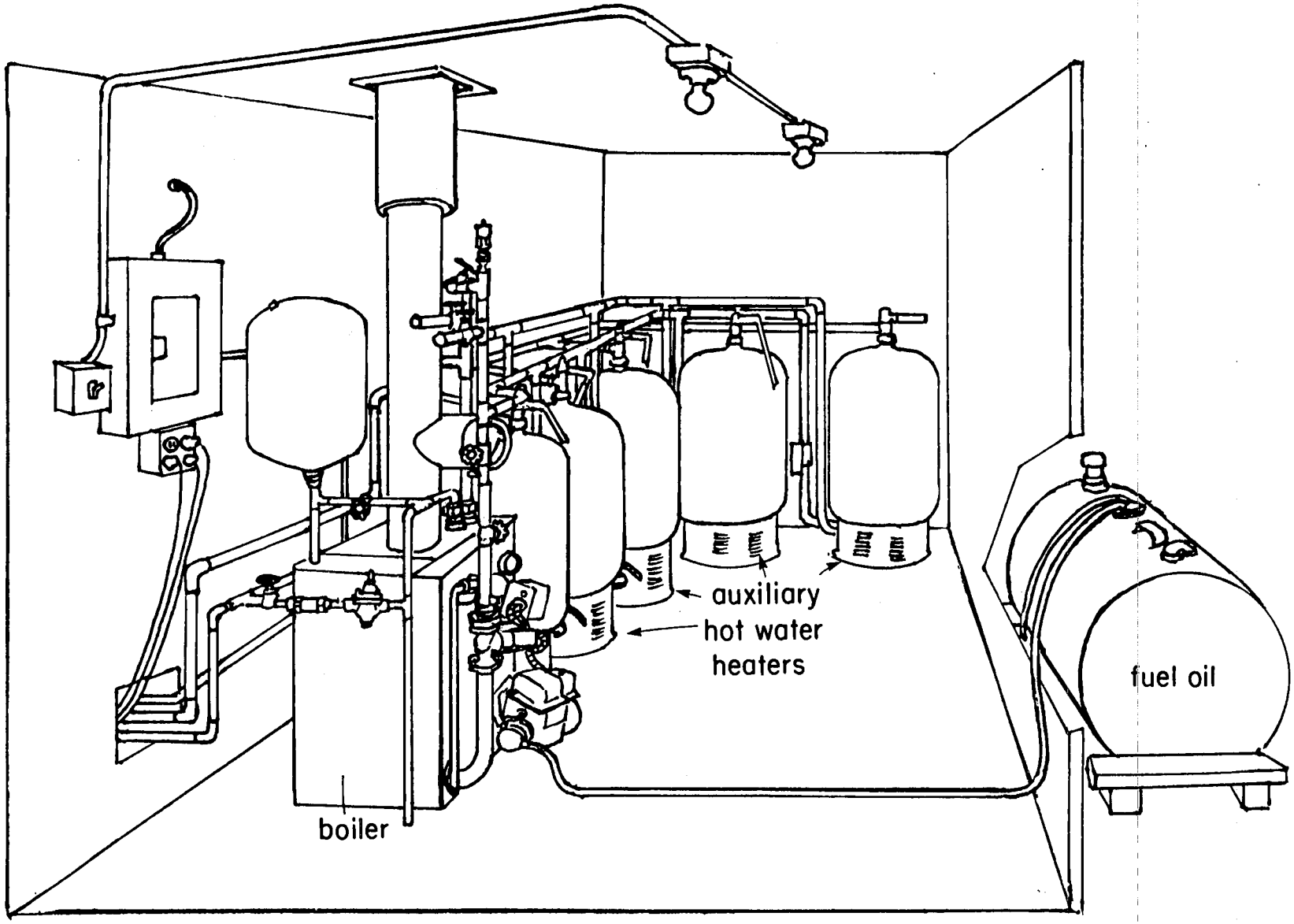


Figure 1.6 The hot water system at the Valdez Center. The system consisted of a boiler and five auxiliary hot water heaters. Capacity was about 60 gallons per minute.

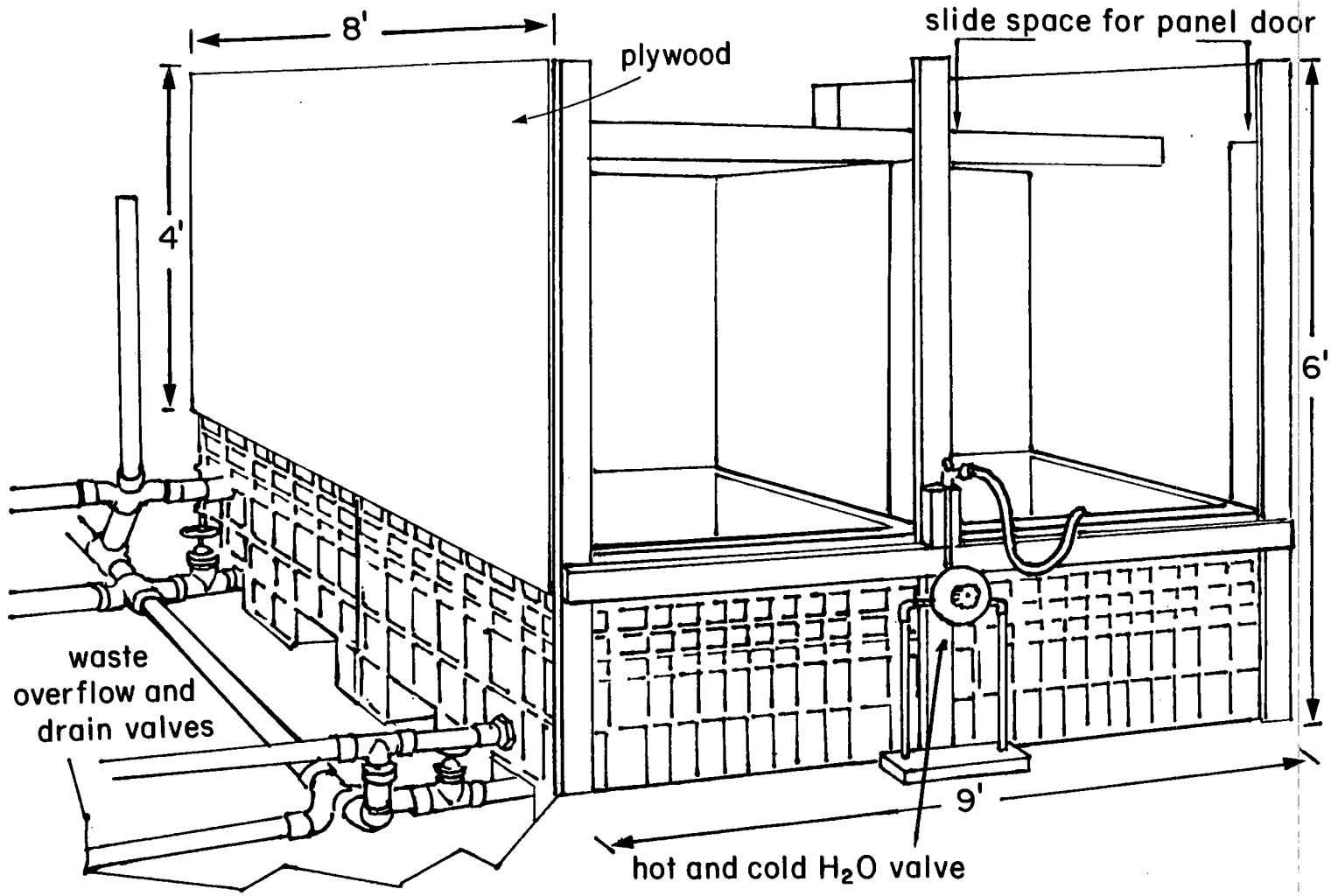


Figure 1.7 Holding pens for the critical care facility in Valdez. The pens were constructed from plastic totes and plywood.

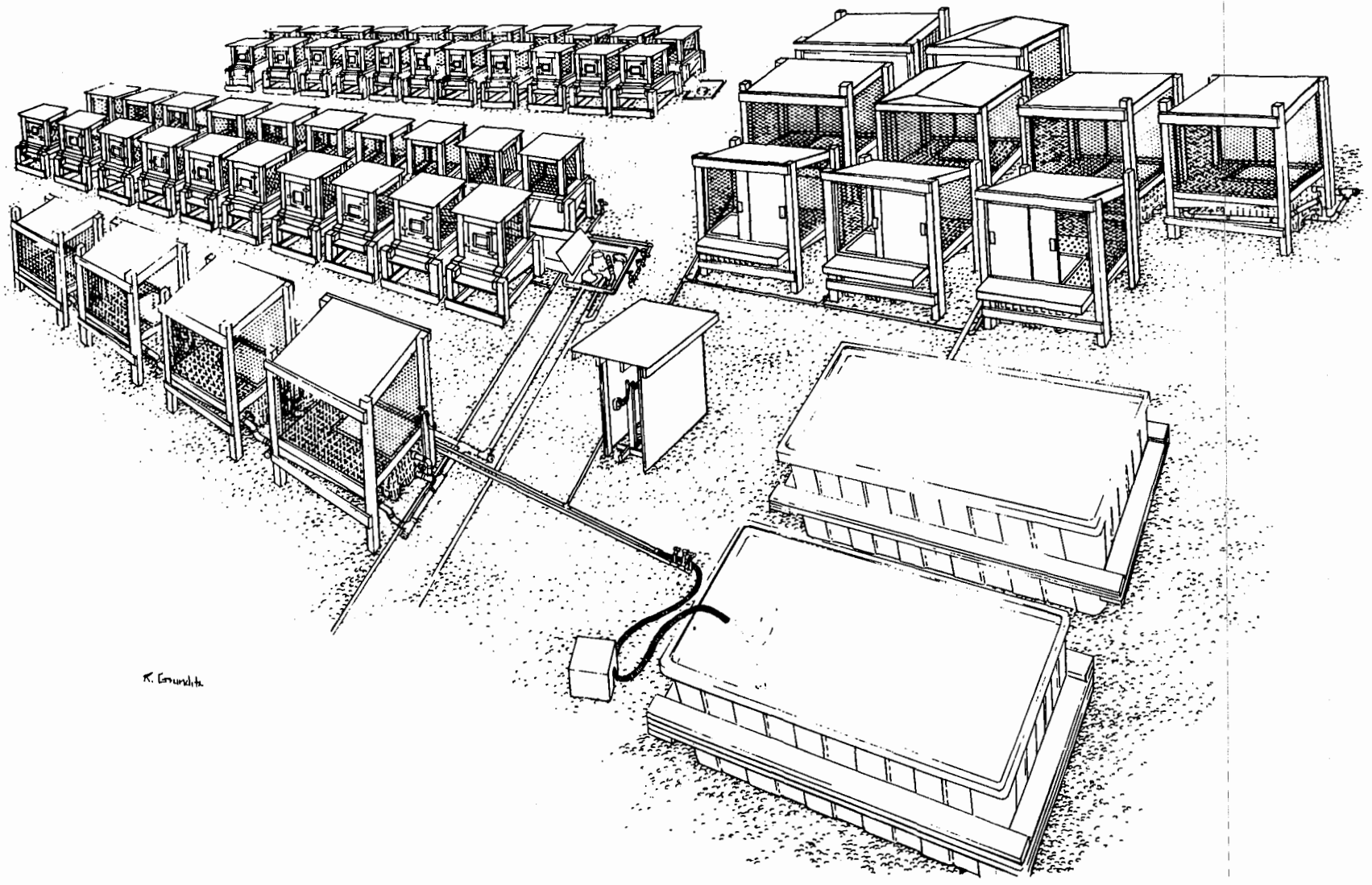


Figure 1.8 Outdoor sea otter pens at the Valdez Center. Forty of the pens were dry and 13 had plastic totes. Seawater, which was stored in the two fiberglass reservoirs, was pumped into the pen pools. Waste water was pumped into a sewage line.

Wooden Outdoor Pen

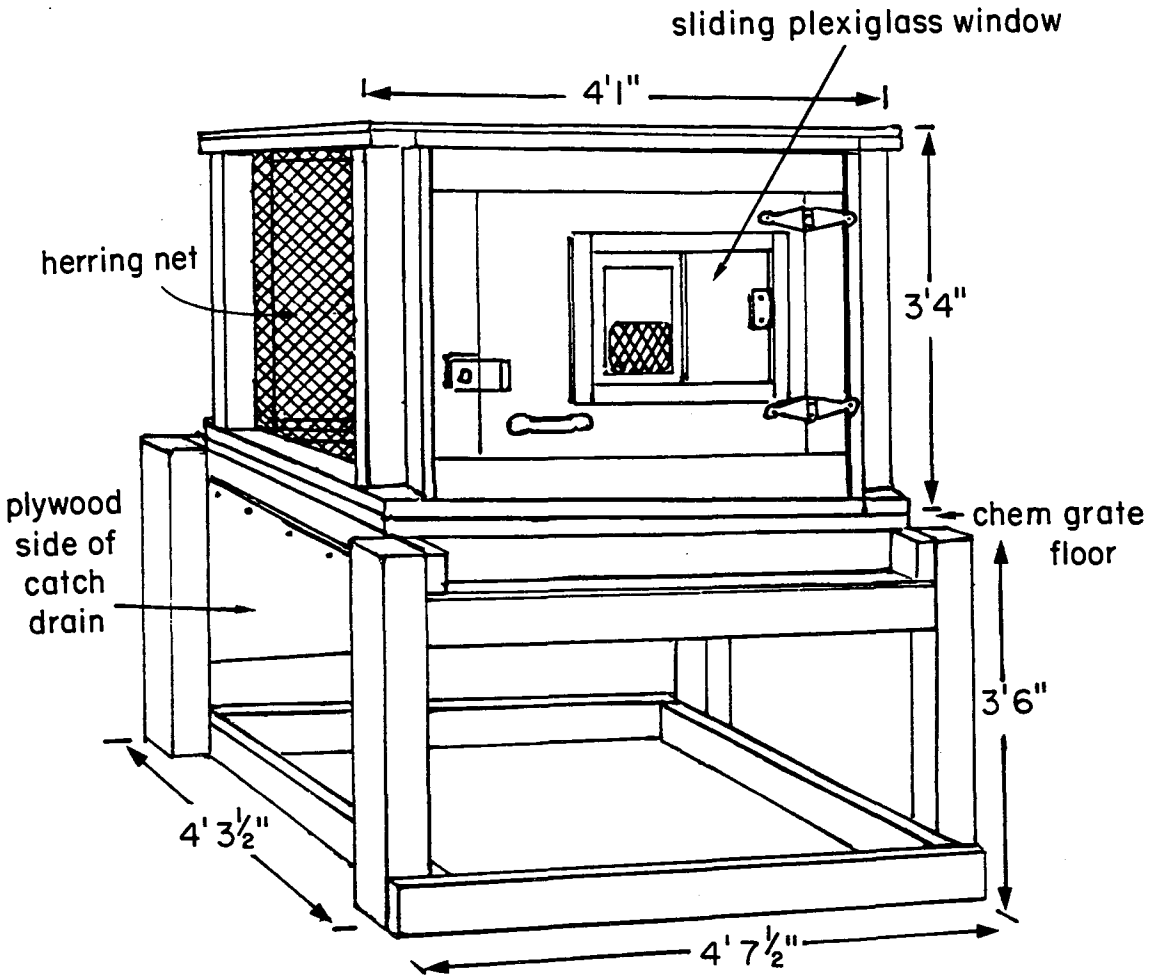


Figure 1.9 Wooden sea otter pen. The floor was made of plastic grate and the walls were made of plywood and herring net. A catch basin beneath the cage drained into a central raceway (see Figure 1.14).

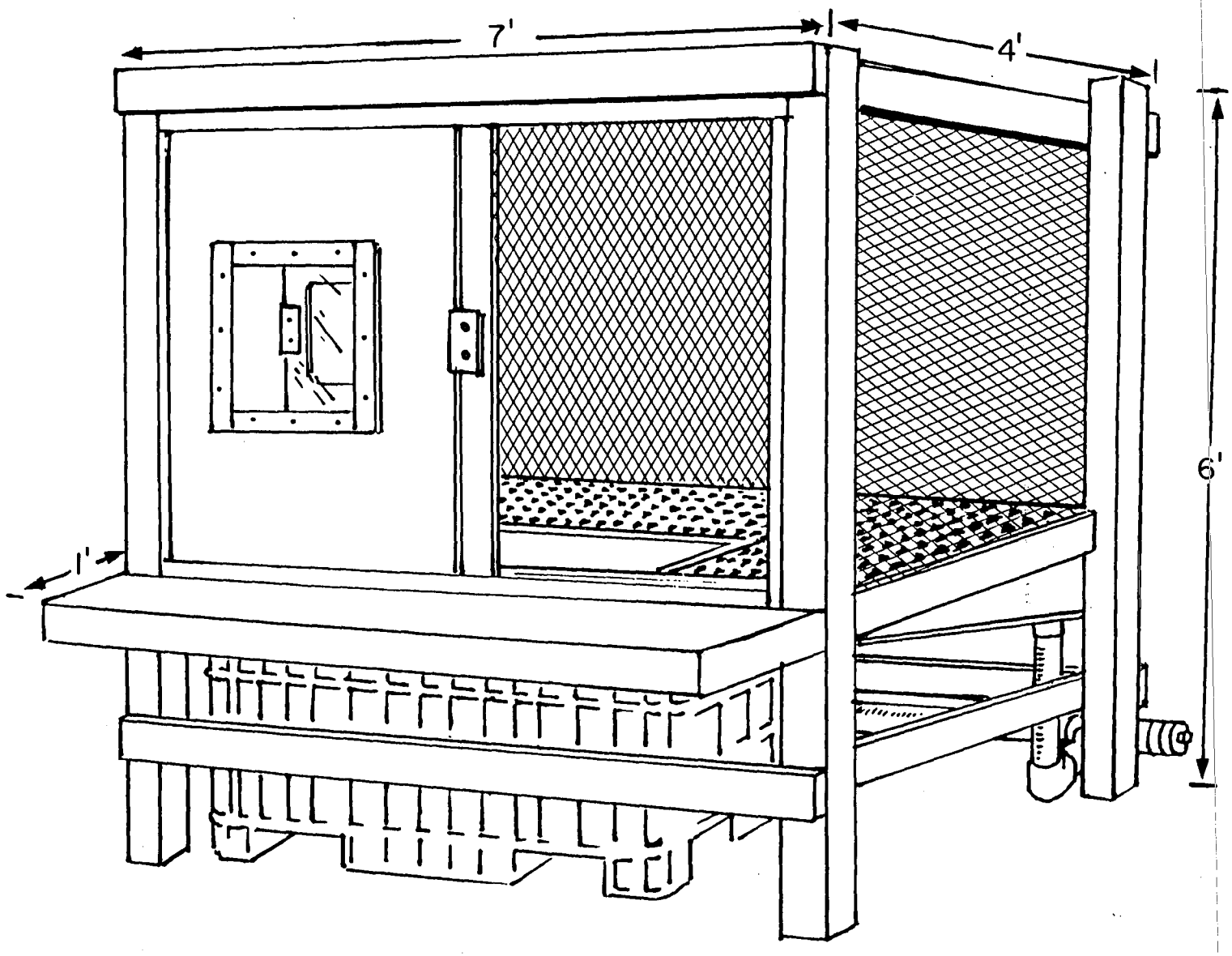


Figure 1.10 Front view of a wooden pen with a tote pool. This pen could hold one or two otters. The floor was made of plastic grate and the walls were made of plywood and herring net.

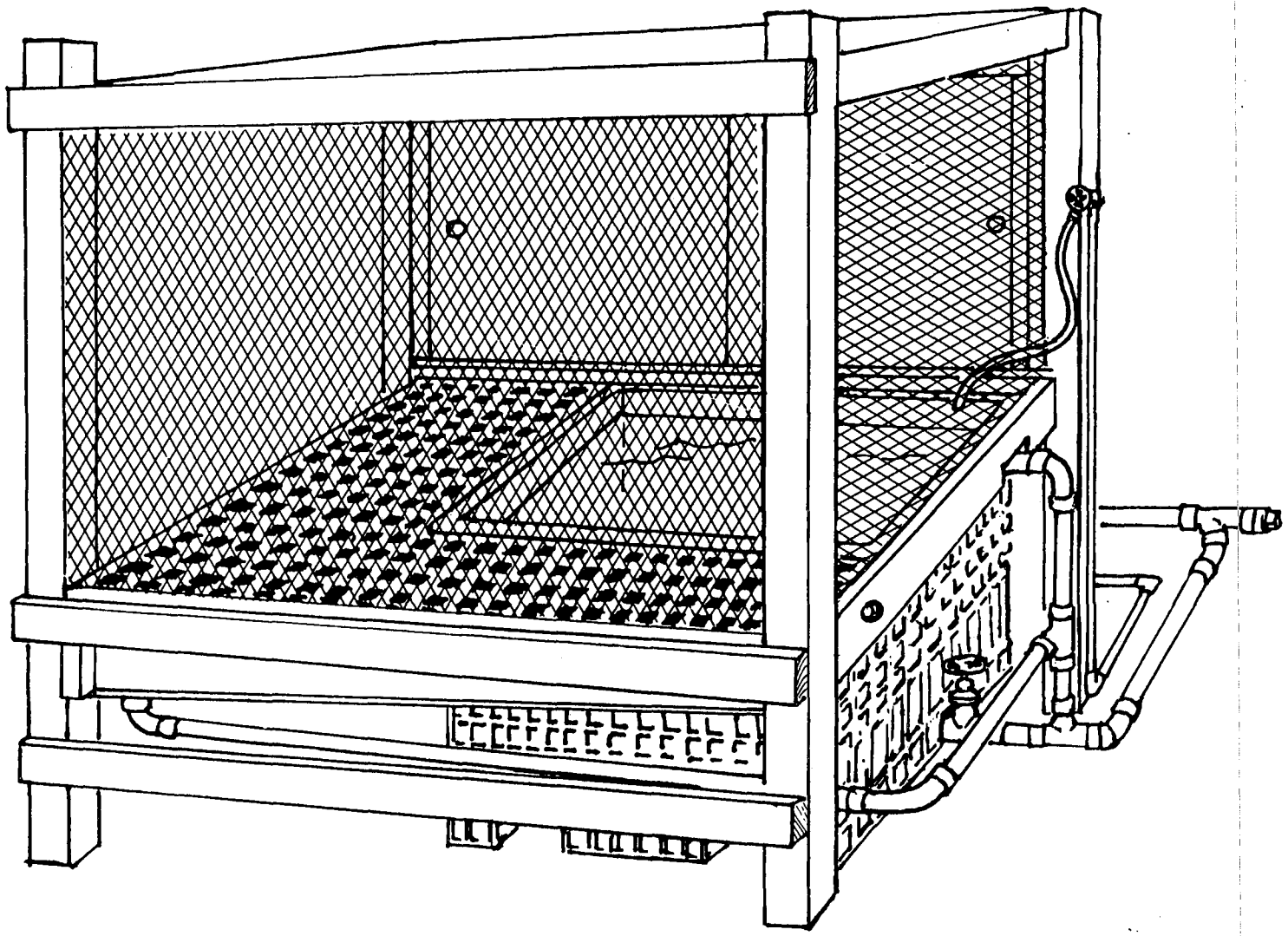


Figure 1.11 Rear view of a wooden pen with a tote pool. The pool was plumbed with sea water and had a floor drain and a skimmer drain.

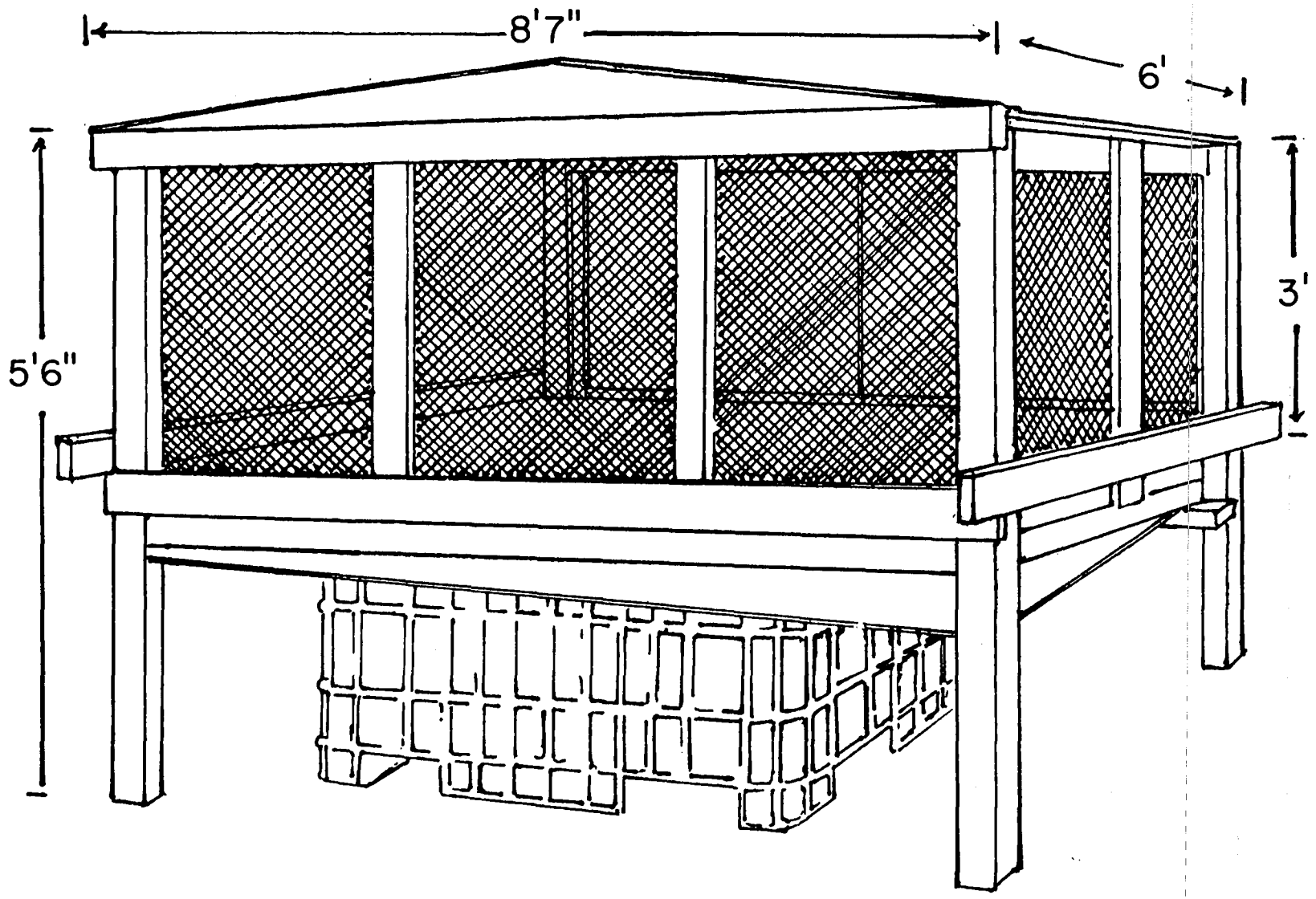
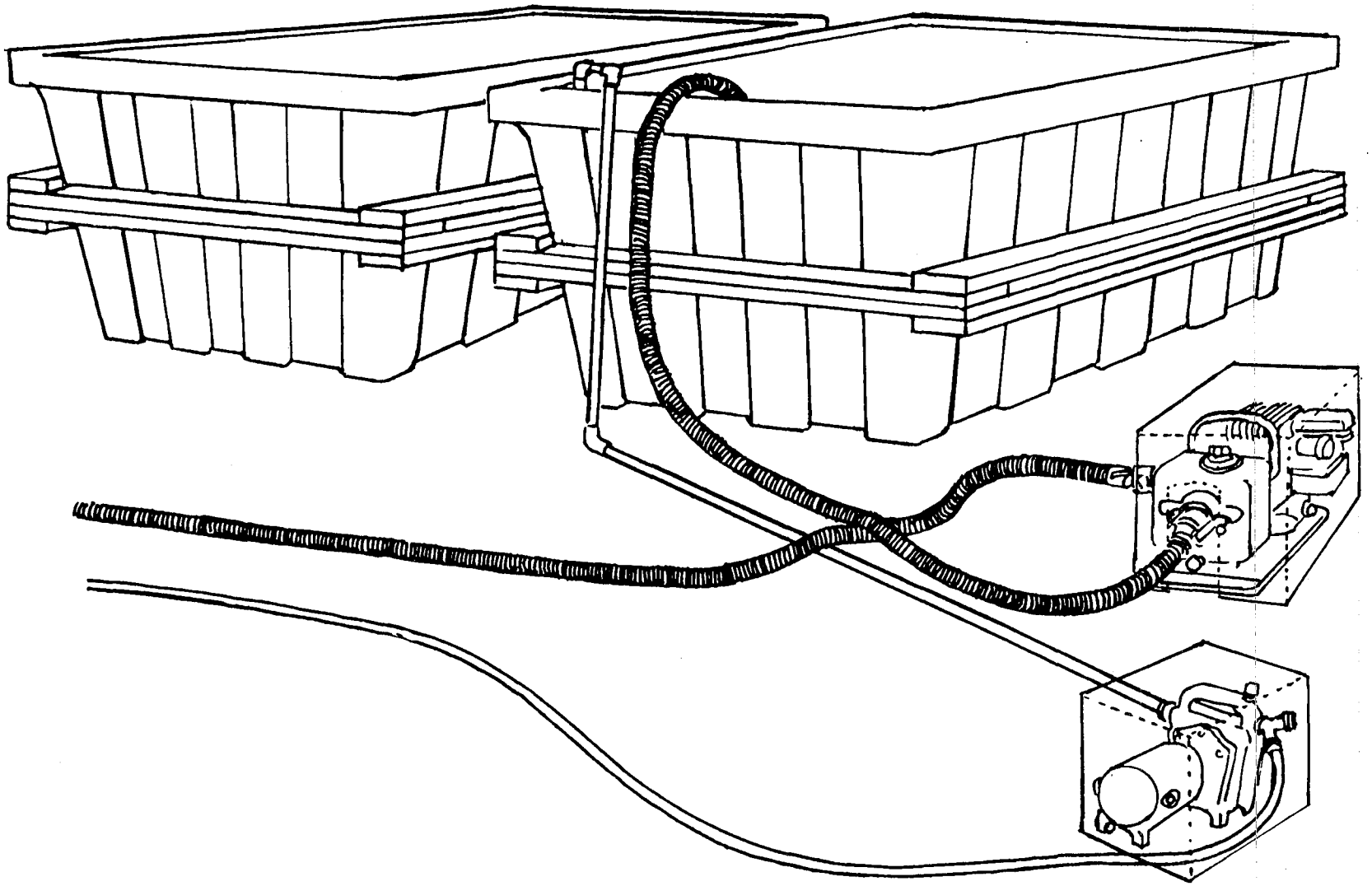


Figure 1.12 Rear view of a wooden pen with a tote pool that was designed for three-to-four otters. The basic design and materials are similar to the pens shown in the Figures 1.10 and 1.11.



Figures 1.13 Seawater was stored in two fiberglass reservoirs and pumped into the pens and pools at the Valdez Center. The seawater was replenished by a tanker truck that obtained the water from Port Valdez Bay.

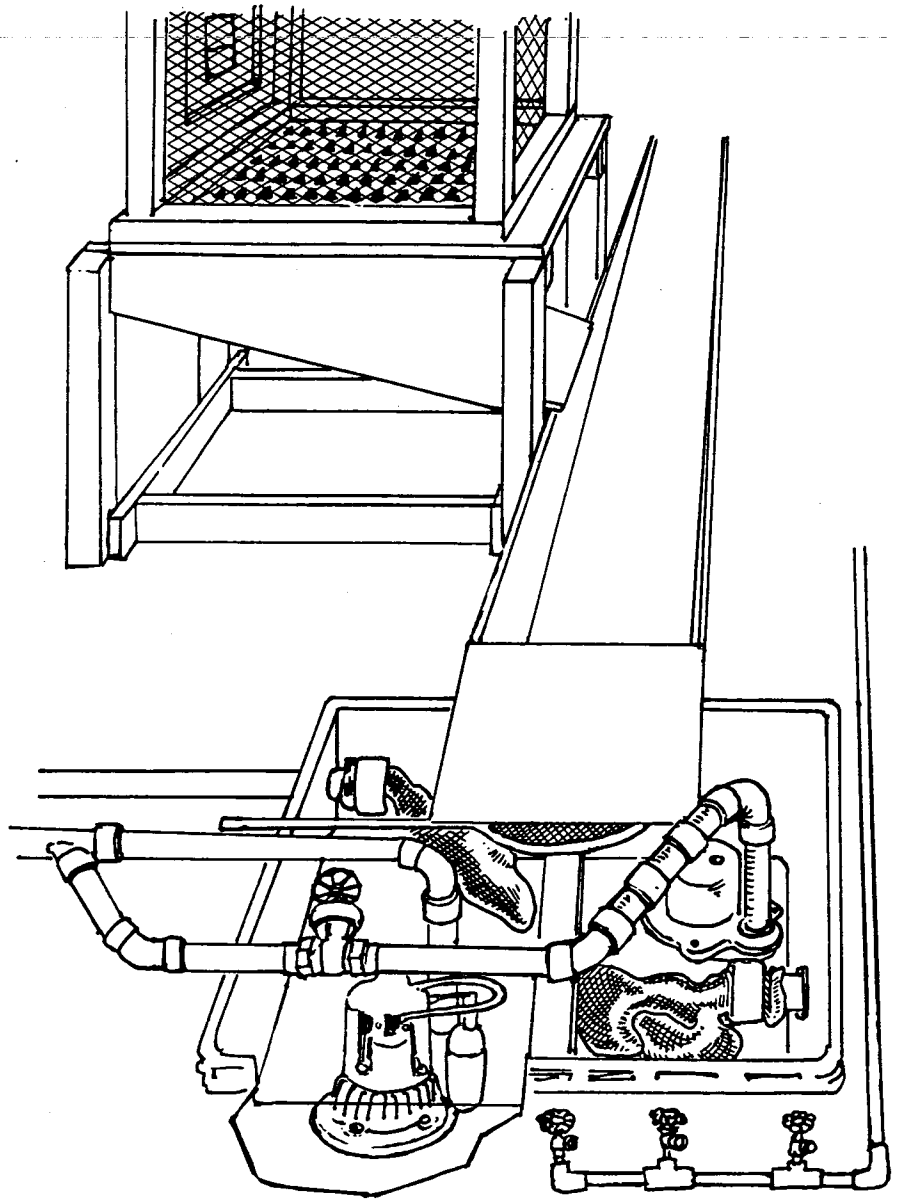


Figure 1.14 The central raceway that drained waste water and debris from the dry pens. The waste was washed into a central sump, filtered through nylon mesh, and pumped into a sewer line.

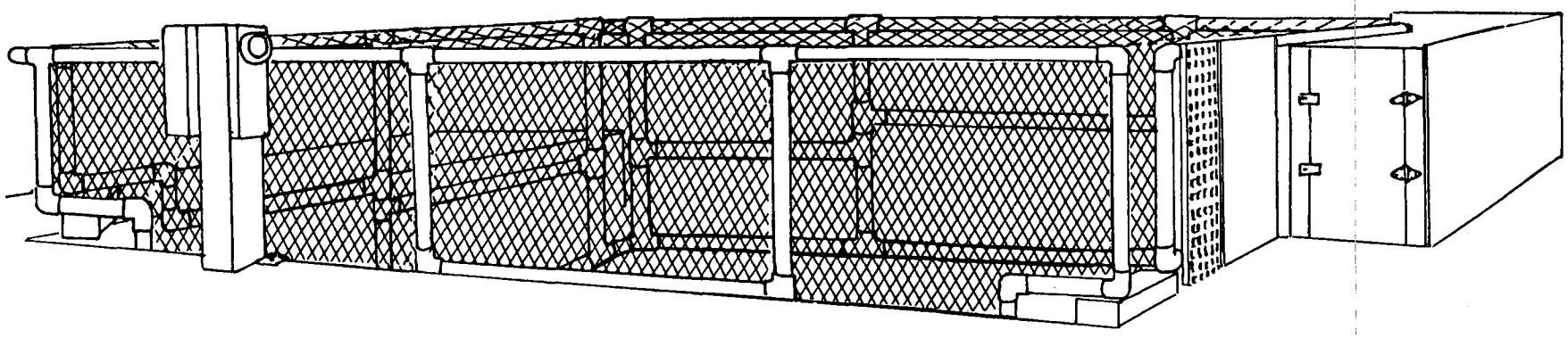


Figure 1.15 Sea otter holding pen located in the small boat harbor in Valdez. The pen (20 ft x 20 ft x 5 ft deep) was constructed of PVC pipe and herring net. The enclosure on the right lead into a haul-out area on the dock.

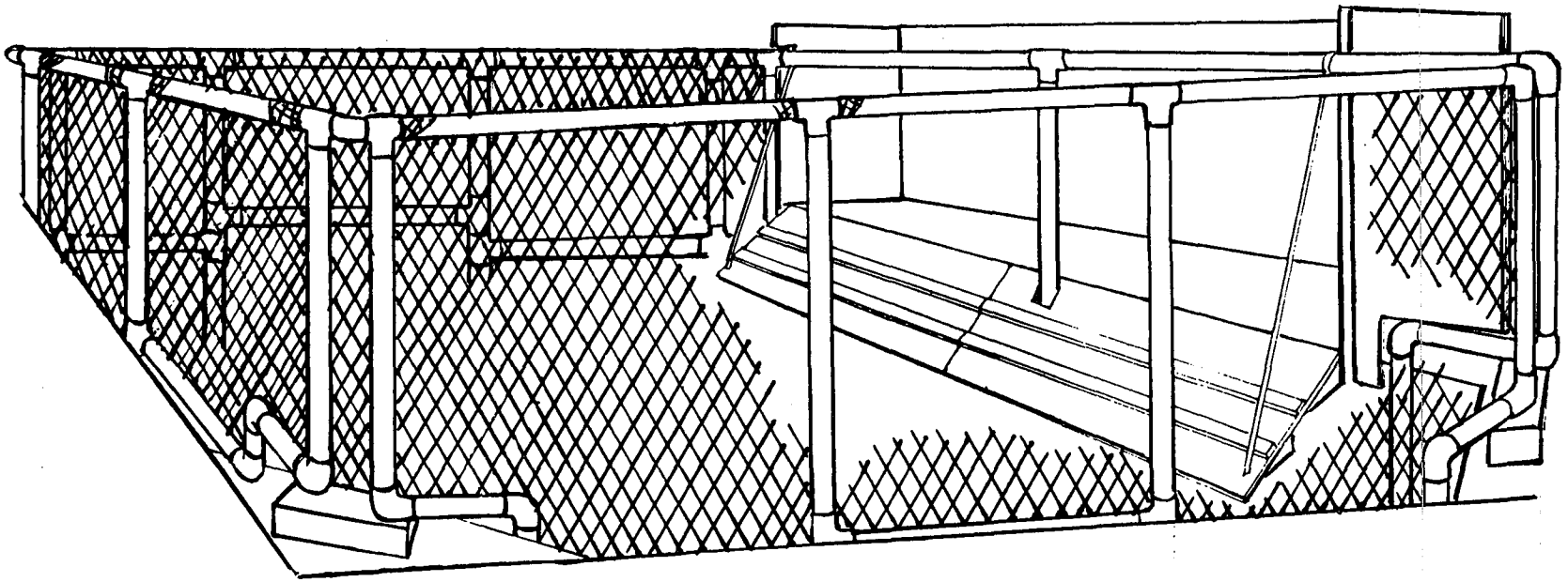


Figure 1.16 Sea otter holding pen showing the haul-out area.

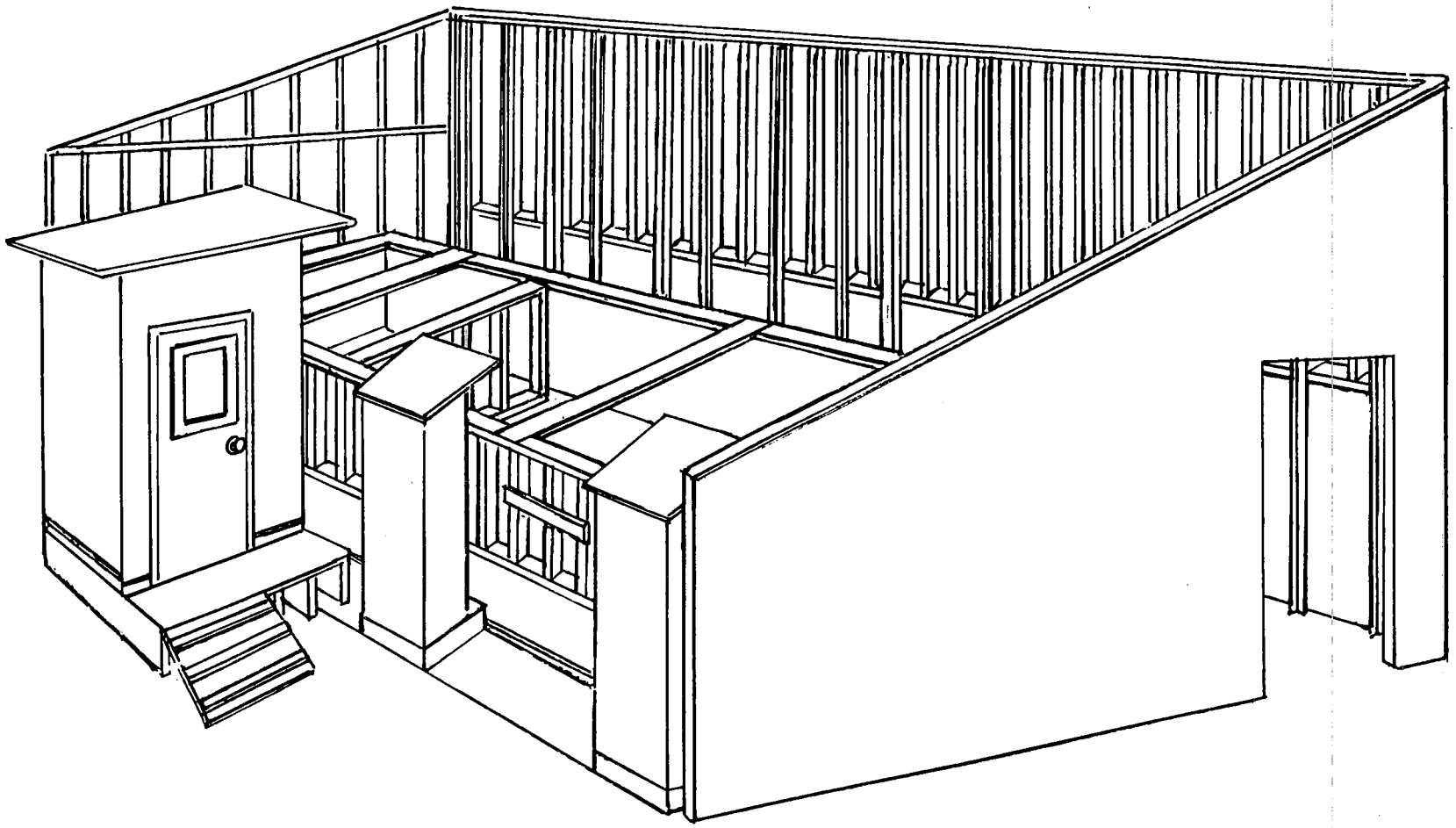


Figure 1.17 An enclosed salmon raceway at the Solomon Gulch Hatchery that was used to hold rehabilitating sea otters. The small hut was used by the observers.

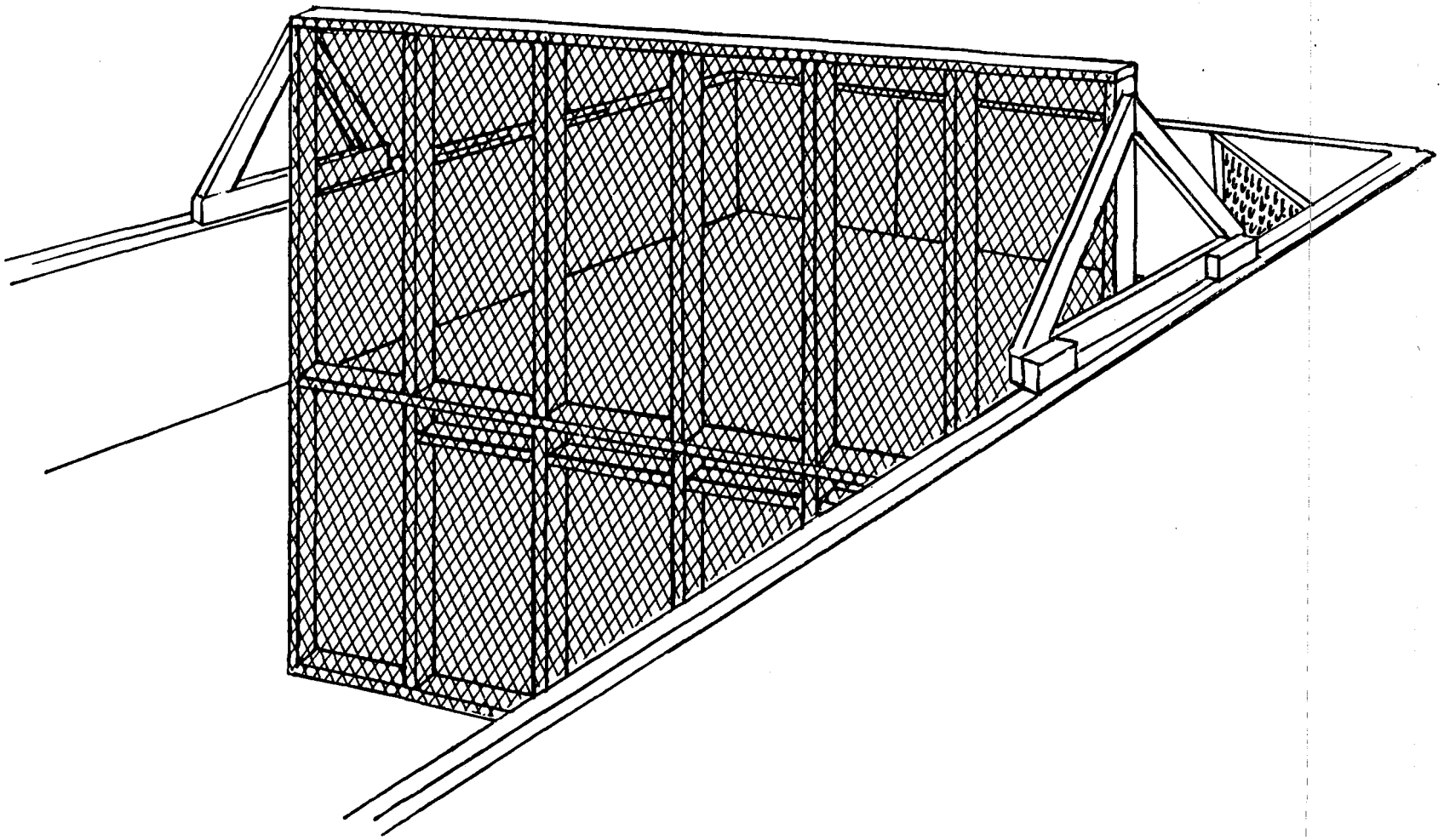


Figure 1.18 Movable partition made of wood and herring net that was used to separate groups of otters in the salmon raceways at the Solomon Gulch Hatchery.

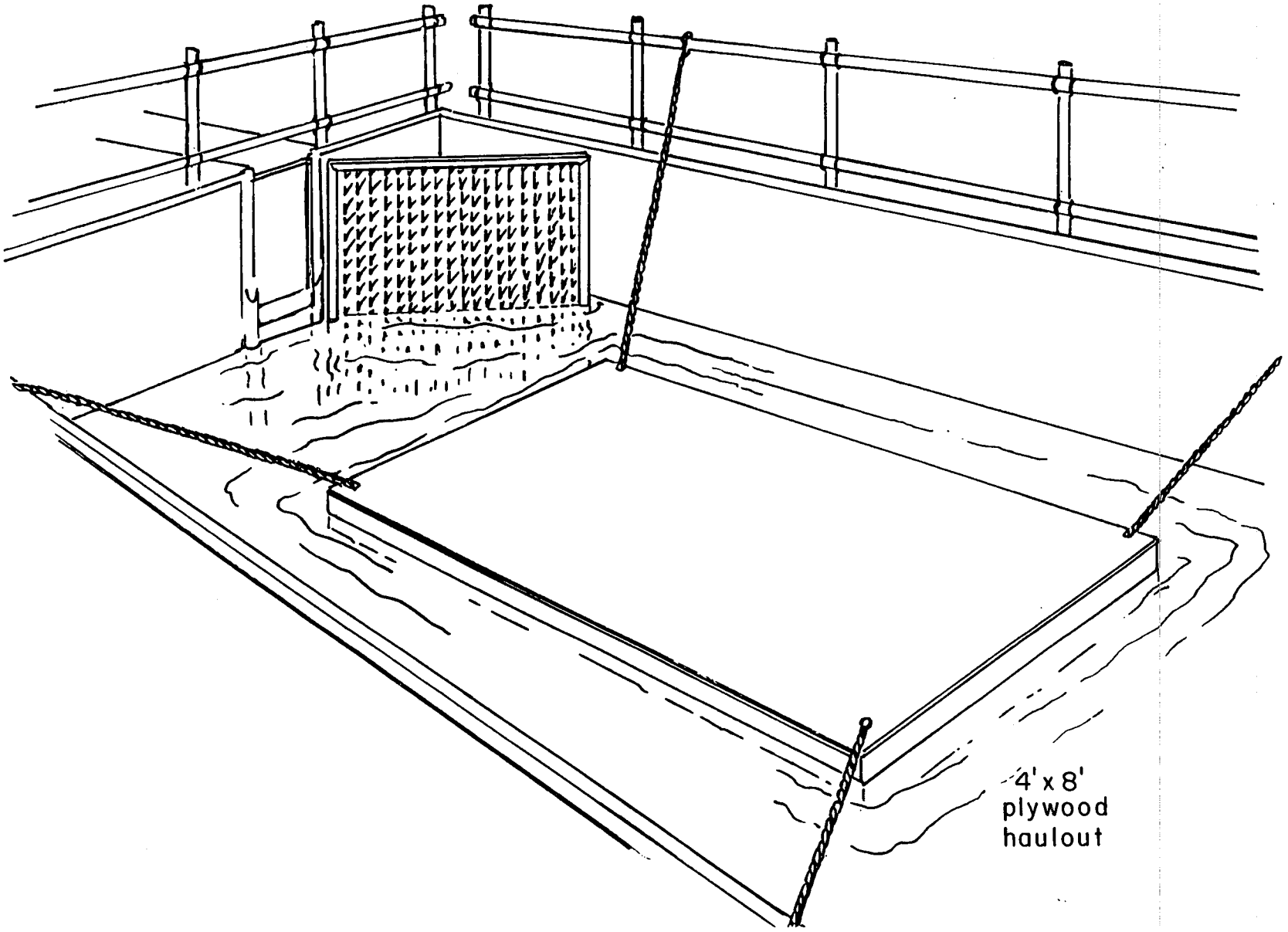


Figure 1.19 Floating haul-out platform in the salmon raceway at the Solomon Gulch Hatchery.

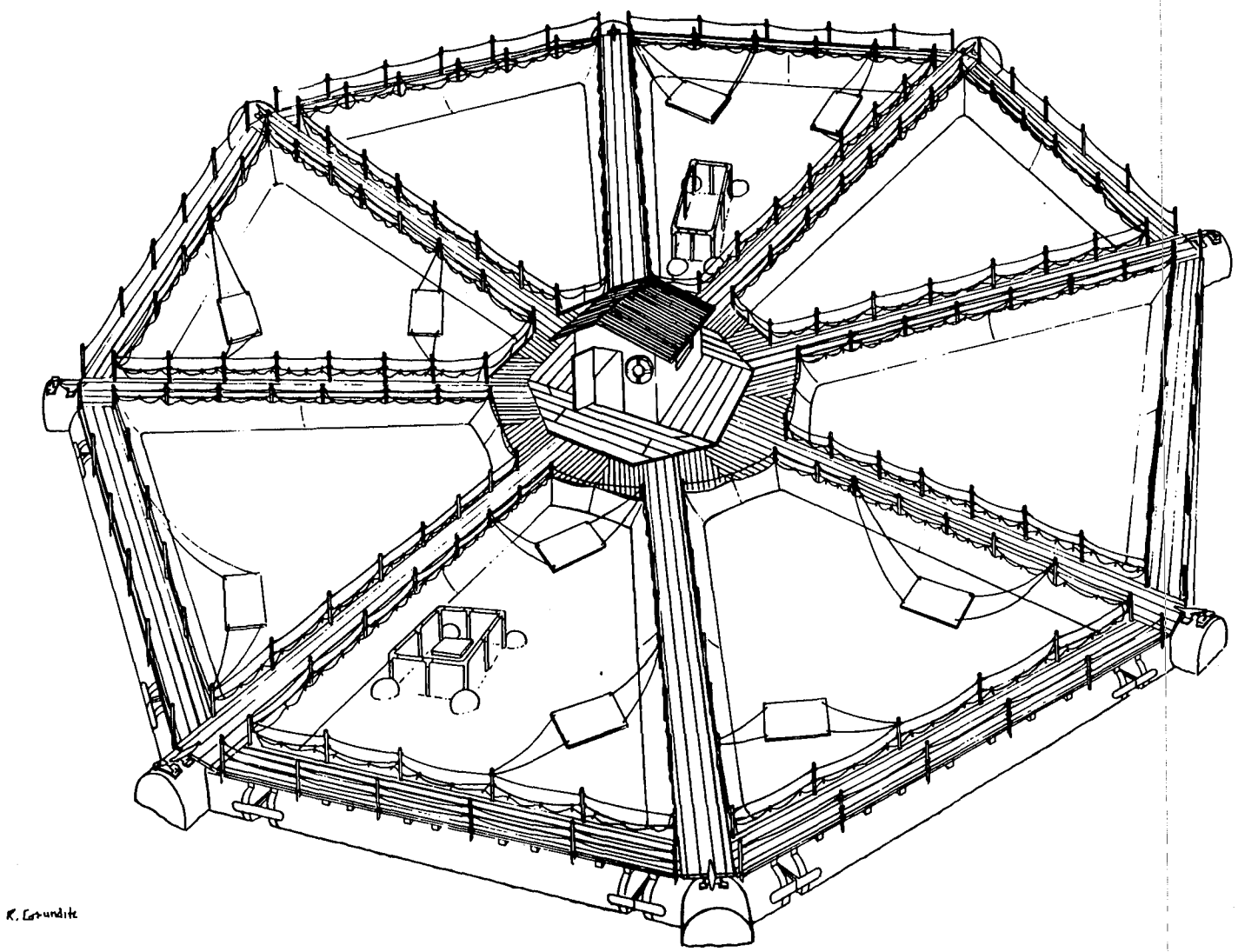
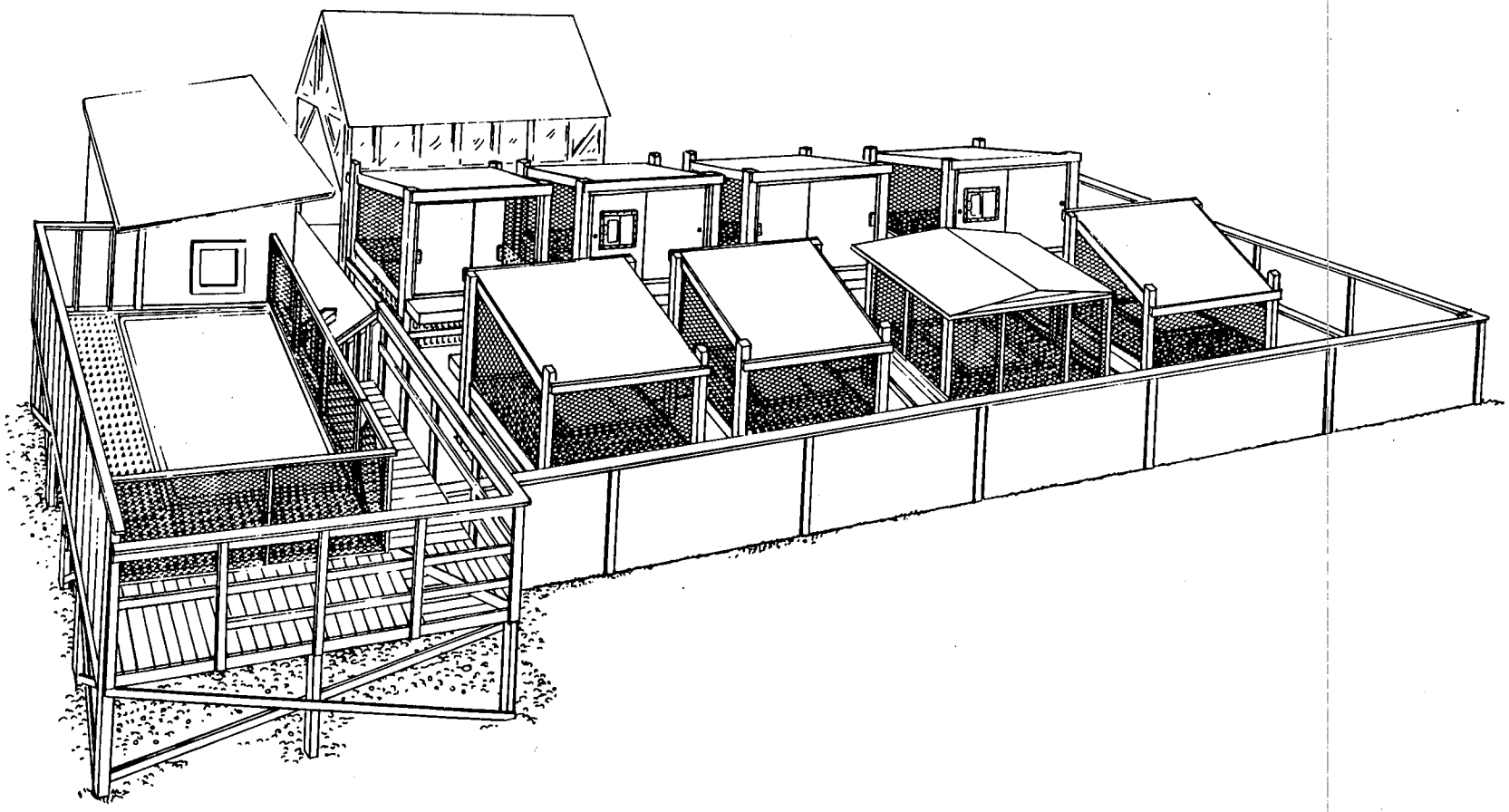


Figure 1.20 The floating, octagonal salmon pen that was used to hold rehabilitated sea otters in Port Valdez Bay. Each netted section was about 80 feet long, 15 feet deep and could hold 20-30 otters. Haul-out platforms were placed in each section. Some sections also contained smaller, secondary pens. The small hut was used by the husbandry staff.



R. Brandt

Figure 1.21 Holding facility in Valdez for harbor seal pups. Each pen had a tote pool that was plumbed with seawater. Seals were exercised in the larger seawater pool twice daily.

B. Seward

The Seward Sea Otter Rehabilitation Center was designed as a modular facility that could be moved to sites with appropriate connections for electricity, freshwater, seawater and sewage. Many design features at this facility were adapted and refined from our earlier experiences at the Valdez center and reflected the most current knowledge on rehabilitating oiled otters. The principal designers of the Seward facility were James Styers (Director), Thomas McCloskey, Thomas Williams, Tag Gornall and James Stewart.

The Seward Center consisted of 10 trailers (10 ft x 50 ft) that were connected with covered walkways (Figures 1.22 and 1.23). The trailers provided space for sea otter weighing and sedation (250 ft^2), cleaning (250 ft^2), drying (125 ft^2), critical care (250 ft^2), husbandry staff (125 ft^2), sea otter food preparation (250 ft^2), veterinary clinic (250 ft^2), a nursery (250 ft^2), staff dressing room (250 ft^2), staff eating area and meeting room (500 ft^2), pathology and necropsy room (250 ft^2), medical support room (250 ft^2), indoor pens (1000 ft^2), storage and utility area (500 ft^2) and offices for the construction contractor (500 ft^2). About 4000 ft^2 of outdoor space was used for pens and pools, cage cleaning, fuel oil tanks and a waste water tanker truck; the entire facility occupied about 1.5 acres. The administrative offices (800 ft^2) were located in the Sea View Plaza business complex across the street from the rehabilitation facility.

The functions of the various space allocations listed above have been described for the Valdez rehabilitation center (section IIA). However, a few differences are noteworthy.

Hot water in each trailer was provided by propane instantaneous water heaters (Aquavac 42). These small, wall-mounted water heaters were very effective and easier to install and service than a large boiler. The sea otter washing room, which had the greatest need for hot water, had a water heater for each cleaning station.

After cleaning on one of three washing tables (Figure 1.4), sedated otters were taken to a separate drying room with two tables and four, high speed pet dryers. The dryers were mounted on the roof to reduce noise. By placing the washing and drying activities in separate rooms, two otters could be dried while two more were washed. It also allowed the otters to be more thoroughly dried because the humidity was lower than in the wash room.

Once their fur was completely dried, otters were placed in cages in the critical care room to recover from sedation. Part of the floor in this room was modified into a shallow trough that

was coated with plexiglass and resin. The cages were set over the trough so that water and debris that fell through slats in the bottoms of the cages could be washed into a drain; this made sanitation easy.

After the otters had recovered from sedation and had begun eating, they were transferred to either indoor or outdoor pens. Twelve single-otter indoor pens (one haul out platform; Figure 1.24) were designed for animals that needed additional protection from the weather. Twelve two-otter outdoor pens (two haul out platforms; Figure 1.25) were designed for animals that were in relatively good health and showed good restoration of their fur. Both types of pens, which were built from 2 inch PVC pipe instead of wood, were modified from a design (Figures 1.10-1.12) used at the Valdez rehabilitation center. The hard, rounded surface of the PVC pipe was a great improvement over wood because it prevented the otters from biting into the framework and was easier to keep clean. As in Valdez, the pens were covered with herring net that was flexible and prevented the otters from injuring their teeth and gums. A plastic tote (3 ft x 3 ft x 2 ft deep) provided a small pool that was plumbed with seawater. As in Valdez, the haul-out platforms were made of plastic grate (Chemgrate), which proved to be unsuitable as a surface for otters; it was too rough and damaged the fur and skin on the hind flippers. A less abrasive surface such as smooth, perforated plastic would have been better. Hinged doors provided easy access to the tote pool or the haul-out platform.

The indoor and outdoor pens sat in shallow spillways that were lined with galvanized sheet metal. Seawater in the tote pools was allowed to overflow into the spillway and drain into a sump at one end; the seawater was then returned to the bay without further treatment. Alternatively, the pool could be emptied into the spillway through a 2 inch floor drain. Each pen was plumbed with seawater (2-5 gallons/minute), which was pumped from the bay with a submersible pump (maximum capacity 160 gallons/minute). The pump was located offshore at a depth of about 40 feet.

After an otter had regained the water repellent quality of its fur (determined visually) and was eating well, it was transferred from the outdoor pens to one of six large pools (12 ft diameter and 4 ft deep; Figure 1.26). The prefabricated pools were enclosed with PVC pipe and herring net. Seawater was provided by the offshore pump. Each pool had a four inch floor drain and a skimmer drain. Two haul-out platforms made of plastic grate were placed in each pool. These pools were deep enough to allow the otters to groom well. However, the seawater supply (10-15 gallons/minute) was insufficient to maintain good water quality (i.e. coliform bacteria counts were very high). The poor water quality was exacerbated by the accumulation of uneaten food and fecal matter on the flat bottom of the pool.

Consequently, these pools had to be frequently drained and cleaned. A sloped bottom with a large central drain, a larger skimmer drain, and increased seawater flow (i.e. total flow of 500 gallons/minute for the 24 pens and six pools) would have corrected this problem.

A seawater pond (about 60 ft x 60 ft x 12 ft deep), which belonged to the University of Alaska and was located near the rehabilitation center, was used to hold two floating pens (6 ft x 12 ft x 8 ft deep). Otters that had completed the rehabilitation process were held in the pens until they were transferred to the pre-release facility at Little Jakolof Cove or released into the wild. As with the large pools, the pond had an insufficient flow of seawater which resulted in unacceptably high concentrations of bacteria. However, this was a temporary holding facility (usually less than one week), and none of the otters appeared to suffer from the poor water quality.

The nursery for sea otter pups had a water bed (6 ft x 6 ft), a table for preparing formula, a refrigerator for holding food and medicine, and a sink for washing the pups.

Facilities at the Seward Sea Otter Rehabilitation Center

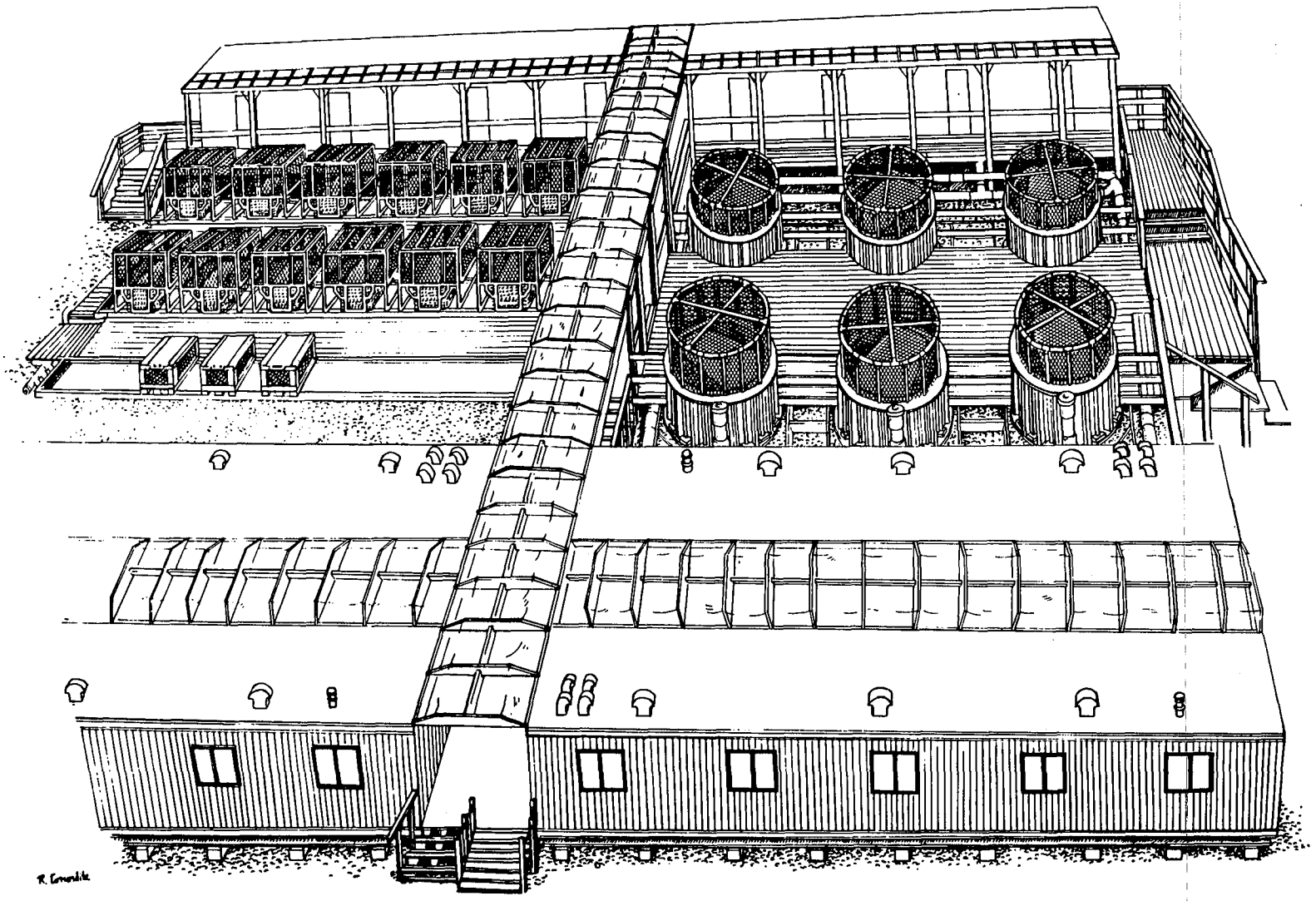


Figure 1.22 The Seward Center showing six of the ten trailers, the covered walkway, the outdoor pens with tote pools and the larger pools.

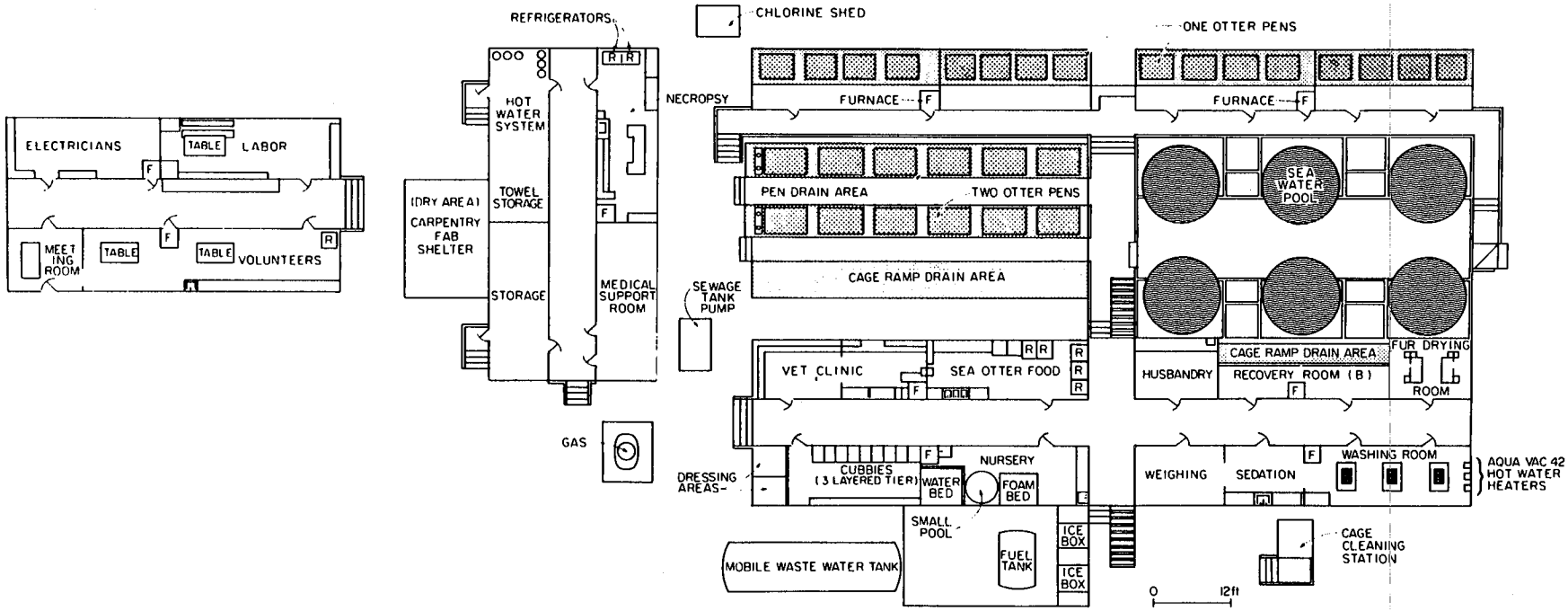


Figure 1.23 Floor plan of the Seward Center.

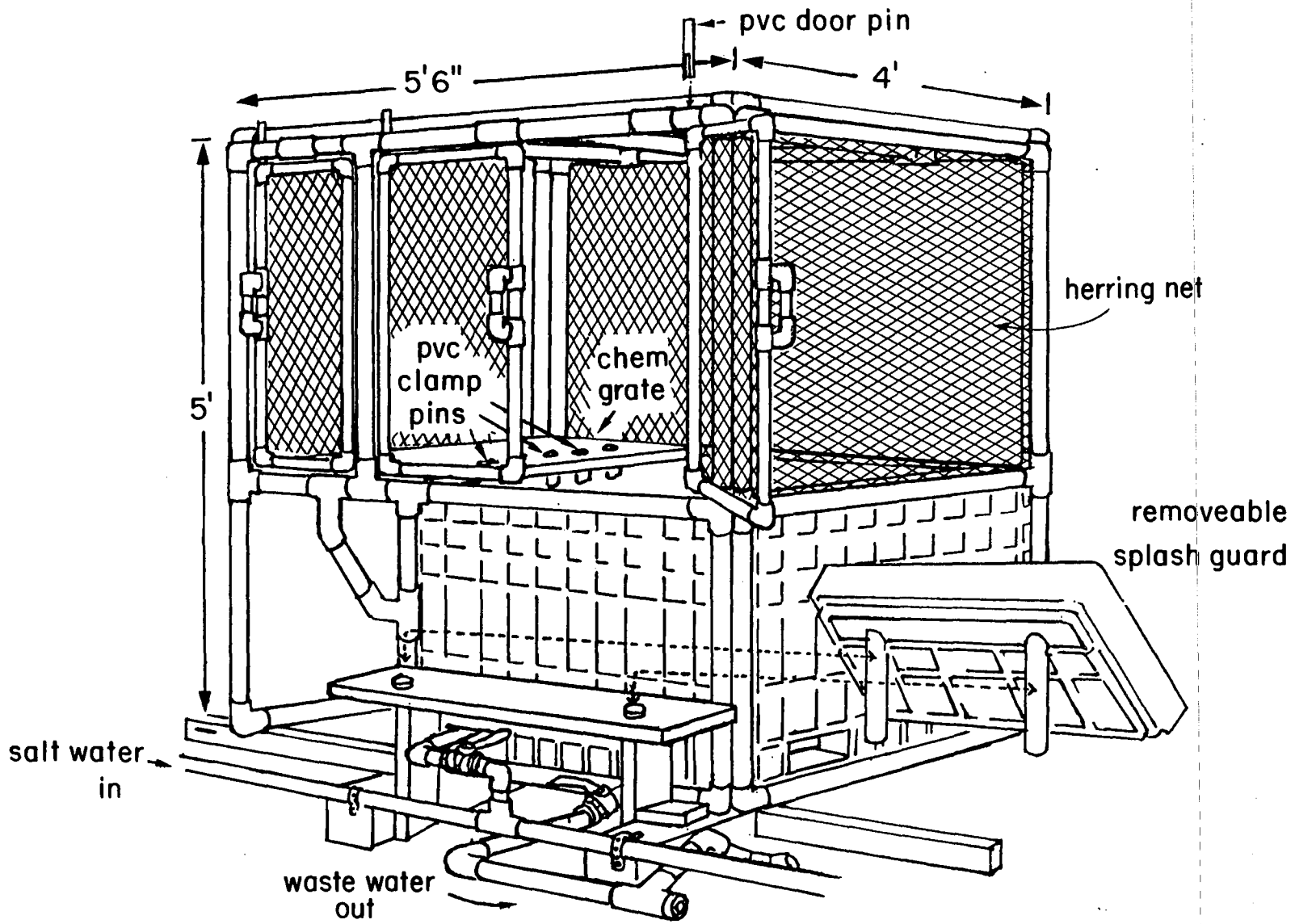


Figure 1.24 Sea otter pen at the Seward Center designed for one otter. The pen was made from a plastic tote, 2 inch polyvinylchloride (PVC) pipe and herring net. The pen was plumbed for seawater which then drained into a shallow spillway beneath the tote pool.

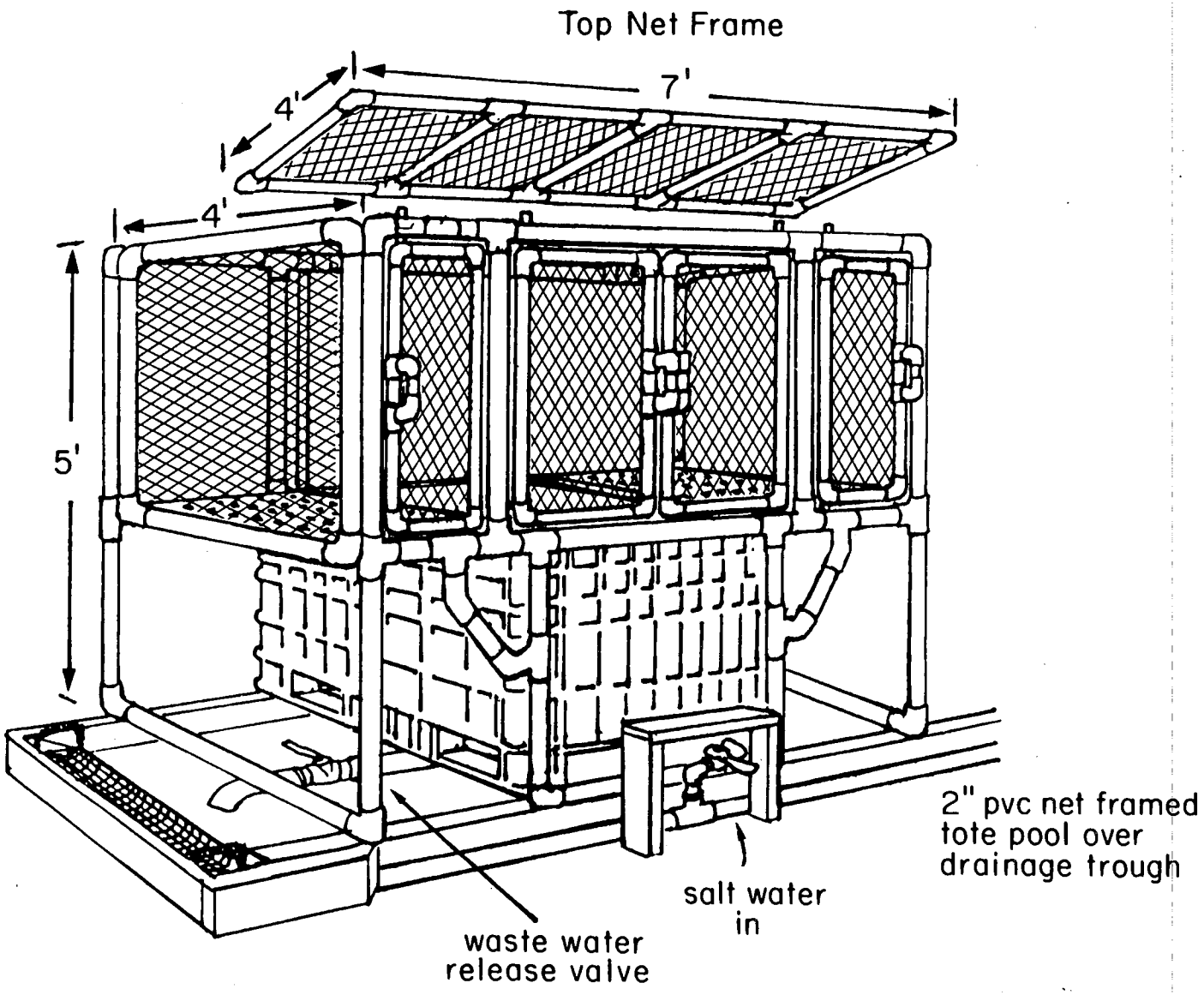


Figure 1.25 Sea otter pen designed for two otters.

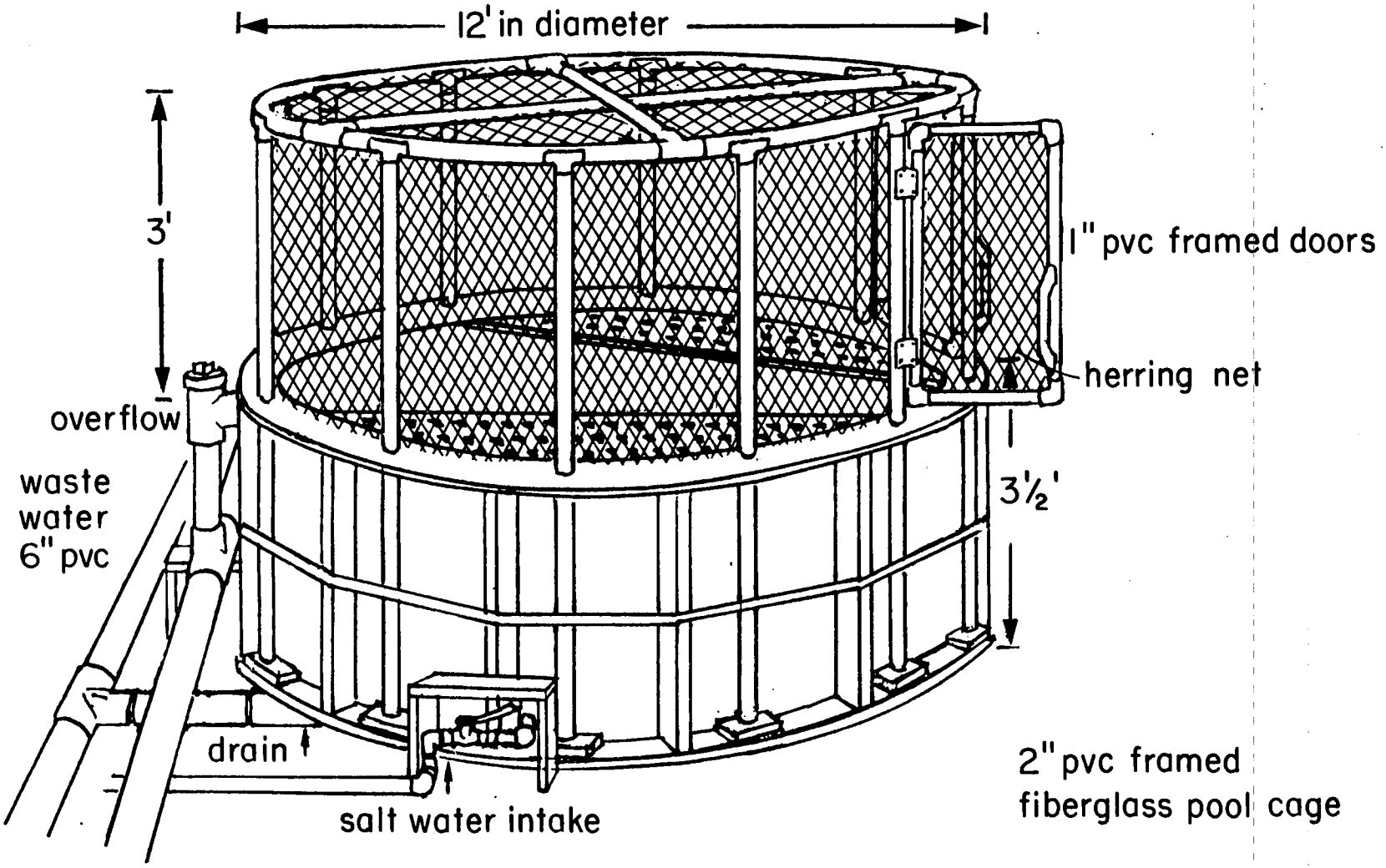


Figure 1.26 Seawater pool at the Seward Center designed for four-to-six otters.

C. Homer

The temporary care facility was located behind the Homer Junior High School and consisted of four wooden pens with plastic tote pools and a cleaning station similar to those described for the Valdez rehabilitation center. The freshwater supply to the pools was provided by garden hoses. Food for the otters was stored in a chest freezer and thawed in water before distribution by the husbandry staff. Only seven otters were treated at this facility before the floating pens were built at Little Jakolof Cove.

Little Jakolof Cove is located along the southern shore of Kachemak Bay across from Homer. This site was chosen for the sea otter pre-release facility because it provided an isolated, natural setting where the stress associated with captivity could be minimized. The facility consisted of an articulated floating dock (about 10 ft x 300 ft) and 33 floating pens (Figure 1.27). The pens (14 ft x 28 ft x 10 ft deep) were made out of wood and herring net; styrofoam blocks (1 ft x 1 ft x 5 ft) mounted along the sides of the pens provided buoyancy (Figure 1.28). Each pen had a haul-out platform (14 ft x 2 ft) made of plastic grate or wood. A utility area for storing ice chests and a small hut (8 ft x 15 ft) that provided shelter for the staff were located at one end of the dock. A cabin (about 600 ft^2) on the shore was used for administration, staff meals and sleeping quarters.

A small kitchen was built on the dock at the Kasitsna Bay Research Center (about 2 miles from Little Jakolof Cove) and used for sea otter food preparation. The food was purchased daily from a supplier in Seldovia and transported by truck to the Kasitsna Bay facility. There it was thawed in plastic totes, placed in plastic bags, weighed and loaded into ice chests. The prepared food was then transported by skiff to the holding pens in Little Jakolof Cove. In addition to the frozen food, the otters were fed fresh mussels, cockles and sea urchins purchased from local fishermen.

D. Kodiak

This temporary care facility had five dry pens similar in design to those at Valdez. When weather conditions prevented immediate air transport to the rehabilitation centers in Valdez or Seward, otters could be held overnight in the pens.

III. Personnel

A. Staffing Requirements

Valdez had 159 paid staff and did not use volunteers after early April (Figure 1.29). Seward had 36 paid staff and 63

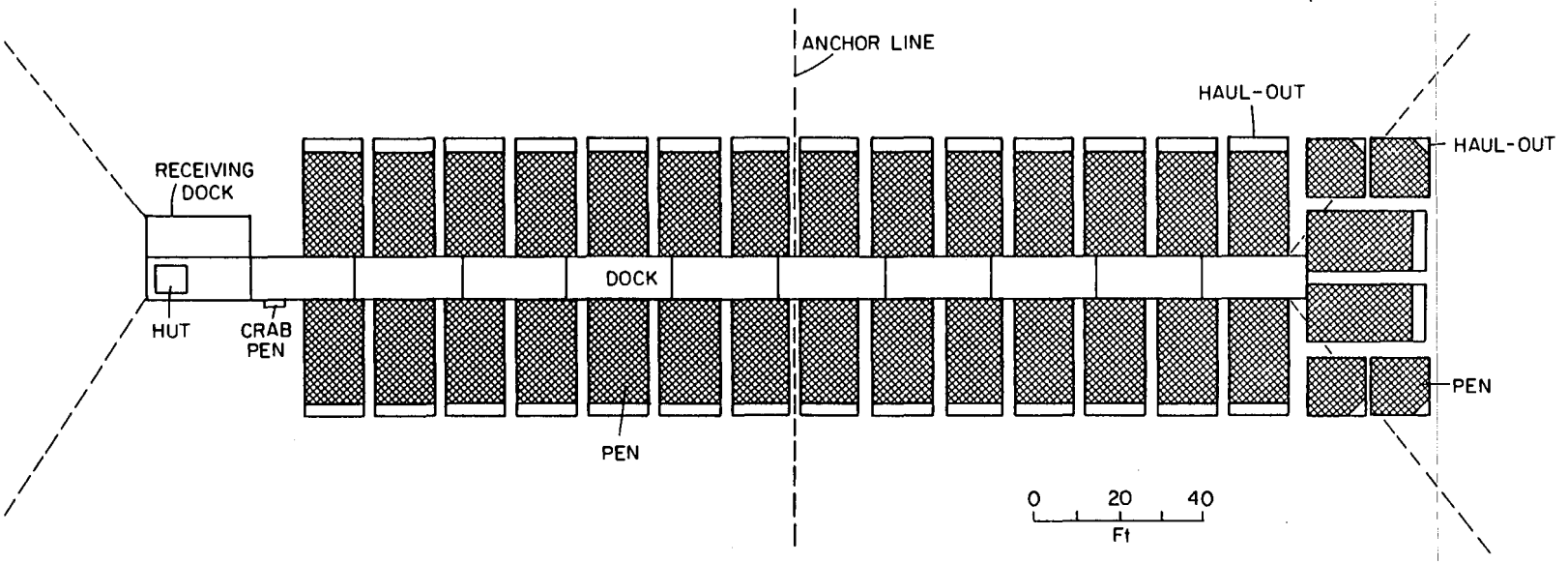


Figure 1.27 Overhead view of the floating dock and sea otter pens at the Little Jakolof Cove pre-release facility.

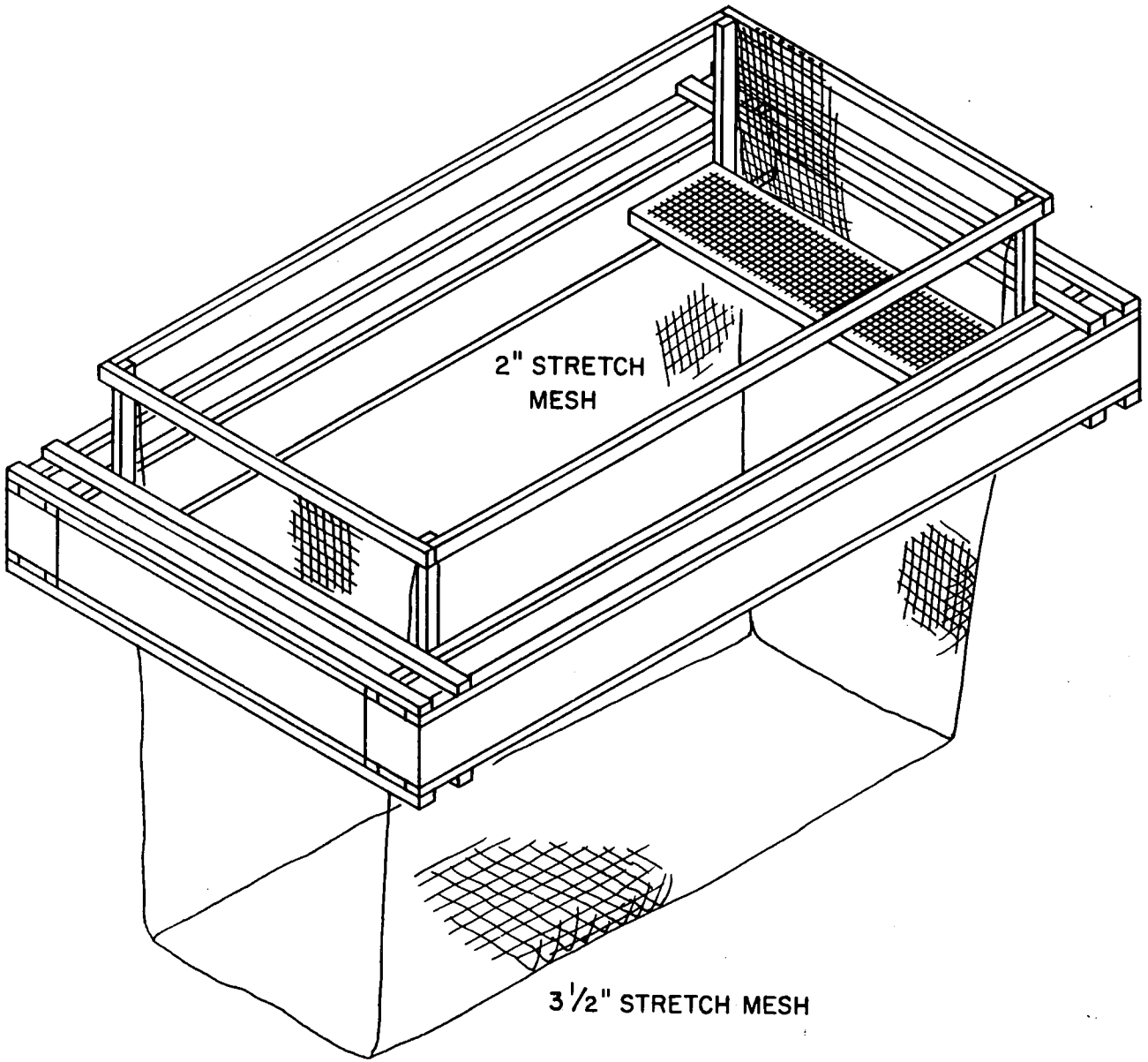


Figure 1.28 Floating sea otter pen at the Little Jakolof facility. Floatation was provided by styrofoam blocks around the perimeter. Otters were contained within a net bag that was hung within the wooden framework. A haulout platform of plastic grate was placed at one end of the pen.

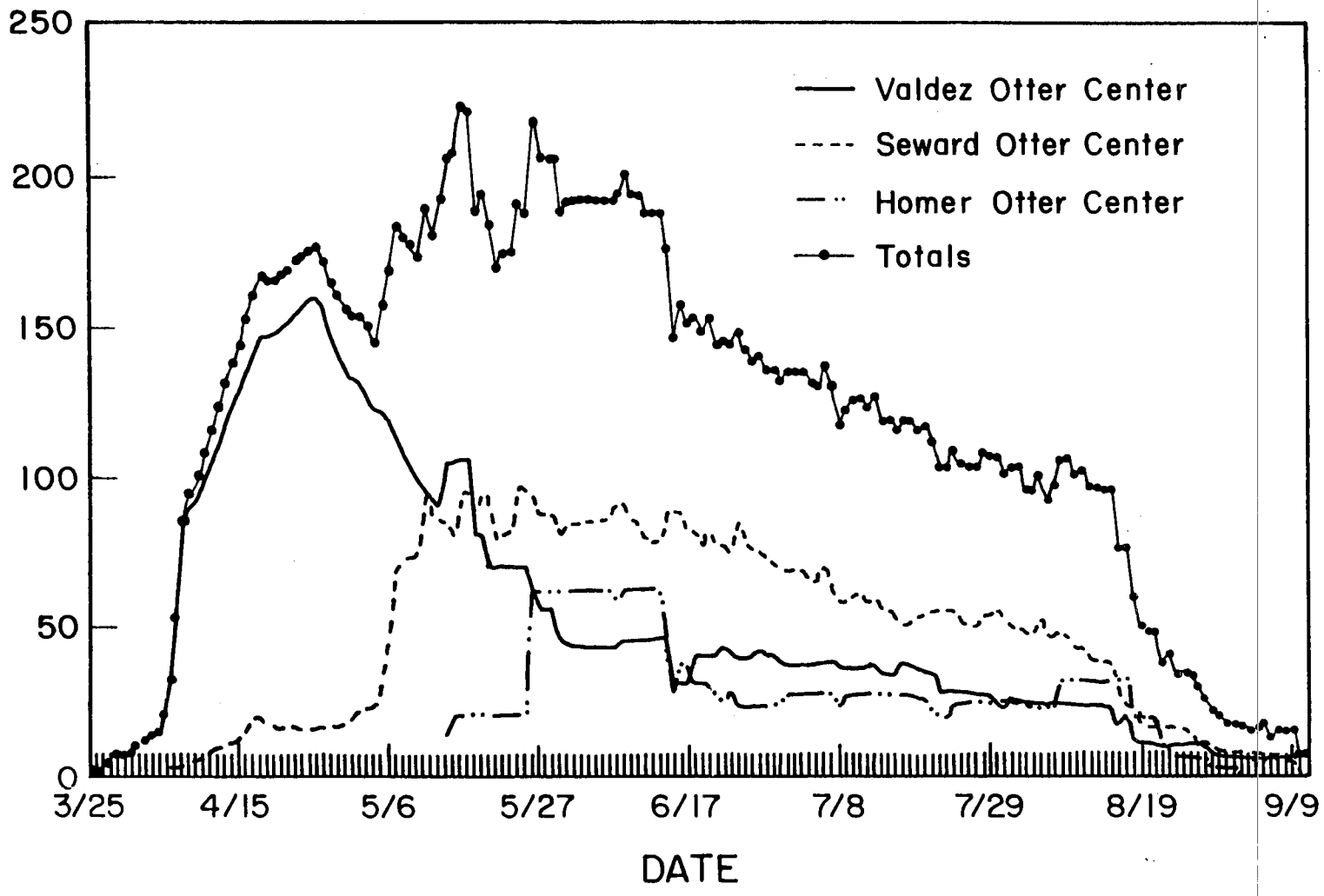


Figure 1.29 Comparison of staff levels at the rehabilitation and pre-release centers.

volunteers for a maximum of 99. The pre-release facility in Little Jakolof Cove had 35 paid staff and 28 volunteers for a maximum of 63. When all three facilities are considered together, the ratio of personnel to otters reached a peak of 3.9 in April (the period of heaviest oiling and the most severe toxic reactions) and showed a steady decline to about 0.5 through July and early August (the period when most of the otters were rehabilitated and awaiting release) (Figure 1.30). In September, the ratio increased as the last otters were released and the activities of the remaining staff were directed towards preparation of a computerized database and data analysis.

B. Key Personnel

1. Exxon Environmental Program Manager. Alan Maki

2. Exxon Coordinators for Birds and Sea Otters

   a. Thomas Monahan
   b. Rocky Ortega

3. Senior Staff

   a. Randall Davis, Senior Director, Sea Otter Rehabilitation Program
   b. Terrie Williams, Director, Valdez Rehabilitation Center
   c. James Styers, Director, Seward Rehabilitation Center
   d. Nancy Hillstrand, Director, Homer Pre-release Facility
   e. Thomas McCloskey, Operations Manager, Seward Rehabilitation Center

4. Veterinarians

Jenny Balke
Randy Basaraba
Cook Bittner
John Blake
Ralph Broshes
Tag Gornall
Glen Grady
Joseph Groff
Keith Harris
Chris Harvey-Clark
Ken Hill
Mike Isenhart
Mike Jones
Judy McBain
Carolyn McCormick
Rob Moeller
Scott Rapp
Don Sawyer
Pete Schroeder
Harold Spaulding
Jack Tuomi
Pamela Tuomi
Neil Utkov
Vicky Vanek
Susan Wagner
Tom Williams
Riley Wilson
Thierry Martin Work
George Wrightson

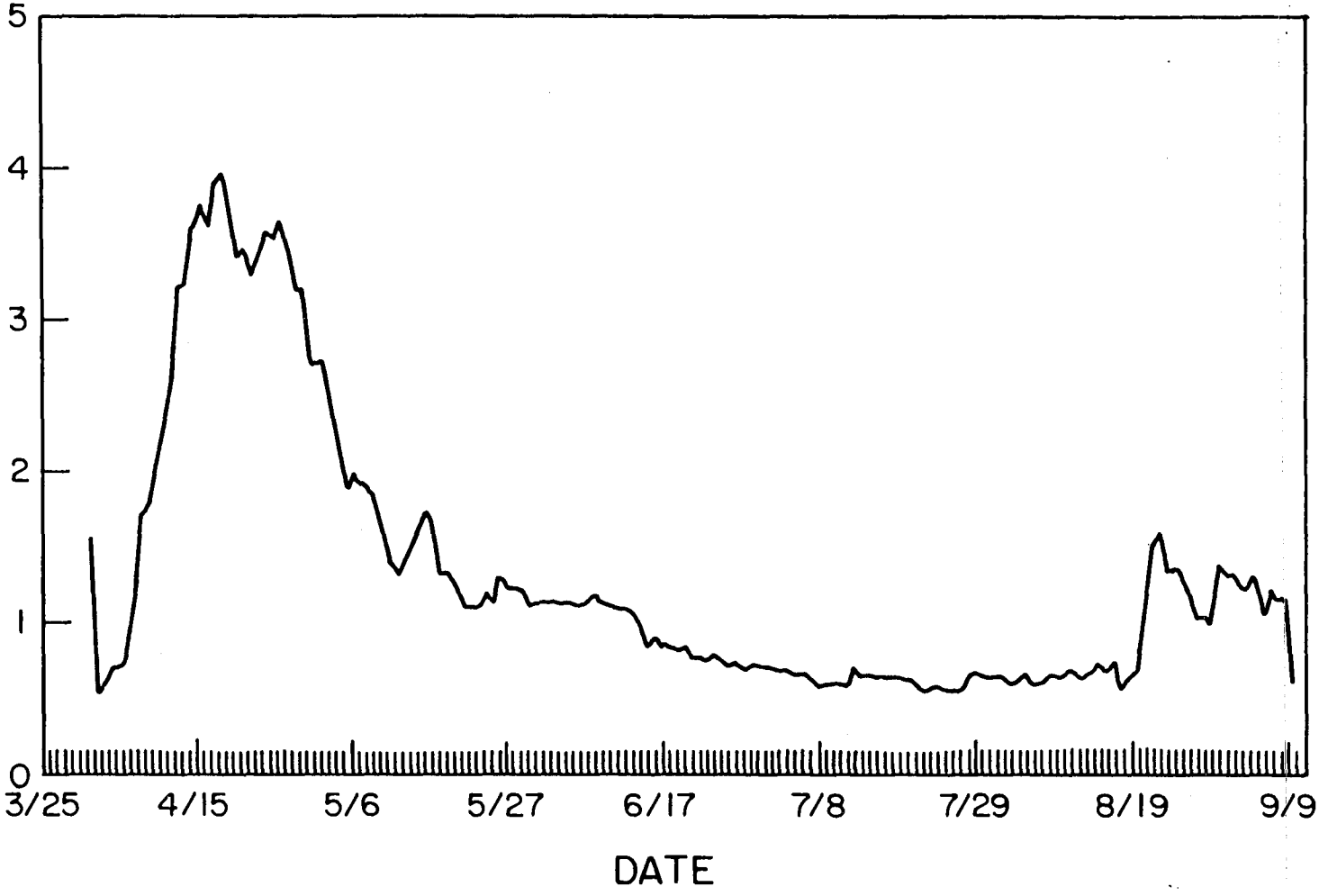


Figure 1.30 Ratio of personnel to sea otters for the three centers.

5. Veterinary Technicians

Patty Chen	Laura Kelly
Amy Christiansen	Debbie Mays
Cindy Evans	Bonnie Miller
Anne Green	Tamela Thomas
Laurie Kari	

6. Toxicologist. R.V. Chalam

7. Staff. See Appendix 2 for a complete list of staff members, consultants, and employees of government agencies that worked at the rehabilitation centers or on the capture boats.

C. Staff Organization

1. Critical Functions. Each of the three otter centers had their own staff, but many of the key positions were similar. This was especially true at the Valdez and Seward facilities, which were designed to clean and rehabilitate oiled otters. The pre-release facility at Little Jakolof Cove was designed to hold rehabilitated otters and had a smaller staff. In general, the following staff positions existed at all three facilities, although some individuals may have assumed multiple responsibilities. In addition, the Little Jakolof Cove facility had no sea otter cleaning crews. A representative of the USFWS provided guidance and technical assistance at each of the facilities.

a. Director
b. Operations Supervisor
    (1) Husbandry Shift Coordinators (two shifts)
        (a) Animal monitors/handlers/cage cleaners
        (b) Nursery staff
        (c) Sea otter cleaning crews
    (2) Animal Food Coordinator
        (a) Kitchen staff
    (3) Veterinary Coordinator
        (a) Clinical veterinarians
        (b) Veterinary pathologists
        (c) Veterinary technicians
        (d) Toxicologist
c. Logistics Supervisor
    (1) Secretarial staff
    (2) Housing and Meals Coordinator
    (3) Supplies and Equipment Procurer
    (4) Facilities Maintenance
    (5) Security
    (6) Transportation Coordinator
        (a) Aircraft and ship transportation
        (b) Ground transportation

(7) Communications Coordinator

d. Personnel Supervisor
   (1) Accounting/payroll
   (2) Training

e. Documentation Supervisor
   (1) Archives
   (2) Computer data entry

g. Public Relations Coordinator

2. Responsibilities of the Director and Staff Supervisors.

a. Director

(1) Organized and directed response operations associated with the cleaning and rehabilitation of oiled sea otters. The USFWS supervised capture operations.

(2) Insured that Exxon Environmental Program Manager and Program Coordinators were kept fully informed on all issues relating to the capture, rehabilitation and release of sea otters.

(3) Maintained contact with designated representatives of the USFWS, members of the Regional Response Team and others directly involved with the capture, cleaning and rehabilitation of oiled sea otters.

(4) Obtained USFWS authorization to capture and rehabilitate oiled sea otters.

(5) Designated and met regularly with supervisors; established priorities to ensure efficient and effective operations.

(6) Met with Press Relations Coordinator in order to organize press briefings and respond to press inquires.

(7) Approved all requests for personnel, equipment, supplies and construction.

(8) Approved the discharge of personnel.

b. Operations Supervisor

(1) Coordinated the cleaning, husbandry, food preparation and veterinary care of sea otters in the center.

(2) Worked with the Logistics Supervisor to identify and maintain required equipment and supplies.

(3) Worked with the Personnel Supervisor to recommend the hiring or discharge of personnel for sea otter cleaning, husbandry, food preparation and veterinary care.

(4) Ensured that all husbandry staff were properly trained and adequately clothed.

(5) Established safety protocols to protect animal monitors and handlers from injury.

(6) Supervised the cleaning and care of oiled otters.

(6) Worked with the Documentation Supervisor to ensure that proper records were maintained and that each otter was identified with a flipper tag.

(7) Worked with the Logistics Supervisor to arrange for the purchase and delivery of seafood for the otters.

(8) Instituted quality control procedures for the preparation and distribution of otter food to the husbandry staff.

(9) Coordinated with the veterinary staff to ensure proper care and treatment for otters in the center. Ensured that all otters that died in the center were necropsied by a veterinary pathologist and that tissue samples were taken for toxicological and histopathological analysis.

(10) Established security procedures for personnel entering the facility. Ensured that no domestic animals entered the facility.

c. Logistics Supervisor

(1) Worked with the Operations Supervisor to determine the equipment and supply needs for personnel and the facility.

(2) Established a communications network between capture boats, aircraft, ground transportation and the center.

(3) Chartered capture boats.

(4) Coordinated the transportation of otters from capture boats to the center and from the center to long term holding facilities or for release into the wild.

(5) Coordinated the transportation of personnel and supplies to and from the capture boats and the rehabilitation centers.

(6) Arranged housing and meals for the staff.

(7) Supervised the secretarial staff

d. Personnel Supervisor

(1) Worked with the Operations Supervisor and Logistics Supervisor to establish staffing needs. Actively recruited paid and volunteer staff.

(2) Worked with Logistics Supervisor to ensure that personnel were properly housed and fed.

(3) Ensured that personnel received proper training in their particular job.

(4) Maintained personnel records and administered payroll.

e. Documentation Supervisor

(1) Established protocols and forms for the documentation of sea otters during capture, cleaning, rehabilitation and release.

(2) Worked with the Operations Supervisor to ensure that each otter was identified with a flipper tag and that animal handlers were properly trained to keep husbandry records.

(3) Worked with Veterinary Coordinator to ensure that all medical and necropsy data were properly recorded and filed.

(4) Maintained records and supervised the distribution of copies to responsible government agencies.

(5) Coordinated the formation of a computer database for all records.

g. Public Relations Coordinator

(1) Worked with the Director and Exxon Media Relations Officer to coordinate press briefings and media interviews.

IV. Role of Responsible Government Agencies during an Oil Spill with Regards to Sea Otters

A. National Contingency Plan

1. The National Oil and Hazardous Substances Pollution Contingency Plan or simply the National Contingency Plan (NCP) was developed to ensure that the resources and expertise of the Federal government would be immediately available for serious oil and hazardous substance incidents that require a national or regional response (National Response Team Annual Report, 1989).

2. The NCP established a group of federal agencies that together form the National Response System.

a. National Response Team (NRT) consists of 14 federal agency representatives with expertise in responding to incidents:

(1) Environmental Protection Agency, Chair
(2) U.S. Coast Guard, Vice-Chair
(3) Department of the Interior
(4) Department of Commerce
(5) Federal Emergency Management Agency
(6) Department of Energy
(7) Department of Labor
(8) Nuclear Regulatory Commission
(9) Department of Defense
(10) Department of Agriculture
(11) Department of Health and Human Services
(12) Department of Justice
(13) Department of Transportation
(14) Department of State

b. Regional Response Teams (RRT) work with state governments to provide guidance and assistance within their regions.

B. Notification procedure in the event of a serious marine oil spill.

1. The U.S. Coast Guard (USCG) provides predesignated On-Scene Coordinators (OCS) for the coastal zone, co-chairs the standing RRT's and acts as the NRT vice-chair. The USCG

staffs and administers the National Response Center(NRC). When a serious marine spill is reported to the NRC by the discharger, the OSC contacts the other Federal agencies that form the NRT.

2. As a member of the NRT, the Dept. of Interior then contacts the following agencies under its jurisdiction.

a. U.S. Fish and Wildlife Service (USFWS)- federal trustee for sea otters and migratory birds.

b. National Parks Service (NPS)

c. Bureau of Land Management (BLM)

d. Minerals Management Service (MMS)

e. Bureau of Indian Affairs (BIA)

3. In Alaska, the overall responsibility for directing response operations for sea otters rests with the USFWS. When sea otters are at risk from an oil spill, the USFWS will designate a Field Response Coordinator (FRC), who will ensure that the discharger implements appropriate measures to protect and/or clean and rehabilitate oiled sea otters. If the discharger is unable to respond, then the FRC will mobilize federal resources to fulfill this need.

V. Conclusions

1. Exxon's sea otter rescue program rehabilitated 225 otters at an estimated cost of $18,300,000 ($81,300 per otter). This was the most expensive program to rehabilitate oiled marine mammals ever sponsored by a private company or a government agency. With advanced preparation, more cost effective rehabilitation programs are possible.

2. The rehabilitation and pre-release facilities had administrative, veterinary, husbandry, and support personnel. Volunteers were successfully used in the program, but they required good supervision and training.

3. In addition to cleaning oiled sea otters, the rehabilitation facilities had to provide for the special husbandry requirements of ill and pregnant animals. Of critical importance were appropriately designed pens and pools with an adequate supply of seawater.

4. After washing, otters were moved from critical care areas to outdoor pens as soon as they could thermoregulate at ambient air temperatures.

5. Because the immediate release of rehabilitated sea otters was not possible, they were transferred to large, pre-release facilities. The octagonal salmon pen used in Port Valdez Bay and the pre-release facility at Little Jakolof Cove permitted space for socialization and exercise by the otters.

6. For a rapid and effective response, rehabilitation facilities and a trained staff need to be established as part of an oil spill contingency plan for sea otters and other marine mammals.

VI. Literature Cited

National Response Team: A Report on the National Oil and Hazardous Substances Response System. 1989 Annual Report. Prepared by the U.S. Coast Guard and the Environmental Protection Agency, Washington D.C., March 1989

Chapter 2. Capture Operations

Kenneth Hill, D.V.M.
Fred Weltz
Thomas Monahan
Randall Davis, Ph.D.

I. Geography and Weather Conditions

The oil spill affected western Prince William Sound, the southern coast of the Kenai Peninsula, the northern end of the Kodiak archipelago, and the coast of the Alaska Peninsula along the Shelikof Straits (Figure 1.1). The coastal geography of this area includes numerous islands, rocky cliffs, fjords, sand and cobble beaches, enclosed lagoons and rocky reefs. Much of this coastline is considered sea otter habitat (Garshelis and Garshelis, 1984), although the density of sea otters along the coast is variable (Figures 2.1-2.4). An estimated 11,500 sea otters were at risk in the oil affected area (Degange, USFWS, personal communication).

Locating and capturing oiled sea otters was greatly influenced by prevailing sea conditions and weather. A series of large, outer islands protects Prince William Sound from ocean swells and limits the formation of wind waves. In contrast, the outer coast of the Kenai Peninsula and some areas around Kodiak Island are exposed to ocean swells and storms in the Gulf of Alaska. As a result, capturing sea otters in the latter areas was more difficult.

Typical spring weather conditions along the southern Gulf Coast of Alaska include snow, rain, high winds and fog. During the first month after the spill, the average daily air temperature in Valdez, Homer and Kodiak Island ranged from -4 - +8° C (24-46° F), and there were seven days of snow fall (Appendix 3). The beaches were covered with snow above the high tide line. Nevertheless, there were many days of clear or partly cloudy skies and light winds (i.e. less than 5 mph), and this greatly facilitated the initial capture operations in Prince William Sound. As summer approached, the average air temperature increased to 14° C (57° F), but there were more cloudy days (about 60% of the time) and frequent rain showers. Because the spill occurred three days after the vernal equinox, there were over twelve hours of daylight. The time between sunrise and sunset increased to a maximum of 19 hours by June 21.

The occurrence of the spill in early spring rather than in the winter greatly facilitated the capture of oiled sea otters. If the spill had occurred from November to February, the short, cold days and severe storms typical of that time of year would have greatly impeded capture operations and resulted in the

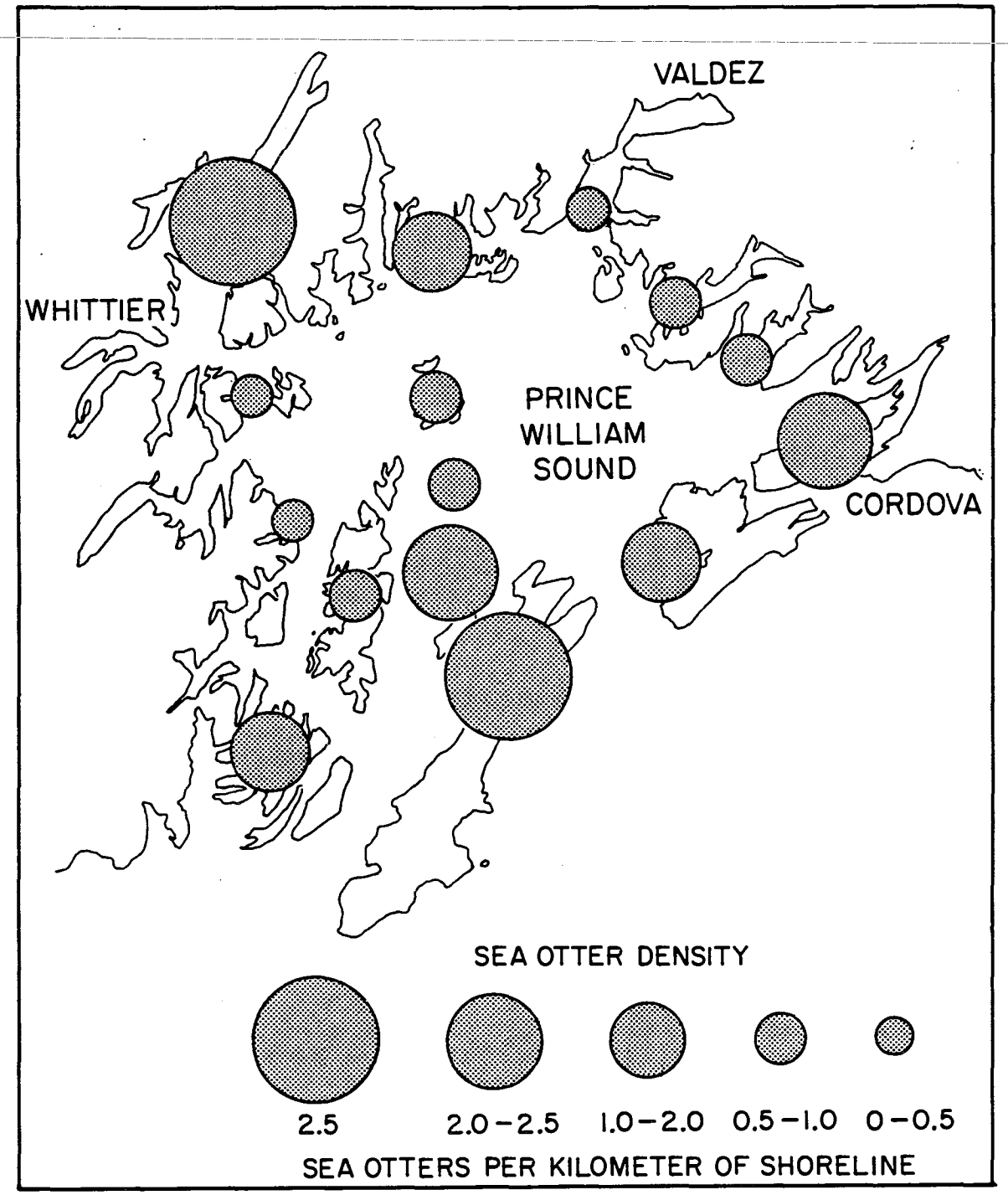


Figure 2.1 Coastal densities of sea otters in Prince William Sound prior to the oil spill (data courtesy of the USFWS).

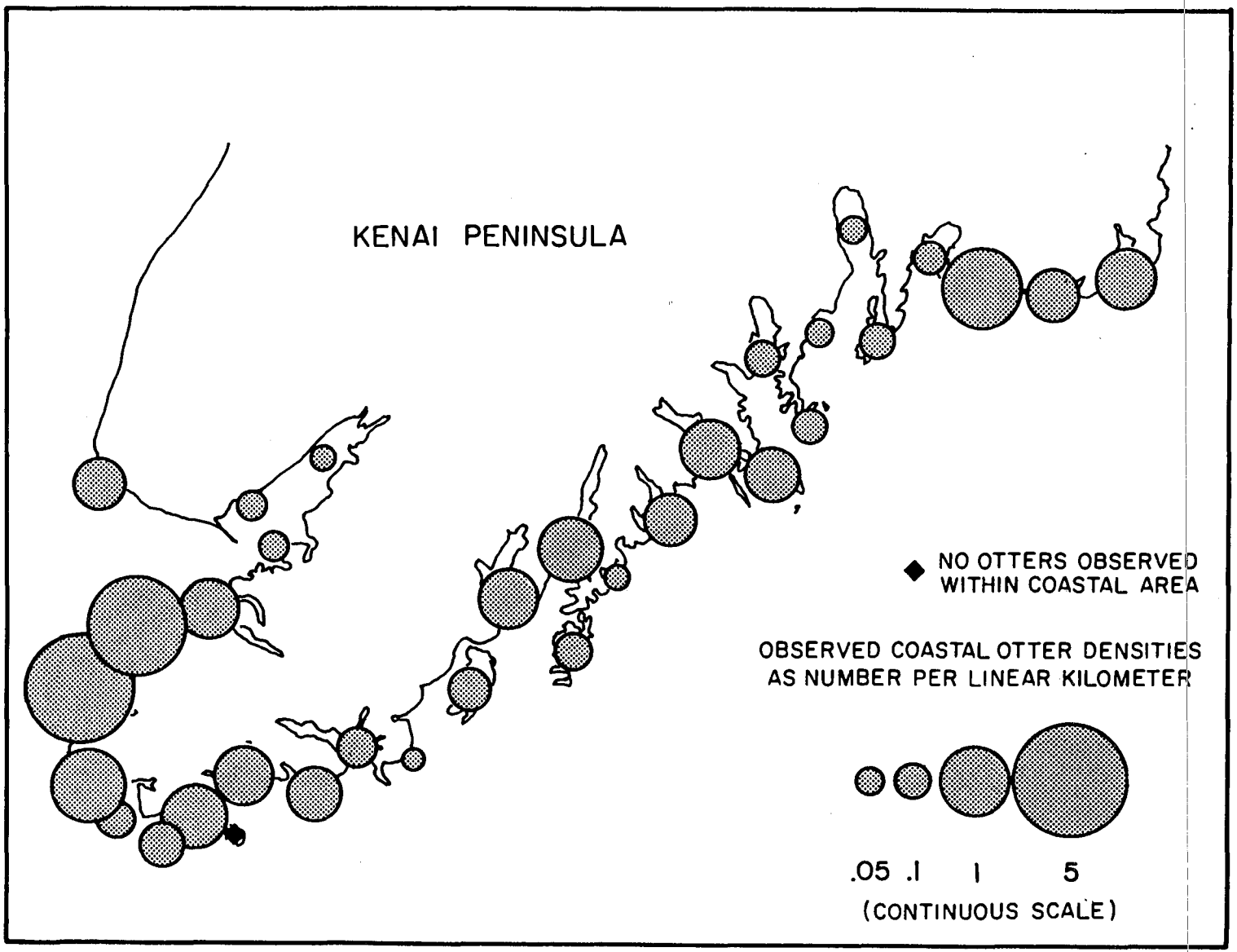


Figure 2.2 Coastal densities of sea otters along the Kenai Peninsula prior to the oil spill. Note change in scale from Figure 2.1.

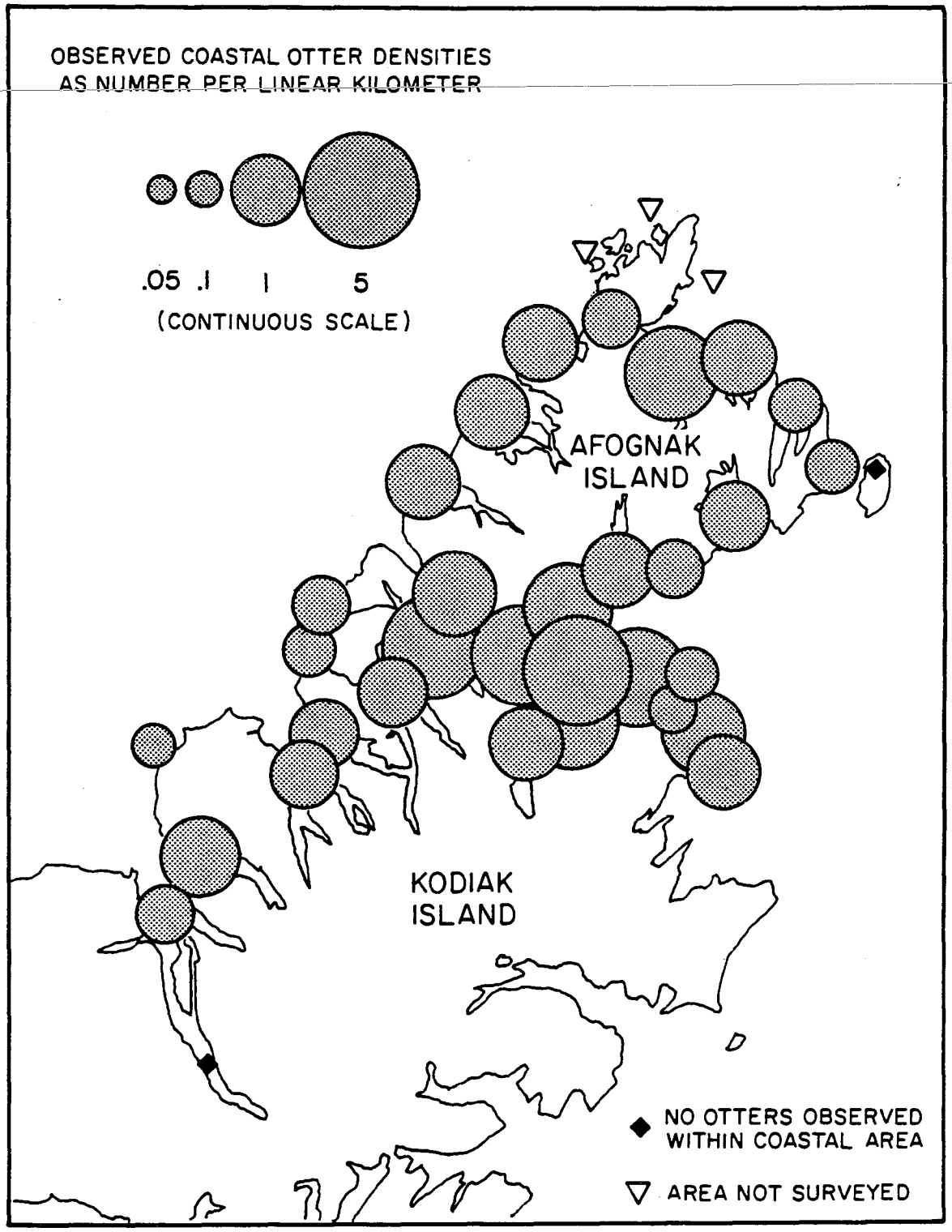


Figure 2.3 Coastal densities of sea otters around the Kodiak archipelago prior to the oil spill.

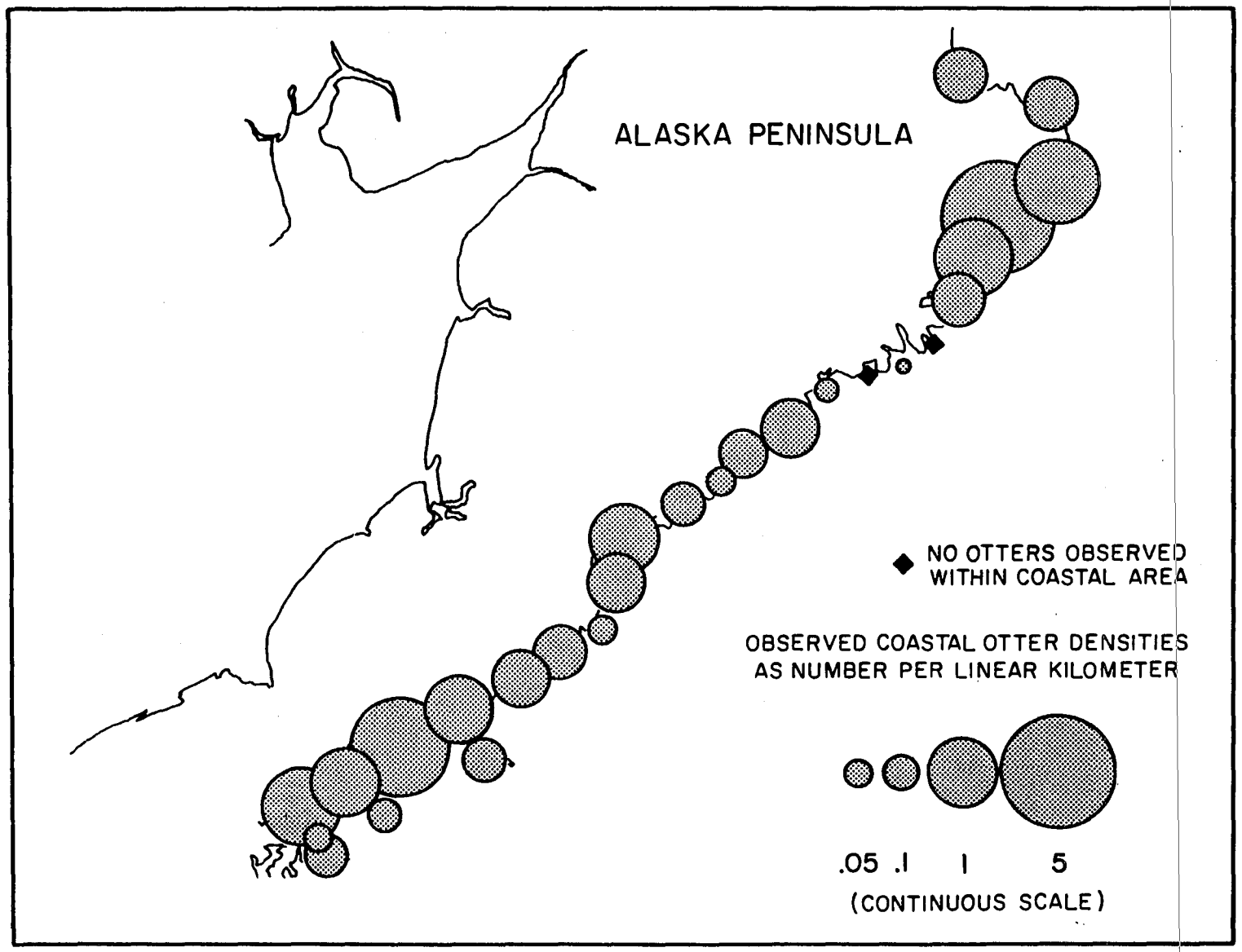


Figure 2.4 Coastal densities of sea otters along the Alaska Peninsula prior to the oil spill.

rehabilitation of fewer otters. It would have also made the operation more dangerous for the capture personnel. Future oil spill contingency plans for sea otters should consider the more stringent requirements for a winter oil spill.

II. Capture Personnel

A. Role of Exxon and the USFWS

Personnel sanctioned by the USFWS for capturing sea otters were either private contractors or employees of the USFWS and other state and federal agencies; the former were paid by Exxon and the latter were supported by their respective agency. In addition, some capture boats used Native volunteers including members of the Indigenous Conservators of the Environment (ICE). At least one person on each boat had experience in capturing sea otters or other marine mammals. This person became the leader of the capture team which included two or more assistants. In some instances, the capture team also served as crew on the boat.

In early April, some oiled otters were captured and brought to the Valdez rehabilitation center by the U.S. Coast Guard and private citizens who attempted to assist in the spill response. This included a group of about 28 fishing boats that were organized by Kelly Weaverling from Cordova and financially supported by Exxon. The primary mission of these boats was to recover oiled and dead seabirds under the direction of the bird rehabilitation center in Valdez. However, they soon began capturing oiled sea otters as well. Because people without proper training could have injured the otters and risked being bitten, the USFWS established a policy in early April that only authorized individuals could legally capture sea otters. However, many privately operated boats continued to provide valuable information about the location of oiled sea otters.

Initially, capture operations in Prince William Sound were coordinated by Kenneth Hill on the Rhoda Mae and Fred Weltz on the Dancing Bear. On March 29, Randall Davis requested the assistance of the USFWS, which chartered two capture vessels (details below). Keith Bayha at the USFWS regional office in Anchorage then assumed responsibility for directing capture operations. Working in close association with K. Bayha, K. Hill began supervising the transfer of sea otters by helicopter from the capture boats in Prince William Sound to the rehabilitation center in Valdez. When the sea otter rehabilitation center in Seward became operational in late April, Tom Early, Mike Hedrick and Jay Bellinger of the USFWS assisted K. Bayha in coordinating boats, personnel and helicopter operations.

B. Training

During the initial weeks of the oil spill, we attempted to hire persons with experience in capturing sea otters. We relied on these experienced persons to train their capture teams in the proper methods of using dip nets and tangle nets (details below), as well as methods of safely handling sea otters. In April, the USFWS issued guidelines to the capture teams to supplement their training (Appendix 4). These guidelines included a discussion of when otters suspected of being oiled should be captured, correct handling after capture, tagging, caring for the otters on the boats and recording capture information. When the USFWS decided to use Native volunteers from ICE in late April, they conducted a training program in Anchorage on May 14.

C. Authorization

Pursuant to the Marine Mammal Protection Act of 1972, the USFWS is authorized to designate persons to collect, clean and rehabilitate oiled sea otters under emergency conditions. On March 25, 1989, the USFWS verbally authorized R. Davis and those operating under his supervision to immediately begin such activities as a result of the Exxon Valdez oil spill. Written authorization was subsequently issued by the USFWS on May 4, 1989 (Appendix 5). In addition to sanctioning the rehabilitation of oiled otters, the letter authorized the rehabilitation centers to euthanize terminally ill animals and to perform necropsies and pathological investigations on otters that died.

III. Logistics

A. Overview

Capture operations began on March 29, 1989 in Prince William Sound and expanded to the Kenai Peninsula, the Kodiak archipelago, and the Shelikof Straits by the end of April. Thirteen boats and one helicopter were dedicated to capturing oiled sea otters; two of these boats were chartered by the USFWS (Table 2.1). Additional helicopters and fixed-wing aircraft (some of which were chartered by the USFWS) were used for aerial surveys and for transporting sea otters between the rehabilitation centers and to release sites. When capture operations ended in early August, two boats surveyed sites along the Kenai Peninsula for the release of rehabilitated otters. The last capture boat was released from service on September 2, soon after the rehabilitated sea otters had been released.

During the first week of the spill, the USFWS considered translocating unoiled sea otters at risk of becoming oiled. To ensure that the otters did not return to the oiled areas, it would have been necessary to move them at least 300 miles

Table 2.1. Capture boats for the sea otter rehabilitation centers. All dates refer to 1989. The location refers to the primary area of operation: PWS = Prince William Sound; KP = Kenai Peninsula; KI = Kodiak Island.

VESSEL	DEPLOYED	RELEASED	LOCATION
Dancing Bear	3/29	6/7	PWS
	7/17	7/23	PWS
Rhoda Mae	3/30	6/3	PWS
Viking	4/1	4/29	PWS
Sea Raker	4/1	4/29	PWS
Breaktime	4/10	7/26	KP
	8/7	8/31	KP
Foxy Lady	4/13	7/26	KP
Ten Bears	4/16	8/4	KI
Callisto	4/19	8/1	KP
Mystic Lady*	4/21	5/22	KP
Sea Ducer*	4/24	5/22	KP
Roman E	4/26	7/26	KP
	8/7	9/2	KP
Wayward	4/29	5/30	KP,KI
North Light	5/1	6/17	KP,KI

* means that the primary vessel also used a skiff for capture operations.

away or hold them in captivity (i.e. a netted lagoon in eastern Prince William Sound) until the oil dissipated. In the absence of advance planning, the USFWS decided that there was neither the time nor the resources to effectively plan and execute such a large translocation of otters. As a result, capture operations focused on oiled otters only.

B. Capture Boats

The first four capture boats were chartered from Cordova between March 29 and April 1, 1989, and sent to Prince William Sound. The Rhoda Mae and the Dancing Bear were under Exxon contract, and the Viking and the Sea Raker were under USFWS contract. At the same time, an ERA Bell 212 helicopter was dedicated to the program to airlift captured otters from the boats to the Valdez rehabilitation center. A Bell 206 helicopter based in Seward was chartered by the USFWS to assist in aerial surveys and to transport sea otters to the rehabilitation center.

On April 29, the USFWS terminated their contract with the Viking and the Sea Raker because of the rapid decline of otters requiring capture in Prince William Sound. On May 2, the Bell 212 helicopter was sent to Seward where capture efforts were beginning. After notifying the USFWS, Exxon released the Rhoda Mae and Dancing Bear on June 3 and June 7, respectively. However, the Dancing Bear was later dispatched to Prince William Sound from July 17-23 to monitor the behavior of otters and birds living in oil impacted areas.

As capture activity in Prince William Sound declined in mid-April, operations along the Kenai Peninsula were mobilized. Boats from Seward and Homer were contracted on April 10 and April 26, respectively, and the first sea otter from the Kenai Peninsula was captured on April 15. The number of capture boats working along the Kenai Peninsula peaked in early May with eight boats contracted from Seward and two boats contracted from Homer (Table 2.1). Generally, these boats worked along the eastern Kenai Peninsula from Nuka Passage south to Windy Bay. The Bell 212 helicopter and two Bell 206 helicopters transported otters from the capture boats to the Seward rehabilitation center and the temporary care facility in Homer.

Sea otter capture operations along the Kenai Peninsula began to decline in mid-May. Two of the boats, the Wayward and the North Light, were transferred to Kodiak on May 14 and 21, respectively. Between May 17 and May 30, an additional five otter boats from Seward were released leaving only three boats to work along the peninsula. The North Light, which had been sent to Kodiak, was transferred back to the Kenai Peninsula on June 17. These five boats continued working along the Kenai Peninsula until late July.

Three boats were dedicated to capturing oiled otters around the Kodiak archipelago. The Ten Bears was hired in Kodiak on April 16 and the other two boats, which came from the Kenai Peninsula area, were transferred to Kodiak in mid-May. The Jeonoah, whose primary goal was to capture oiled seabirds, captured two sea otters along the Alaska Peninsula near Katmai National Park in May. In addition, the USFWS trained Native skiff crews in the villages of Larson Bay and Ouzinke to capture oiled sea otters around the northern end of the Kodiak archipelago. Aircraft for transporting oiled otters from Kodiak Island to the Seward rehabilitation center were chartered as needed.

Because few oiled otters were found around Kodiak Island, the Wayward was released from its charter on May 30, and the North Light was sent back to Homer on June 17. The Ten Bears resigned from service on August 4, and no boat was hired to replace it.

By early June, most of the otters along the Kenai Peninsula were either unoiled or so lightly oiled that the degree of contamination could not be determined visually. It became questionable whether capture operations should continue, especially if the otters appeared healthy and eluded easy capture. As a result, the Breaktime, the Roman E and the Foxy Lady were released by Exxon on July 26, followed by the Callisto on August 1 and the Ten Bears on August 4. In addition, the helicopter used for transporting otters was removed from dedicated service. However, Bell 212 or Bell 206 helicopters were available for transporting otters between the Seward rehabilitation center and the pre-release facility in Little Jakolof Cove.

On July 31, a meeting was held in Anchorage between Exxon and the USFWS to discuss the status of the wildlife rescue program. As a result of this meeting, the Roman E and the Breaktime were redeployed on August 7 to look for unoiled areas along the Kenai Peninsula where rehabilitated sea otters could be released. No otters were to be captured from that time onward. The Ten Bears was asked to monitor otters around Kodiak Island. However, the captain was not interested in being rehired, and the USFWS did not request a replacement. By the end of August, all of the rehabilitated otters had been released. Contracts with the remaining two boats were terminated by September 2, 1989.

C. Aircraft

Various aircraft were used during the sea otter rescue effort. The most versatile was a Bell 212 twin-turbine helicopter which was dedicated to the program. This helicopter could carry 12 kennel cages at a time and was equipped with radar enabling it to fly in low visibility weather. The crew was

familiar with the geography and weather of Prince William Sound and the Kenai Peninsula. Although two Bell 206 helicopters were also used by the USFWS, they could carry no more than three cages and one passenger at a time.

The Bell 212 helicopter was used from March to September to transport otters from the capture boats to the rehabilitation centers as well as between the centers. However, it was less useful for aerial surveys of oiled sea otters. The sound of the engines frightened the otters, and it was difficult for the observers to locate the animals before they dived. For this reason, a Cessna 206 on floats and the smaller Bell 206 helicopter were preferred for aerial surveys.

Other aircraft included a twin-engine deHavilland "Otter" which was often used to carry sea otters from Kodiak Island to the rehabilitation center in Seward. On several occasions, a single-engine deHavilland "Otter" transported otters between Seward and Homer. A variety of helicopters including a twin-rotor Sikorsky from the U.S. Marines, an H-3 from the Coast Guard, a Bell 212, and a Bell 214 were used to transport over 150 rehabilitated sea otters to release sites in Prince William Sound and along the Kenai Peninsula. The Sikorsky and H-3 helicopters could carry 15-20 cages and up to ten people at a time, but required a larger landing area than the other helicopters.

D. Communications

The high mountains surrounding Valdez and Seward prevented line-of-sight radio communications between capture boats and otter rehabilitation centers. As a result, ship-to-shore communication was only possible using the marine operator. Unfortunately, the marine operator was often difficult to contact because of the increased demand associated with the oil spill response activities. Initially, information from the capture boats in Prince William Sound was passed by single side-band radio to Chitina Air Service in Cordova. The radio operator in Cordova would then telephone the sea otter rehabilitation center in Valdez.

To overcome poor radio communications, K. Bayha in Anchorage and K. Hill in Valdez scheduled a daily telephone conference to exchange information and plan the deployment of capture boats. When the rehabilitation center in Seward opened, K. Bayha conducted daily telephone conferences with T. Early and M. Hedrick, who relayed directions to the capture boats along the Kenai Peninsula when the helicopters flew out to pick up the sea otters. When weather permitted, the helicopters made morning and afternoon flights.

The inability to establish direct and reliable communications between the rehabilitation centers and capture

boats was one of the most serious problems in the sea otter rehabilitation program. Good ship-to-shore communications would have greatly improved the efficiency of the capture operation and expedited the delivery of sea otters to the rehabilitation centers.

E. Field Documentation

The captain of each capture boat maintained a log of his movements and capture locations. Capture information (i.e. date, location, the animal's condition, tag number) was recorded on forms provided by the USFWS or written in indelible ink on duct tape that was placed on the transport cages. The capture forms were placed in the otters' medical files when they arrived at the rehabilitation centers. However, otters often arrived without capture information because 1) the animals had been picked up by unauthorized persons, 2) the information had been lost in transport or 3) the forms had been delivered directly to the USFWS.

IV. Location of Captured Sea Otters

The prevailing winds and currents in Prince William Sound carried the oil slick in a southwesterly direction from Bligh Reef. As a result, most of the oiled sea otters captured in the Sound came from Green Island, the Knight Island group, Evans Island, La Touche Island and Fleming Island (Figure 2.5). Some bays and islands in the affected area were not oiled and became sanctuaries for sea otters and other wildlife. Seventy-five percent (117) of the sea otters that arrived at the Valdez rehabilitation center from Prince William Sound were captured by April 11, and no otters were captured in this area after April 22 (Figure 2.6). Otters arriving at the Valdez center after this date came from the Kenai Peninsula or the Kodiak archipelago.

Capture locations along the Kenai Peninsula were even more concentrated than in Prince William Sound. This resulted from the large number of sea otters in this heavily oiled area and limitations in the capture operation imposed by rough seas and severe weather along exposed areas of the Kenai Peninsula. About 85% of the otters in this area were captured in Windy Bay, Rocky Bay and Tonsina Bay between April 15 and July 23 (Figure 2.7). The few oiled sea otters from the Kodiak archipelago came from Afognak Island, northwestern Kodiak Island, and the Alaska Peninsula between May 17 and June 14 (Figure 2.8).

V. Capture Techniques

Oiled sea otters were captured with dip nets (Figure 2.9) or tangle nets (modified gill nets, Figure 2.10). Both methods have

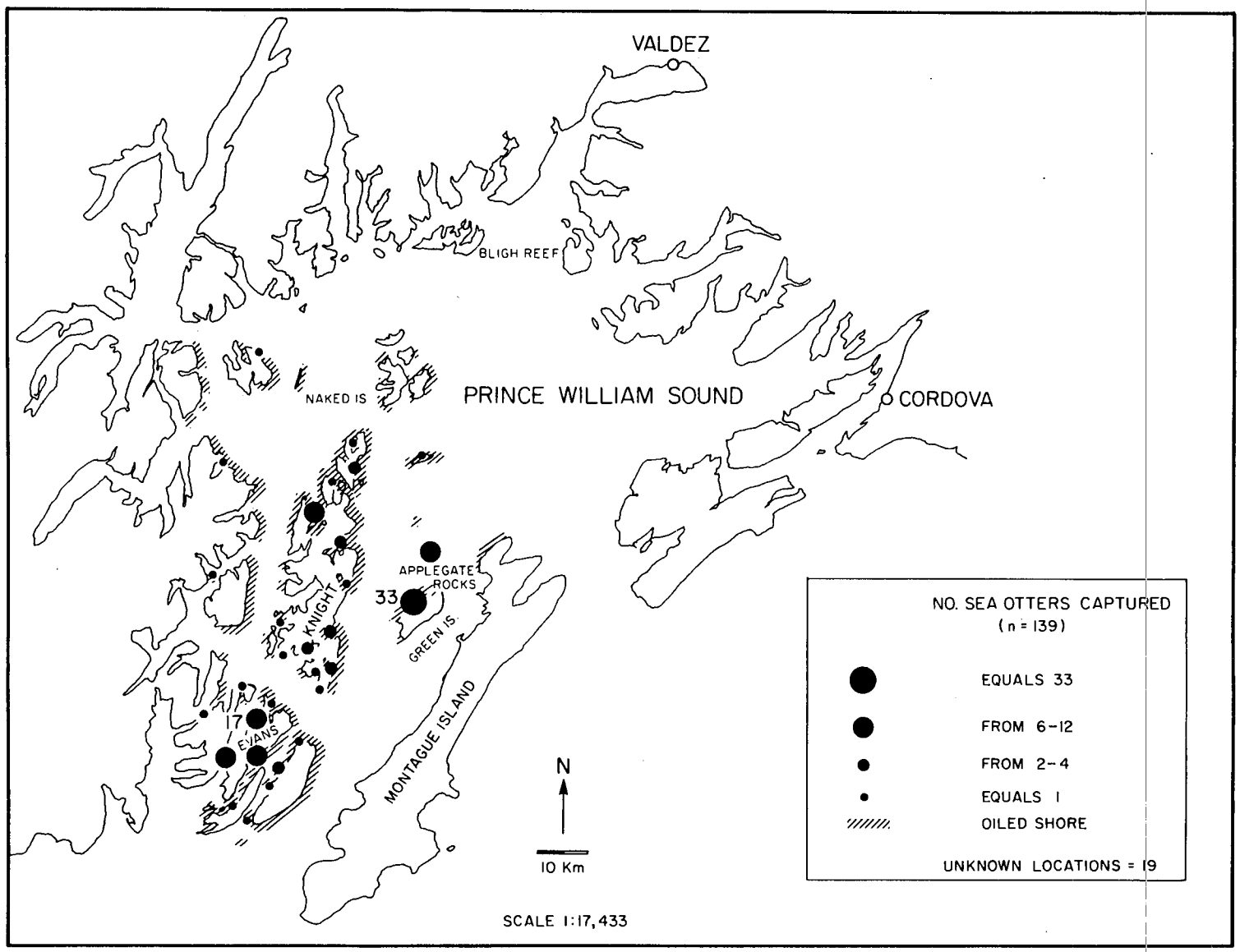


Figure 2.5 Sea otter capture locations in Prince William Sound.

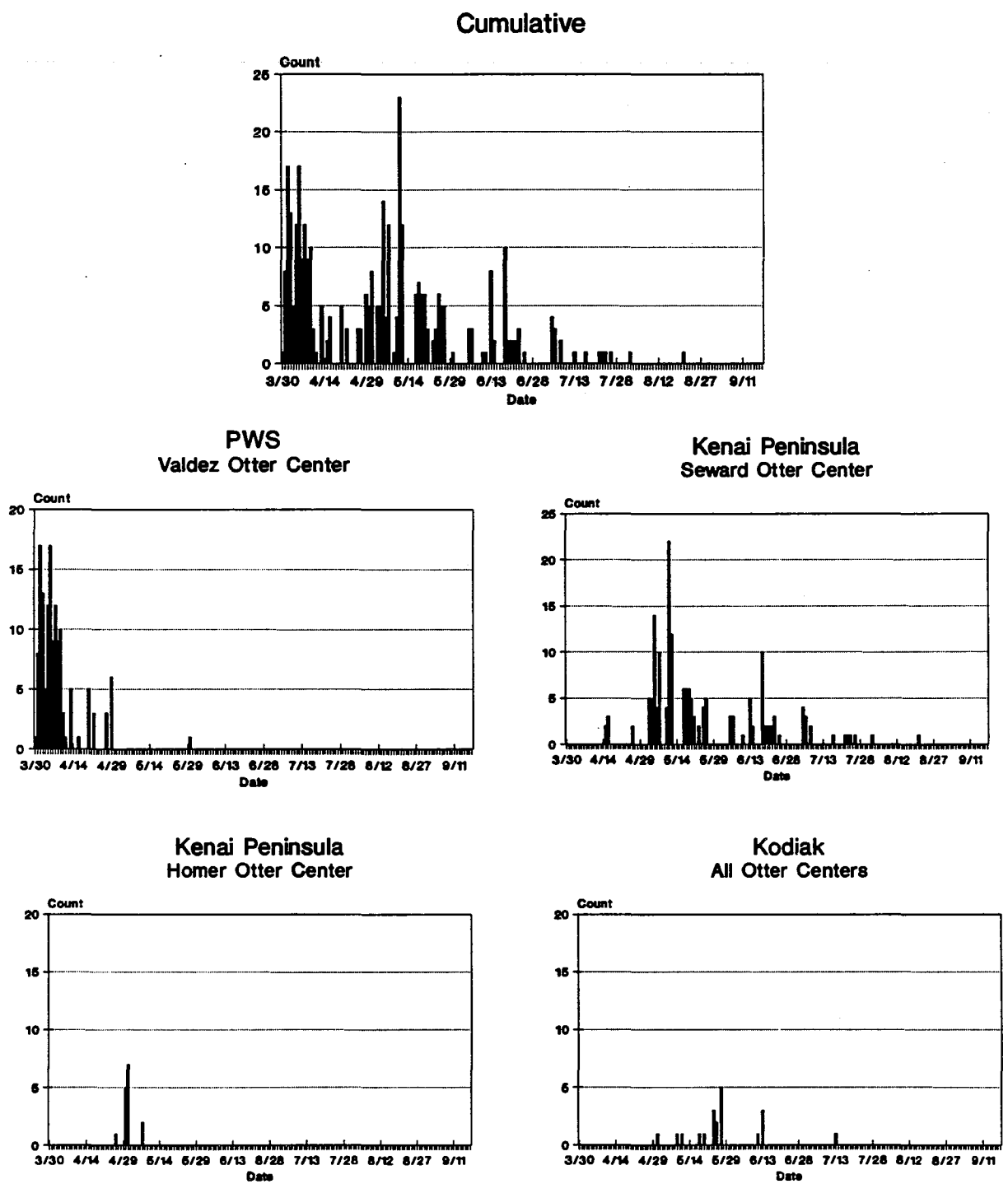


Figure 2.6 Daily sea otter captures in Prince William Sound, along the Kenai Peninsula and around the Kodiak archipelago.

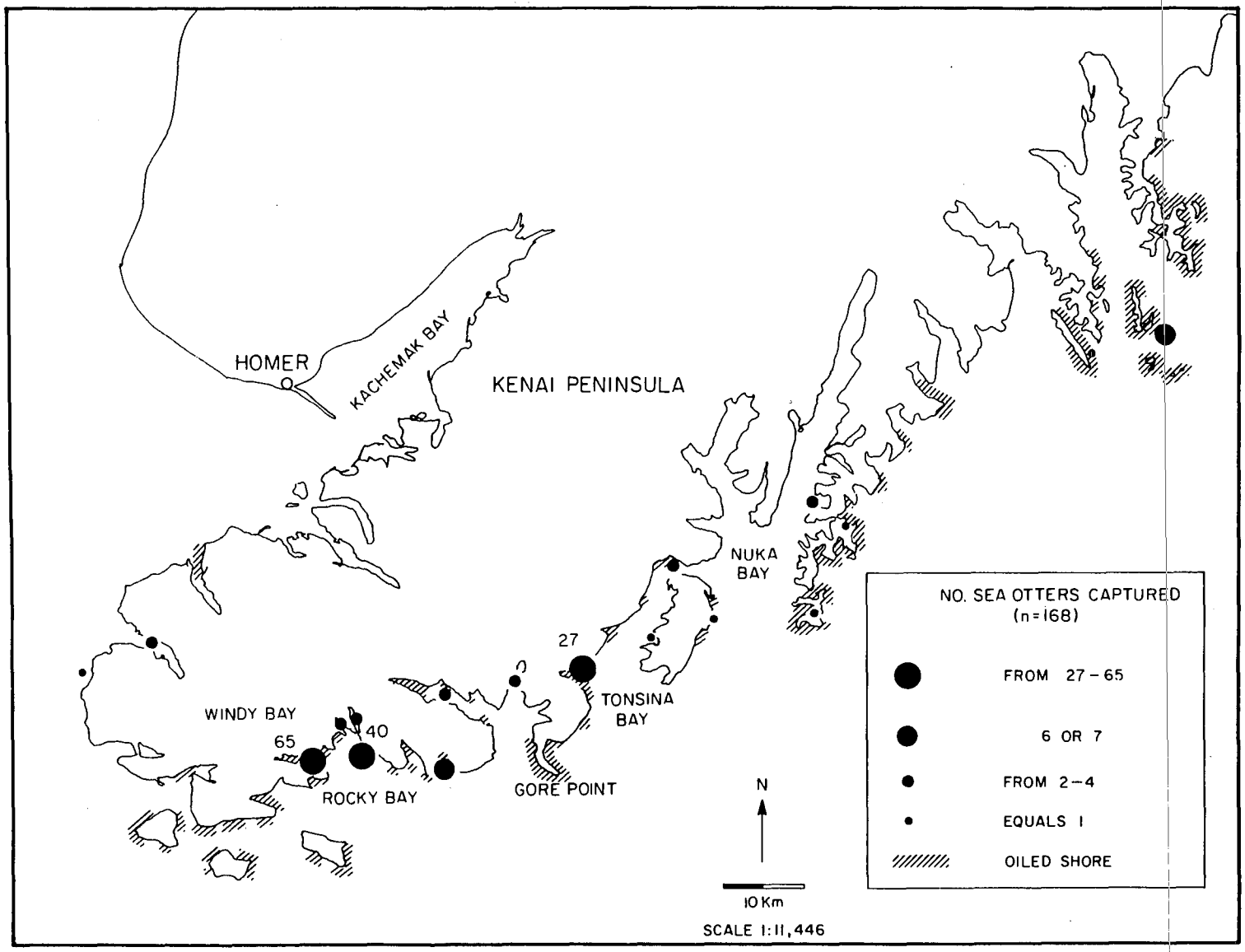


Figure 2.7 Capture locations along the Kenai Peninsula.

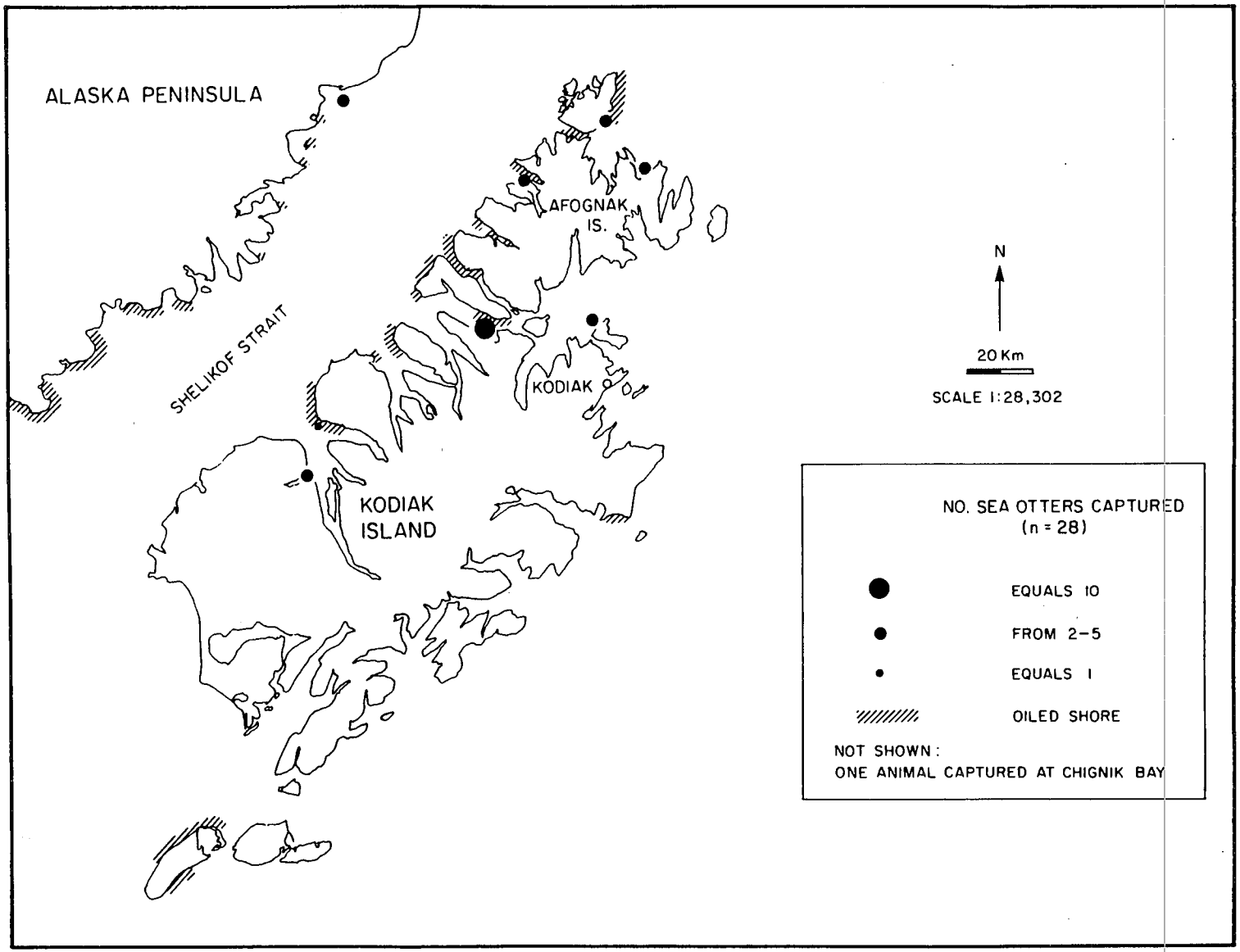


Figure 2.8 **Capture locations around the Kodiak archipelago.**

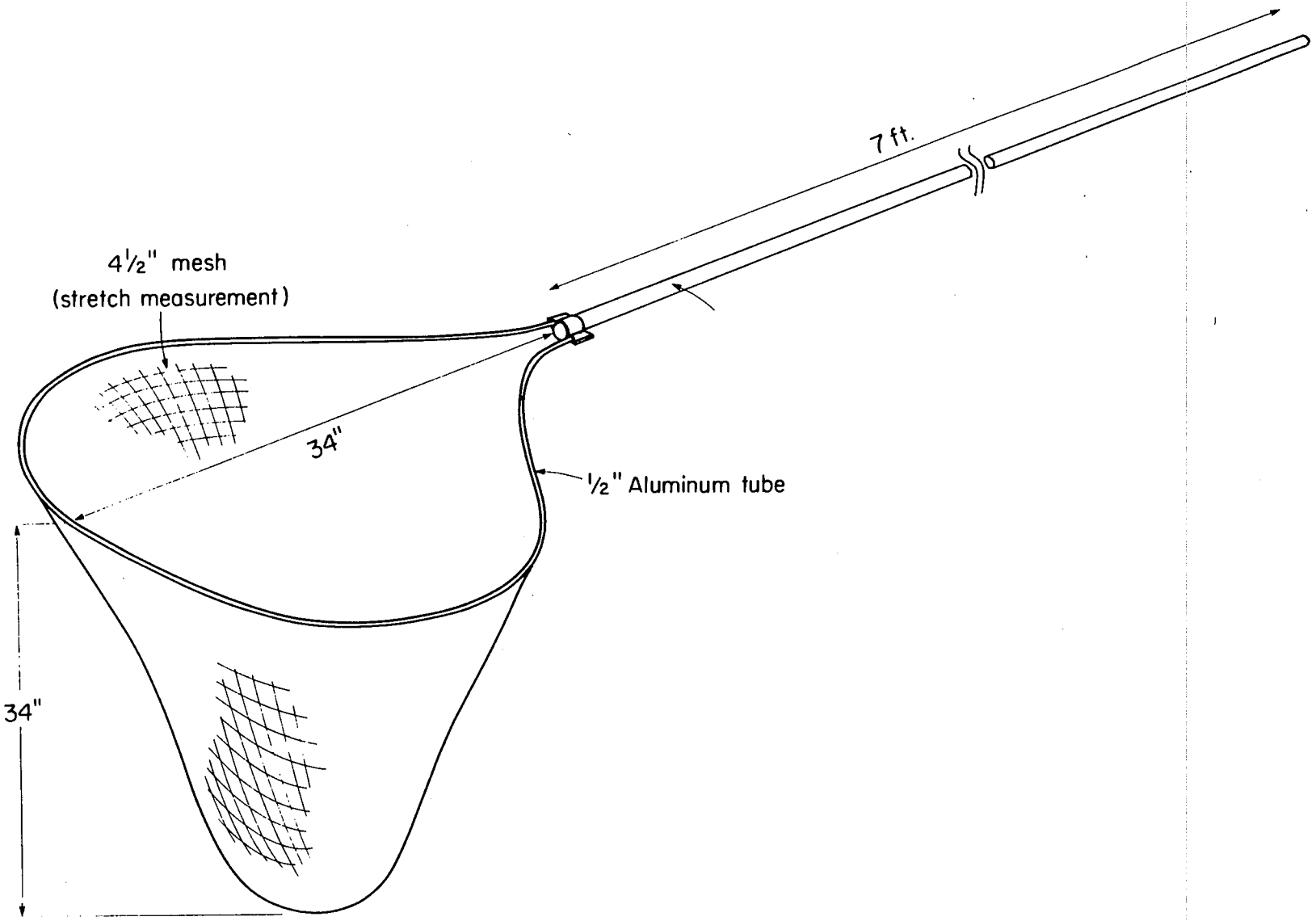


Figure 2.9 Dip net used to capture sea otters.

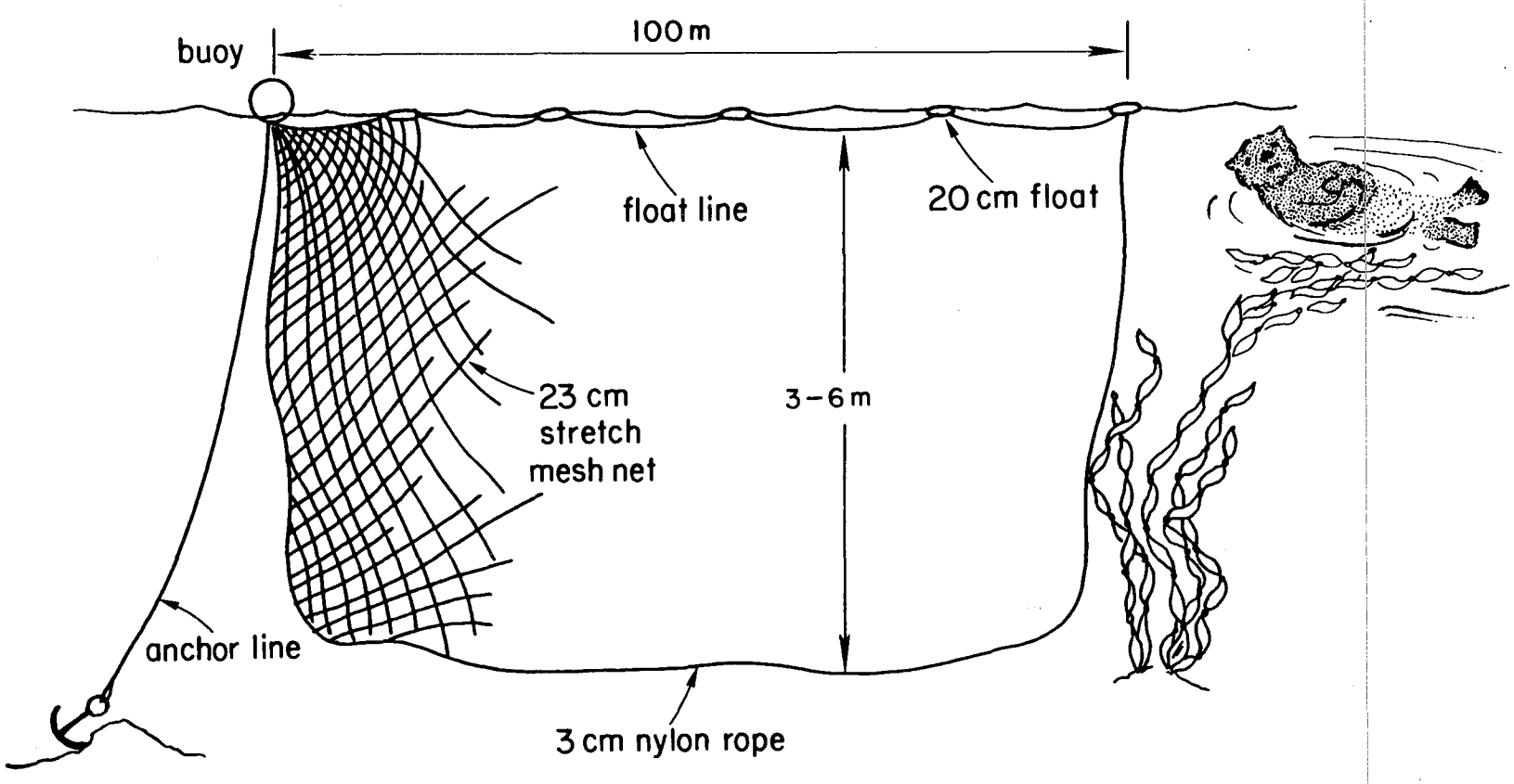


Figure 2.10 Tangle net made from a modified gill net. Otters become entangled when they attempt to swim through the netting.

disadvantages and can injure or kill an otter if improperly used. Dip nets were very effective early in the spill when heavily oiled otters were lethargic and easily approached on land or in the water. In a few instances, extremely distressed otters were picked up by hand on shore and placed in cages. Lightly or moderately oiled otters showed fewer signs of distress and were difficult to capture with dip nets. Consequently, greater reliance was placed on tangle nets, especially along the Kenai Peninsula.

The major advantage of using dip nets was that oiled otters could be selectively captured. The technique required a small skiff, a driver, and a person to handle the dip net. The net handler stood in the bow while the boat was driven toward the otter at high speed. When the boat reached the otter, the net handler scooped the animal out of the water before it submerged. If the otter was on the shore, the boat approached the beach as quickly as possible in order to net the animal before it could escape. The driver secured the skiff and assisted the net handler in placing the otter in a kennel cage.

It was often necessary to chase lightly oiled otters until they became too tired to dive. However, long chases were often unsuccessful, stressful to the otters, and may have caused muscle injury (capture myopathy syndrome). In addition, chasing female otters with young pups could cause the mother to inadvertently drown or abandon the pup. As a result, we discouraged the use of dip nets when the otters were healthy enough to elude easy capture.

Tangle nets are modified gill nets made of 23 cm stretch mesh similar to that used for catching king salmon (Figure 2.10). The nets are generally 30-90 meters long and 3-6 meters deep. The cork line is made of floats that are spaced one meter apart or rope that is buoyant. The bottom edge is unweighted or very lightly weighted so as not to drown the entangled otter.

The disadvantages of using tangle nets were: 1) they had to be checked hourly, 2) the entangled otters sometimes injured one another and 3) they captured both oiled and unoiled otters. This latter problem was most pronounced along the Kenai Peninsula, where most of the lightly oiled otters were too healthy to be captured with dip nets. As a result, many otters captured with tangle nets and sent to the Seward rehabilitation center did not require cleaning.

VI. Transport Cages

The most convenient method of transporting sea otters for short periods of time (less than 3 hours) was in plastic Vari-Kennels (series 300, 400 and 500; Figure 2.11). These

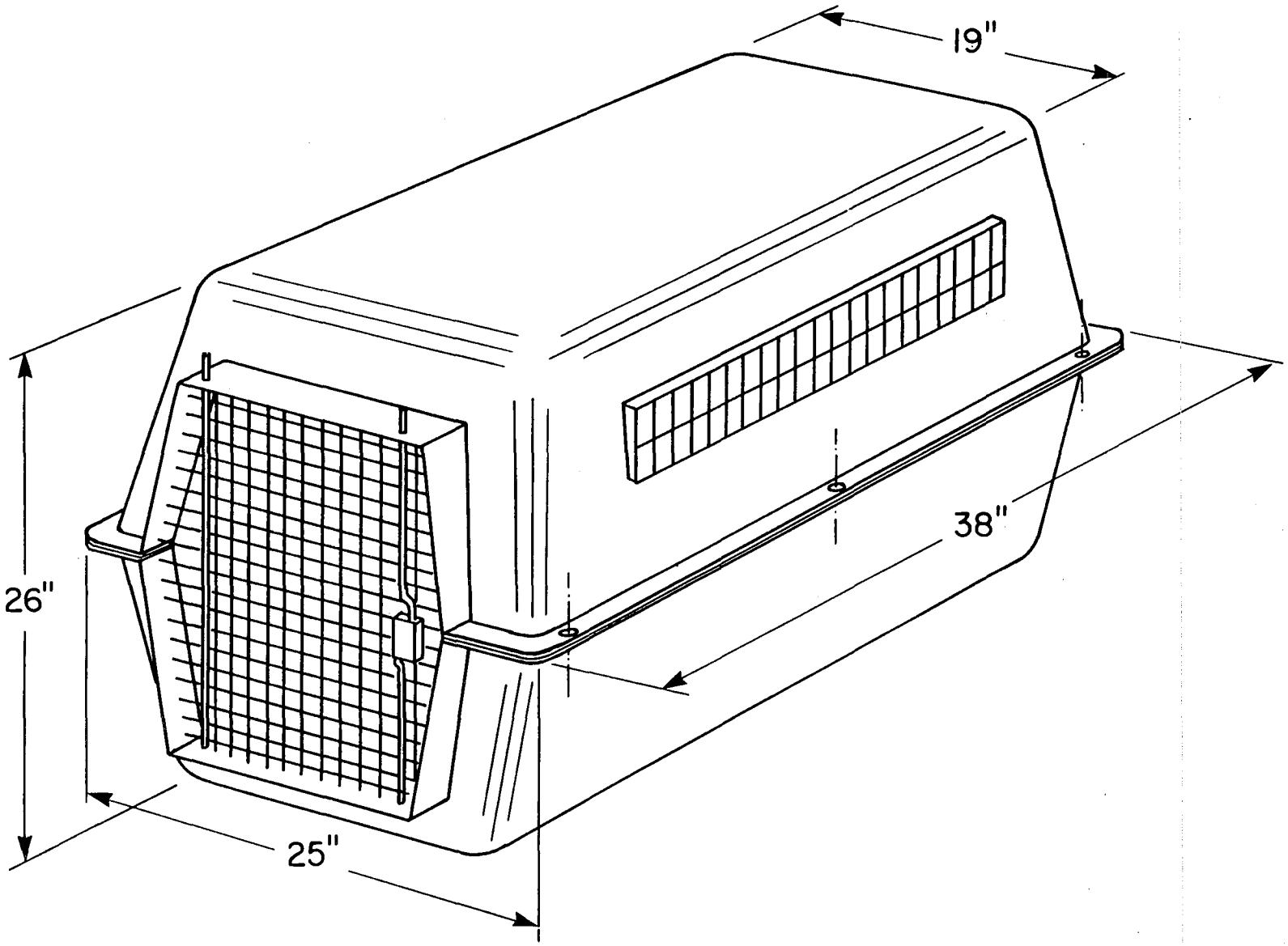


Figure 2.11 Plastic kennel cage used to transport sea otters on aircraft. A metal rack was placed in the bottom of the cage to prevent the otter's fur from becoming soiled with feces and urine.

inexpensive, light-weight cages could be easily loaded into a helicopter or airplane by two people. They were also easy to clean and disinfect if they became soiled or oily. When transporting rehabilitated sea otters, a small rack was placed in the bottom of the cage to prevent the otter's fur from becoming soiled with feces and urine.

Caged sea otters were subject to overheating (hyperthermia) or could become chilled (hypothermia) depending on their medical condition and the weather. Oiled otters were often susceptible to hypothermia because the insulating quality of their fur had been damaged. This was a problem on the capture boats on cold nights. If an otter was shivering or the hind flippers were cold to the touch, then the animal was moved to an area protected from wind or rain. In some instances, an infrared heat lamp was used to warm the animal.

Hyperthermia was a concern for healthy and rehabilitated otters, especially during transport in warmer summer months. To prevent this problem, a layer of crushed ice or pieces of block ice were placed in the cages. The ice cooled the otters and provided a source of fresh water to prevent dehydration. The ice was changed when it became contaminated with feces.

VII. Establishing Objective Criteria to Determine When Capture Operations Should Cease

Heavily oiled sea otters displayed a variety of abnormal behaviors such as:

1. Excessive or exaggerated grooming behavior during initial contact with oil. This included raising the upper body out of the water and shaking vigorously.

2. Lethargy after several hours of oil exposure.

3. Hauling out on shore and a reluctance to leave the beach when approached by the capture crews.

4. Absence of normal feeding behavior resulting in emaciation.

The oily appearance of the fur and the abnormal behaviors described above were less apparent in lightly oiled otters. As a result, it became increasingly difficult after the first month to determine whether an animal was oiled and should be captured. To help capture personnel determine the degree of oiling, a pilot study was conducted at the Seward center with 20 sea otters captured along the Kenai Peninsula. Dimethyl chloride was used to solubilize oil on fur samples taken from behind the neck and the lower abdomen. If oil were present, the solvent became brown

in color. Unfortunately, the study was conducted in late June, by which time most of the otters were unoiled or too lightly oiled for detection by this method. Further research is needed to develop a field test for future oil spills.

The ability of lightly oiled otters to avoid easy capture with dip nets raised the question: How much oiling can be tolerated without the need for cleaning? It may be possible for lightly oiled otters to restore their fur by normal grooming, especially when the oil has weathered for several weeks. In addition, we need more information about the tolerance of otters to systemic petroleum hydrocarbons. Because the rehabilitation process is stressful and creates its own risks to the animal's health, we must weigh the effects of oiling against the potential risks of capture and rehabilitation.

VIII. Conclusions

1. Coastal geography, sea conditions and weather were major factors that affected the number and location of oiled sea otters that were captured.

2. Capture operations had to be flexible because the rate of movement and distribution of the oil could not be predicted with certainty. Additional boats with experienced capture crews were deployed as the spill moved along the Kenai Peninsula.

3. Although the preemptive capture and translocation of sea otters in the oil impacted area was considered by the USFWS, it was deemed impractical due to the lack of advance planning. Such a program may have saved additional otters, but it would have required additional capture boats and areas to translocate or hold the otters.

4. Transporting sea otters from the capture boats to the rehabilitation centers with a Bell 212 helicopter worked well and allowed the capture teams to remain at sea. However, poor radio communication often caused delays in delivering oiled otters to the rehabilitation centers. Ideally, otters should be transported to the rehabilitation centers within six hours of capture.

5. Because of the risk of injury to the animals and the handlers, only trained personnel were authorized to capture oiled sea otters.

6. Additional research is needed to determine whether lightly oiled otters can restore their fur without cleaning.

7. An effective capture operation requires advance planning by the USFWS and the rehabilitation centers, especially if

preemptive capture is anticipated.

IX. Literature Cited

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Chapter 3. Critical Care and Toxicological Evaluation of Sea Otters Exposed to Crude Oil

Terrie M. Williams, Ph.D.
Riley Wilson, D.V.M.
Pamela Tuomi, D.V.M.
Lee Hunter, Ph.D.

I. Introduction

Because sea otters routinely swim and rest on the surface of the water, their first contact with an oil slick results in external contamination of the fur. This contamination along with inhalation of volatile petroleum hydrocarbons, transdermal absorption and ingestion of oil can lead to systemic toxic effects. Inhalation of volatile hydrocarbons can result in pulmonary and other toxicological problems in marine mammals (Geraci and St. Aubin, 1988). In addition, sea otters are likely to ingest oil because they lick their fur while grooming and feed on invertebrates that are easily contaminated with oil (i.e. intertidal mussels and clams). Even if the prey is not initially oiled, sea otters may contaminate their food when they bring it to the surface of the water to eat. Despite this, few studies have documented systemic toxic effects from petroleum hydrocarbon ingestion in aquatic mammals (Geraci and St. Aubin, 1988). One exception was the investigation by Baker et al. (1981) which showed ingestion to be a significant cause of death in river otters exposed to an oil spill.

This chapter describes the initial clinical assessment and care of sea otters affected by the oil spill. Criteria for triage and for assessing crude oil exposure are presented. We also describe three major medical problems of oiled sea otters: hypothermia, hypoglycemia, and emphysema. The incidence of these conditions in relation to oil weathering is provided. Finally, we suggest further research to improve our understanding of the toxic effects of crude oil on sea otters.

II. Demographics of Oiled Sea Otters

From March 30 to August 21, 339 sea otters were received at the Valdez, Seward, and Homer rehabilitation and pre-release facilities (Figure 3.1; Appendix 6). In addition, 18 pups were born in captivity. Almost 75% of the 154 sea otters that were captured and sent to the Valdez rehabilitation center arrived within the first three weeks of the spill (March 24 to April 11); the remainder arrived within six weeks of the spill. In comparison, 69% of the 175 otters that were captured and sent to the Seward center arrived from May 1-25. The pre-release center

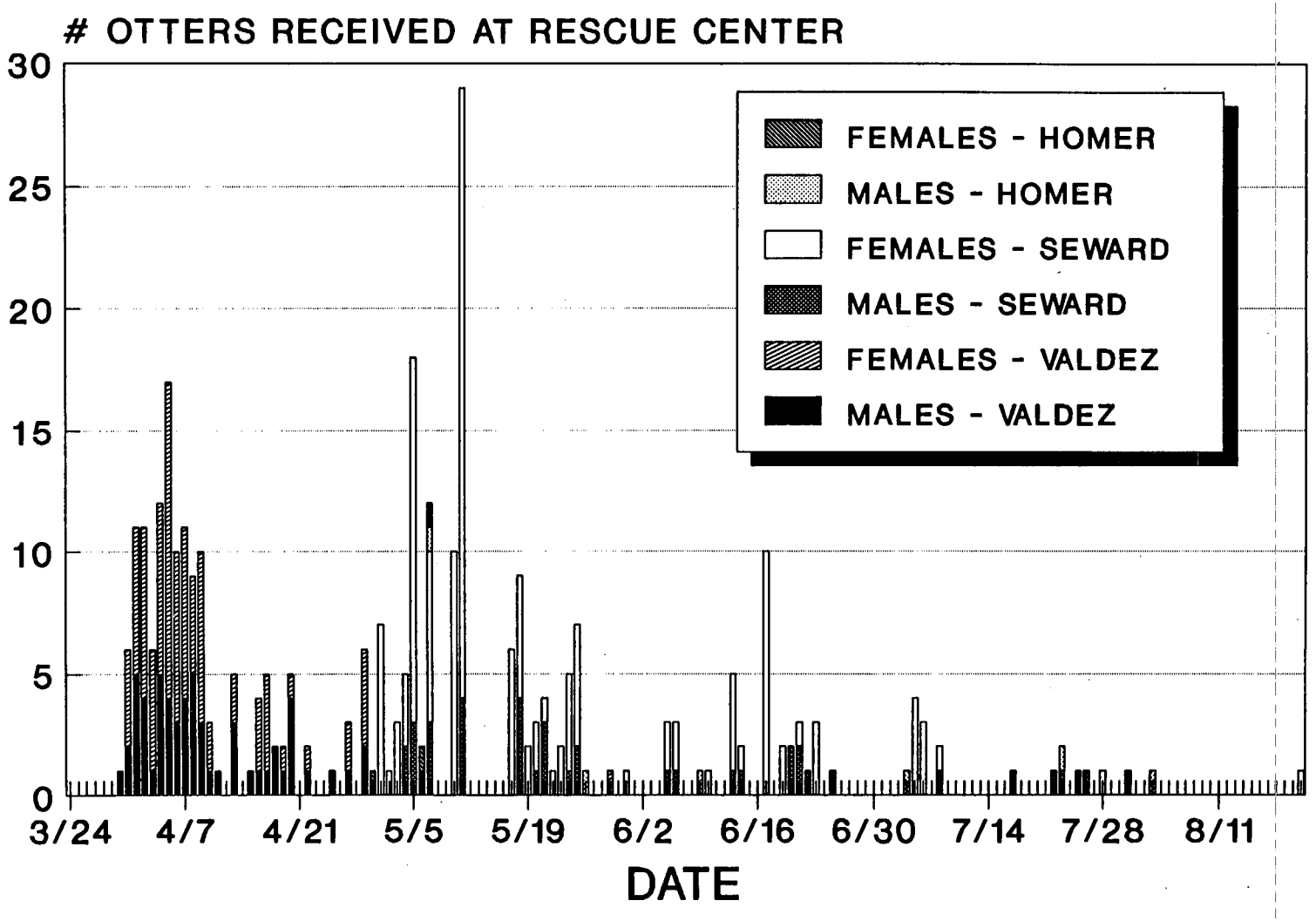


Figure 3.1 The number of sea otters received at the Valdez, Seward, and Homer centers in relation to sex and date.

in Little Jakolof Cove received ten adult otters directly from the wild over the period of April 25 to August 3.

Females made up the majority of the otters at the rehabilitation centers; 55% of the otters at Valdez and 77% of the otters at Seward were female (Figure 3.2). This sex ratio resulted from the movement of oil into areas occupied predominantly by females (Degange and Lensink, in preparation). Forty-six female otters (21%) were diagnosed as pregnant (by palpation) when they arrived at the rehabilitation centers (Figure 3.3). Of these, three females in Valdez, and eleven in Seward and four in Homer gave birth to live pups in captivity. Fourteen of the pregnant animals died before giving birth, and 10 pregnancies ended in abortion or stillbirth. Toxicological and histopathological analysis of tissue samples will be necessary to determine whether oil contamination contributed to these deaths.

Mortality was high in captive born otters; of the 18 animals born, only one pup from Valdez, three from Seward, and three from Homer survived. The 39% survivorship for these animals is lower than the 57% reported for California sea otters born in the wild (Siniff and Ralls, 1988). Survivorship was higher for orphaned pups retrieved during capture operations than for those born at the rehabilitation centers (Figure 3.3). Of the eleven orphaned pups received by the Seward center, only one died. Two abandoned pups from Prince William Sound were brought to the Valdez facility and both survived. Nine mother-pup pairs were captured along the Kenai Peninsula. Of these, four pairs were eventually released, three pups were raised in the nursery at Seward and later sent to Point Defiance Aquarium, and two pups died.

Average body weight at the time of admission at the Valdez rehabilitation center was 19.5 kg $\pm$ 5.1 SD (n = 53) for male sea otters and 18.6 kg $\pm$ 4.5 SD (n = 79) for females. Otters at the Seward facility were slightly larger with mean weights of 28.8 kg $\pm$ 9.5 (n = 22) and 22.8 kg $\pm$ 4.0 (n = 66) for males and females, respectively. Differences in the average weight of the otters in the two centers may have resulted from 1) pre-capture weight loss in heavily oiled otters, 2) inherent size differences between the Prince William Sound and Kenai populations (Rotterman and Simon-Jackson, 1988), and 3) the stage of pregnancy for female otters on admission (i.e. a greater proportion of female otters at the Seward facility were near the end of pregnancy on admission). Despite these differences, the average body weight of otters at both rehabilitation centers was within the normal range for juvenile and adult sea otters (Kenyon, 1969; Estes, 1980; Rotterman and Simon-Jackson, 1988).

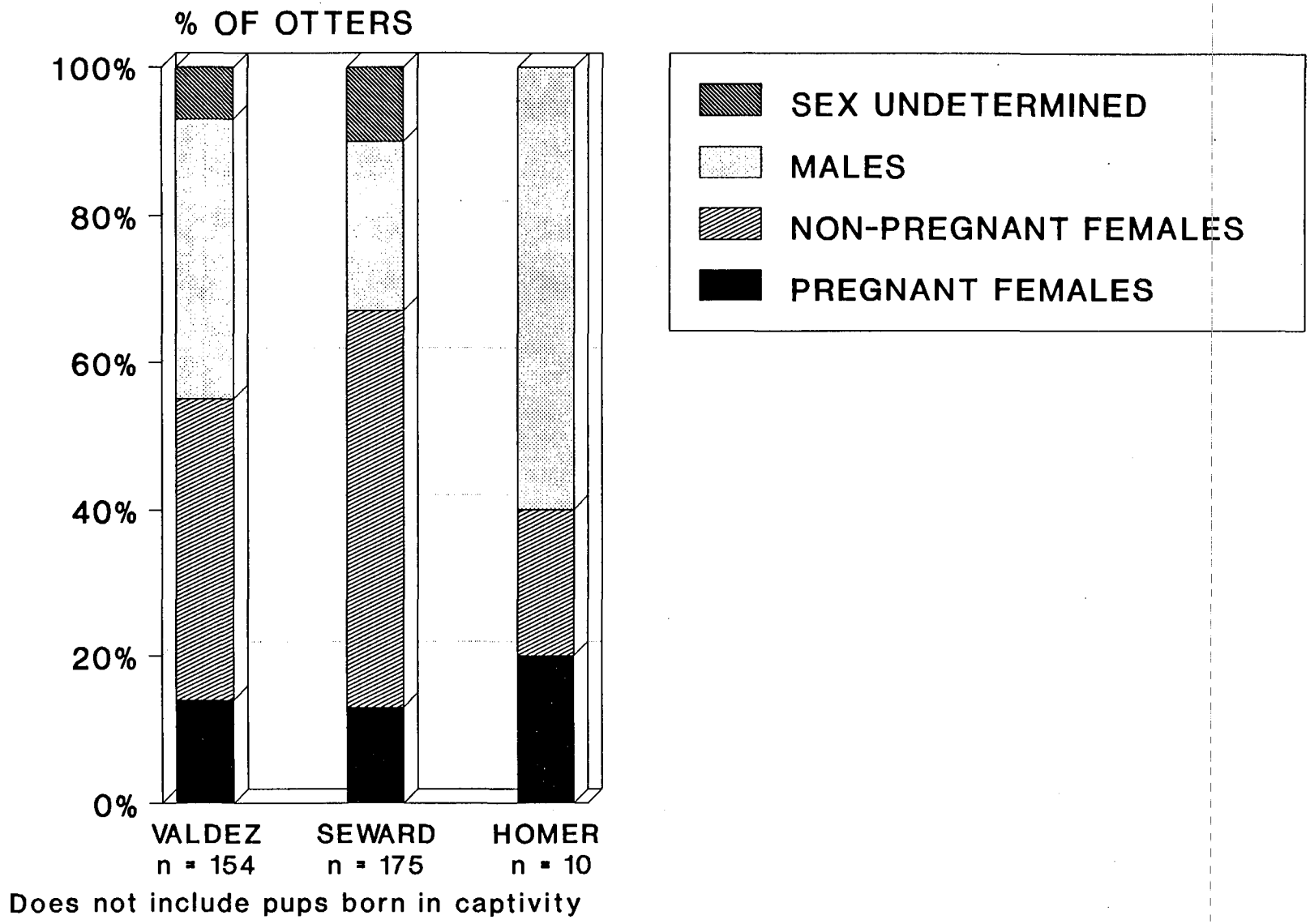


Figure 3.2 Percentage of male, female and pregnant sea otters at the three centers.

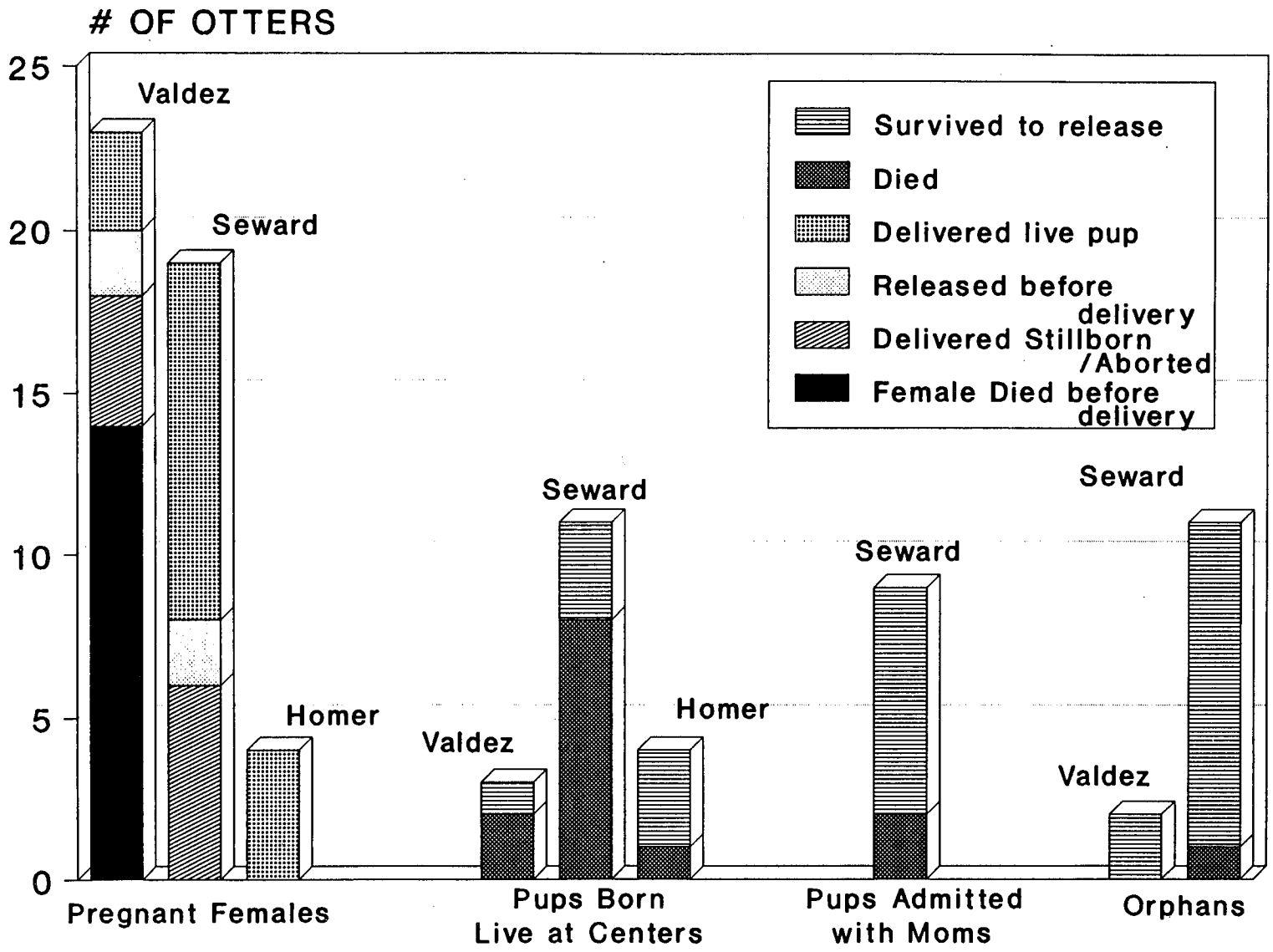


Figure 3.3 Pregnant female and perinatal survival in the three centers.

III. Triage

With large numbers of sea otters arriving simultaneously at the rehabilitation centers, it was necessary to develop a quick, straightforward system for evaluating the overall condition of the animal. Unfortunately, the condition of each otter depended on many unknown factors such as the age (fresh or weathered) of oil encountered, duration of exposure to oil, and general health of the animal before the oil spill. Our initial evaluation of the otters was limited to 1) activity level, 2) physiological indices, 3) degree of oiling, and 4) blood parameters.

A. Activity Level

Sea otters arriving at the centers varied in responsiveness. The activity level of heavily oiled animals ranged from agitated to lethargic and probably depended on the duration of exposure to oil. In severe cases of oil on the head, the otters scratched the cornea and membranes surrounding the eyes. Damaged fur on the abdomen and the exposure of cartilage on the edge of the ears resulted from excessive grooming in at least two heavily oiled otters. Moderately and lightly oiled animals were usually alert, groomed, and accepted food. Normal grooming included rubbing the ears, muzzle, and forearms, as well as licking and nuzzling the abdomen.

B. Physiological Indices

Respiratory rate, evidence of pulmonary distress, dehydration, coat condition, signs of emaciation, and body temperature were assessed. Except for core body temperature, all indices were determined visually or by palpation. An initial, qualitative assessment of core body temperature was made by feeling the hind flippers. These appendages are important areas for heat loss in sea otters, and their temperature is a good indicator of hyperthermia or hypothermia. Shivering and panting were also useful indicators of general thermal status. In addition, the core body temperature of each otter was measured periodically with a rectal thermometer during washing and rehabilitation.

C. Degree of Oiling

Both external (pelage/dermal) and internal (inhalation and ingestion) exposure to petroleum hydrocarbons occurred in the sea otters. Initial assessment of oil contamination was by examination of the pelage. Four classifications were used:

1. Heavily Oiled (>60% body coverage)

2. Moderately Oiled (30 - 60% body coverage)

3. Lightly Oiled (<30% body coverage or light sheen on fur)

4. Unoiled (no visual evidence of oiling)

Based on this ranking, 78 (50%) of the animals that came into the Valdez facility were heavily or moderately oiled, 51 (33%) were lightly oiled, and 11 (7%) were unoiled (Figure 3.4). The degree of oiling was not documented in 16 (10%) Valdez otters. In comparison, only 19 otters (10%) at the Seward center arrived heavily or moderately oiled, 72 (39%) were lightly oiled and 44 (23%) were unoiled. The degree of oiling was not documented in 52 (28%) of the Seward otters. This was due to the difficulty of detecting oil on animals captured late in the spill. Six otters taken to the Homer center were unoiled.

To determine the degree of systemic absorption of oil, we measured the total petroleum hydrocarbon concentration (TPH) in the blood. Blood samples were taken from sea otters on arrival at the rehabilitation centers and at the time of death or release. Up to five ml of whole blood in potassium oxalate vacutainers were frozen until analysis. TPH was determined by National Medical Services (Willow Grove, Pennsylvania) using capillary headspace gas chromatography (C_6 through C_{12} paraffins) and extract gas chromatography at 210° C (C_{13} through C_{24} paraffins) and at 240° C (C_{25}, C_{26}, C_{27}, and C_{28} paraffins). TPH (mg/l) was calculated from the sum of all three fractions.

Preliminary analyses showed that the TPH in blood samples from five heavily oiled sea otters ranged from 20 ppm (20 mg/l) to 800 ppm (800 mg/l) (Figure 3.5). The largest fraction consisted of C_{13} to C_{24} paraffins for all of the otters except one (VA34) in which C_{25} to C_{28} paraffins predominated. TPH was inversely correlated with survival (Figure 3.6). Low (<180 ppm) whole blood petroleum hydrocarbon concentration was associated with increased survivorship.

In comparison, TPH in the blood of nine heavily oiled harbor seals ranged from 22 to 260 ppm (Figure 3.5). As observed for sea otters, the largest hydrocarbon fraction consisted of C_{13} to C_{24} paraffins in eight of the seals. Only one seal had a TPH that exceeded 200 ppm, a lethal level in sea otters. Although this seal lost weight during the first two weeks in captivity, its condition gradually improved. With the exception of one animal that was retained for further observation, all of the seals were released back into the wild.

These results demonstrate a relationship between the concentration of petroleum hydrocarbons in whole blood and survivorship. Additional analyses are being conducted to determine the lethal thresholds for sea otters and harbor seals. Such thresholds appear to be species specific. For example, one

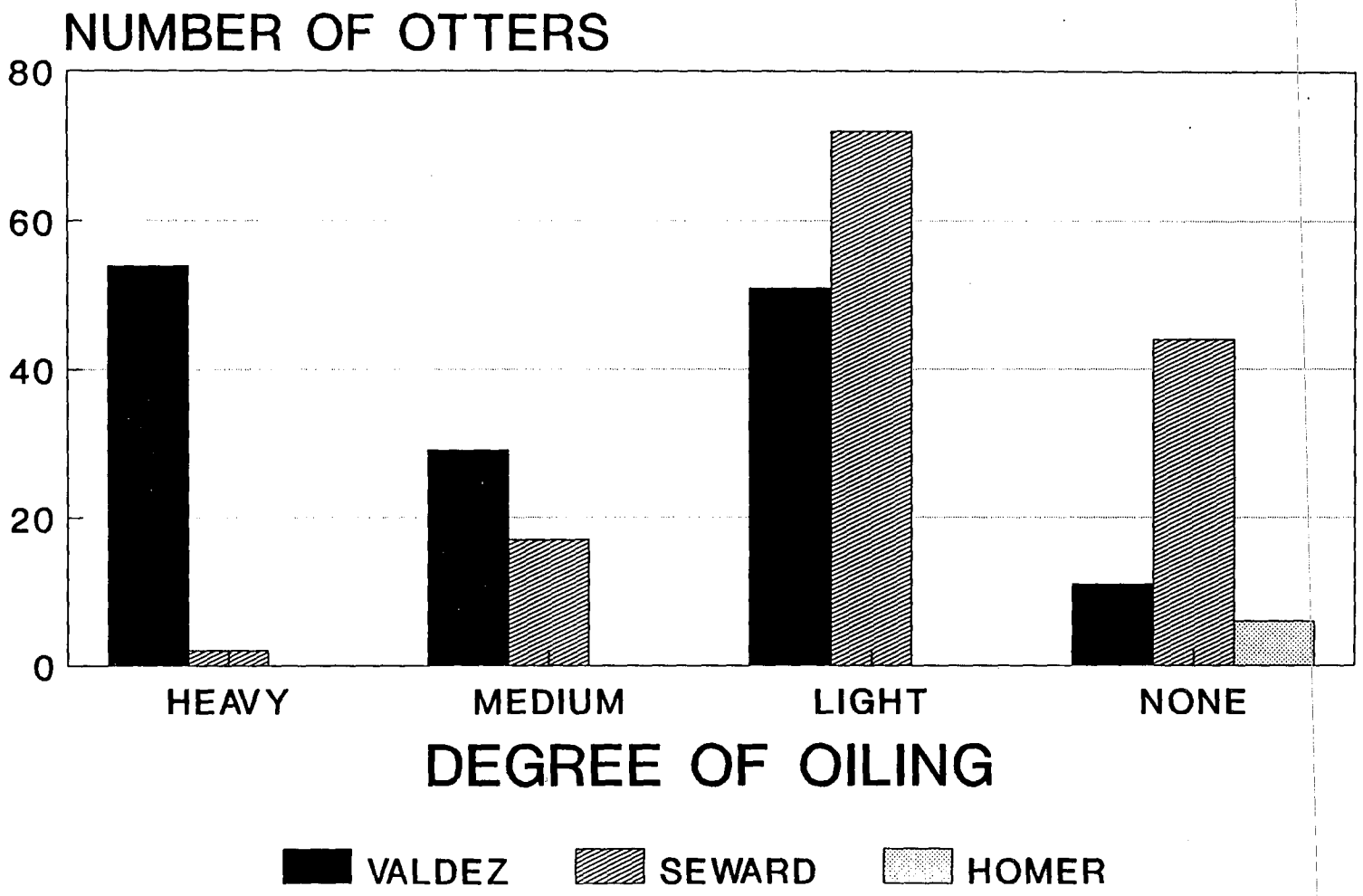
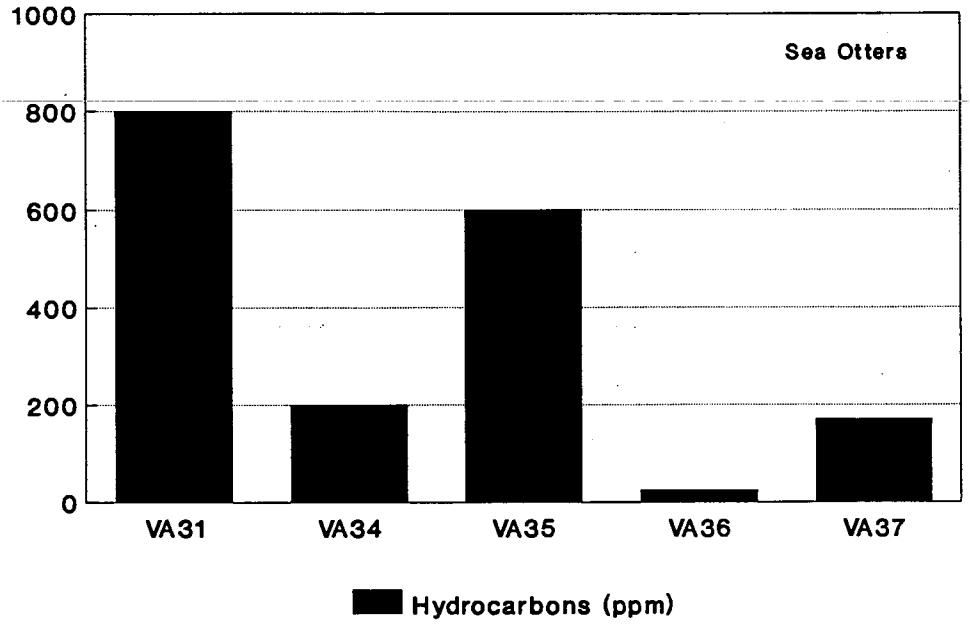


Figure 3.4 The number of otters that arrived at the three centers that were heavily, moderately and lightly oiled or unoiled.



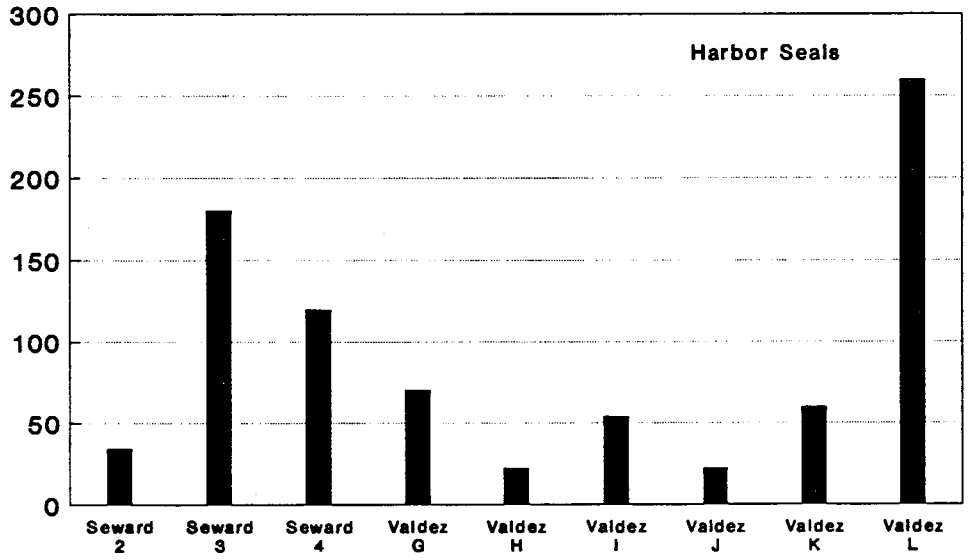


Figure 3.5 Total whole blood petroleum hydrocarbon concentration (ppm) in five heavily oiled otters and nine harbor seal pups. Each bar represents the blood value on the day that the animal was admitted to the rehabilitation center.

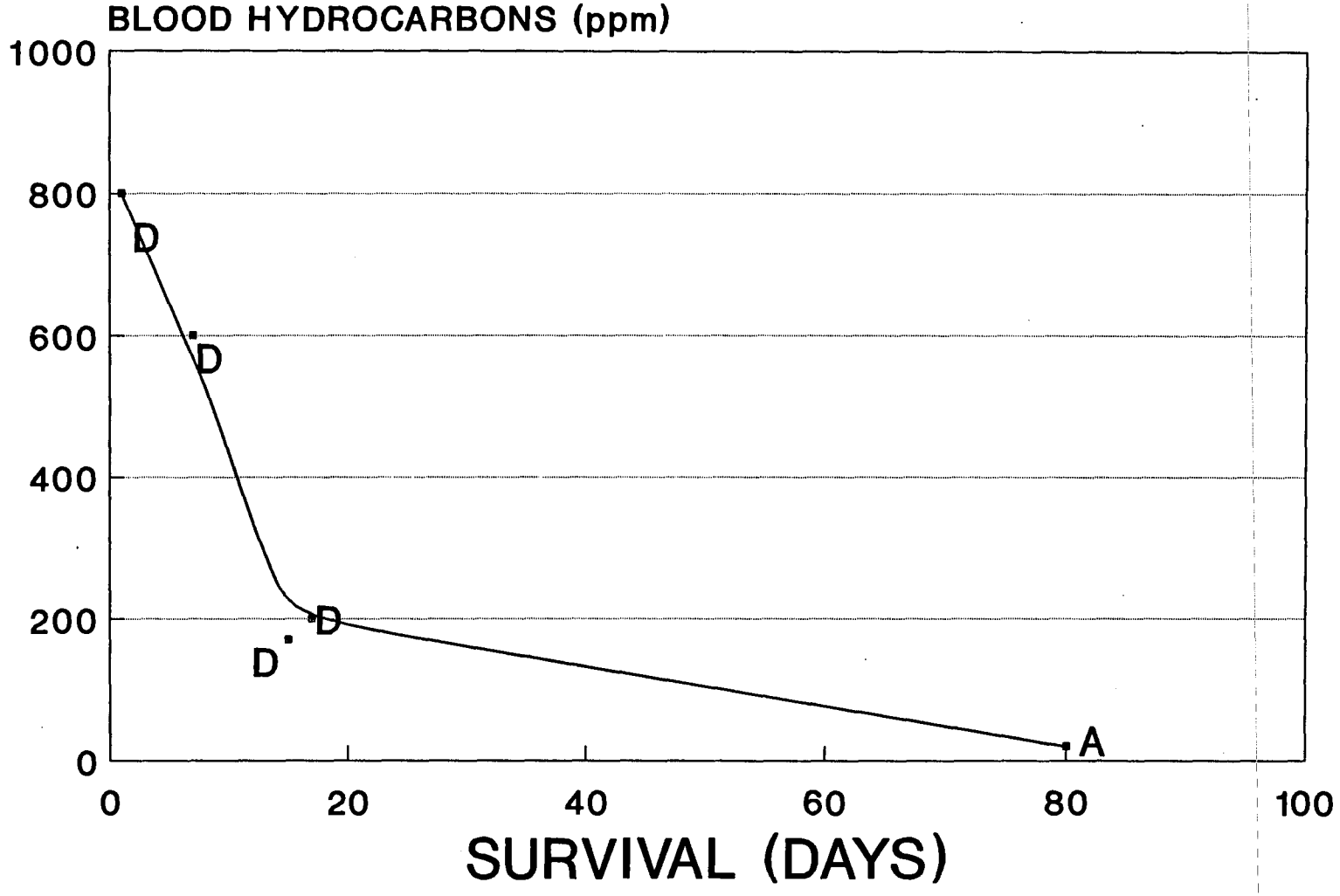


Figure 3.6 Total blood petroleum hydrocarbons versus survivorship for five heavily oiled sea otters. Blood samples were taken on the day of admission to the rehabilitation center. Survivorship decreased in otters with petroleum hydrocarbon concentrations greater than 200 ppm.

seal survived with a petroleum hydrocarbon concentration that exceeded the apparent lethal level for sea otters. It is likely that many factors such as age, diet, weathering of the oil, and duration of exposure will influence lethal thresholds.

D. Blood Parameters

Blood samples were taken from either the femoral, jugular, or popliteal vein for every animal on admission, as needed during rehabilitation, and prior to release. Basic hematological and blood chemistry parameters (Table 3.1) were measured at the rehabilitation centers and provided diagnostic information for the veterinary staff. A more complete analysis of duplicate samples was provided within seven days by the Physicians Medical Laboratories in Portland, Oregon.

The hematocrit (HCT) of blood taken from sea otters on arrival at the centers showed no correlation with degree of oiling or survivorship (Table 3.2). However, anemia often developed in heavily and moderately oiled sea otters after several weeks of captivity (see Chapter 4). Plasma glucose concentration was below normal levels in the heavily oiled otters that subsequently died. Indices of kidney and liver damage (i.e. BUN, SGOT, SGPT) were highly variable in the otters. BUN was approximately two-fold greater than normal levels in all otters that died and was elevated in heavily oiled animals that survived. In general, liver enzymes were elevated in otters that did not survive. However, increases in these enzymes were only loosely correlated with the external degree of oiling. Serum creatinine was two-fold greater in otters that died, but was still within the normal range for this species. Further research is needed to differentiate between the effects of oil exposure, hypothermia, dehydration, starvation, and the stress of capture on these blood parameters.

IV. Medical Disorders of Oiled Sea Otters

Heavily oiled animals arriving in Valdez during the first three weeks of the spill showed the severest medical problems and, consequently, the highest mortality. As the oil dissipated and weathered, the incidence and severity of many medical disorders declined. Three disorders commonly diagnosed in oiled sea otters were:

A. Hypothermia/Hyperthermia

Previous studies have shown that body temperature is unstable in oiled sea otters (Davis et al., 1988). In healthy otters resting in water, core body temperature ranges from 37.0°C to 37.8°C (98.6°F to 100.0°F) (Costa and Kooyman, 1982). At the rehabilitation centers, we found that the rectal temperature of oiled otters was variable during: 1) transport from the capture boats, 2) sedation and washing, and 3) the initial recuperation period of heavily or moderately oiled otters. More than 36% of

Table 3.1. Sea otter blood parameters used for medical diagnosis. Parameters that could be measured within one hour at the rehabilitation centers are indicated by an asterisk. For a key to the abbreviations, see Table 3.2.

HEMATOLOGY

Hematocrit	Buffy Coat
Hemoglobin*	Sedimentation Rate*
White Blood Cell Count	Platelets
Red Blood Cell Count	Differential count

CHEMISTRY

Glucose*	Creatinine	Blood Urea Nitrogen*
Uric acid	Cholesterol	Lipase
Triglycerides	Bilirubin	Total Protein*
Sodium	Albumin	Globulin
Thyroxine	Amylase	Potassium
SGPT	SGOT	LDH
CPK	Chloride	Iron
Calcium	Phosphorus	

Table 3.2. Blood parameters for sea otters at the Valdez Center. Samples were drawn immediately upon arrival. The top portion of the table refers to animals that survived and were released. The lower portion presents values for otters that died in the center. Means ± 1 S.D. are shown. Numbers in parentheses denote the number of animals in each category. Normal ranges for unoiled sea otters in captivity are also shown (after Thomas Williams, personal communication). In this table, HCT = hematocrit, GLU = glucose concentration, BUN = blood urea nitrogen, SGPT = serum glutamic pyruvic transaminase (also AGT), SGOT = serum glutamic oxaloacetic transaminase (also ALT), LDH = lactate dehydrogenase, CPK = creatinine phosphokinase, CREA = creatinine.

	HCT %	GLU mg/dl	BUN mg/dl	SGPT u/l	SGOT lu/l	LDH lu/l	CPK u/l	CREA mg/dl
Degree of Oiling			RELEASED OTTERS					
Heavy	**52.5**	**105.7**	**72.2**	**329.5**	**574.6**	**746.6**	**-**	**0.6**
S.D.	9.4	14.9	19.1	120.9	272.8	296.6		0.2
(n)	(7)	(6)	(5)	(2)	(5)	(5)		(5)
Medium	**48.2**	**110.7**	**70.6**	**251.5**	**484.3**	**629.0**	**1283**	**0.5**
S.D.	7.9	44.6	23.7	145.1	305.5	509.6	1262	0.2
(n)	(7)	(7)	(7)	(6)	(7)	(7)	(5)	(7)
Light	**48.0**	**155.9**	**48.8**	**420.4**	**738.0**	**538.7**	**746**	**0.8**
S.D.	5.9	50.8	8.4	213.9	445.5	259.3	291	0.1
(n)	(8)	(8)	(8)	(8)	(8)	(7)	(8)	(8)
			DEAD OTTERS					
	HCT %	GLU mg/dl	BUN mg/dl	SGPT u/l	SGOT lu/l	LDH lu/l	CPK u/l	CREA mg/dl
Heavy	**60.3**	**53.2**	**189.6**	**287.3**	**960.8**	**1332**	**6654**	**1.2**
S.D.	12.5	36.1	143.3	52.3	563.5	594	5234	0.5
(n)	(6)	(6)	(7)	(4)	(6)	(5)	(5)	(6)
Medium	**59.2**	**101.8**	**144.5**	**1384**	**3917**	**2194**	**2469**	**1.1**
S.D.	8.3	77.2	54.9	1374	4322	1804	1823	0.6
(n)	(11)	(7)	(10)	(7)	(8)	(7)	(6)	(9)
Light	**49.3**	**119.4**	**108.2**	**610.1**	**1009**	**1798**	**4902**	**0.8**
S.D.	11.9	91.7	61.7	554.4	781	1345	3624	0.6
(n)	(8)	(11)	(11)	(10)	(10)	(10)	(9)	(9)
Normal Range-								
LOW	50.3	87.6	34.3	96.4	87.0	94.7	169.8	0.5
HIGH	62.1	150.2	63.6	240.0	511.0	419.3	490.2	1.4

the sea otters received at the Valdez center were hypothermic on arrival. Many of these animals were heavily oiled, lethargic, and captured early in the spill when ambient air temperatures were -7°C to -1°C (20°F to 30°F). The lowest core body temperature, 29.4°C (85°F), was recorded for an otter that arrived cyanotic and unconscious. The condition of this animal improved following gradual rewarming by immersion in warm water and intravenous administration of warm saline with dextrose. No further complications occurred, and this animal was eventually released.

By contrast, 27% of the otters received at the Valdez rehabilitation center were hyperthermic on arrival. These animals were usually moderately or lightly oiled. High body temperatures resulted from excessive grooming of oiled fur, inadequate ventilation in transport cages, and hyperactivity associated with handling. To prevent hyperthermia, capture teams often placed a layer of ice in the bottoms of transport cages. This was especially important for active otters, on warm days, and during prolonged transport.

Because of the lethal consequences of either hypothermia or hyperthermia, it is critical to determine the nature of the thermoregulatory imbalance in oiled sea otters. Core body temperature should be monitored during cleaning and the period of critical care. Such information allows veterinarians and husbandry personnel to take appropriate corrective action.

B. Hypoglycemia

Hypoglycemia (abnormally low blood glucose concentration) was a common problem in animals admitted to the rehabilitation centers during the initial days of the oil spill. During this period, more than 45% of the sea otters tested showed blood glucose concentrations below the normal range (87.6 - 150.2 mg/dl; Thomas Williams, personal communication). These low glucose concentrations may have resulted from 1) the inability of the wild otter to feed prior to capture, 2) impaired liver function or intestinal absorption, 3) fasting during capture and transport, or 4) stress/shock.

Hypoglycemia undoubtedly contributed to the thermoregulatory and metabolic problems of heavily oiled sea otters that died. Therefore, the blood glucose concentration became an important diagnostic parameter in the rehabilitation centers. Initially, Gluco-Stix™ (Ames Laboratories) were used as a qualitative indicator of the blood glucose concentration. The donation of blood chemistry analyzers by Eastman Kodak (Valdez center) and Abbot Laboratories (Seward center) permitted more rapid and quantitative analyses. As soon as hypoglycemia was diagnosed, 5% dextrose was administered intravenously or subcutaneously until normal blood glucose concentrations were re-established.

Comatose animals also received a dextrose bolus either intravenously or through a feeding tube introduced into the stomach.

C. Emphysema

Pulmonary distress occurred frequently in sea otters arriving at the rehabilitation centers during the first three weeks of the spill. This condition was often associated with subcutaneous and/or pulmonary emphysema. Subcutaneous emphysema was characterized by pockets of air that could be felt under the skin. Small bubbles were first noted in the axillary region of the otters. In severe cases, air pockets could be felt beneath the skin along both sides of the neck and thorax, and along the spine. Postmortem examination showed that the subcutaneous emphysema resulted from ruptured membranes in the lungs. Air escaping from the lungs moved along the mediastinum, through the thoracic inlet and accumulated subcutaneously.

Subcutaneous emphysema was recorded in 27 of the 154 sea otters admitted to the Valdez rehabilitation center. Twenty-five of these cases occurred within fourteen days of the oil spill. The actual incidence of subcutaneous emphysema during this period may have been higher, because this condition was not diagnosed until the first necropsies were performed on April 2. After that date, palpation of the axillary region was included as part of the clinical examination.

Mild-to-severe pulmonary emphysema was observed in 45 of the sea otters necropsied at the Valdez and Seward rehabilitation centers. More than half of the cases were recorded within two weeks of the spill. During this period nearly 70% of the otters that died exhibited some form of pulmonary emphysema.

The incidence of emphysema during the first weeks of the spill suggests that the inhalation of volatile petroleum hydrocarbons may have been responsible. Depending on environmental conditions, lighter aromatic hydrocarbons (i.e. benzene, toluene, xylene) will evaporate within several days after an oil spill. These compounds are considered the most toxic of the major classes of compounds in crude oil and are known to cause damage to the lungs and mucus membranes of the airways (Geraci and St. Aubin, 1988).

V. Cleaning Oiled Sea Otters

Following initial examination, sea otters were weighed and either 1) washed immediately, 2) placed in a holding pen if cleaning was not required, or 3) stabilized with fluid therapy and fed before washing. Oiled sea otters were cleaned using methods modified from Williams et al. (1988) and Davis et al.

(1988) (See Chapter 4 for details on restraint). Animals that were heavily oiled were washed immediately. This prevented further petroleum hydrocarbon exposure by absorption or by ingestion during grooming. Sea otters with light or patchy oil on their fur were fed, given fluids subcutaneously if dehydration was evident and washed within 12-24 hours. Delaying the cleaning process for several hours permitted otters exposed to less toxic forms of oil to recover from the stress of capture before washing.

Each oiled otter was placed on a cleaning basin and washed with a solution (1:16 in water) of Dawn™ dish washing detergent (Procter and Gamble). The detergent was massaged into the oiled fur and immediately rinsed with freshwater. Applications were repeated for at least 40 minutes or until there was no indication of oil on the fur or in the rinse water. Heavy oiling, weathered oil, or the presence of tar balls on the fur prolonged the cleaning process. An additional 40 minutes of rinsing with spray nozzles was necessary to thoroughly remove the detergent and help restore the water repellency of the fur (Williams et al., 1988).

After rinsing, the otters were dried with towels and pet dryers. Improved results were obtained at the Seward facility with the addition of a drying room that was separate from the humid environment of the washing room. Drying time was approximately one hour, after which the sea otters were placed in cages to recover from sedation.

One result of cleaning oiled sea otters with detergent is that their fur does not immediately regain its water repellent quality. This may result from:

1. Mechanical disruption of the underfur so that the hairs no longer form an interlocking mat that entraps air.

2. The depletion of natural oils (predominately squalene) in the fur and skin (Davis et al., 1988).

3. A monolayer of detergent molecules that remains on the hairs and makes them hydrophilic.

As a result, sea otters that were washed in the rehabilitation centers could not be placed immediately into water. Normal grooming and a gradual re-introduction into water usually resulted in full restoration of the fur in 7-10 days. However, if the otter failed to groom, then restoration of the fur was prolonged.

In an attempt to accelerate the restoration of the fur, Dr. Lee Hunter (Redken Laboratories) developed a synthetic sebum (squalane in volatile silicon or ethanol) that could be applied to the otter's fur after cleaning and drying. The ethanol was

co-miscible with water and penetrated the wetted fur. Both solvents were at least as volatile as water, and therefore, facilitated complete drying of the fur in addition to coating the fur with squalane.

Initial testing was conducted on sea otter pelts. Squalane was then applied to the fur of seven otters, and their coat condition compared to untreated controls. Preliminary results indicate that the fur of treated otters dries faster than untreated fur. Consequently, rehabilitation time may be shortened in otters whose fur has been treated with a natural oil substitute after washing.

VI. Further Research

Several important areas of research are needed to improve the treatment of oiled sea otters. The most important of these is the short and long term toxicological effects of petroleum hydrocarbons. Because of the high incidence of abortion and stillbirths, a study of the effects of crude oil exposure on pregnant, lactating, and young animals is warranted. A method of quickly (less than three hours) measuring petroleum hydrocarbons in blood samples is needed. This will enable veterinarians to assess systemic exposure and improve medical treatment when the animals arrive at the rehabilitation centers.

The current method of cleaning oiled sea otters can be improved. Although otters can be successfully cleaned using Dawn™ dish washing detergent, this method does not result in immediate restoration of the fur's water repellency. Preliminary tests have demonstrated the beneficial effect of applying squalane to the fur of cleaned otters in order to restore natural oils removed by the detergent. Further research is needed to develop a cleaning method that immediately restores the insulating qualities of the fur so that the otter may be placed into a seawater pen after it recovers from sedation. This will greatly accelerate the rehabilitation process.

VII. Conclusions

1. Because sea otters rely on fur for thermal insulation and eat while resting on the surface of the water, they are especially vulnerable to the detrimental effects of an oil spill. To rehabilitate oiled otters, their fur was cleaned with Dawn™ dish washing detergent, and they were medically treated for hypothermia, hypoglycemia, and petroleum hydrocarbon toxicosis.

2. The sex ratio of sea otters admitted to the rehabilitation centers reflected the movement of oil into areas of Prince William Sound and along the Kenai Peninsula occupied primarily by

females.

3. Ninety percent of heavily oiled sea otters were captured during the first three weeks of the spill. These animals showed the severest medical problems. As the oil weathered, contaminated otters showed fewer signs of petroleum hydrocarbon toxicosis.

4. The activity level of sea otters arriving at the rehabilitation centers ranged from lethargic to alert and depended on the degree and duration of oiling.

5. Hypothermia, hyperthermia, hypoglycemia, emphysema, and petroleum hydrocarbon toxicosis were the primary medical disorders experienced by oiled sea otters. Core body temperature, blood glucose concentration, and total circulating petroleum hydrocarbon concentration are important parameters to monitor when oiled animals arrive at the rehabilitation centers.

6. Further research is needed to improve techniques for cleaning and treating oiled sea otters and to better understand the toxicological effects of petroleum hydrocarbon exposure.

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Chapter 4. Clinical Treatment and Rehabilitation of Oiled Sea Otters

Riley K. Wilson, D.V.M
Pamela Tuomi, D.V.M.
J. Pete Schroeder, D.V.M.
Thomas Williams, D.V.M.

I. Introduction

The degree of oiling and general health of sea otters arriving at the rehabilitation centers varied widely. For example, heavily oiled otters were often emaciated and lethargic, while animals with little or no external oiling were alert and in excellent body condition. This chapter describes the veterinary care and treatment of these animals during the cleaning and rehabilitation process. Many of the treatment protocols changed during the course of the oil spill as we learned more about the toxic effects of petroleum hydrocarbon exposure. Clinical treatment of oiled sea otters and the medical problems resulting from long term captivity are reviewed.

II. Medical Treatment During Washing

Following an initial examination (see Chapter 3), sea otters that required washing were weighed and sedated. Exceptions to this protocol were heavily oiled otters that were lethargic, hypothermic, or displayed respiratory distress. Immobilizing agents were considered a health risk in these cases, so physical restraint was used during washing.

When chemically restraining sea otters for washing, blood sampling or physical examination, the goal was to achieve short term sedation without depressing respiratory or cardiac function. It was also imperative that the immobilizing agents had a wide margin of safety and were reversible. The most desirable immobilizing agents for these purposes were narcotic analgesics that were readily reversible with a competitive antagonist such as naloxone hydrochloride. Reversibility provided better control over the degree of immobilization and allowed rapid recovery at the end of the procedure.

Two hundred and fourteen out of 308 sea otters required chemical restraint for the washing and treatment procedure. Fifteen different drug combinations were used from March 24 to August 30.

The immobilizing agents most commonly used to restrain sea otters at the rehabilitation centers are shown in Table 4.1.

Table 4.1. Combinations of chemical agents used to restrain sea otters during 1) washing, 2) blood sampling, x-rays and biopsies, and 3) surgical implantation of radio transmitters. Average dose is shown in mg per kg of body mass.

chemical agents	dose (mg/kg)	number of sea otters anesthetized: washing	blood sampling, x-rays, biopsies	surgery
meperidine	12	54		
diazepam	0.2			
meperidine	26	6		
diazepam	0.3			
fentanyl	0.14	25	3	29
azaperone	0.45			
diazepam	0.14			
fentanyl	0.14	34		
acepromazine	0.16			
diazepam	0.14			
fentanyl	0.14	65	186	13
diazepam	0.18			
butorphanol	0.5	15		
diazepam	0.18			
butorphanol	0.3	6		
acepromazine	0.16			
oxymorphone	0.3	6		
diazepam	0.5			
Telazol	4.0	2		

These agents were administered by deep intramuscular injection in the hind leg while the otter was physically restrained. The otter was then placed in a cage until immobilization was complete. Initially, a combination of meperidine hydrochloride (a narcotic analgesic, 12 mg/kg) and diazepam (a sedative, 0.2 mg/kg) was used at dosages recommended by Joseph et al. (1986). Because of the long induction time (i.e. up to one hour) and premature recovery during the 1-2 hour washing procedure, other combinations of immobilizing agents were also used. These included fentanyl, butorphanol, oxymorphone or Telazol in combination with diazepam, acepromazine (a tranquilizer) and azaperone (a neuroleptic). The effectiveness of some of these agents for immobilizing sea otters has been reviewed by Williams and Kocher (1978). Naloxone hydrochloride (0.06 mg/kg) was used to reverse the narcotic analgesics.

For most routine procedures, the combination of fentanyl (0.09 mg/kg), azaperone (0.55 mg/kg) or acepromazine (0.09 mg/kg), and diazepam (0.1 - 0.2 mg/kg) provided safe and rapid immobilization. Repeat doses of fentanyl were needed in only 5% of the animals, and repeat diazepam was given to 15% of the otters. Diazepam smoothed the induction process and decreased the incidence of seizures that commonly occur during neuroleptanalgesia in a noisy environment.

Induction using the above fentanyl combination was usually complete in 15 minutes and recovery was rapid when reversed with naloxone hydrochloride. Effective immobilization was also achieved when this combination was used for the 30 minute surgical implantation of abdominal radio transmitters. The neuroleptanalgesia that is produced by fentanyl and azaperone in sea otters has been described (Williams et al., 1981).

During the oil spill, another advantage of fentanyl was its availability in 50 mg quantities in powder form. Except for butorphanol, all of the other opiates were only available in low concentrations in liquid form.

To mitigate the effects of crude oil exposure and stress, we began a number of treatments as soon as the otters were immobilized for washing. Because corneal ulcers were occasionally found in heavily oiled sea otters, the eyes were routinely flushed with an irrigating eye wash. A broad spectrum antibiotic ophthalmic ointment (Neosporin) was then applied to the cornea to reduce irritation from crude oil and detergent.

During the first three weeks after the spill, many otters exhibited clinical signs associated with the ingestion of petroleum hydrocarbons (i.e. disorientation, gastro-intestinal distress, lethargy). To neutralize the effects of recently ingested oil, 60 ml of an activated charcoal solution (Toxiban™)

was given orally to heavily and moderately oiled sea otters. The solution was administered to sedated otters through a syringe connected to a stomach tube. Activated charcoal is routinely used to counteract the ingestion of poisonous materials. It acts by binding toxic substances which are then passed with the charcoal in the stool. However, the activated charcoal darkens the stool and makes immediate detection of blood or oil in the feces difficult.

A high caloric lipodextrose paste (STAT™, PRN Pharmacel, Inc.) was often administered with Toxiban during intubation. STAT™ was used to treat hypoglycemia and undernourishment, which were common problems in heavily oiled otters that had poor appetites or may not have eaten recently (Chapter 3). Further research is needed to establish the effectiveness of these treatments in carnivores.

Several medications were given prophylactically to sea otters during the washing process. These included antibiotics, vitamin E, selenium, dexamethasone, Lactated Ringer's solution and 5% dextrose solution. Vitamin E and selenium were used to mitigate capture myopathy syndrome. This condition is characterized by lactic acidosis that damages the muscle fibers. Clinical and histological evidence suggested that some otters arriving at the rehabilitation centers had developed capture myopathy, perhaps while being chased during capture with a dip net. Vitamin E and selenium act as antioxidants to help mitigate this type of tissue damage.

Initially, dexamethasone was given to all otters that arrived at the rehabilitation centers in order to treat stress or shock. Although dexamethasone is effective in treating these problems (Kirk, 1983), glucocorticoids such as dexamethasone may cause abortion late in gestation in some mammals (Barth, 1986). Because of the incidence of unexplained stillbirths and abortions in sea otters at the rehabilitation centers (see Figure 3.3), this treatment was limited to male otters after the third week of the spill.

To prevent shock and correct dehydration, Lactated Ringer's solution (10 ml/kg) was routinely administered subcutaneously to the otters while they were being washed. Although fluid absorption is more rapid through the peritoneum, we seldom used this route of administration because of the risk of fibrinous peritonitis. In documented cases of hypoglycemia, dextrose (5% w/v) was added to the Lactated Ringer's solution. Fluids were administered intravenously if the animal was severely debilitated or hypoglycemic.

III. Medical Treatment during Rehabilitation

Many of the medical problems experienced by sea otters in the rehabilitation centers resulted from: 1) the inability to thermoregulate in water until the fur had regained water repellency, 2) hydrocarbon toxicity and 3) the stress of captivity. Treatment protocols changed as new information about the toxic effects of crude oil became available. In establishing medical protocols, we considered the additional stress that would be caused by a treatment and the aversion of otters to oral medication (medications were limited to those that could be injected or hidden in food). Some of the more common disorders were:

A. Respiratory Disorders

Heavily and moderately oiled sea otters often had labored breathing which was distinct from the apneustic breathing pattern of many marine mammals. In severe cases of pulmonary dysfunction, breathing was primarily diaphragmatic several hours before the animal died. Postmortem examinations revealed the presence of mild-to-severe bulus emphysema in the lungs of these animals. If the pleural membranes ruptured, air moved along the mediastinum and emerged subcutaneously in the axillary area (for a discussion, see Chapter 3). Medical care was limited to making the animal comfortable, as there was no immediate treatment for this condition. Aminophylline (5 mg/lb), a bronchodilator, was tried with little success on 12 sea otters to facilitate respiration.

Chronic sinusitis contributed to the respiratory distress of heavily oiled sea otters. Postmortem examination indicated that the sinusitis could have resulted from: 1) inhalation of petroleum hydrocarbons, 2) nasal mite infestation, or 3) secondary infection. In one case at the Valdez center, an otter developed severe sinusitis characterized by epistaxis (bleeding nose) and purulent nasal discharge. Treatment with amoxicillin was unsuccessful. Because of the animal's anorexia and aversion to oral medications, it was tube fed a formula that included cephalexin. Oral and injectable cephalexin were continued for six weeks and resulted in improved appetite and muscle strength. A culture and sensitivity test performed on the nasal discharge revealed the presence of multiple bacteria including E. coli and Proteus. Although these bacteria are sensitive to ciprofloxicin treatment, this antibiotic is only available in oral form. Therefore, ciprofloxicin therapy was delayed until the otter's appetite improved and the tablet could be hidden in the food. Following this treatment, the frequency of epistaxis and nasal discharge decreased, and full recovery occurred after three months.

B. Gastrointestinal Disorders

The most common medical problems observed in the oiled otters involved the gastrointestinal tract. Many of these conditions may have resulted from a combination of factors including the ingestion of crude oil, stress, physical handling, parasites and a change in diet.

Diarrhea occurred in most of the otters regardless of the degree of oiling or the duration of captivity. Although loose stools may indicate dysfunction in a variety of organs (i.e. liver, pancreas, intestine), it was most likely due to stress or the change in diet at the rehabilitation centers. Increasing the amount of roughage in the diet and reducing physical contact with the animals helped to alleviate this condition.

Melena (dark tarry stools) occurred in many of the otters during the initial days after the spill and resulted from gastrointestinal bleeding. Intestinal ulcers, gastric ulcers and hemorrhagic enteritis were observed in many of the otters during postmortem examinations (Chapter 6). Although the etiology is unclear, stress and the toxicity of ingested oil could have been responsible for these problems. However, the detection of blood in the otters' stools was often complicated by the presence of crude oil, activated charcoal (Toxiban™), or squid ink present in the diet. Treatment included a reduction in environmental stressors (excess handling, noise) and cimetidine (Tagamet™, an inhibitor of histamine in gastric parietal cells) therapy.

Other gastrointestinal disorders included rectal prolapse and the presence of parasites. Rectal prolapse was associated with straining during defecation by sea otters with diarrhea. Only one case required surgical intervention, first by a purse string suture which failed, and second, by an intraabdominal tie-back. This otter subsequently died three weeks after the second surgery.

A variety of parasites, including nematodes, cestodes, and acanthocephalids are common in sea otters. While these parasites are not usually lethal, they may become a problem in sea otters whose gastrointestinal or immune systems are compromised by exposure to crude oil. Praziquantel was used to treat cestode infestations and Fenbendazole was used against acanthocephalids; no adverse reactions were recorded. Because cestodes can cause vitamin B deficiency, the otters were given injections of vitamin-B complex.

C. Anemia

The diagnosis of anemia was based on the hematocrit and blood hemoglobin concentration. When otters first arrived at the

rehabilitation centers, they generally were not anemic. In fact, some heavily oiled otters that died within the first few days had elevated hematocrits (Table 3.2), which was suggestive of dehydration. However, their hematocrits were still within the normal range for sea otters.

A low hematocrit often developed in oiled otters after their first week at the rehabilitation centers. This condition was particularly apparent in heavily oiled animals. For example, 81% of heavily oiled otters that survived more than seven days in captivity had hematocrits below normal values. Hematocrit usually returned to normal levels in 1-3 months depending on the severity of the anemia (Figures 4.1 and 4.2). The etiology of this anemia is unknown but could have been caused by: 1) the stress of captivity, 2) steroid treatment for stress-related medical problems, 3) gastro-intestinal bleeding, and 4) petroleum hydrocarbon toxicosis. Anemic otters were closely monitored and given supplemental vitamin B-complex.

D. Skin Disorders

Many sea otters developed abrasions or pressure sores from resting on plywood, plastic grate, or wire mesh in the pens. Confinement to dry pens during critical care was associated with dermatitis, pyoderma, and damage to the fur. Perineal areas (urogenital area) and the hind flippers were the primary areas affected. Dermatitis, characterized by red erythematous regions and abrasions, was found in many animals after they had rested for several days on a hard surface.

Localized abrasions were sprayed with a Betadine solution. In severe cases where the bone was exposed, surgical intervention was required. During surgery, the necrotic tissue was debrided and the area sutured. Antibiotics were administered depending on the severity of the problem. In most cases, placing the otters in seawater pools or floating pens dramatically improved the condition of the skin and fur.

Abscesses occurred occasionally and appeared to be associated with an unusual or impaired immune response to local irritation. Abscesses found in the mouth may have resulted from splinters acquired while chewing on wooden cages or platforms. In addition, intramuscular injection sites on the hind legs may have been responsible for abscesses in some animals. Treatment included lancing the abscessed site, flushing with Betadine and hydrogen peroxide, and long term antibiotic therapy. Infected areas were not shaved and the incision left open to drain. This procedure was effective for all of the animals treated and resulted in no further complications.

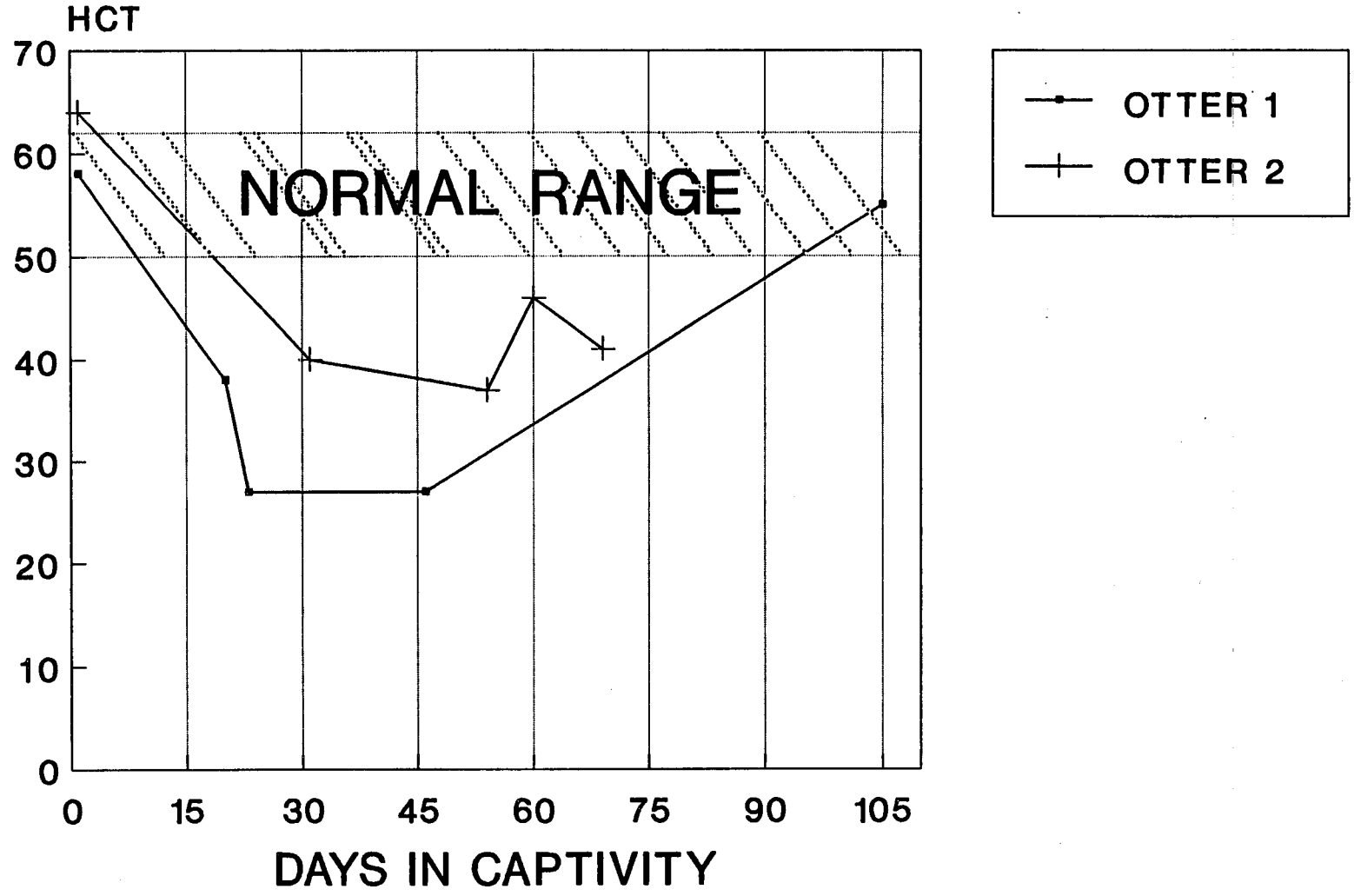

Figure 4.1 Hematocrit in two heavily oiled otters in relation to their time in captivity.

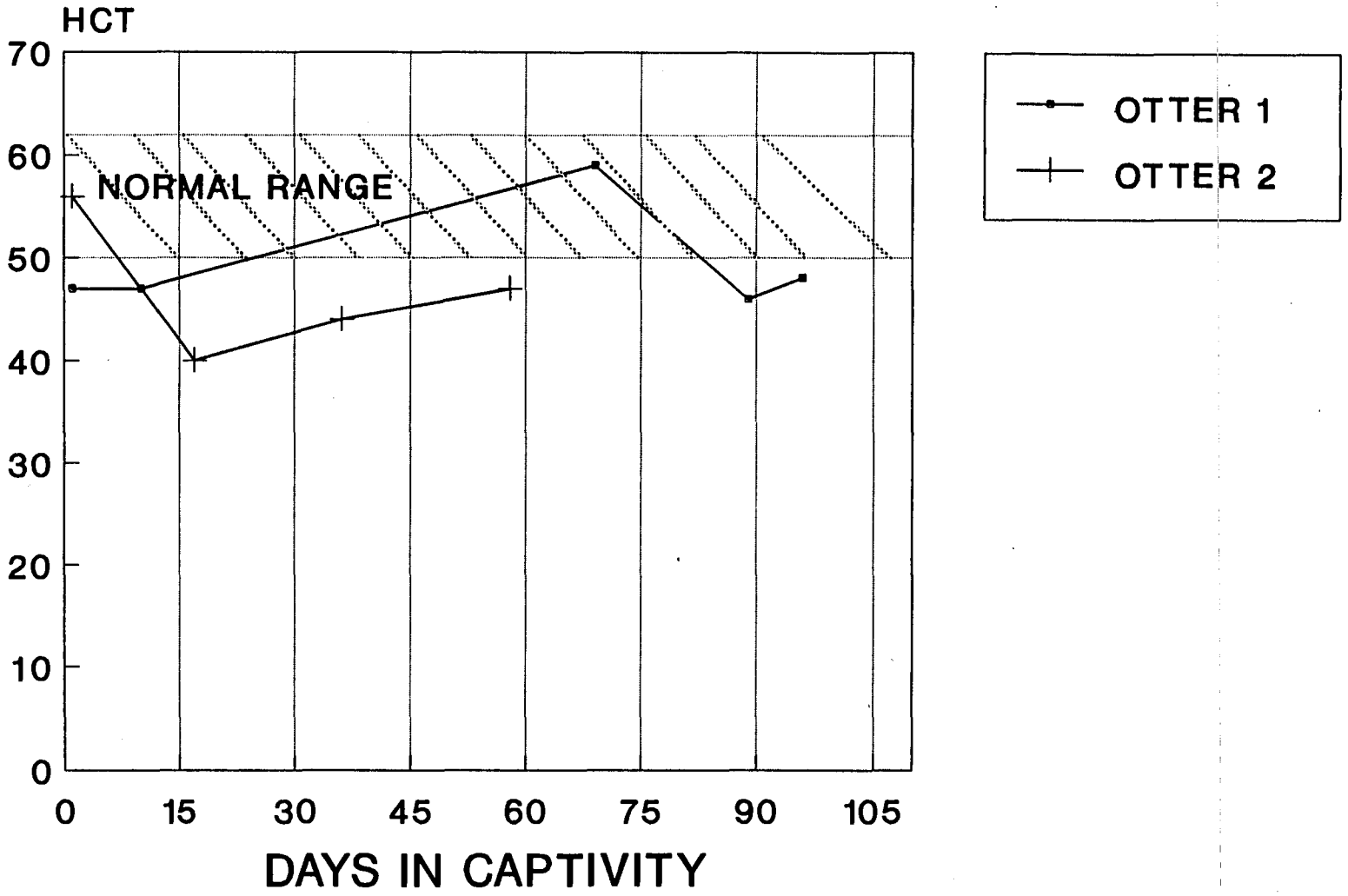

Figure 4.2 Hematocrit in two lightly oiled otters in relation to their time in captivity.

E. Seizures

During the first two weeks of the spill, many otters exhibited seizures or signs of shock. Ten heavily oiled otters had seizures within 48 hours of arriving at the Valdez rehabilitation center and subsequently died. The cause of these seizures is unknown. However, hypoglycemia, hepatic encephalopathy, hyperthermia, hypothermia, electrolyte imbalances, stress, reaction to fentanyl anesthesia, and exposure to petroleum hydrocarbons may have been contributing factors. Periodic seizures persisted for several weeks in some of the animals. One animal exhibited seizures lasting 3 to 5 minutes every 48 hours for approximately one week. Because the episodes were short and their etiology unknown, treatment was conservative. Depending on the severity of the seizure, supportive care ranged from observation to intravenous diazepam and fluids (500 ml Lactated Ringer's solution). When hypoglycemia was documented, glucose was added to the fluids (5% in Lactated Ringer's) or given as a bolus injection.

F. Miscellaneous Treatments

Paraphimosis (prolapse of the penis) required surgical intervention for two sea otters. In one case, the penis and prepuce were severely edematous, and areas of mucosal sloughing were evident after several days. Because manual reduction was ineffective, sugar was applied for 15 minutes to reduce the edema. A purse string suture (absorbable Vicryl™) helped to prevent reoccurrence. The prepuce was flushed alternately with a Betadine/hydrogen peroxide solution and DMSO. The sutures were removed after three days with no complications.

An umbilical hernia was treated surgically in an otter pup born at the Valdez rehabilitation center. Grooming of the lower abdomen by the pup's mother caused the umbilicus to bleed. To prevent infection, the area was cleaned with Betadine and the protruding necrotic tissue trimmed, ligated, and removed. Margins of the hernia were trimmed and closed with 3-0 Vicryl™. Following injection of a broad spectrum antibiotic (Tribrissin), the pup was returned to its mother. Recovery was uneventful.

Orthopaedic problems were treated in three otters and appeared to be unrelated to the oil spill. Serial radiographs revealed progressive calcifying synovitis in an adult otter that had developed extensive swelling of the tibial tarsal joint. The animal responded well to antibiotic therapy and was able to move normally despite extensive joint damage. Several other animals demonstrated posterior weakness during swimming or hauling out. The cause of weakness in these otters included: 1) healed compression fractures, 2) spinal deviation as a result of handling, 3) muscle damage during capture or 4) possibly the direct toxic effects of oil. These animals recovered with little

or no veterinary intervention except for antibiotic therapy when indicated.

IV. Domestic Diseases

The potential for introducing domestic pet diseases into the wild otter population through the rehabilitation program was a concern. Diseases such as canine distemper and canine parvovirus could cause high mortality in adult and neonate sea otters. Canine distemper is known to be a problem in many species of mustelids (weasel family), but has not been documented in sea otters. Although mustelids are generally considered to be resistant to parvovirus, pregnant ferrets can acquire the infection and pass it to their fetuses. The infection can lead to cerebellar hypoplasia in the fetus.

Upper respiratory viruses such as parainfluenza might also infect sea otters. Dogs and humans can carry and transmit various types of parainfluenza viruses, some of which are known to infect mustelids. These infections may cause a low grade bronchitis which can easily lead to bacterial pneumonia. Other infectious agents of concern are calicivirus, infectious canine hepatitis, Chlamydia, herpesvirus and Bordetella.

To avoid infecting the otters with these diseases, no domestic animals were allowed in the rehabilitation facilities. In addition, persons handling the otters were required to wash their hands well before beginning work. Despite these precautions, a quarantine was instituted at the Valdez center for two weeks in May after four otters unexpectedly died in one day. Postmortem examinations of these otters showed lesions suggestive of viral enteritis. As a result, no otters were allowed into or out of the facility until serological tests (canine distemper, herpes, parvovirus) and immuno-fluorescence assays (canine distemper) proved negative. A quarantine was also instituted at the Seward facility when oral lesions were observed in some of the otters. The infectious agent was identified as a herpes-like virus that is naturally present in the otter population in Prince William Sound and along the Kenai Peninsula (Harris et al, 1990).

V. Stress Assessment in Oiled Sea Otters

Oiled sea otters that were sent to rehabilitation centers experienced a variety of stressors including the effects of petroleum hydrocarbon exposure, capture, transport, medical treatment, and a change in diet. Because of the complexity of the stress response (Figure 4.3), we could not determine the separate effect of each stressor on the otters. However, several

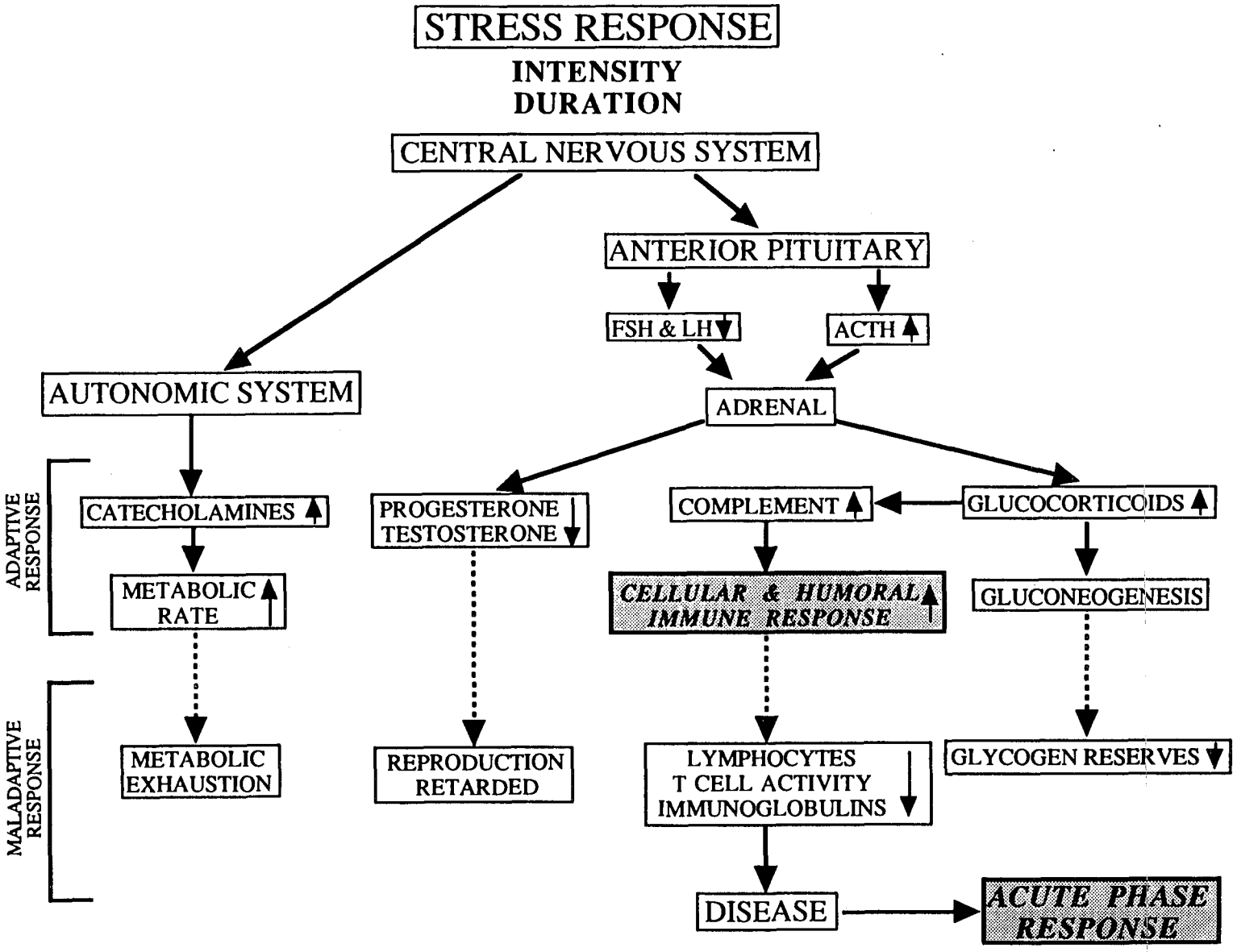

Figure 4.3 The stress response. The shaded areas indicate where tests were conducted to identify adaptive and maladaptive responses to stressors.

methods were developed by Dr. J.P. Schroeder (NOSC) to examine the overall stress response of rehabilitating otters.

Blood samples were taken from either the femoral, jugular or popliteal vein and processed according to the protocol in Appendix 7. The following tests provided a rapid diagnostic evaluation of stress in sea otters.

Hematocrit. The hematocrit provides an indication of anemia, hemolysis, and dehydration. Serum color can reveal lipemia or jaundice. The width of the white cell layer indicates cellular immune response to infection.

Total Blood Protein. Total protein level in the blood can be determined by refractometry and indicates the degree of hydration, nutrition, and the humoral immune status of the animal.

Blood Urea Nitrogen (BUN). Reagent Strips (AZO Stix® Miles Inc., Elkhart, IN 46515) provide a relative index of blood urea nitrogen and, hence, kidney function.

Blood Glucose. Chem Strips (Chem Strip BG® Boehringer Mannheim, Indianapolis, IN 46250) provide a qualitative evaluation of blood glucose and can identify hypoglycemic animals.

The above tests can be performed on 0.5 ml of blood in 30 minutes. The following tests require a larger blood sample and take longer to complete:

60 Minute Erythrocyte Sedimentation Rate (ESR). A Wintrobe tube sedimentation rack is used for determining the erythrocyte sedimentation rate, an early Acute Phase Response indicator of inflammation or bacterial infection. The test requires 1-2 ml of blood which can be re-used for other tests.

Serum Chemistry Panel (see Table 3.1). Serum samples can be analyzed for up to 30 constituents including serum iron.

The standard blood analysis for sea otters at the rehabilitation centers included hematocrit, serum color, width of the white blood cell layer, glucose, urea nitrogen, total protein and 60 minute ESR. Serum chemistry panels usually required 12 to 24 hours for analysis and were used to support the preliminary diagnoses.

The otter's immediate response to stress, termed the Acute Phase Response, was determined from the 60 minute ESR and changes in the serum iron concentration. The rate of settling by red blood cells, as measured by the ESR, is increased by infection and inflammation. Otters judged to be clinically ill at the rehabilitation center had 60 minute ESR's that were seven-fold faster than the mean value for healthy animals (Table 4.2). Serum iron levels decrease in response to bacterial infection, a condition that often precedes changes in ESR. In the otters examined at the rehabilitation centers, the mean serum iron concentration was lower in unhealthy otters (Table 4.2).

In addition to the above tests, Dr. M. Fry (University of California, Davis) examined the serum proteins, and Dr. N. Vedros (Department of Virology and Immunology, University of California, Berkeley) conducted preliminary research on the cellular and humoral immune responses of sea otters. Serum protein electrophoresis showed normal patterns except for one unusual protein that appears to be unique to sea otters. Radioimmunoassay of immunoglobulins IgG and IgM (Suer et al., 1988) demonstrated no significant differences between 86 oiled sea otters, 13 controls from Prince William Sound (pre-spill), and 29 California sea otters. Blood samples from the three study groups of otters were also assayed serologically for antigen/antibody reactions to eight bacterial pathogens. Three bacteria, Vibrio cholera (non 01), Pasteurella parahemolyticus, Staphylococcus aureus showed similar antigen/antibody reactions. An enhanced response to five other bacteria, Salmonella newport, S. pullorum, S. typhimurium, V. alginolyticus, P. multocida were observed for the oil spill group. The latter response may have resulted from contamination of the food while the otters were in captivity.

VI. Conclusions

1. The medical treatment of oiled sea otters began as soon as the animals entered the rehabilitation facilities. Medical disorders could be divided into four major categories: 1) the effects of exposure to crude oil, 2) health problems associated with capture and captivity, 3) exposure to domestic animal diseases and 4) health problems naturally occurring in the sea otter population.

2. Common medical disorders resulting from exposure to crude oil included:

hypothermia	dehydration
emphysema	diarrhea
anemia	sinusitis
hemorrhagic enteritis	seizures

Table 4.2 Acute Phase Reaction Assessment in Sea Otters

60 minute Erythrocyte Sedimentation Rate and serum iron concentration for sea otters at the Valdez rehabilitation center. Mean values ± 1SD are presented.

	Erythrocyte Sedimentation Rate (mm/hr)	Serum Iron (ug/dl)
Receiving Medication (n)	56.0 ± 10 (8)	123.0 ± 38 (8)
Healthy (n)	7.5 ± 7 (59)	173.7 ± 73 (211)

Most of these conditions were treated symptomatically when possible using standard veterinary procedures.

3. Health problems resulting from captivity during rehabilitation included:

gastric ulcers	diarrhea
sores/abrasions	

Improving the rehabilitation facilities and minimizing the stress of captivity could prevent many of these problems. Because stress directly or indirectly contributed to many of the medical disorders of recuperating otters, the clinical assessment of stress is essential for medical diagnosis and treatment.

4. Exposure of sea otters in the rehabilitation centers to domestic animal diseases (and subsequent introduction into the wild population) was a concern, but there were never any documented cases of such diseases during the rehabilitation program.

5. Naturally occurring health problems were associated with aging, parasitism, pregnancy and a herpes-like virus that caused oral lesions in some sea otters. These medical problems were treated when possible using standard veterinary procedures for domestic animals.

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Chapter 5. Husbandry

Pamela Tuomi, D.V.M.

I. Introduction

The primary responsibilities of the husbandry staff were to: 1) provide a suitable environment where washed otters could restore the water repellent quality of their fur and recover from the toxic effects of the oil, 2) provide a nutritionally balanced diet to recuperating animals, 3) keep the facility sanitary and free from disease, 4) train personnel to handle otters in a safe and humane manner, 5) maintain detailed records on the behavior and medical condition of each otter, and 6) prepare the otters for eventual release.

The animal care facilities in Valdez, Seward and Homer are described in Chapter 1. This section reviews husbandry procedures used during the rehabilitation process.

II. Nutrition

Sea otters in the wild eat a wide variety of food depending on locality and season (Kenyon, 1969; Estes et al., 1982; Garshelis et al., 1986). Although nutrition is always an important factor in animal husbandry, adequate caloric intake is especially important for sea otters because they have a high resting metabolic rate (2.4-fold higher than mammals of the same size) and little body fat (Costa and Kooyman, 1981; Davis et al., 1988). As a result, inadequate food intake results in rapid weight loss and may cause stress induced hemorrhagic enteritis (Stulken and Kirkpatrick, 1955). For oiled otters, these problems were exacerbated by a decrease in the thermal insulation of their fur. To prevent hypothermia, the otters had to increase their metabolic rate or go ashore to reduce heat loss. However, once ashore, they could no longer feed and lost weight.

Otters at the Valdez and Seward rehabilitation centers were fed a mixed diet consisting primarily of shrimp, scallops, pollack fillets, squid, dungeness crabs and geoduck clams (Figures 5.1 and 5.2). On average, the proportion of each food item in the diet depended on commercial availability and the individual preferences of the otters. Food items containing roughage (indigestible material such as the carapace of crabs and shrimp) were usually included in the diet. However, they were offered less frequently in April at the Valdez center. At that time, many of the otters were housed in indoor pens whose drains were easily obstructed by debris. The amount of dietary roughage increased in May and June as the rehabilitated otters were placed in outdoor floating pens.

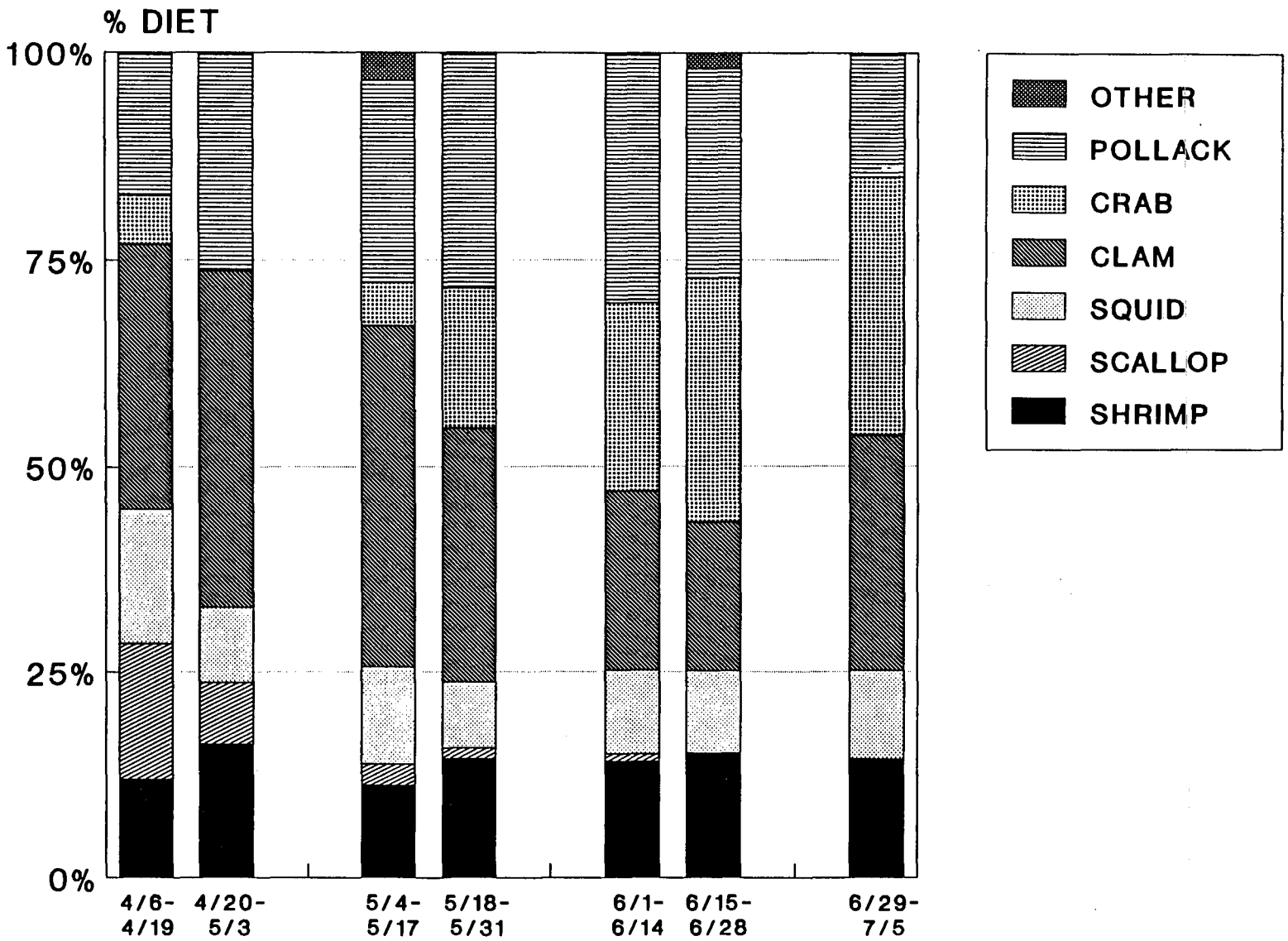

Figure 5.1 Food types as a percentage of diet at the Valdez Center.

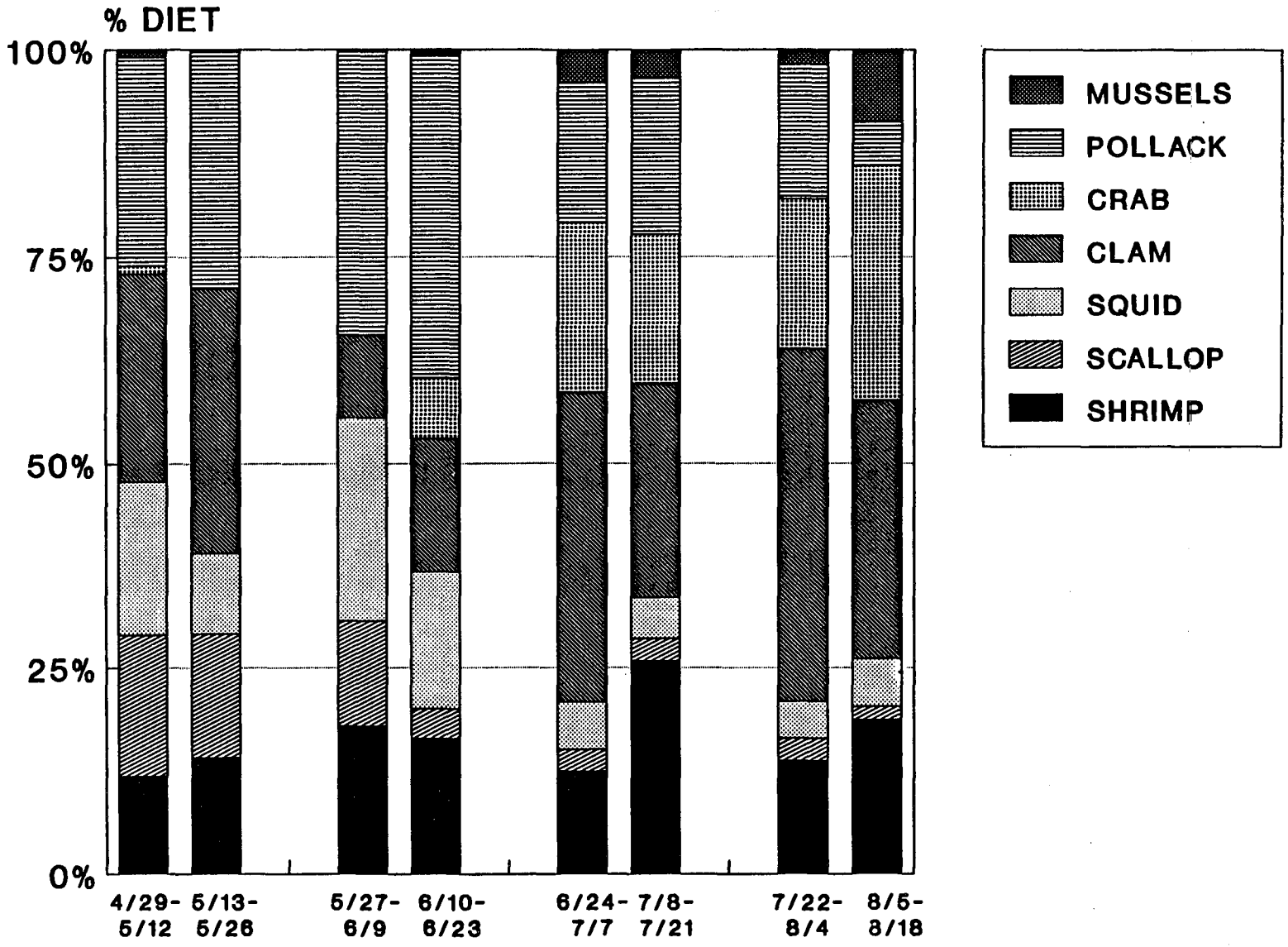

Figure 5.2 Food types as a percentage of diet at the Seward Center.

Because ulcers and hemorrhagic enteritis were observed during the postmortem examination of otters that died during the first three weeks of the oil spill, the veterinarians requested that bones and spines be removed from the food to prevent further irritation of inflamed intestines. The ink sacs of squid were also removed to prevent tarry-colored stools that were difficult to distinguish from bloody stools resulting from hemorrhagic enteritis. As the incidence of melena (blood in the stool) decreased, small amounts of roughage (shrimp carapace and whole squid) were added to the diet. The roughage resulted in stools with more form, but color and consistency continued to vary.

Most food for the otters was obtained in bulk from commercial seafood processors. Because freezing is believed to destroy most parasite larvae (Sweeny, 1965), fresh frozen seafood was generally used. After thawing in air or in cold water, the food was kept on crushed ice or refrigerated until delivered to the husbandry staff. Kitchen personnel wore gloves and disinfected all utensils and working surfaces regularly.

At Little Jakolof Cove, fresh cockles, mussels and sea urchins were purchased from contractors who collected the shellfish on certified local beaches under licenses granted by the Alaska Division of Seafood and Animal Health. As much as 4,000 pounds of fresh shellfish was purchased every two days and kept in seawater until used.

After thawing, the food was weighed, placed in plastic bags and kept chilled. Each bag was labeled with the type of food, its weight, and the time of preparation. This information was used to estimate food intake and to insure that unused food was discarded after 12 hours. Although sea otters normally consume 20% of their body weight in food each day (Costa, 1982; Garshelis et al., 1986), animals in poor health often ate less. The amount of food eaten by fully rehabilitated otters in the floating pens could not be determined, but the average amount offered ranged from 30-40% of body weight. This estimate includes uneaten food that accumulated on the bottom of the floating pens and was discarded as waste.

Otters with serious health problems were offered food hourly, whereas rehabilitated otters were generally fed every four hours from 7 am to 11 pm. For otters in dry cages and tote pens, food was either placed in a stainless steel bowl or offered one piece at a time with metal tongs. Otters in large pools and floating pens dived for food that was either tossed to them or placed in perforated plastic buckets suspended under water. Although some otters preferred one or two types of food (especially geoduck clams), they were offered a variety at each meal.

Chipped ice or pieces of block ice were regularly placed in the cages and pens as a source of fresh water for the otters. "Snowballs" of chipped ice sprinkled with table salt, glucose or seafood juices were accepted by some otters that refused other foods. Although vitamin supplementation was attempted, multivitamin-mineral tablets (Marine Tabs™) or liquid vitamins inserted into pieces of seafood were often rejected. The greatest success was achieved using Nutri-cal™ (EVSCO Pharmaceuticals, IGI Inc., Buena, N.J.), a vitamin-mineral paste that was squeezed onto bits of food and offered to recuperating otters in pens.

III. Sanitation

Pens were periodically rinsed with water to remove food and feces. Clean, dry terrycloth towels were used for bedding and replaced as they became soiled. Each day, the pens were disinfected with dilute chlorine bleach (1 part bleach to 30 parts water) and rinsed well. Pools were drained and scrubbed with the dilute chlorine at least every third day. Waste water from the pools was filtered to remove shells and pumped into a sewage line or into the harbor. Uneaten food and shells were removed from the bottom of the floating pens with long handled nets or by using a suction pump with a long, plastic hose. Plastic shipping kennels and food containers were washed with Dawn™ dish washing detergent, sanitized with a dilute solution of chlorine or chlorhexidine (Nolvosan™, AVECO Inc., Fort Dodge, IW) and then rinsed with fresh water.

Water quality varied widely among the rehabilitation centers. Until a continuous supply of seawater became available in mid-April, pools at the Valdez facility quickly became contaminated with feces and had to be cleaned several times per day. Although the seawater supply (about 100 gallons/minute) at the Seward facility was better than at Valdez, it was still inadequate to maintain water quality at optimum levels. Pools had to be drained and cleaned daily to prevent coliform counts from increasing to unacceptable levels (greater than 1,000 colonies per 100 ml, USDA, 1979). This was a particular problem in the seawater pond at Seward, where water turnover was inadequate for holding more than 10 otters. Tidal action was sufficient to maintain good water quality in the floating pens in Valdez and Little Jakolof Cove. However, algal growth on the nets was a problem at Little Jakolof Cove and Seward, and they had to be cleaned periodically. In Port Valdez Bay, the silty, glacial water prevented algal growth below a depth of one foot.

To prevent the introduction of disease, domestic pets were excluded from the rehabilitation centers at all times. Footbaths were used to decrease the risk of fomite transmission of disease. To prevent infections, staff members wore rubber gloves when

cleaning pens and washed their hands with povidone iodine hand soap or chlorhexidine solution before and after handling the otters.

IV. Animal Restraint and Handling

Although unnecessary handling was discouraged, oiled sea otters had to be restrained for cleaning and medical treatment. All procedures were performed as quickly as possible to minimize stress. Heavy leather gloves with long cuffs were worn by otter handlers to prevent scratches and bites. Otters in small pens or cages were captured by hand or with a short handled dip net. Long handled dip nets were required to capture otters in the floating pens. At the Solomon Gulch Hatchery, a seine net was used to encircle the otters in the large floating pens (the "octagon") before they were captured with dip nets. The otters were weighed in a cage (Figure 5.3) on a platform scale or by suspending the dip net from the hook of a hanging spring scale.

Injections, blood sampling and rectal temperature measurements were often performed while the otters were restrained with a stuff bag (burlap sacs or nylon gear bags filled with foam rubber or dry towels). The bag was pressed firmly against the otter's chest and forelegs thereby leaving the hindquarters free for examination or medical procedures. For more complete restraint, the otter was sedated (see Chapter 4 for details) or placed in a "squeeze box". The latter device was a shallow, wooden box with a narrow floor, sloping sides and a sliding door or small opening at one end. The otter was placed in the box on its back and restrained with a stuff bag. The rear legs and lower abdomen were pulled through an opening at one end of the box for taking blood samples, palpation of the abdomen, cystocentesis or administering fluids.

Very lethargic or lightly sedated animals were physically restrained for washing or medical treatment. An animal handler grasped a fold of skin at the back of the neck with both hands or placed a figure eight rubber pull-toy for dogs over the forelegs and chest and held the free ends tightly behind the otter's shoulders. An assistant held the rear legs and a third person performed the cleaning or medical procedure.

Otters that required tube feeding were chemically restrained (see Chapter 4), and a plastic or wooden dowel was placed between the premolars. A stomach tube was inserted into the esophagus to a premeasured length (about 40 cm). Proper placement of the tube in the stomach was tested by listening for bubbling sounds when air was blown into the tube. Liquefied food or medication (antibiotics, Toxiban™, or STAT™) was injected through the tube with 60 ml syringes. The tube was sealed while it was withdrawn to prevent aspiration.

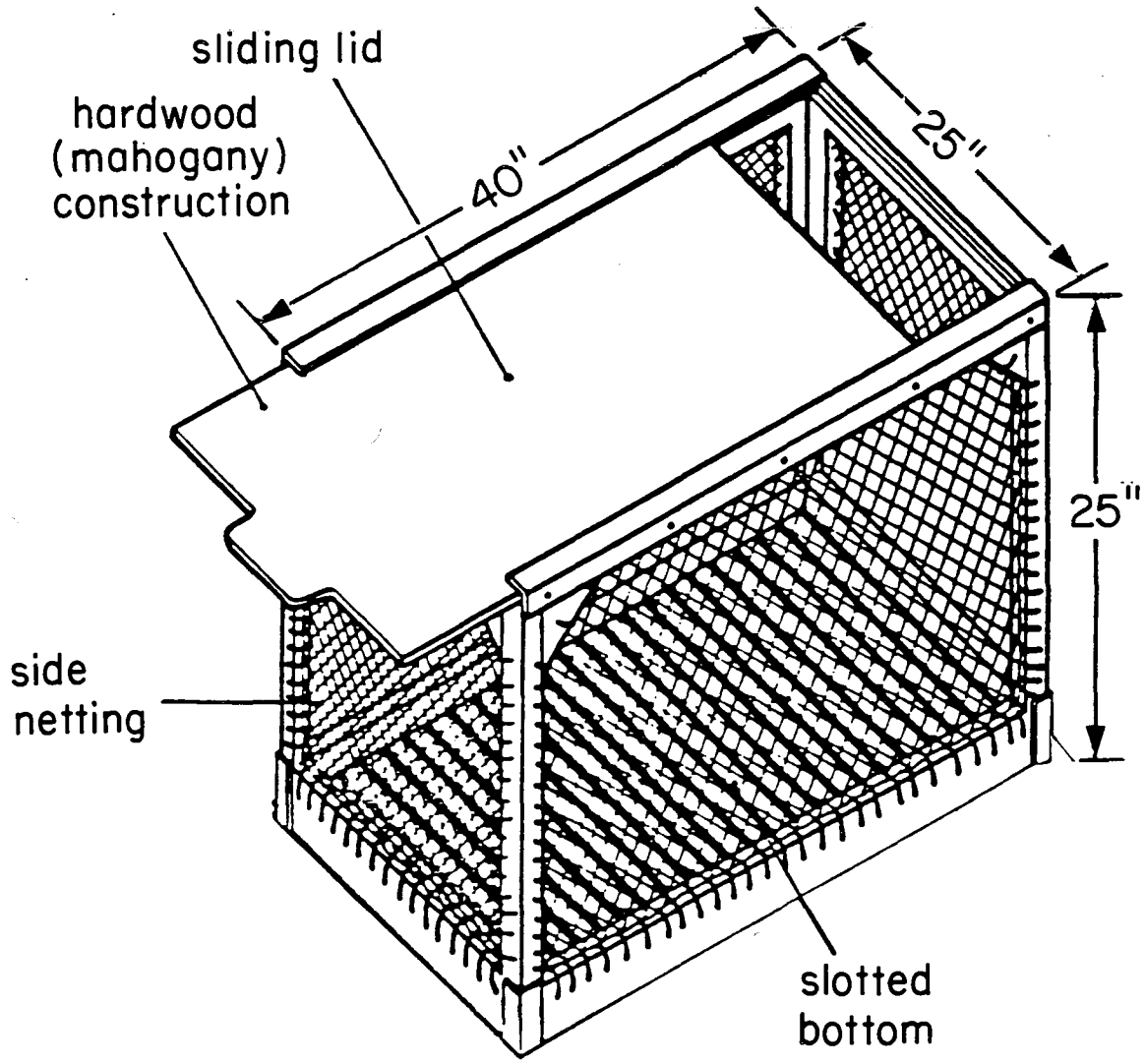

Figure 5.3 Wooden cage with net walls used to weigh and transport sea otters within the rehabilitation centers.

V. Staffing

Personnel in the critical care facility monitored the otters 24 hours per day. Each shift included a supervisor, otter monitors and handlers, food preparation staff, a pen cleaning crew, a veterinarian and a veterinary technician. Usually, each monitor was assigned 1-4 otters and was responsible for feeding, recording behavior, cleaning the pens and advising the shift supervisors and veterinary staff of the otter's behavior. Crews for washing oiled sea otters were assembled from available personnel and community volunteers as needed.

Rehabilitated otters in floating pens required much less supervision. An observer usually monitored 10-20 otters and recorded information on the amount of food placed in each pen and any abnormal behavior or activity. During each shift, maintenance chores such as pen cleaning were performed by the observers.

During the first two months in Valdez, the professional staff and supervisors held daily meetings to discuss the status of the otters, evaluate ongoing procedures, and review suggestions for changes and improvements. In Seward, similar staff meetings were held twice weekly. By rotating the veterinarians between all three centers, we encouraged the evaluation of new techniques and the discussion of unusual medical problems.

Most of the nonprofessional staff at the otter rehabilitation centers began as volunteers, many with little or no experience in handling wild animals. During the first few weeks after the spill, training was provided by the center directors, veterinarians and by professional marine mammal husbandry personnel from the Monterey Bay Aquarium, Vancouver Aquarium, the Point Defiance Aquarium and Sea World. Written instructions were posted and periodic meetings were held with each shift to explain or reinforce protocols. Training videos on methods of cleaning and caring for oiled sea otters were produced by Tom McCloskey at the Valdez center in April. Procter and Gamble produced a second video on cleaning sea otters that was made available to the staff in May. After mid-April, most of the personnel were paid staff, although volunteers continued to be utilized at Seward and Homer (see Chapter 1). Biweekly sessions were held at the Seward rehabilitation center to train volunteers. Safety, sanitation, and techniques to create a low stress environment for the otters and people were emphasized at all times.

VI. Record Keeping

Each otter was assigned two letters and a number which designated the numerical order in which it arrived at the centers in Valdez (VA), Seward (SW), or Homer (HO). In addition, a toe tag was attached to one of the hind flippers to identify each animal. Tag numbers changed if a tag was replaced; otter numbers usually remained the same even when the animal was transferred to another rehabilitation center. Pups born at Seward were assigned their mother's number with the addition of the letter "P" (i.e. the pup of SW 023 would be SW 023P); in Valdez they were assigned the next available number in sequence plus a "P".

Observations were recorded for each otter throughout its rehabilitation. Record sheets were kept on a clipboard and marked with each otter's tag number and otter number. In the critical care facility, notations about the otter's behavior, food consumption, the appearance of feces, medical treatments, pen changes, and any comments thought to be of importance were made every 15-30 minutes. For rehabilitated otters in the pre-release facilities, only unusual behavior and medical treatments were recorded. Feeding records were made for groups of otters in each pen. All record sheets were dated and initialed by the monitors.

During daily rounds, notations were added to the record sheets by the veterinary staff using red pens to highlight their entries. Separate forms were used for recording sedation procedures and laboratory tests. Summary forms were used by the veterinarians and husbandry supervisors to monitor each animal's progress and as an aid for medical diagnosis.

Record sheets were collected daily and filed. In Valdez, one photocopy was returned to the otter's clipboard and a second copy was kept in a working file that was used by the veterinary and husbandry staff. In Seward, a photocopy was kept in the veterinary clinic and specific information entered into a computerized database each day; summaries were printed the following morning. Copies of all records were given to the USFWS before the centers closed.

When an animal died, copies of the summary sheets and laboratory test results were sent to the pathology laboratory with a short clinical report highlighting information that might be important to the pathologist. Similarly, animals transferred to another facility were accompanied by a photocopy of their entire file.

After the centers closed, information from written records was consolidated into a computerized database for; 1) biographical information, 2) clinical laboratory tests of blood, 3) medical treatments, 4) necropsy results, 5) husbandry data and

6) feeding records. Microfilm copies of records were made at the University of Alaska, Fairbanks, and the original files were stored at Exxon Company offices in Anchorage.

VII. Supportive Care

A. Maintenance of Core Body Temperature

Oil contaminated otters arriving at the rehabilitation centers had usually lost the insulating properties of their fur. Although the washing process removed the oil, it did not immediately restore the water repellent quality of the fur. This required active grooming by the otters in seawater for 7-10 days (Chapter 3). Otters that did not groom well took longer to restore their fur.

Until the cleaned otters had restored the water repellency of their fur, hypothermia was a potential problem whenever the otters entered the water. Mild shivering was not a reliable sign of hypothermia because healthy otters often shiver when they are sleeping or resting in the water. Violent shivering, lethargy, lack of reaction to handling, and palpably cold flippers were easily recognized signs of hypothermia. Otters with these symptoms were moved to dry pens and warmed with pet dryers or heat lamps; in severe cases, the flippers were placed in warm water. Otters were offered food as soon as possible during these episodes, and veterinary assistance was sought if the animal did not respond to rewarming.

Hyperthermia (overheating) most frequently occurred when the otters were in an enclosed area without access to water or ice. Sedated otters were especially at risk, and their body temperature was measured periodically with a rectal thermometer. Mild hyperthermia could be corrected by placing cold water or ice on the hind flippers. Immersing the entire otter in cold water or placing it on chipped ice was effective in severe cases.

B. Coat Condition and Grooming

Grooming in water is essential for a washed sea otter to restore the water repellent quality of its fur (Davis et al., 1988). While grooming, an otter often rolls in the water, rubs its fur vigorously with its forepaws and flippers, and blows air into the fur. Otters typically groom about 35% of the time in captivity (Davis et al., 1988), but only 6% of the time in the wild (Garshelis et al., 1986). The grooming is thought to interlock the hair shafts (similar to the imbrication of feathers) trapping an insulating layer of air next to the skin. The secretion of sebum at the base of the hair shaft may be important for keeping the hair healthy and may also make the fur hydrophobic. When properly groomed, the underfur is water

repellent, and the outer guard hairs dry quickly when the otter hauls out.

In the rehabilitation centers, sea otters in poor health did not groom, and their fur lost its insulating qualities. This often occurred when the animals could not thermoregulate well and had to be kept in dry, indoor pens. Otters that could thermoregulate at ambient air temperatures (-4 - +14°C, 24-57°F) were placed in seawater pools to groom. A newly cleaned otter usually groomed its head and shoulders first, then its abdomen and back. Otters were able to perform grooming maneuvers adequately when the water depth was at least two feet. If they became chilled, they were removed from the water and dried. This process was repeated daily until each otter could remain in the water indefinitely, or until it would voluntarily haul out.

C. Stress

Otters are normally subjected to stress from parasitism, disease, pregnancy and infirmity resulting from old age. For otters in the rehabilitation centers, these natural stressors were compounded by oil contamination of the fur, oil toxicity, capture, sedation, medical treatment and captivity (see Chapter 4).

Overcrowded conditions and the need to treat oiled otters while the Valdez center was under construction made it impossible to provide a quiet environment during the first month. These stressful conditions were improved by moving otters to outdoor pens as soon as they could thermoregulate at the near-freezing ambient air temperatures. Quiet periods were established at night and unusual or loud noises minimized whenever possible. At the pre-release facility in Little Jakolof Cove, husbandry protocols were designed to minimize visual and physical contact with the otters.

When stress-associated behaviors such as chewing on the pens were observed, the otters were offered food, ice or a canine rubber pull-toy to chew. This often relieved the animals' immediate distress. Placing the animals in water to swim and groom was also effective, and stress behaviors were less common when otters had free access to pools.

D. Injuries

Pressure sores and abrasions on the feet and legs occurred in many otters placed in dry pens for more than one or two days. A variety of surfaces were tested to prevent this problem including wire mesh (0.5 inch x 0.5 inch), indoor-outdoor carpeting and plastic grate (1.5 inch x 1.5 inch; Chemgrate Corp.). In some cases, dry towels were placed on the wire mesh or plastic grate. A smooth plastic surface that was perforated

with holes one inch in diameter caused the fewest sores.

One otter broke its upper canine teeth while chewing on a wire cage. Flexible herring net was subsequently used on the pens and prevented further injuries to the teeth. Several otters developed facial abscesses that may have been caused by splinters from the wooden pens. Pens made of PVC pipe instead of wood prevented this type of injury.

E. Social interactions

In the wild, sea otters frequently gather in large "rafts" around preferred feeding or resting areas (Garshelis et al., 1984). Although the importance of social interaction within these natural groups is unknown, it appeared that social contact was beneficial while the otters were in the centers. Otters that were visually isolated from each other often vocalized intensely and ate less; placing two otters together in a pen reduced these problems. Female otters sleeping on haulout platforms in the seawater pens would often lie together even when there was sufficient room to avoid physical contact. Social behaviors such as sharing food and allogrooming were also observed. Males would sometimes group in this manner, but appeared to have a more rigid social hierarchy.

In general, males and females were kept in separate pens. This prevented the bite wounds typically inflicted by males during breeding. Occasional threat displays were noted when a large, new male was placed in a pen. Fighting was rare but did occur when free-ranging, territorial males encountered captive male otters at the Solomon Gulch Hatchery and in the floating pens at Little Jakolof Cove. As a result, several territorial males had to be captured and temporarily placed in pens. Most mature males were housed individually at Little Jakolof Cove to avoid aggression in the floating pens.

Social "bonding" appeared to occur between a number of otters that often slept, swam and played together. In several cases, juvenile otters appeared to be "adopted" by older females. The adults in these pairs would groom the younger otter, hold it by the neck, and share food. In at least three pairs, the adult female allowed the younger otter to nurse, although lactation could not be verified.

VIII. Caring for Pups

Young sea otter pups require constant attention to ensure their survival. Basic techniques to care for orphaned sea otter pups had been developed at the Monterey Bay Aquarium. The nurseries at the Valdez and Seward rehabilitation centers were modeled after the Monterey Bay Aquarium facility, and the

husbandry techniques were modified as needed.

Six pups born at the centers after mid-May were successfully cared for by their mothers. Five of these were eventually released with their mothers into the wild; the sixth pup was moved to the nursery after ten days because the mother stopped grooming it. Most of these pups were taken briefly from their mothers for weighing, movement to other pens, or medical treatment. The mothers and pups vocalized loudly while separated but resumed normal activity as soon as they were reunited. Females with newborn pups were usually separated from other otters until the pup was at least one month old.

The Valdez nursery cared for five pups. Two wild orphan pups were brought to the center in early April and transferred to the Monterey Bay Aquarium on April 13, where they were successfully raised. Two pups born at the rehabilitation center were moved to the nursery when their mothers were unable to care for them; both pups died within 36 hours. Another wild orphan pup was treated for two weeks and transferred to the Seward nursery when that center began full operation in May.

The Seward nursery cared for 21 pups. Of these, eight were born at the rehabilitation center, and eight were wild orphans (including the pup transferred from Valdez). Five pups arrived at the center with their mothers, but were taken to the nursery when their mothers died or were unable to care for them. In all, thirteen pups survived and were transferred to the Point Defiance Aquarium when the Seward center closed in early September.

The nursery staff worked in 12 hour shifts, and each attendant cared for 1-3 pups. Pups were fed a formula (Appendix 8) with a stomach tube or by allowing them to suckle from the end of a 6 ml plastic syringe. Each pup was fed 4-5 ounces of formula per pound of body weight each day; this quantity was divided into 8-10 feedings. The formula was prepared twice daily, refrigerated, and warmed to approximately 38°C (100°F) before use. Additional fluid was administered to very young or weak pups by injecting lactated Ringer's solution subcutaneously twice daily. Diarrhea was a common problem in all of the pups until the formula was modified by adding bran cereal and substituting whipping cream for the Half-and-Half.

The nursery room was kept at about 18°C (64°F). Only nursery staff, veterinary personnel and a limited number of visitors were allowed to enter the nursery. An unheated waterbed was used by the pups during play periods and while sleeping.

Newborn pups (up to four weeks of age) were kept on a 2-3 hour schedule consisting of: 1) a short bath in water at room temperature to stimulate urination and defecation, 2) towel drying, 3) tube or syringe feeding of formula, 4) rinsing the

coat to remove food, feces or urine, 5) thorough towel drying and combing, 6) a short play period on the water bed, and 7) sleep period of 1-2 hours.

Maintenance of normal core body temperature (38°C, 100°F) at this age was critical. Rectal temperatures were taken just after waking. If the pups were chilled, they were gradually warmed with a hair dryer. Pups with core body temperatures above 39°C (102°F) were cooled by placing them on cold water bottles or ice packs and wetting the fur on the neck and flippers.

At one month of age, pups were allowed to swim in a tub filled with seawater. Pups would begin grooming themselves at this age but still required meticulous combing to keep the fur from matting. Small pieces of solid food were offered at 1-2 months of age, and the frequency of formula feedings decreased to every four hours. Daily food intake was maintained at 25-30% of body weight, and the pups were weighed at least once daily to monitor growth. Rectal temperatures taken several times daily confirmed that the pups had better control over body temperature; occasional fluctuations were corrected by placing the pup in water or blow drying the fur.

By three months of age, most pups were placed in pens with pools during the day and ate mostly solid food. Gradually, larger pieces of geoduck, shrimp and fish were offered, and the pups were encouraged to dive for food that was dropped into the pools. Formula was still provided four times daily until the pups were eating sufficient solid food to equal 25% of body weight. As they became more proficient at grooming, attendants spent progressively less time combing and drying the pups. Some pups seemed to acquire swimming and grooming skills instinctively, while others were extremely slow to achieve independence in these areas.

All pups tolerated handling from a very early age. Mortality was highest during the first week. Most pups that survived longer than two weeks continued to do well and could tolerate problems such as loose stools or skin rashes without serious complications.

IX. Conclusions

1. To restore the water repellent quality of their fur, washed sea otters were placed in seawater pools or floating pens as soon as their health permitted. The amount of time in water was increased gradually until the insulating properties of the fur were restored.

2. A varied diet and adequate caloric intake were essential for rehabilitating sea otters.

3. Constant monitoring was necessary to prevent the otters from becoming hypothermic or hyperthermic during rehabilitation and transport.

4. To reduce the stress of captivity, unnecessary handling was avoided, and otters were kept in groups of the same sex.

5. Sanitation and quarantine protocols were difficult to institute in the rehabilitation facilities, especially during the first month. This could have been avoided if well designed facilities were available before the spill.

6. Exposure of the sea otters to contagious diseases, especially from domestic animals, was a potential problem in the rehabilitation facilities.

7. Regular meetings of supervisors, veterinarians and husbandry staff were important to improve husbandry protocols.

8. Records of behavior, medical treatments and clinical laboratory tests were used by the veterinarians to monitor each otter's progress and as an aid for medical diagnosis.

9. Sea otter pups required constant attention to ensure survival. Preventing hyperthermia or hypothermia, meticulous care of the fur, and good nutrition were critical. By the age of three months, most pups were placed in pens with pools during the day and ate mostly solid food.

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Chapter 6. Postmortem Examination of Sea Otters

Kent Osborn, D.V.M.
Terrie M. Williams, Ph.D.

I. Introduction

Postmortem examination (necropsy) of dead otters provided valuable information that was used to improve treatment and husbandry protocols. This report summarizes data from necropsies performed on sea otters during the 90 day period following the oil spill. The potential effects of petroleum hydrocarbon exposure and chronic stress on the pathology and mortality of sea otters are discussed.

II. Postmortem Examinations

A. Participating Organizations and Agencies

Sea otters that died during rehabilitation were usually examined within two hours at the pathology laboratories in Valdez or Seward. Protocols for necropsy and tissue sampling for histopathology and residue analyses were established by veterinary pathologists from the University of Alaska (Fairbanks) and University of California (Davis) Pathology Departments. These were modified after April 21 to conform to protocols used by the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Fish and Wildlife Service (USFWS). Carcasses were returned to USFWS after examination.

A veterinary pathologist performed the necropsies and was usually assisted by a veterinary clinician and a laboratory technician. Institutions that provided pathologists included the University of Alaska at Fairbanks, the University of California at Davis, California Department of Fish and Game, Washington State University, USFWS, the EPA, the Armed Forces Institute of Pathology, and the National Wildlife Health Research Center.

B. General Examination

After the carcass was opened, gross observations were made without disturbing organs to be sampled for toxicology. Blood samples were taken from the heart within 15 minutes of death and analyzed for serum chemistry and petroleum hydrocarbon concentration. Six blood smears were made, and the remainder of the blood was frozen in acid washed vials (I-Chem). Impression slides of femur bone marrow were made within three hours of death. After toxicological samples were taken, all organs and tissues were grossly examined and morphological abnormalities described.

Organ weights were determined if the tissues were not used for petroleum hydrocarbon analyses. Necropsy reports for each animal were summarized in a computerized database with notations made as to the presence or absence of abnormalities in each major organ or tissue.

C. Toxicological Sampling

Tissue samples for petroleum hydrocarbon analyses were collected before each organ was examined. To avoid cross contamination, instruments were rinsed in dichloromethane. Triplicate samples (approximately 50 gm each) of liver, lung, kidney, and brain were collected routinely; bile, urine, stomach contents, intestinal contents, and placenta were collected when available. Two sets of samples were provided to USFWS, and the other was retained by the rehabilitation centers. Tissues were frozen individually in I-Chem jars or in aluminum foil packets that were cleaned with dichloromethane.

D. Histopathological Sampling

Tissue samples (<1 cm thick) for histopathology were taken from representative organs of approximately 100 sea otters. All samples were preserved in 10% neutral buffered formalin and stored in sterile containers. Histological samples were divided into two identical sets for the sea otter rehabilitation center and the USFWS. Organ lesions and abnormalities were noted and sampled. The following tissues were routinely sampled:

Thyroid/Parathyroid
Cross section trachea and esophagus
Thymus (neonate/fetus)
Heart
Loin Muscle
Bone Marrow
Eyes
Stomach
Skin
Mesenteric Lymph Node
Gonads
Pancreas
Adrenals
Kidney
Lung
Liver
Diaphragm
Gall Bladder
Small Intestine
Large Intestine
Spleen

Fixed tissues were embedded in paraffin, sectioned on a microtome, and stained with hematoxylin and eosin.

III. Mortality of Oiled Sea Otters

Fifty-one of the otters examined during necropsy were adult females and 23 were adult males (Table 6.1). This represented 23% of the female and 21% of the male otters brought into the rehabilitation centers. Among the adult females, six had term or near-term fetuses, and one had a first trimester fetus. Seven

Table 6.1. Demographics of sea otters examined postmortem at the Valdez and Seward Rehabilitation Center Pathology Laboratories. Animals were classified as pups (Pup) if they were not weaned and as juveniles (Juv) if they had not obtained adult (Adt) weight. Fet denotes fetuses examined, and Unk indicates animals of unknown age.

	Fet	Pup	Juv	Adt	Unk	Tot
Male	9	5	8	23	1	46
Female	4	7	8	51	1	71
Not Recorded	1	0	1	3	0	5
TOTAL	14	12	17	77	2	122

additional adult females had evidence of recent parturition or were still lactating. Thus, among the 51 adult females that were examined, 13 were pregnant or had been recently pregnant. An additional eight fetuses were also examined; of these, three were premature and five were term or near-term in size. The remaining animals included 11 unweaned pups and 17 juveniles.

Over 60% of the sea otters received during the first three weeks of the spill died (Figures 6.1 and 6.2). After April 14, mortality declined sharply. Overall, mortality was 54% at the Valdez rehabilitation center and 20% at both the Seward and Homer facilities (Figure 6.3).

Mortality was correlated with the degree of external oiling (Figure 6.4). Seventy-five percent of the heavily oiled otters and 41% of the moderately oiled otters died. These animals were captured during the first three weeks of the spill, presumably while the oil was most toxic, and accounted for the high mortality at the Valdez center. The lower mortality at the Seward center resulted from the larger number of lightly oiled and unoiled animals that were received, and the low toxicity of the weathered oil that impacted the Kenai Peninsula and Kodiak archipelago. The pre-release facility at Little Jakolof Cove received mostly rehabilitated otters from Seward and, consequently, experienced a low mortality.

Approximately 25% of the otters that were lightly oiled or unoiled died at the rehabilitation centers (Figure 6.4). Note that this excludes pups which, as discussed in Chapter 3, have high mortality rates independent of oil exposure. A 25% mortality rate was also observed for otters in which the degree of oiling could not be determined. The similar mortality rates for these three groups suggests that the stress of capture and transport was a contributing factor. Because the mortality of unoiled otters in the rehabilitation centers was nearly three-fold greater than experienced during sea otter translocation programs (G. VanBlaricom, personal communication), prolonged captivity may have also been a contributing factor.

IV. Summary of Organ Lesions

Abnormalities were found in the majority of organ systems examined and included lesions in the lungs, liver, gastro-intestinal tract, and kidneys (Figure 6.5).

Pulmonary lesions were observed in nearly 66% of the otters. The most common lesion, pulmonary emphysema, was characterized by the accumulation of excess interlobular gas. In severe cases, areas of trapped gas were also found along the tracheal membranes and under the skin of the thorax. All but two of the severe cases of emphysema were noted during the first six weeks of the spill;

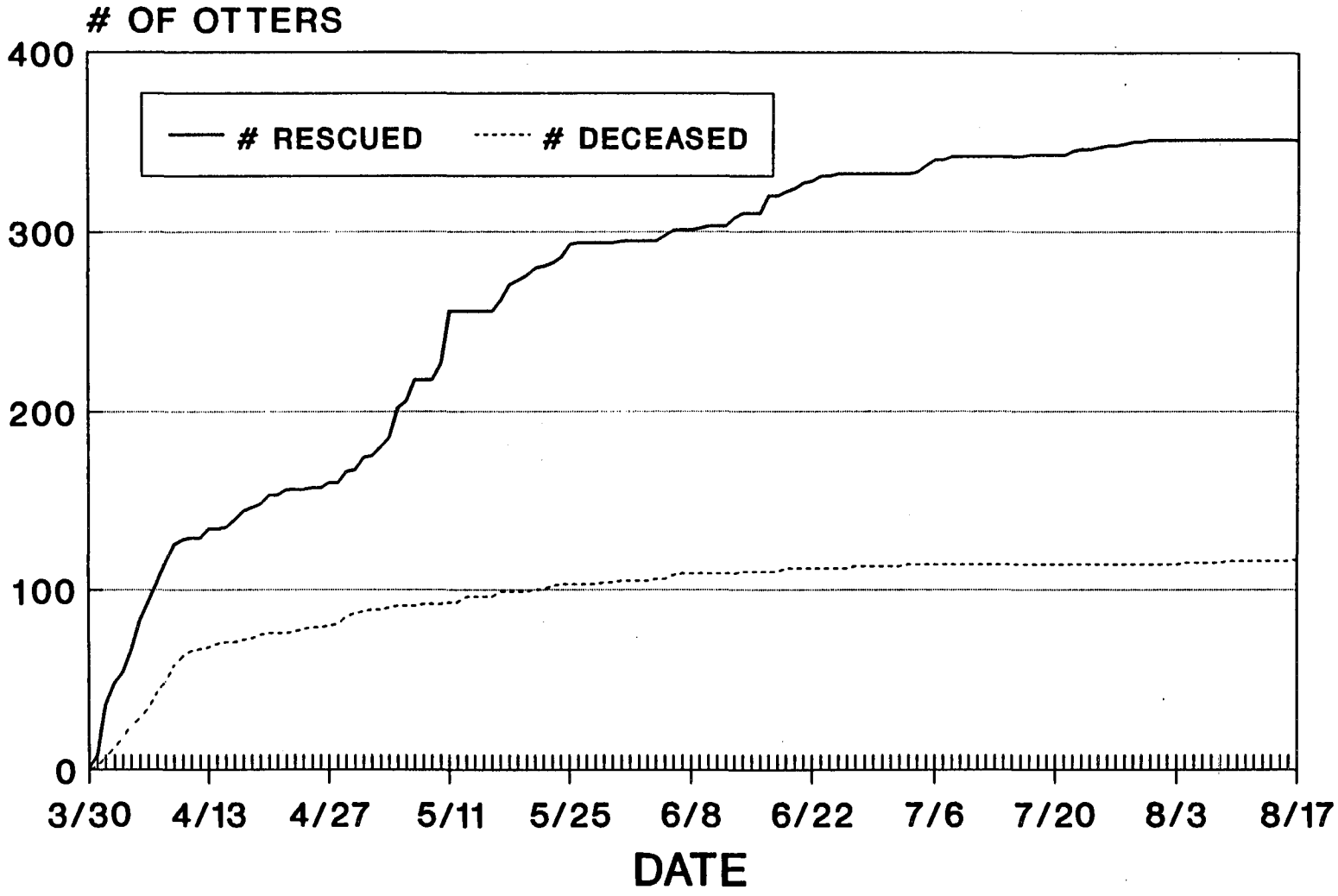


Figure 6.1 Cumulative totals for sea otters that were admitted and later died at the Valdez, Seward and Homer centers.

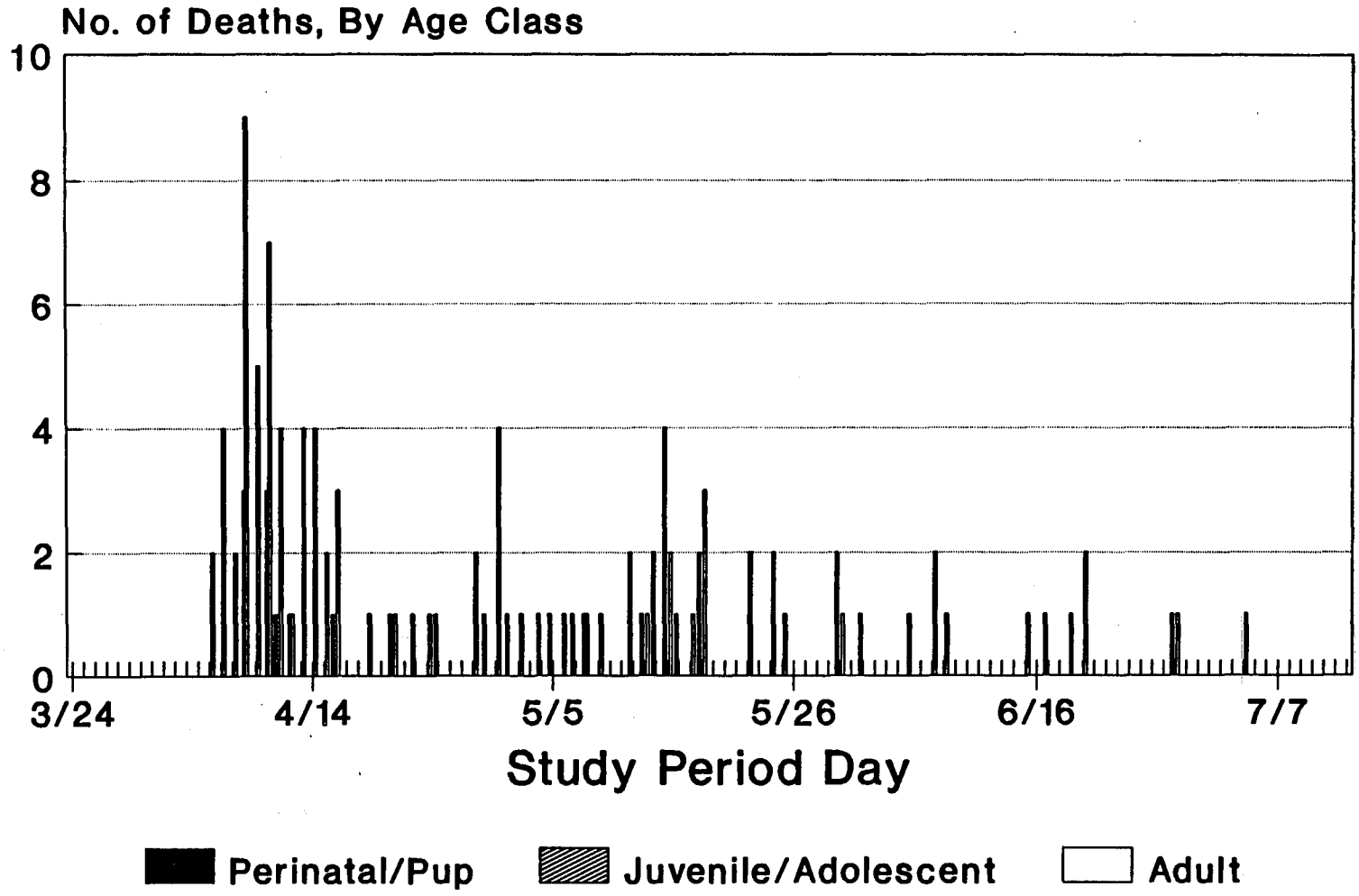
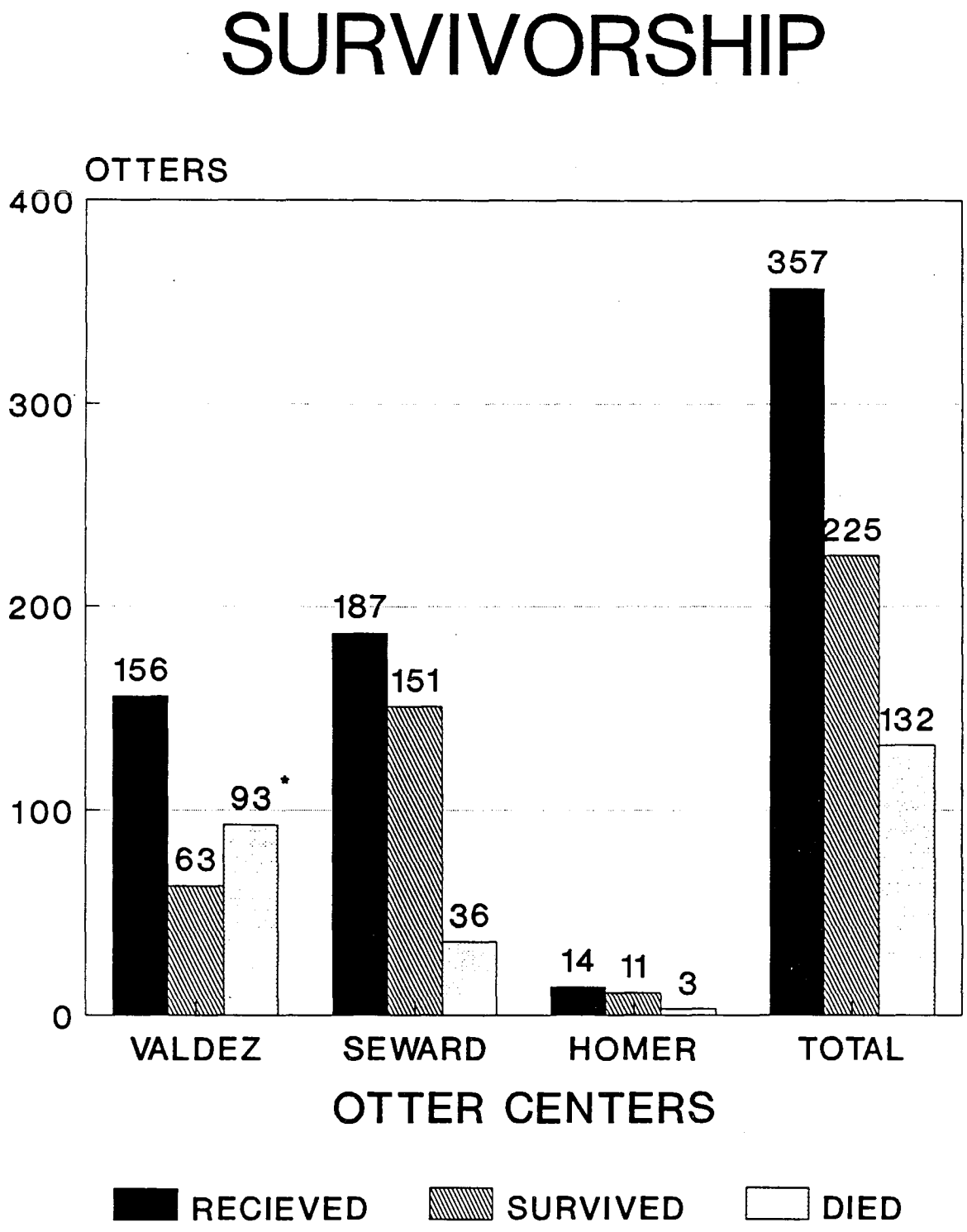


Figure 6.2 The number of sea otters that died at the rehabilitation centers by age class in relation to time after the spill.



*8 died at aquariums

Figure 6.3 Differential survivorship at the three centers.

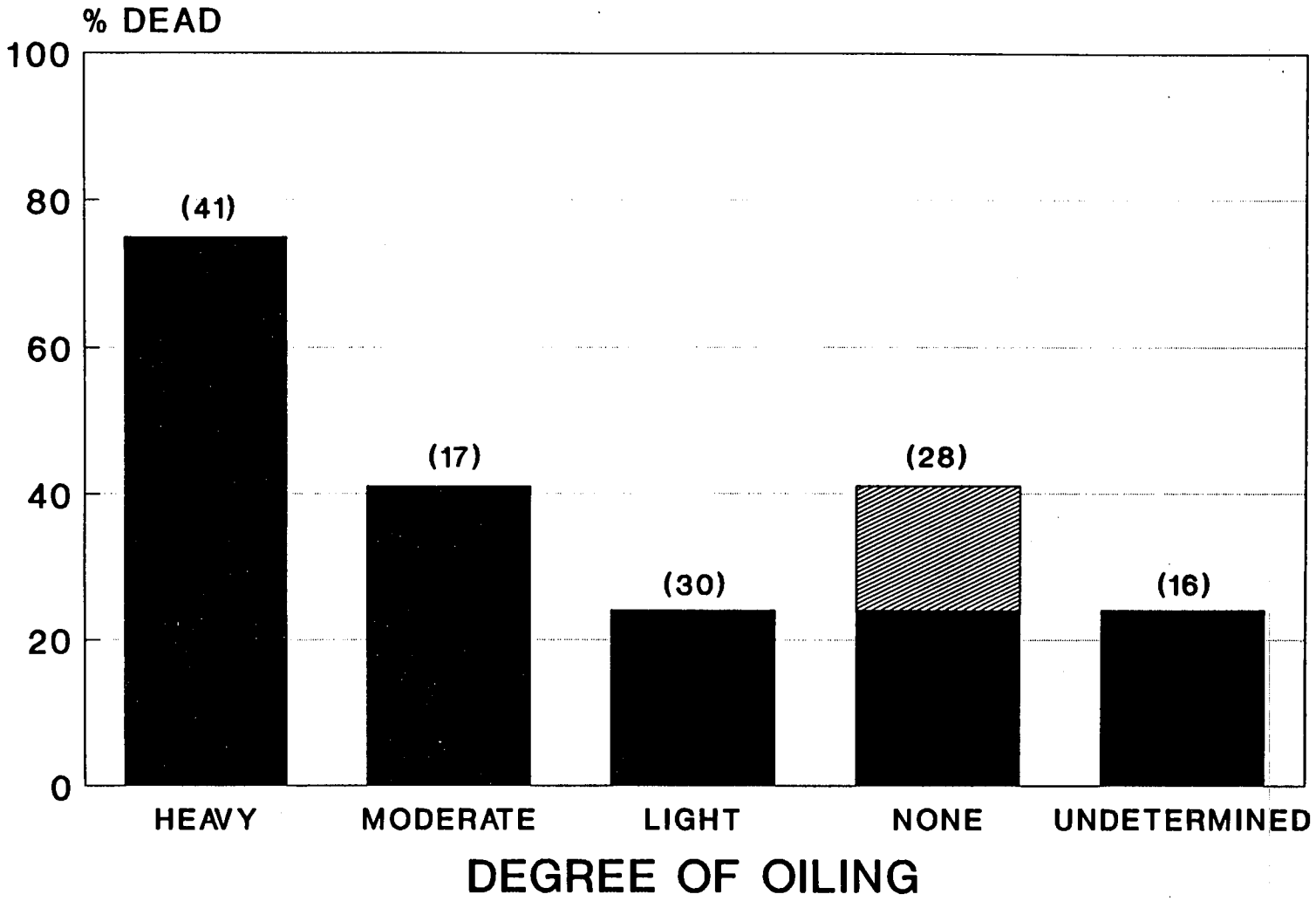


Figure 6.4 Survivorship in relation to the degree of external oiling. The shaded area represents pups, which had a high mortality that was unrelated to oil exposure. Otters in the undetermined category were either so lightly oiled or unoiled that the staff could no make a determination.

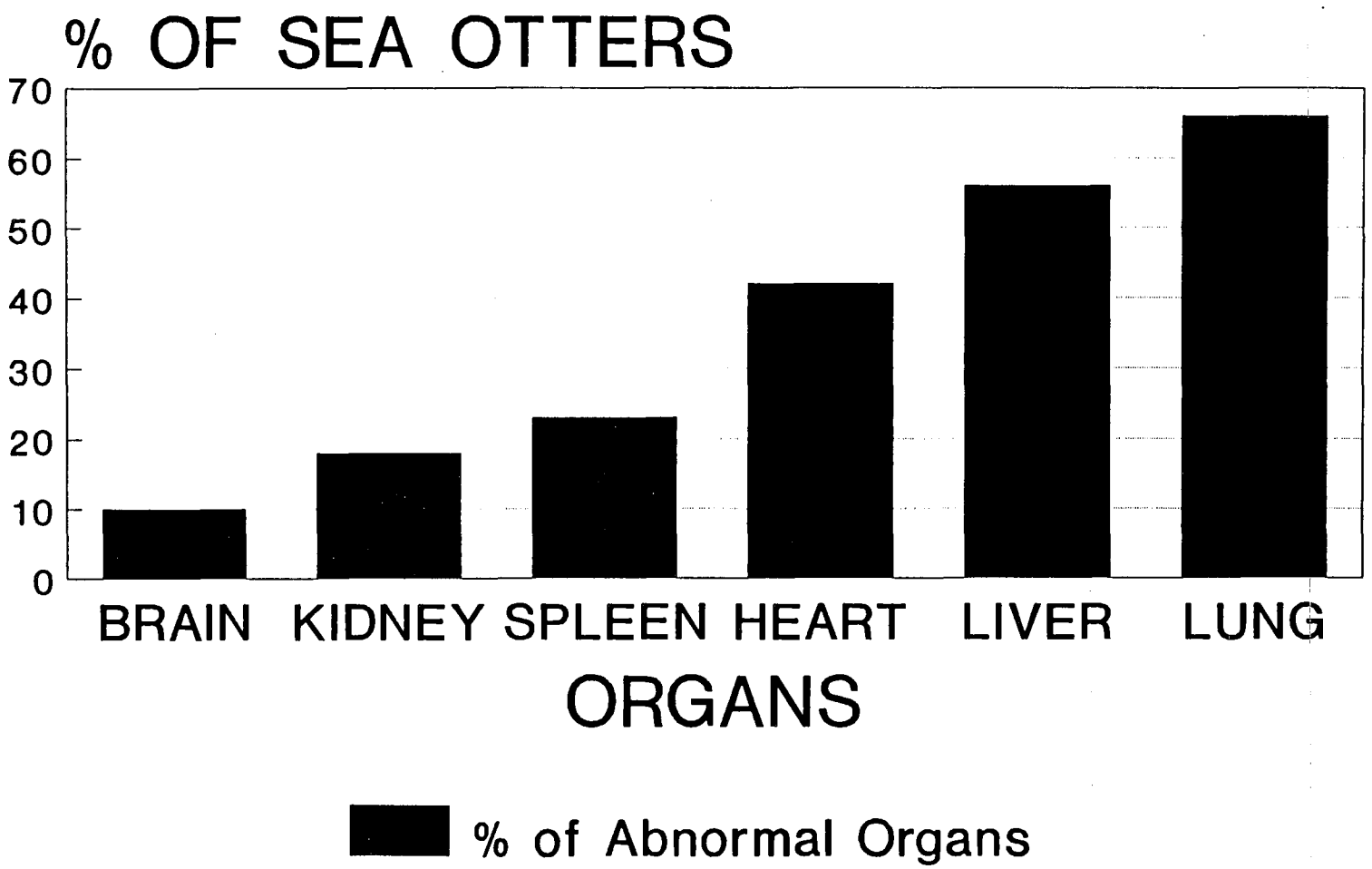


Figure 6.5 Percentage of necropsied sea otters with gross organ abnormalities. One hundred and twenty two otters were examined.

only mild emphysema was observed after this period (Figure 6.6). Emphysema was not observed in unoiled pups. Therefore, it appears that this lesion is associated with exposure to fresh crude oil.

Liver abnormalities, characterized by changes in color and texture of the organ, were noted in 55% of the otters. These changes were caused by degeneration and necrosis (death) of the liver. As with the lung lesions, gross liver lesions occurred in otters that became oiled during the first weeks of the spill.

A variety of other problems also contributed to the mortality of otters at the rehabilitation centers. Abnormalities in the kidney and spleen, including discoloration and enlargement, occurred in approximately 20% of the sea otters examined. There was little correlation between the incidence of these abnormalities and the degree of external oiling.

Gastrointestinal inflammation was frequently observed in the sea otters, but was only associated with mortality later in the spill. Parasites and ulceration were the most common gastro-intestinal problems; often the two conditions occurred simultaneously. There was a positive correlation between degree of oiling and the incidence of stomach ulcers, but not for intestinal ulcers (Figure 6.7). It is possible that stress associated with oiling, illness, or captivity led to gastric ulceration in these animals.

Gross abnormalities of the heart were found in 42% of the sea otters examined. Problems included coronary congestion, dark fluid in the pericardial sac, and apparent myocardial damage. Occasional abnormalities were observed in skeletal muscle, gall bladder, lymphatics, and adrenal and thyroid glands. Fetal deaths and subsequent abortions were most likely due to secondary maternal-placental circulatory problems.

A common finding in many animals that died after May 1 was adrenal hyperplasia. This condition may have resulted from chronic stress and caused a decreased resistance to infection. This conclusion is supported by the high incidence of infections such as pneumonia, purulent rhinitis, mastitis, enteritis and peritonitis in oiled otters. In addition, histopathologic analyses of heavily oiled sea otters transferred to Sea World (San Diego) revealed progressive lymphoid depletion in immune system tissues and problems with bone marrow and blood cell production. Until the analyses of petroleum hydrocarbons in tissues is completed, we cannot fully determine the effects of oil-related toxins and stress on the immune system of sea otters.

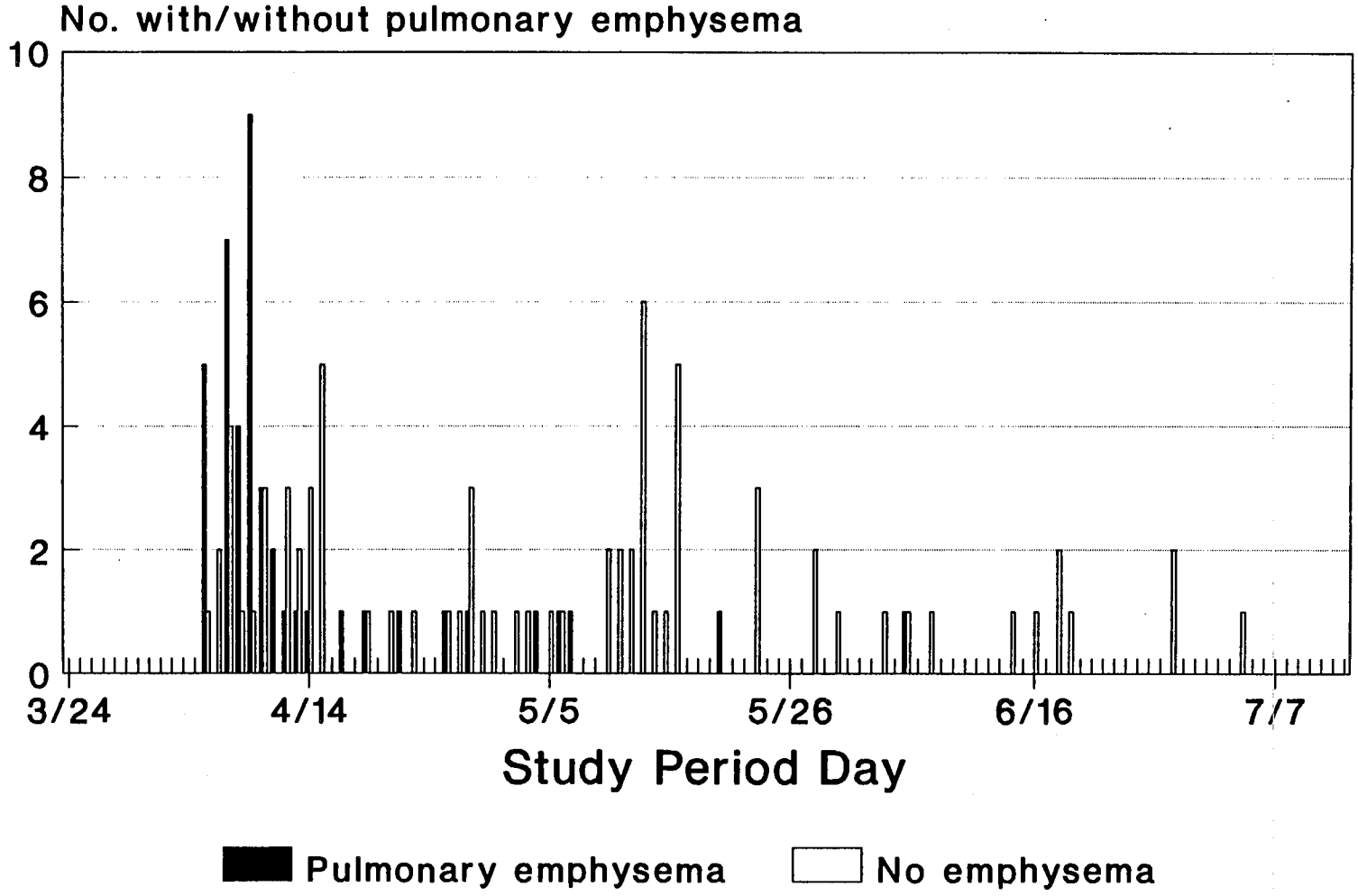


Figure 6.6 The incidence of pulmonary emphysema in necropsied sea otters in relation to time after the spill.

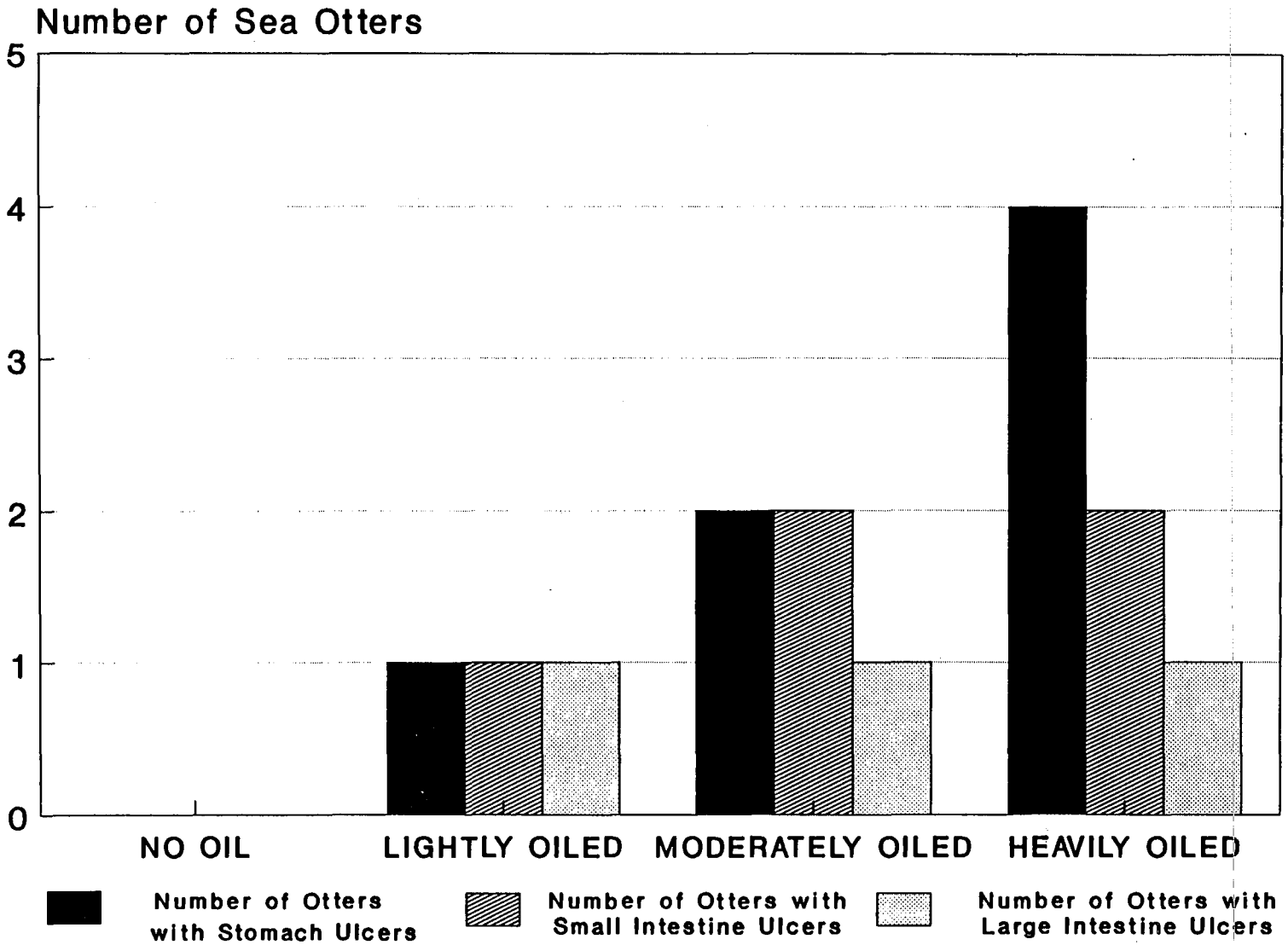


Figure 6.7 The number of sea otters that were diagnosed with gastro-intestinal ulcers at the time of necropsy. Over 50% of the otters examined had stomach, small intestine, or large intestine ulceration.

V. Conclusions

1. Mortality was greatest during the first three weeks of the oil spill when the oil was most toxic.

2. As the degree of external oiling decreased, the incidence of organ lesions and mortality of the sea otters declined. Mortality ranged from 75% in heavily oiled otters to approximately 25% in otters that were lightly oiled or unoiled.

3. The stress of capture, transport, and prolonged captivity appears to have contributed to the mortality of sea otters at the rehabilitation centers.

4. Based on gross examination of tissues, the liver and lungs of sea otters appear to be the most susceptible to acute petroleum hydrocarbon toxicity. Pulmonary lesions were observed in almost 66% of the otters that were examined. Liver abnormalities were noted in 55% of the otters.

5. Histopathological and toxicological analyses are required before we can determine the relative effects of oil toxicity and the stress of captivity on sea otters.

Chapter 7. Summary and Recommendations

Terrie M. Williams, Ph.D.
Randall W. Davis, Ph.D.

The fundamental lesson from this oil spill is that an effective sea otter rehabilitation program requires a detailed contingency plan, trained personnel, and well designed facilities. Prior to the Valdez spill, such a plan did not exist, facilities were built on short notice, and many personnel had to be trained while on the job. Treating heavily oiled sea otters proved to be difficult and required a lengthy, costly rehabilitation process.

A more efficient and less stressful alternative requires a pre-existing organization and rehabilitation facilities. Specific recommendations include:

I. Facilities, Husbandry and Personnel

Facilities and equipment must meet administrative, veterinary, and staff needs for cleaning and holding sea otters. A "flow-through" system as exemplified by the Seward facility permits otters to move quickly through areas designated for sedation, cleaning, drying, recovery, rehabilitation, and long term holding. In this way, large numbers of otters can be treated quickly and efficiently.

The U.S. Department of Agriculture sets standards for holding marine mammals. These standards specify large seawater pools, good water quality, and stringent sanitation. These requirements are not easily satisfied in temporary or hastily built facilities, especially if one anticipates caring for several hundred sick sea otters. Attempting to build such a facility after an oil spill prevents a quick response (i.e. less than 12 hours), which is essential for minimizing exposure to crude oil or instituting preemptive capture operations. In view of this, pre-existing facilities are essential. Such facilities can be permanent or housed in trailers which can be stored. Permanent facilities enable an immediate response regardless of the season and provide better quality buildings and seawater pools. Although trailers are less expensive and offer mobility, they have a shorter life-span, require several days to install (longer if stored off-site), and will generally have smaller pools and a more limited seawater supply.

Whether permanent or mobile, the minimum space requirements for a sea otter rehabilitation facility are similar (Table 7.1). Approximately 20,000 ft^2 of indoor space and an equivalent amount of outdoor space are required for a facility that can treat and

hold 100 sea otters; this would include holding pens for 60 otters and space in large pools for 40 otters. In addition, a pre-release facility such as the "octagon" salmon pen is needed for holding rehabilitated otters or animals captured preemptively. Holding pens in the pre-release facility should have good seawater circulation and should be large enough for swimming and diving (at least 100 ft x 50 ft x 20 ft deep).

An ideal rehabilitation facility would combine elements of a permanent facility, mobile triage units in trailers, and a pre-release facility. To create a low stress environment for the otters, the permanent facility should be placed in a natural setting and have controlled access. Additional requirements include all-weather access by road and aircraft, good telephone communications, a seawater supply, and easy access to a commercial seafood supplier.

The mobile triage units should be designed for transport to remote locations (greater than 300 miles from the permanent facility) and for use as temporary care facilities. These units, by necessity, are self contained (including electrical generators and hot water) and transportable by helicopter or fixed-wing aircraft. Oiled otters arriving at the triage units would be stabilized (i.e. treated for hypothermia, dehydration, malnourishment or capture stress) before transport by aircraft to the permanent rehabilitation facility for cleaning and rehabilitation.

The pre-release facilities should be modular so that they can be stored and then assembled when needed. Like the permanent facility, the pre-release structure should be in a natural setting such as a secluded lagoon. However, note that the pre-release facility also requires a food preparation area, freezers, a supply of seafood, electrical utilities, and accommodations for staff. These amenities are most easily obtained near developed areas.

To prevent the introduction of domestic animal diseases into the wild population, quarantine procedures are essential in the rehabilitation centers. All pets and visitors should be excluded from the site. Ideally, visitors and press corps should be confined to an interpretative center or allowed to view the otters from behind a glass partition.

It is important that management have well defined responsibilities and authority under the Marine Mammal Protection Act. Although the organization should be interactive and encourage the free exchange of information, staff members should have a clear understanding of the chain-of-command (Chapter 1 provides an example of an organizational chart). To ensure the

Table 7.1 Recommended space requirements for a rehabilitation facility that can treat and hold 100 sea otters.

I. Indoor Space

A. Administration	
1. Conference room for 30 persons	800ft^2
2. Reception/waiting area	280ft^2
3. Secretarial staff offices	420ft^2
4. Director's office	380ft^2
5. Administrative personnel (3 offices)	750ft^2
6. Reproduction room (xerox)	200ft^2
7. Central files room	200ft^2
8. Communications room (outdoor antenna)	200ft^2
9. Plant security / personnel ID room	200ft^2
10. Administration lounge/kitchenette	200ft^2
11. Corridors/toilet/custodian/utility	1215ft^2
TOTAL	4845ft^2
B. Animal Rehabilitation	
1. Weighing and sedation	450ft^2
2. Animal cleaning room (6 stations)	520ft^2
3. Animal drying room	500ft^2
4. Critical care room	650ft^2
5. Animal food preparation room	530ft^2
6. Nursery	500ft^2
7. Veterinarian clinic/laboratory	900ft^2
8. Utility room (laundry)	500ft^2
9. Dressing room for volunteers and staff	1400ft^2
10. Personnel lunch room	600ft^2
11. Freezer space for animal food	800ft^2
12. Ice machine room	300ft^2
13. Carpentry and machine shop	700ft^2
14. Corridors/toilet/utility/loading dock	2630ft^2
15. Necropsy laboratory	600ft^2
TOTAL	11580ft^2
C. Classroom	375ft^2
D. Pen storage	3000ft^2
TOTAL INDOOR SPACE	19800ft^2

Table 7.1 continued

II. Outdoor Space

A. Concrete holding pools (8 @ 19 ft diameter) and walkways (animal rehabilitation)	2270ft^2
B. Concrete raceways for pens (6 @ 3ft x 50ft) and walkways (animal rehabilitation)	3000ft^2
C. Helicopter pad (animal rehabilitation)	10000ft^2
D. Parking	4500ft^2
E. Sea water treatment (1000 gallons/minute)	300ft^2
TOTAL OUTDOOR SPACE	20670ft^2

III. Land Requirements

A. Land use summary
   1. Combined indoor and outdoor space for each function:
      a. Animal rehabilitation = 10980ft^2
      b. Administration = 4845ft^2
      c. Classroom = 375ft^2
      d. Pen storage = 3000ft^2
      f. Parking, landscaping and misc. = 20200ft^2
   2. Minimum site size = 39400ft^2 (1 acre)

B. Special requirements
   1. Should have access by road
   2. Proximity to sea water source

continuity of animal care, a core staff is necessary. The size of the staff will depend on the number and health status of animals in the facility; a ratio of one to three staff persons per otter is recommended. In addition, the staff should be large enough to accommodate 12 hour shifts while providing 24 hour care for the animals. Some overlap in shifts will allow the exchange of information between members of the husbandry staff.

Volunteers can be a valuable addition to the staff at rehabilitation centers. To be effective, this group must be well trained and supervised. We recommend that training programs with yearly refresher courses be an integral part oil spill contingency plans.

II. Capture and Transport of Otters

As with other aspects of the rehabilitation program, capture operations require good organization and communications. We recommend equipping boats with single side band radios and, if possible, cellular telephones. Because otters should be transported to rehabilitation centers within six hours of capture, frequent contact between capture boats and aircraft is required.

Before an oil spill, capture boats and aircraft should be identified and personnel should be trained in otter handling techniques. We found the Bell 212 helicopter to be the most versatile aircraft for transporting captured otters from the boats to the rehabilitation or triage centers. However, for flights exceeding 300 miles, a twin engine deHavilland "Otter" or other large capacity, fixed-wing aircraft should be used. Equipment such as dip nets, tangle nets, kennel cages, spring scales, flipper tags and record forms should be stockpiled and readily accessible by capture teams.

A logistics officer should coordinate capture boats and aircraft. He should work in close association with the federal and state trustees to estimate the number of otters at risk and develop a flexible capture policy that accounts for oil dispersal, coastal geography, and weather. This information should be used to deploy capture boats as needed. If preemptive capture is planned, then the logistics officer must mobilize boats and capture crews within 12-24 hours.

Because capture and transport are stressful to otters and may result in mortality (Chapter 6), only trained personnel should be used. Dip nets should be used to selectively capture oiled sea otters. However, long chases should be avoided because they can cause stress or capture myopathy and may separate mothers and pups. Tangle nets may be used during preemptive capture and for lightly oiled otters that elude capture with dip

nets. The nets should be monitored hourly and never deployed during severe weather.

Captured sea otters should be transported within six hours to a triage center or rehabilitation facility. An animal care specialist placed on each capture boat is needed to assess the otters' medical condition and to provide supportive care (stabilize body temperature, offer food and water, treat shock and dehydration). Otters should be offered food on the boats if transport to the rehabilitation centers is delayed more than three hours. Transport cages should be cleaned and sanitized after each use and never used to hold domestic animals.

Criteria for preemptive capture, cessation of the capture program, and release of rehabilitated otters must be established by the USFWS before an oil spill. Because the policy for release was not well defined, rehabilitated sea otters from the Valdez spill were held unnecessarily for an additional six weeks. This delay could have compromised the health of the animals and resulted in additional costs exceeding $1 million.

III. Treatment and Care of Oiled Otters

Veterinary personnel at the rehabilitation facility should be prepared to treat pulmonary distress, hypothermia, hyperthermia, hypoglycemia, dehydration, and petroleum hydrocarbon toxicosis. The most severe medical problems will probably occur within the first weeks of the spill when the oil is most toxic. To determine treatment protocols, initial examination of the otters must include: 1) palpation of the thorax for evidence of subcutaneous emphysema, 2) measurement of core body temperature, and 3) assessment of the degree of oiling. Based on results from the initial examination, sea otters may be washed or placed in quiet areas to rest. Heavily and moderately oiled animals usually require immediate washing to prevent further exposure to toxic hydrocarbons. Lightly oiled otters may be fed, given fluid therapy, and allowed several hours to recover from the stress of capture before washing.

Medical treatment for oiled otters was often limited to supportive care. Aside from treating symptoms resulting from petroleum hydrocarbon toxicity, veterinary protocols should include methods for reducing stress. Stressors may include exposure to petroleum hydrocarbons, capture, transport, medical treatment, and a change in diet. Varied diets with adequate roughage, reduced human contact, and proper sanitation are especially important.

Blood samples provide valuable information about hydration, nutritional status, and systemic exposure to crude oil. Because anemia, stress responses, and circulating petroleum hydrocarbon

concentrations in the otters change during rehabilitation, we recommend periodic blood sampling. A final blood sample is important for determining the general health of the otter and for preventing the introduction of domestic animal diseases into the wild population.

Comprehensive records are needed to assess the effectiveness of medical treatments in the rehabilitation center. Behavioral, medical, and nutritional records also provide information about the progress of each otter and its readiness for release. If an animal dies, a well equipped laboratory with an experienced pathology staff should be available to collect tissues for petroleum hydrocarbon residue analyses and for histopathology.

IV. Further Research

All aspects of the sea otter rehabilitation program will benefit from further research. The design of rehabilitation facilities, pens, pools and seawater systems should be critically examined and modified to provide optimum conditions for otters recovering from oil exposure. Cleaning methods must be refined to provide for the immediate restoration of the water repellency of the otter's fur. Currently, the restoration process takes seven to ten days. We also need to evaluate the short term and long term effects of petroleum hydrocarbon exposure on sea otters. This study should include the effects of oil on pregnant, lactating, and young animals.

Several analytical tests are needed. First, a field test to quantify the amount of oil on an otter's fur should be developed. The results from these tests can be used to determine when capture operations should cease. In addition, we need objective criteria for determining the level of petroleum hydrocarbon exposure that can be tolerated by otters.

Second, a quick, inexpensive blood test for measuring the total petroleum hydrocarbon concentration should be developed. The results of such tests will enable veterinarians to design treatment protocols based on the degree of systemic exposure to petroleum hydrocarbons. The effectiveness of treatments such as oral administration of activated charcoal and bile toxin binding agents should be tested.

Accurate tests are also needed for determining the exposure of sea otters to domestic animal diseases. Current tests for diseases such as canine distemper, herpes, and parvovirus are inconclusive for sea otters.

Overall, the objective of a marine mammal rehabilitation program should be to provide state-of-the-art care to oiled animals while minimizing risks to the wild population. This can only be accomplished by preparedness and continued research.

Appendix 1. Chronology of events for the sea otter rehabilitation centers

Valdez

March 24	T/V Exxon Valdez runs aground on Bligh Reef.
March 27	First rehabilitation center opens in the Copper Basin Hall at the Prince William Sound Community College. Terrie Williams selected as director.
March 30	The first oiled sea otter arrives at the rehabilitation center.
April 2	Begin construction of the new rehabilitation center in the gymnasium at the Growden-Harrison Complex (formally an elementary school and now part of the Prince William Sound Community College).
April 2	Send six otters to Sea World, San Diego; one dies in Anchorage and four eventually die in San Diego.
April 6	Rehabilitation center moves out of the Copper Basin Hall and into the Growden-Harrison Complex.
April 12	Send six otters to Point Defiance Aquarium; two ultimately die and one is transferred to Sea World.
April 13	The first rehabilitated sea otters are placed into floating pens in the small boat harbor.
April 17	Send six sea otters (four survived) to Vancouver Aquarium, British Columbia.
April 22	Transfer rehabilitated sea otters from floating pens in the small boat harbor to the Solomon Gulch Hatchery.
May 15	USFWS releases six rehabilitated sea otters with flipper radio tags in Simpson Bay, Prince William Sound.
May 22	Sea otters being held at the Solomon Gulch Hatchery are transferred to a large, floating salmon pen (the "octagon") in Port Valdez Bay.
June 1	Move the rehabilitation center out of the Growden-Harrison Complex and adjacent to the Salmon Exchange.
July 13	Unknown individuals cut the nets at the octagon holding pens; 13 rehabilitated sea otters escape and five are recaptured.

July 13,14,17	Abdominal radio transmitters implanted in 23 sea otters at the "octagon" holding pens.
July 27	Release 13 rehabilitated female sea otters (nine with abdominal radio-implants) in Sheep Bay, Prince William Sound.
July 28	Release 15 rehabilitated male sea otters (12 with abdominal radio-implants) in Nelson Bay, Prince William Sound.
August 4	Four sea otters with chronic health problems sent to Sea World, San Diego.
August 15	Release six rehabilitated sea otters in Nelson Bay and eight in Sheep Bay, Prince William Sound.
August 16	Release three rehabilitated sea otters in Nelson Bay and eight in Sheep Bay, Prince William Sound.
August 18	Rehabilitation center at Salmon Exchange and the "octagon" closed; demobilization completed on August 25.
August 29	Transfer work on the computerized database from the community college to Exxon's offices in the Royal Center in Valdez.
September 15	Transfer work on the computerized database from Valdez to Exxon offices in Anchorage.

Seward

April 1	Oil spill threatens Kenai Peninsula. USFWS asks Exxon to open a sea otter rehabilitation center in Seward.
April 7	James Styers is selected to be the director of the rehabilitation center in Seward; site selection and facility design begin.
April 21	Ground-breaking and construction begin on new facility.
May 2	First sea otter from Kodiak arrives.
May 5	First oiled sea otter from the Kenai Peninsula is cleaned. Cleaned otters are temporarily held at the Seward bird center.
May 8	Basic facilities for treating oiled sea otters are operational.

May 28	First rehabilitated sea otters are transferred to the pre-release facility in Little Jakolof Cove.
July 15,27	Abdominal radio transmitters implanted in seven rehabilitated sea otters.
August 16	Seven radio-implanted sea otters are released in Nelson Bay, Prince William Sound.
August 17	Seven sea otters are released in Taylor Bay and one in Picnic Harbor, Kenai Peninsula.
August 22	Four otters are released in Harris Bay, Kenai Peninsula.
September 11	Thirteen sea otter pups are transferred to the Point Defiance Aquarium.
September 12	Sea otter rehabilitation center closes and is winterized for possible use in 1990.

Homer

April 14	Temporary care facility established at the Homer Junior High School by Nancy Hillstrand.
April 25	First oiled otter arrives from Tonsina Bay and is cleaned at the temporary care facility.
May 10	Kenai Peninsula Borough begins providing funds for construction of the pre-release facility at Little Jakolof Cove.
May 15	Exxon assumes financial responsibility for the pre-release facility.
May 23	Temporary care facility at the Homer Junior High School is closed; the four remaining sea otters are transferred to the pre-release facility at Little Jakolof Cove.
May 28	First transfer of rehabilitated sea otters from the Seward center to Little Jakolof Cove.
June 17	Release two pregnant female sea otters in Little Jakolof Cove.
July 14,15	Release four female sea otters with their pups in Little Jakolof Cove.

August 11	Abdominal radio transmitters implanted in 12 rehabilitated sea otters. Ten rehabilitated sea otters without transmitters released in Little Jakolof Cove.
August 19-21	Rehabilitated sea otters without radio transmitters released in Nuka Bay (seven), James Lagoon (24) and Harris Bay (25) along the Kenai Peninsula. Two sea otters released near Herring Island in Kachemak Bay.
August 22	Twelve sea otters with abdominal radio transmitters and nine sea otters without transmitters released in Sheep Bay and Nelson Bay in Prince William Sound.
August 30	Last four rehabilitated sea otters released in Little Jakolof Cove. Demobilize facility.

Appendix 2. Staff directory for the rehabilitation centers and capture boats

I. Rehabilitation Centers and Pre-release Facility

A. Valdez Rehabilitation Center

Adams, Stephen
Adamthwaite, Myra
Adkins, Bruce
Armitstead, Clyde
Aytch, Walter
Baird, Leslie
Balke, Jennifer
Ballesterov, Sera
Basaraba, Randy
Basham, Mike
Bates, Melisa
Bell, R. Joy
Bennett, Roscoe
Berrey, David
Bittner, Cook
Bizzanelli, Richard
Blake, John
Braumberger, Dan
Bressler, Mark
Bridgman, Rachel
Brooks, Keith
Brown, Nancy
Burke, Greg
Burr, Harlan
Butler, Jeff
Carr, Mary
Casson, Chet
Castleman, Mikki
Chalam, R. V.
Chapman, Bob
Chen, Patty
Christiansen, Amy
Clark, Marianne
Clarke, Jeanie
Coiley, Pippa
Corey, Cathy
Coulter, Wendy
Cripe, Julie
Crisp, Ken
Cross, Joel
Cunard, Jeffrey
Curtis, Steve
Darbonne, Oliver
Datta, John
Davis, Gene
Davis, Randall
Davis, Sherry
Day, James
DeVaul, DeeDee
Donofrio, Gary
Doss, Doug
Dudley, Marilyn
Ennen, Lori Anne
Ernst, Ricardo
Elperszce, Fred
Evans, Cindy
Ezell, Barbara
Exell, Sunny
Facer, Robert
Ferrante, Peter
Finstad, Gregory
Fitz-Gibbons,Jeremy
Fleagle, Tim
Francis, Peter
Fritze, Milton
Fry, Michael
Gallagher,
Garrett,Mary
Godomski, Jim
Goodman, Richard
Gornall III, Tag
Graham, Lindsay
Green, Ann
Green, John
Groff, Joseph
Groundwater, Paula
Grunditz, Robert
Guenther, Richard
Gunion, Daniel
Haebler, Mona
Hale, Amanda
Hamblen, Lori
Hans, Darla
Hardy, Bob
Harlan, Riet
Heathman, Don
Hendricks, Jim
Hill, Ken
Holbrook,Randy
Holliker, Allen
Hoppmann, Michael
Houck, John
Howe, Tim
Huber, Ron
Hubinsky, Christy
Hudson, Bruce
Hudson, Charles
Humphrey-Dahl,Vicky
Hunter, Lee
Hymer, Julie
Isenhart, Mike
Jenkins, Richard
Jenkins, Tom
Jenks, Bob
Jennings, Paul
Jones, Michael
Kari, Laurie
Kelly, Laura
Kelsey, Tom
Kincaid, Susan
King, Christine
King, Rick
Klein, Joanne
Kleinhans, Lew
Knight, Rebecca
Knuepfer, Gary
Kresh, David
Kurtz, Joseph
Landry, David
Lapella, Elean
Lillie, John
Lillie, Paul
Lorenzo, Danilo
Loshbaugh, Shana
Maillard, Howard
Maki, Mike
Maleski, Ed
Marksberry, Janice
Marquardt, Kurt
Masson, Mike
Matters, Mene
Maurer, Mike
Maynes, Linda
Merry, Dianna
Michaelson, Nancy
Micic, Vidak
Millard, Gary
Miller, Karen
Minish, Kayla
Mitsui, Bonnie
Morrison, John
Mosenthin, Elizabeth
Mucler, Merne

Mulcahy, Mark
Murphy, Daniel
Murphy, Linda
Murphy, Tim
McBain, Judy
McBain, Lesley
McCarthy, Kim
McCormick, Carolyn
McCollum, Carolyn
McDonough, Danny
McGuire, Sean
McHole, Darlene
McKim, Terri
McNally, Dena
McPhersen, Roy
Neece, Mike
Nelson, Judy
Nielsen, Bonnie
Nielsen, Rich
Norton, Larry
Osburn, Joe
Paul, Dean
Paul, Diana
Peers, Ronald
Peterson, Brian
Peterson, Earl
Pettit, Marvin
Pierce, Lee
Pike, Gary
Pittman, Larry
Pittman, Marty
Poland, Dan
Porritt, DeeAnn
Privett, Bruce
Quintero, Bernardo
Rapp, Scott
Rash, Jeff
Rice, Brad
Rich, Kym
Richards, John
Rideout, Bruce
Roletto, Jan
Romey, Tracy
Rooth, Sharon
Rudd, Lloyd
Rynshoven, Pete
Salcedo, Jose
Samms, Andrew
Sassic, Pat
Sawyer, Donald
Scanldn, Kevin
Schaedler, Chris
Schlichting, Patrick
Schroeder, Pete
Sclenk, Bill
Shaw, Donna
Sheldon, Dan
Small, Kris
Smith, Dawn
Smith, Lynne
Smith, Roland
Snodgrass, Joy
Stack, CeCe
Stern, Stephen
Stevens, Colett
Stevens, Sylvia
Stewart, Jan
Stolpe, Suzanne
Stough, Ruth
Stoughton, Luisa
Suchin, Ken
Suits, Jack
Swanson, Bernice
Swanson, Kenneth
Sweitzer, Albert
Tabler, Hope
Taylor, Dorothy
Thomas, Marilou
Thomas, Tamela
Tomlinson, Jerry
Tomlinson, Paul
Tomlinson, Terry
Tonsha, Mike
Toor, Abe
Tornquist, Craig
Truit, Bob
Tundidor, James
Tuomi, Jack
Tuomi, Pam
Utkov, Neil
Vans, Forest
Vanlandingham,Carla
Vasey, Kirk
Vicary, Clyde
Violett, Bud
Walter, Lee
Watkins, Dan
Watson, Rick
Watts, John
Weiss, Fred
Welch, Carol
Westra, Cindy
Westy,
Wheatley, Ernie
Whitehead, Timothy
Wicken, Michael
Wigdahl, Dudley
Wiles, Jimmie
Wilkinson, Bob
Williams, Billy
Williams, Gene
Williams, Marianne
Williams, Terrie
Williams, Thomas
Wilson, Jeanne
Wilson, Riley
Winkley, Barbara
Wood, Bert
Woodbery, Benson
Wrighton, George
Wunnicke, Paul
Ydon, Ralph
Yonikos, Pete

B. Seward Rehabilitation Center

Anton, John
Anton, Nicole
Brigmon, Deborah
Cassen, C.J.
Chen, Patty
Christiansen, Amy
Coiley, Pippa
Colgan, Gala
Della Rocca, Marc
Dumas, Christine
Ferrante, Peter
Fisher, Russell
Foster, James
Geis, Edmee
Gornall III,Thomas
Hackett, Steve
Hancock, Robin
Harvey-Clark,Chris
Henderson, Robert
Holonko, Tanya
Kahlstrom, Arvid
Kelly, Laura
Kerns, Patrick
Kunnuk, Irene
Kurihara, Joel
Loquvam, John
Mackie, Paul
Marquardt, Kurt
Mays, Deborah
McCloskey, Thomas
McCormick, Carolyn
McKay, Susan
Michaelson, Nancy
Miller, Bonnie
Nadeau, Jolayne
Neece, Mike
O'Malley, Teresa
Ollestad, Onnolee
Olsen, Miriam
Ord, Robert
Otten, Jill
Peers, Ron
Prochazka, Janet
Rainville, Susan
Rash, Jeffrey
Roletto, Jan
Romey, Tracy
Rose, Samuel
Schmidt, Karin
Spalding, Harold
Strough, Ruth
Styers, Avadale
Styers, James
Styers, Jeffrey
Suellentrop, Laura
Swarthout, David
Thomas, Tamara
Thomas, Tamie
Tuomi, Pam
Utkov, J. Neil
Valet, Scott
VanBlaricom, Glen
Vasey, Kirk
Vastbinder, William
Vicary, Clyde
Wiles, Jimmie
Williams, Thomas
Wilson, Frank
Work, Thierry
Wunnicke, Paul

C. Homer Temporary Care Facility and Little Jakolof Cove Pre-release Facility

Ackert, Denise
Almond, Dave
Balke, Jenny
Baugher, Tina
Brown, Nancy
Christiansen, Amy
Curtis, Steve
Dequattro, Susan
Dunn, Pauli
Falardeau, Sherrie
Fletcher, Barrett
Galvan, Jay
Grady, Glen
Hafemeister, Leslie
Hart, Mike
Heneghan, Jim
Heneghan, Tia
Hill, Kathy
Hillstrand, Nancy
Ireland, Collette
Jenkins, Halle
Kaun, Barbara
King, Tricia
Knodel-Fidler, Kaleen
Loshbaugh, Shana
Mario, John
Marquardt, Kurt
Mead, Tim
McCue, Robert
McDonald, Jack
Million, Marsha
Rapp, Scott
Rhyneer, Barbara
Robertson, Michael
Schulz, Steve
Simonis, Liz
Stark, Rory
Thomas, Sandra
Tillet, Carol
Tingook, Tom
Tolle, Jeanne
Tuomi, Pam
Williams, Terrie
Wunnicke, Paul

II. Sea Otter Capture Personnel

A. USFWS Personnel and California Department of Fish & Game

Ames, Jack
Bayha, Keith
Bodkin, Jim
Britton, Ron
Bragoo, Don
Creamer, Dean
Daum, Dave
Dugan, Larry
Early, Tom
Estes, Jim
Hander, Ray
Hatfield, Brian
Hedrick, Mike
Hogan, Mimi
Jamison, Ron
Kenner, Mike
Kvasnikoff, Dean
Monson, Dan
Rappaport, Ann
Sanders, Greg
Sharpe, Elizabeth
Siepel, Nancy
Sonnevil, Gary
Stephenson, Wells
VanBlaricom, Glen
Wilk, Randy
Wiswar, Dave

B. Contractor Employeed Capture Personnel

Anton, Jon
Barthalomew, Mark
Becker, Karl
Blake, Jim
Candopoulos, Bob
Cassions, C. J.
Collins, Rich
Daley,Cornelia "Nina"
Deville, Marty
Donahoe, Chris
Drawbridge, Mark
Edwards, Gary
Fisher, Russell
Foster, Jeff
Goatcher,
Graham, Mac
Haskin, Roman
Haskins, Ed
Heckhart, Larry
Hill, Sue
Hoak, John
Holnics, Amy
Iversen, Sverre
Jewell, Jack
Jewell, Ted
Kade, Steven
Kansteiner, Mark
Keisling, Kelly
Klinkhart, Ed
Knight, Edna
Knight, Greg
Kula, Bon
Lyda, Mark
McCormick, Carolyn
McEntire, Greg
Olstestad, Onnalee
Rasn, Jeff
Reynolds, Julius
Rimery, Ken
Robinette, Jim
Rosencranz, Calisto
Sheridan, Robert
Smith, Kiki
Smith, Roland
Smith, Scott
Styers, Jeff
Styers, Jim
Vastbinder, Bill
Weltz, Fred

C. Volunteers

Alford, Alphus, Jr.
Bare, Fred
Chudocken, Anthony
Dolchok, Cliff
Galaktionoff, Tosha
Hamilton, Hamilton, Jr.
Ivanoff, Jake
Kakaruk, Frederick, Jr.
Kakakuk, Richard
Lanman, Jesse
Layland, Roscoe
Morris, Betty
Reamey, Bert
Regan, Lance
Soper,John
Thomas, Jon
Trefon, Rick

D. Native Skiff Crews

Alpiak, Tom
Carlson, Mike
Chichenoff, Larry
Christofferson, Andrew
Davis, Sharon
Delgado, Joseph
Hochmuth, Richard
Lariouoff, Kalumpi
Llanos, David
Naumoff, Mike
Oja, Brad
Squartsoff, Andrew
Squartsoff, Innocent
Squartsoff, John

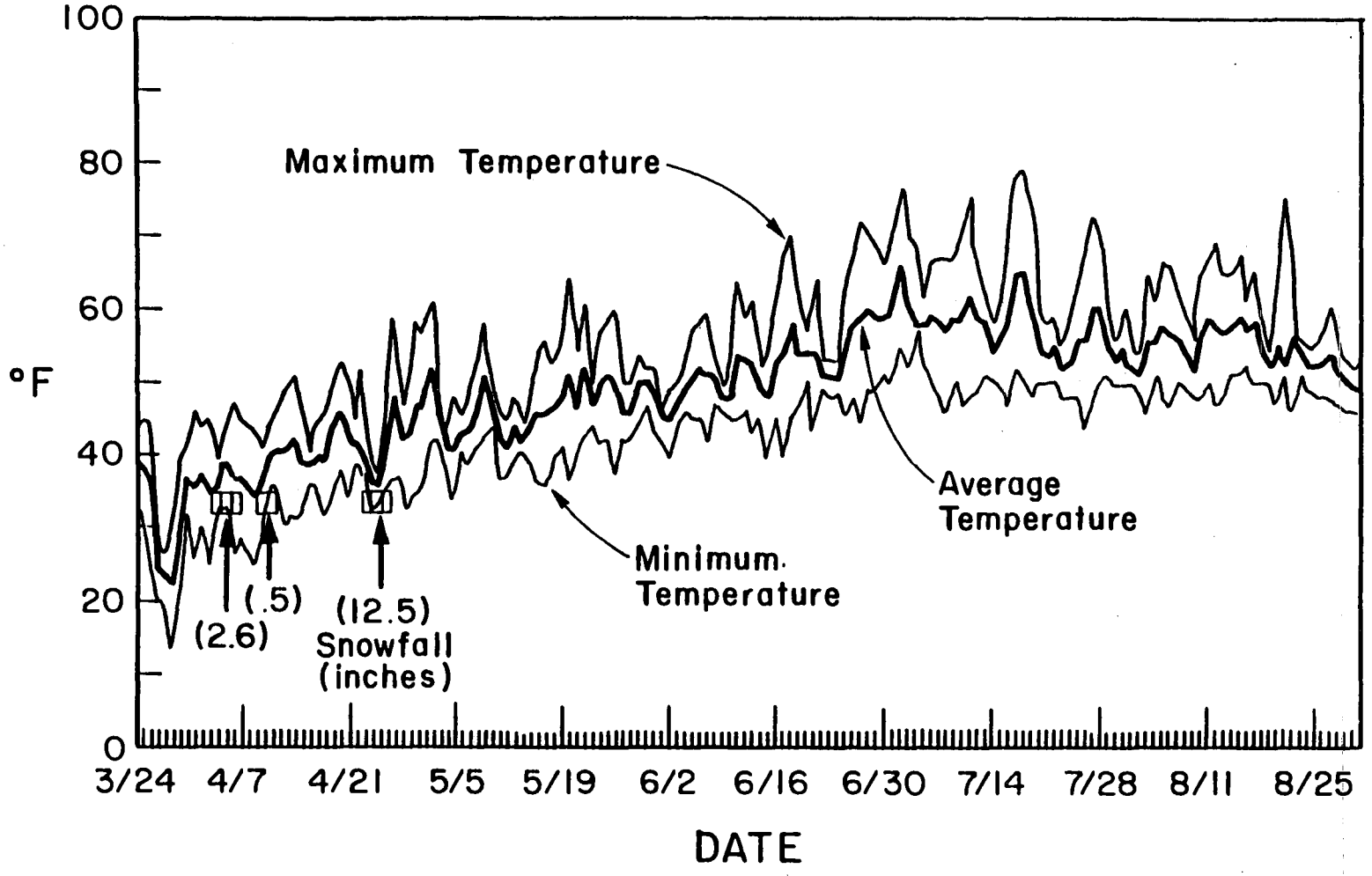
E. Minerals Management Services

Baffrey, Mike
Swanton, Nancy

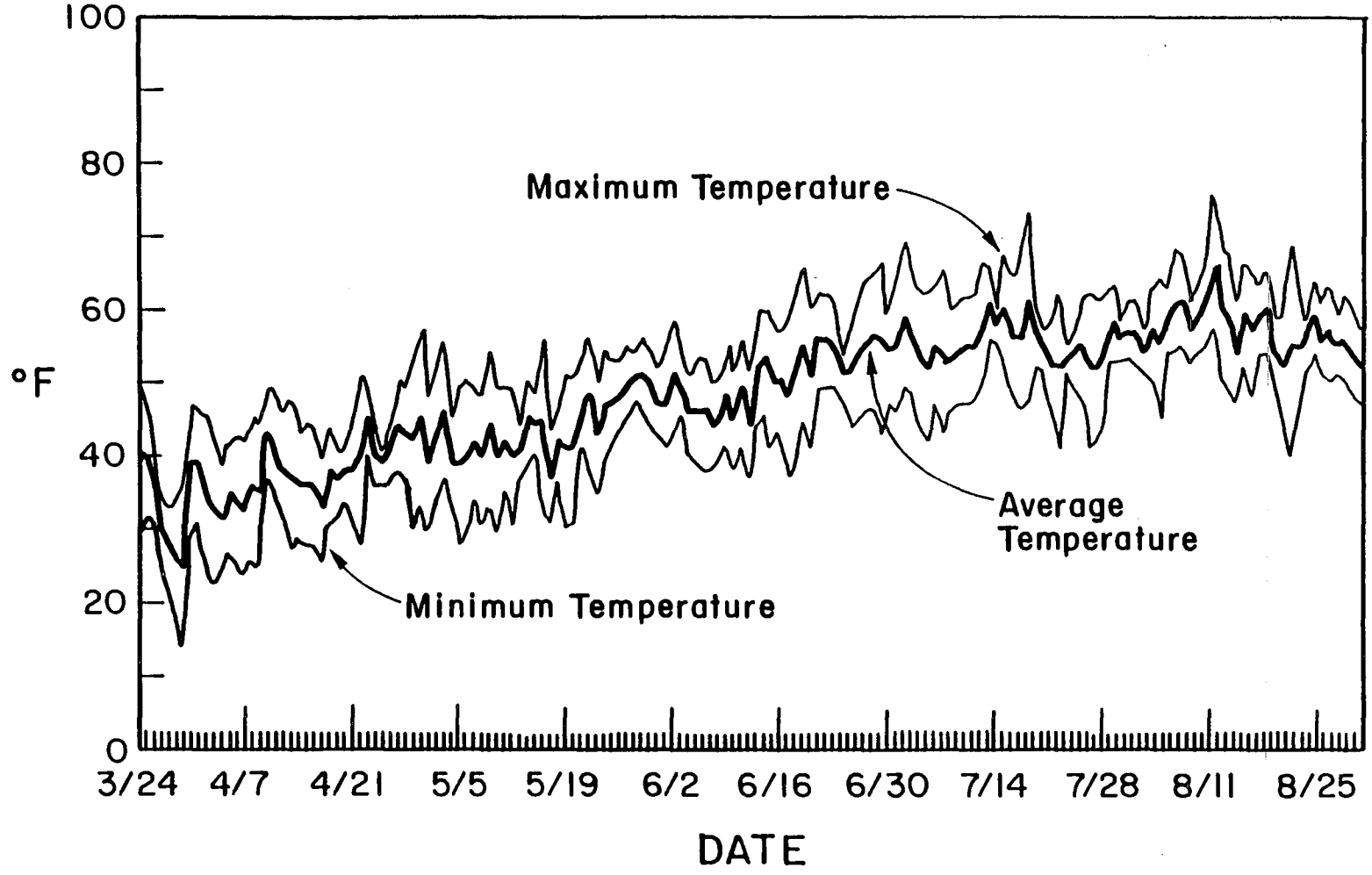
F. Bureau of Reclamation

Keller, Chuck

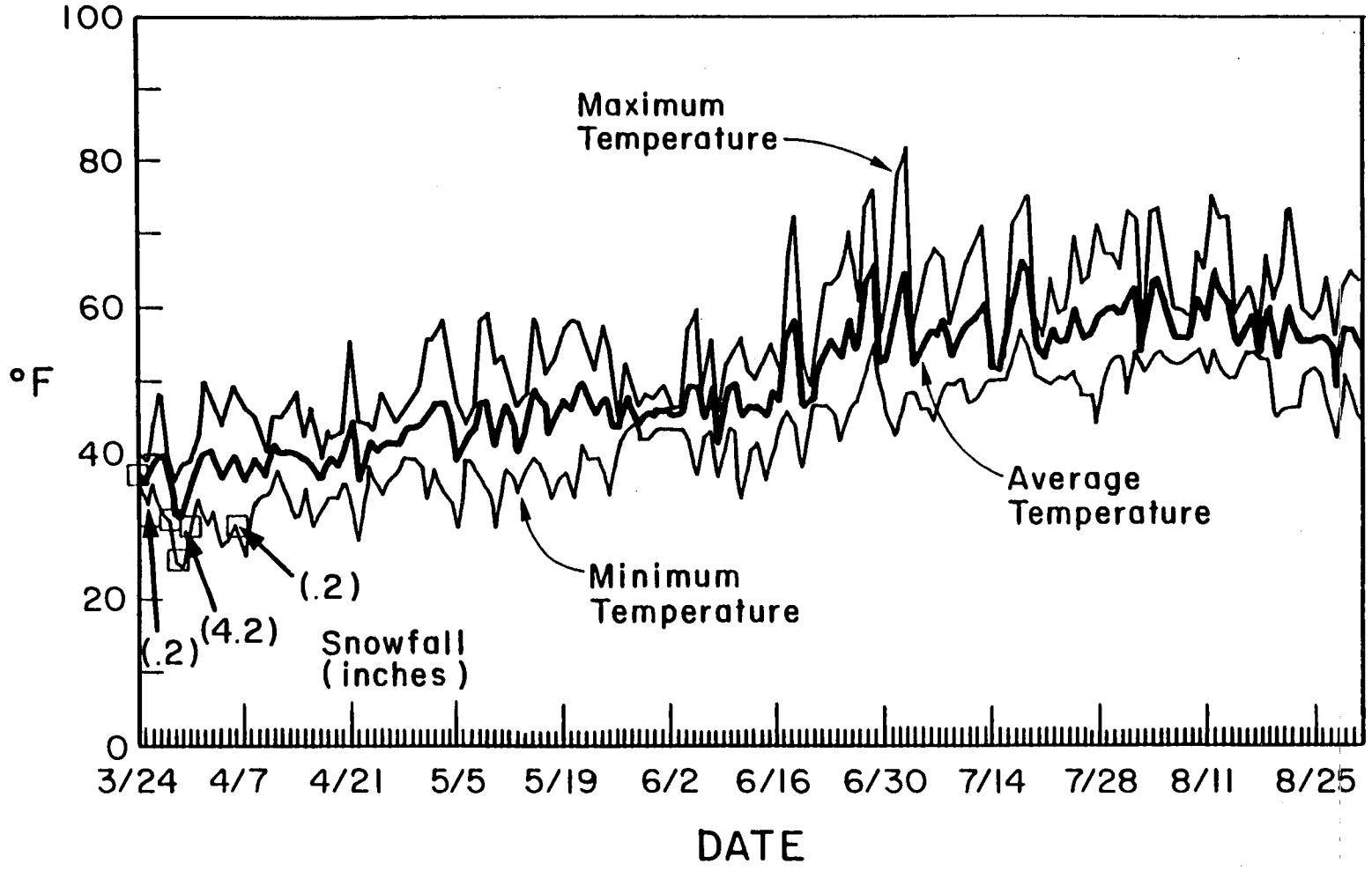
Appendix 3. Average, maximum and minimum air temperatures for Valdez, Homer and Kodiak



Average, maximum and minimum air temperature for Valdez. Boxes indicate days with snow.



Average, maximum and minimum air temperature for Homer.



Average, maximum and minimum air temperature for Kodiak.

Appendix 4. USFWS guidelines for capturing and handling sea otters*

* Prepared by K. Bayha (USFWS, Anchorage Office) and provided to capture personnel during the oil spill.

Capture of live sea otters should be attempted only by persons who have worked with people previously experienced in sea otter capture and handling. Trainees should have had hands-on experience with observation, capture, and handling of live sea otters in the field before they are certified as capture personnel. Sea otter capture typically is done with a large, salmon-type dip net, or with gill nets that have been modified for otter capture. Capture with gill nets is labor-intensive, and is relatively risky (both for the otters and the capture personnel) in rough seas or poor weather. Use of gill nets to capture sea otters should be done only in the presence of experienced personnel.

Selecting otters for capture:

1. Animals hauled out on rocks or beaches:

   Hauling out is normal behavior for sea otters throughout Alaska. An otter resting on a rock or beach is not necessarily in distress. Otters with obviously matted fur or that show signs of lethargy or restricted mobility should be considered for capture.

2. Animals in water:

   Sea otters have many complicated behaviors associated with grooming, feeding, and mating. Common behaviors include rolling, somersaulting, repeated shallow diving, blowing of bubbles, and intensive rubbing and working of the fur with the mouth, forepaws, and hind flippers. These behaviors may be misinterpreted as indicator of stress by inexperienced observers. Healthy sea otter fur can be recognized by the characteristic "beading" of rapid "wicking away" of water when the animal is on the surface.

   Sea otters in the water should be considered for capture if the fur retains a slick, wet appearance even after the animal has been on the surface for 10 seconds or more. Other signs of possible oiling include frequent head shaking (like a dog shakes its head after a swim), obvious shivering, tolerance of close approach by a boat, lethargy, or obvious emaciation. However, none of the above are certain indicators that the animal is in fact oiled. For example, occasional head shaking is common among healthy animals, and healthy young animals and adult males often will tolerate close approach by boat.

   If a sea otter keeps its distance from an approaching boat and appears alert to the presence of the boat, it is probably in relatively good condition and should not be pursued.

Sea otter pups frequently are quite vocal, and their high-pitched calls are easily mistaken for signals of distress. A mother-pup pair should never be pursued simply because the pup is vocalizing frequently. Newborn pups may move relatively little, and may be mistakenly categorized as lethargic or dead by inexperienced observers. The fur of pups often is lighten in color than adult fur. Natural clean fur on pups may resemble the chocolate-brown color of weathered oil. In addition, it is common for mothers and pups to become temporarily separated while the mother dives for food. In such cases the pup often vocalizes frequently. Thus, apparently abandoned pups should be watched from a distance for at least 15-20 minutes before any decision is made to attempt capture. Mother-pup pairs should be approached by boat with the intent to capture only if there is clear evidence of oiling or severe distress (such as shivering or obviously matted fur).

Handling sea otters after capture:

1. General precautions:

Sea otters are powerful, aggressive, dangerous animals when in captivity. Their strength, quickness, and determination should never be underestimated. Their jaws are particularly powerful, and are quite capable of crushing human hand and finger bones. Their forelimbs and forepaws are also surprisingly strong and dexterous, and can grasp and pull a human hand or arm with surprising strength and quickness. Although quite endearing in natural habitat, sea otters must be regarded as dangerous in any sort of confining captive situation.

When handling a sea otter in any kind of net, restraining box, or sky kennel, the head of the animal should be watched constantly. It is essential to concentrate on movements of the otter's head when involved in any handling procedure which brings any part of the handler's body close to the otter.

A large salmon-type dip net should be available whenever handling captive sea otters. Dip nets allow relatively easy recapture should a captive otter escape confinement while on a boat deck or beach. If any escape occurs, it is important to remain calm, concentrate on the animal's movements, and have the dip net on hand. Should a captive otter escape onto a boat deck, it is not necessary to bail out. Captive otters usually are disoriented in such circumstances, and can be readily recaptured with a dip net, as long as the response is not delayed. Handlers should be alert to the possibility of

exceptions.
It is very dangerous for inexperienced persons to attempt to grasp a live sea otter directly with the hands. Sea otters have flexible bodies and very loose skin, and can easily turn toward and bite hands or arms, even if the grip seems quite sure.

A sea otter should never be grabbed by the nape of the neck, or by the tail. Serious injury to the otter or the handler could result.

2. Initial handling after capture:

Sea otters that have been captured with a dip net should be placed immediately into the capture box (see below). Otters captured in tangle nets should be placed in the capture box while still in the tangle net. Netting can be cut away from the rear end of the otter, allowing it to slide free into the box. A dip net and, if available, a bite bat (stuff bag for sleeping bag, filled tightly with foam rubber), should be on hand during the procedure.

If net bags are available, the capture box should be lined with an open net bag before putting the otter into the capture box. Once the otter enters the box, the net bag should be immediately pursed and the lid (if present) of the box closed. If net bags are not available, the otter should be placed directly into the capture box, and the lid immediately closed. A bite bag should be used to keep the otter in the box if there is no lid and no net bag.

Once the otter is secured in the capture box, it should be transported as soon as possible to the main boat for tagging and transfer to a sky kennel. If transport time exceeds half an hour and the otter is in a net bag, the otter should be removed and held over the side in the water for about 5 minutes. This should be repeated at half-hour intervals if extended transport in the skiff is required.

3. Tagging:

Sea otters should receive a single flipper tag prior to transfer to the appropriate rehabilitation center. Position and color of tags will be determined by an USFWS representative.

Tagging should be done while the otter is in the capture box, preferably while in a net bag. The otter should be restrained with a bite bag while the appropriate flipper

is pulled up to a workable location on the edge of the capture box. The tagging hole can be cut with a small pocket knife, a single-hole paper punch, or a leather punch. The cutting implement should be as clean as possible (preferably swabbed with alcohol) prior to cutting the hole. If the flipper feels warm to the touch, ice should be applied prior to cutting, in order to reduce bleeding. The tag should be inserted narrow end first, then pushed through the flipper. If possible, the separate ends of the tag should be secured with a small screw after tag insertion. A screw should be used only if the tag has a pre-drilled hole. It is crucial that the color, number, and position of the tag be recorded on the appropriate data sheet.

4. Placing sea otters in sky kennels:

If possible, sky kennels should have metal grates on the floor, such that there is space for urine and feces to collect without soiling the otter's fur. If grates are not available, place towels or rags in the kennel to absorb waste. Do not use oil absorbent pads; they do not handle urine or feces well. Otters in kennels should not be doused with water, even if the fur is soiled with urine or feces. Oiled otters are likely to hypothermic, and dousing may only make matters worse.

If the otter is in a net bag, it should be lowered into the kennel (held in vertical position, door end up) while still in the bag. The bag should be manipulated so that the bag opening is down, the purse line released, and the bag pulled upward so that the otter falls free into the kennel.

If the capture box is equipped with a sliding door in one end, the sky kennel (with door open) should be placed against the sliding door. The sliding door can then be opened, allowing the otter to crawl into the kennel.

If the capture box does not have a sliding door, and the otter is not in a net bag, the otter should be returned to a dip net before transfer to a kennel. To transfer, tilt the kennel at about a 45 degree angel, with the door open as far as possible. Hold the frame of the dip net flush against the door end of the kennel, such that the frame of the net is firmly against the lower edge of the door frame, and the door is entirely covered by the net. If there is a gap between the net frame and the door frame, it is likely that the otter will slip through the gap and fall free. Once the net frame and kennel are in position, do the following in a continuous motion: Grab the bottom of the net well away from the otter's head,

and swing the otter upward above the kennel door, allowing the otter to fall through the door and into the kennel. Judicious use of a foot may be of help, especially if the otter gets hung up at the kennel door. If the otter doesn't drop into the kennel within a few seconds, lower it down and try again. Once the otter is in the kennel, pull the dip net away and close and latch the kennel door. The procedure is best done with at least three people; one to hold the kennel, one to hold the net frame in position; and one to move the otter.

If desired, the kennel door can be removed before transfer. Door removal reduces the risk of entangling the dip net on the door catches. Remove the door by removing just enough kennel bolts to allow springing of the kennel grate. Make sure that the kennel is held in vertical position (door opening up) once the otter is in. The door should be replaced as soon as the otter is in the kennel. Watch fingers while replacing the door. A bite bag should be close at hand if door removal is required.

It is crucial that all capture records and related data forms be completed once the otter is secured in the sky kennel.

5. Holding an otter in a sky kennel:

The kennel should be held horizontally whenever possible. Accumulated water and urine can be drained by briefly standing the kennel on end, door down, to allow drainage.

Kennels should be placed under shelter to prevent wetting from rain or snow. However, it is crucial to maintain good ventilation. Kennels should be kept in a cool location, and should not be covered with blankets or towels.

Sea otters must have access to drinking water. An otter that is panting and appear frantic to escape from a kennel likely is in dire need of water, and requires an immediate response. They can handle either sea water or fresh water. The best way to deal with water needs is to provide clean chunks of ice or snow. Avoid placing so much snow or ice in the kennel that the otter is forced to lay on it. Accumulated ice water should be drained regularly as described above.

If the kennel is not equipped with a grate. towels or rags used to absorb waste should be changed frequently. To change towels, stand the kennel on end (Door up), open the door, remove towels using a stick with a hook on the

end, drop new towels in, close the door, and return the kennel to horizontal. Do not attempt to remove towels with hands. Have a dip net available whenever the kennel door is open.

6. Transportation of otters in kennels:

If transportation is by aircraft or boat, the kennel should be secured to the floor in the horizontal position with cargo webbing or straps. Ventilation of the kennels must not be obstructed, and ice should be available on board for the otter.

If it is absolutely necessary to transport kennels in tilted position, the door end should be tilted upward. The kennel should be returned to horizontal position as soon as possible after arrival.

If delays are encountered in route, the kennel must be placed in a cool, well-ventilated location that is sheltered from rain or snow.

7. Feeding of sea otters in kennels:

If transportation delays force extended (overnight) holding of a sea otter in a kennel, food should be offered at approximately 2 hour intervals. Preferred foods are geoduck clam meat, fish filets, or whole squid. Crab should be avoided because of excessive debris after feeding.

Food that has been thawed over 24 hours is not suitable for sea otters. All food should be refrigerated or stored on ice. Food need not be fully thawed before feeding to otters.

It is crucial to avoid overfeeding. Otters should be offered two or three pieces of food at each feeding. Captive otters are prone to gorging. Under the stressful circumstances of capture and holding, gorging can produce serious medical problems for otters.

Appendix 5. Rehabilitation program authorization

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. TUDOR RD.
ANCHORAGE, ALASKA 99503

IN REPLY REFER TO:

FWS/LE PRT 1-07

MAY 0 4 1989

Dr. Randall Davis
Hubbs Marine Research
1700 South Shores Road
San Diego, California 92109

Dear Dr. Davis:

Pursuant to the Marine Mammal Protection Act of 1972, 16 U. S. C. 1361 - 1407 (as amended), and the promulgated regulations therewith, the Fish and Wildlife Service (Service) is authorized to designate persons to collect, clean, and rehabilitate sea otters consistent with 16 U. S. C. 1379 (h) and 1382 (c).

By terms of this letter, during the Exxon Valdez oil spill clean up, you, and others with the appropriate skill and training operating under your direct supervision, are authorized to carry out the following tasks:

1. Capture oiled sea otters.

2. Transport oiled sea otters from the capture point to the designated rehabilitation facilities in Valdez or Seward.

3. Wash sea otters to remove oil.

4. Rehabilitate sea otters that have been washed, including the use of drugs and other medications to enhance their survival.

5. Euthanize sea otters which are terminally ill or mortally wounded and are not responding to treatment.

6. Hold cleaned sea otters until they are ready for release.

7. Perform necropsies including pathological work on sea otters which die at the rehabilitation facilities.

All of these enumerated activities must be accomplished in a humane manner and must be directly related to the protection or welfare of the sea otters. Reports on activities, specifically including how many otters have been collected and how many are in rehabilitation, shall be given weekly to the U. S. Fish and Wildlife Service, Mr. Wayne Crayton in the Region 7 Office at 1011 East Tudor Road, Anchorage, Alaska 99503/telephone (907) 786-3544.

In regard to other tasks, all activities related to release of sea otters must be specifically authorized in writing by the Service. Additionally, all necropsy and pathology data collected on sea otters at the Rehabilitation Center are the property of the Service. Authorized Service personnel must be granted unlimited access to the animals and to the data collected from the rehabilitation.

Hubbs Marine Research Center shall at all times indemnify and hold the United States harmless from all claims, loss or liability resulting from actions taken by Hubbs Marine Research Center in fulfilling the activities, responsibilities and conditions enumerated in this letter.

Sincerely,

Walter O. Stieglitz

Regional Director

CONCURRENCE

The Hubbs Marine Research Center agrees to accept the terms and conditions of this authorization.

Dated May 10, 1989 Randall W. Davis

Appendix 6. Bio-summary database

Key to bio-summary database

Otter no.	Sequential identification number given to each otter when it arrived at the particular rehabilitation center. Letters before the number identify the center: H = Homer; SW = Seward; VA = Valdez; P = pup; V = otter voluntarily entered pen.
Tag	The number on the plastic tag attached to the hindflipper of each otter.
Sex	Sex of each otter: F = female; M = male.
Adm date	Date of arrival at the rehabilitation center.
Adm wt	Weight (lbs.) at the time of admission to the rehabilitation center.
Cap loc	Capture location: KP = Kenai Peninsula; AP = Alaska Peninsula; PWS = Prince William Sound; Kodiak = Kodiak Island; H = Homer. Date in parenthesis refers to capture date when different from admission date. Number behind boat denotes the otter capture sequence for that boat.
Cap boat	Name of capture boat. Asterisk means that the capture location and/or boat is based on sources other than capture forms.
Comment	Comment field
Oil	Degree of oiling: N = no oil; L = lightly oiled; M = moderately oiled; H = heavily oiled; U = unknown.
Status	This field shows whether the otters released, transferred to an aquarium, died or euthanized. Also shown is the release location: J = Little Jakolof Cove; KHI = Kenai Peninsula, Herring Islands, Kachemak Bay; KJL = Kenai Peninsula, James Lagoon and McCarty Fjord; KNB = Kenai Peninsula, west arm of Nuka Bay; KTP = Kenai Peninsula, Taylor Bay; KPH = Kenai Peninsula, Picnic Harbor; KHB = Kenai Peninsula, Harris Bay; PWS = Prince William Sound (Sheep Bay for females and Nelson Bay for males); SB = Simpson Bay in Prince William Sound.
Wash date	Date that oiled otters were washed.

Key to bio-summary database continued

Preg	Shows whether the female was pregnant: F = false; T = true; U = unknown.
Final disp	Date that the otter was released, transferred to an aquarium, died or euthanized.

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
HD001	NONE	F	04/25/89	45.50	KP, TONSINA BAY	BREAKTIME- 6	DIED IN TRANSIT TO VALDEZ	N	DECEASED	/ /	F	04/27/89
HD012	NONE	F	04/30/89	0.00	KP, PORT DICK,W ARM	RDMAN E	DIED AT HOMER, MOM OF SW004	N	DECEASED	/ /	F	04/30/89
H0014	570RD	F	05/06/89	60.00	KP, WINDY BAY	BREAKTIME- 23	GAVE BIRTH IN JAKOLOF - PUP# H0019	N	RELEASED KJL	/ /	T	08/19/89
H0016	522	F	05/07/89	0.00	KP, ROCKY BAY	WAYWARD	GAVE BIRTH IN JAKOLOF - PUP# H0020.	N	RELEASED J	/ /	T	07/14/89
H0017	521GR	M	05/07/89	78.00	KP, ROCKY BAY	WAYWARD	"PAPA JOE"	N	RELEASED KNB	/ /	F	08/19/89
H0018	NONE	M	05/26/89	85.00	KP, LITTLE JAKOLOF		ROGUE	N	RELEASED J	/ /	F	08/30/89
H0019	NONE	U	05/15/89	0.00	BORN AT HOMER TEM CARE FAC		PUP OF - MOM H0014. DIED AT JAKOLOF	N	DECEASED	/ /	F	05/25/89
H0020	NONE	M	05/25/89	0.00	BORN IN JAKOLOF		PUP OF - MOM H0016.	N	RELEASED J	/ /	F	07/14/89
H0021	NONE	M	06/09/89	0.00	KP, LITTLE JAKOLOF		ROGUE	N	RELEASED J	/ /	F	06/12/89
H0022	NONE	M	07/04/89	0.00	KP, LITTLE JAKOLOF		ROGUE	N	RELEASED KHI	/ /	F	07/28/89
H0023	NONE	U	07/05/89	0.00	BORN IN JAKOLOF		PUP OF - MOM SW029.	N	RELEASED J	/ /	F	08/11/89
H0024	NONE	M	07/12/89	0.00	BORN IN JAKOLOF		PUP OF - MOM SW013.	N	RELEASED J	/ /	F	08/11/89
H0025	NONE	M	07/23/89	0.00	KP, LITTLE JAKOLOF		ROGUE	N	RELEASED KHI	/ /	F	08/21/89
H0026	NONE	M	08/03/89	0.00	KP, LITTLE JAKOLOF		ROGUE	N	RELEASED KHI	/ /	F	08/21/89
SW001	585	F	05/01/89	10.00	KP, TONSINA BAY, (4/30)	MYSTIC LADY- 5	ORIGINALLY FROM HOMER (HOMER H-6*)	N	DECEASED	/ /	U	05/06/89
SW002	586OR	F	05/01/89	54.00	KP, TONSINA BAY, (4/29)	MYSTIC LADY- 6	(HOMER H-7)RADIO TRANSMITTER IM 7/17/89	N	RELEASED PWS	/ /	F	07/27/89
SW003	B100RD	F	05/01/89	0.00	KP, TONSINA BAY, (4/30)	MYSTIC LADY- 7	(HOMER H-9*) RADIO TRANSMITTER IM. 8/11	N	RELEASED PWS	/ /	U	08/22/89
SW004	NONE	F	05/01/89	10.00	KP, PORT DICK, W. ARM	ROMAN E	(HOMER H-13)PUP OF H-0012, "LITTLE ONE"	N	SHEDD AQUAR	/ /	F	10/31/89
SW005	589OR	F	05/01/89	47.00	KP, TONSINA BAY	MYSTIC LADY- 8	(HOMER H-8) OILED ON HIP, BACK.	L	RELEASED KJL	05/01/89	U	08/19/89
SW006	B008RD	F	05/01/89	0.00	KP, TONSINA BAY (4/30/89)	MYSTIC LADY- 9	(HOMER H-10*) RADIO TRANSM IMP 8/11	L	RELEASED PWS	05/01/89	U	08/22/89
SW007	B050RD	F	05/01/89	0.00	KP, TONSINA BAY	MYSTIC LADY-10	(HOMER H-11*) RADIO TRANS IMP 8/11	L	RELEASED PWS	05/01/89	U	08/22/89
SW008	NONE	F	05/02/89	0.00	AP, SHAKUN IS.	JEANOAH, K-1	ENTIRE BODY OILED.	L	DECEASED	/ /	U	05/02/89
SW009	539OR	F	05/03/89	45.00	KP, TONSINA BAY (5/2/89)	MYSTIC LADY-13	ENTIRE BODY OILED.	L	RELEASED KNB	05/04/89	U	08/19/89
SW010	540OR	M	05/03/89	0.00	KP, TONSINA BAY (5/2/89)	MYSTIC LADY-14	ENTIRE BODY OILED.	L	RELEASED PWS	05/05/89	F	08/22/89
SW011	541OR	F	05/03/89	40.00	KP, TONSINA BAY (5/2/89)	MYSTIC LADY-15	ENTIRE BODY OILED.	L	RELEASED KNB	05/07/89	U	08/19/89
SW012	545OR	F	05/03/89	0.00	KP, WINDY BAY	BREAKTIME- 9	ENTIRE BODY OILED. (LARGE OTTER)	L	RELEASED J	05/07/89	T	08/11/89
SW012P	NONE	M	05/15/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	05/15/89

OTTER_NO	TAG	SEX	ADM_OATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
SW013	5440R	F	05/04/89	0.00	KP, BOOTLEG BAY	WAYWARD- 10	GAVE BIRTH AT JAKOLOF #H0024	M	RELEASED J	05/07/89	T	08/11/89
SW014	532SV	M	05/04/89	60.00	KP, BOOTLEG BAY	WAYWARD- 11	ESC PORT VALOEZ BAY,	M	ESCAPED VH	05/07/89	F	07/13/89
SW015	101YL	F	05/04/89	45.00	KP, BOOTLEG BAY	WAYWARD	RADIO TRANSMITTER IMPLANTED	L	RELEASED PWS	05/04/89	F	07/27/89
SW016	513YL	M	05/04/89	65.00	KP, BOOTLEG BAY	WAYWARO- 13	ESC PORT VALOEZ BAY	M	ESCAPED VH	05/08/89	F	07/13/89
SW017	027YL	F	05/04/89	65.00	KP, BOOTLEG BAY	WAYWARO	RAOIO TRANSMITTER IMPLANTED	L	RELEASED PWS	05/08/89	F	07/27/89
SW018	525GY	M	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 15		N	RELEASED KJL	/ /	F	08/19/89
SW019	5230R	F	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 16	NOT WASHEO. LATE TERM PG WHEN RELEASED.	U	RELEASED J	/ /	T	06/17/89
SW020	515GR	F	05/05/89	0.00	KP, BOOTLEG BAY	WAYWARO	NOT WASHED.	U	RELEASED KJL	/ /	F	08/19/89
SW021	546OR	F	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 18	NOT WASHED.	U	DECEASED	/ /	F	05/11/89
SW022	550OR	F	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 19	NOT WASHED	U	RELEASED KHB	/ /	U	08/21/89
SW023	585RO	F	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 12	NOT WASHED	U	RELEASED J	/ /	T	08/11/89
SW023P	NONE	M	05/21/89	2.70	BORN AT SORC		WAS SW-111 BEFORE SWP# WERE ASSIGNED	N	O/PTDEFIANCE	/ /	F	10/10/89
SW024	514GY	F	05/05/89	0.00	KP, BOOTLEG BAY	WAYWARD	NOT WASHED.	U	RELEASED KHB	/ /	U	08/21/89
SW025	524GY	M	05/05/89	0.00	KP, WINDY BAY	BREAKTIME- 20	NOT WASHED.	U	RELEASEO KJL	/ /	F	08/19/89
SW026	575RO	F	05/05/89	43.00	KP, ROCKY BAY	BREAKTIME/ROME		U	RELEASED KHB	05/07/89	F	08/21/89
SW027	578RO	F	05/05/89	52.00	KP, ROCKY BAY	BREAKTIME/ROME	ENTIRE BODY OILED. STILLBORN PUP 5/9/89	L	RELEASED KHB	05/08/89	T	08/21/89
SW028	106YL	F	05/05/89	53.00	KP, ROCKY BAY	BREAKTIME/ROME	WASHED 5/10 & 5/12.	L	RELEASED PWS	05/12/89	N	08/22/89
SW029	104YL	F	05/05/89	43.00	KP, ROCKY BAY	BREAKTIME/ROME	GAVE BIRTH AT JAKOLOF (H023 PUP #)	M	RELEASED J	05/08/89	T	08/11/89
SW030	NONE	M	05/05/89	49.00	KP, TONSINA BAY	MYSTIC LAOY-17	ESC PORT VALOEZ BAY	U	ESCAPEO VH	05/05/89	F	07/13/89
SW031	108YL	F	05/05/89	37.00	KP, TONSINA BAY	MYSTIC LADY-16		L	RELEASED KHB	05/10/89	U	08/21/89
SW032	064	F	05/05/89	0.00	KP, TONSINA BAY	MYSTIC LAOY-18	NOT WASHEO, ESC JAKOLOF BAY	U	ESCAPED J	/ /	F	08/05/89
SW033	579RD	F	05/05/89	63.00	KP, WINDY BAY	BREAKTIME	GAVE BIRTH 5/12, PUP LIVED 3 HRS.	L	RELEASED PWS	05/12/89	T	08/15/89
SW033P	NONE	U	05/12/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	05/12/89
SW034	105YL	F	05/05/89	40.00	KP, TONSINA BAY	MYSTIC LAOY-19		L	RELEASED PWS	05/08/89	F	08/15/89
SW035	571RO	F	05/05/89	53.00	KP, WINDY BAY	BREAKTIME	RADIO TRANSMITTER IMPLANTED	U	RELEASED PWS	/ /	F	07/27/89
SW036	518YL	F	05/07/89	0.00	KP, ROCKY BAY	WAYWARD		U	RELEASED KHB	/ /	U	08/21/89
SW037	134GY	F	05/07/89	0.00	KP, ROCKY BAY	WAYWARD		U	RELEASED J	/ /	F	08/13/89
SW038	569RD	M	05/07/89	77.00	KP, WINDY BAY	BREAKTIME	RAOIO TRANSMITTER IMPLANTED 08/11/89	M	RELEASED PWS	05/10/89	F	08/22/89
SW039	519YL	F	05/07/89	51.00	KP, ROCKY BAY	WAYWARD		U	RELEASED PWS	/ /	F	07/27/89
SW040	586RD	F	05/07/89	30.00	KP, WINDY BAY	BREAKTIME/ROME		U	RELEASED PWS	/ /	F	07/27/89
SW041	031YL	F	05/07/89	57.00	KP, TONSINA BAY	MYSTIC LADY-20		U	RELEASED PWS	/ /	F	08/15/89
SW042	115YL	M	05/07/89	0.00	KP, TONSINA BAY	MYSTIC LADY-21	RELEASE TAGS 75&76GLD	L	RELEASED KJL	05/12/89	F	08/20/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
SW043	109YL	F	05/07/89	50.00	KP, TAYLOR BAY	NORTH LIGHT	MOM OF SW044, RADIO IMPLANT	L	RELEASED PWS	05/10/89	F	08/22/89
SW044	B009RD	M	05/07/89	0.00	KP, TAYLOR BAY	NORTH LIGHT	REL W/ MOM SW043;RADIO IMPLANT 8/11	L	RELEASED PWS	05/10/89	F	08/22/89
SW045	516YL	F	05/07/89	50.00	KP, PICNIC HARBOR	WAYWARD	ORIGINALLY #H0015, RADIO IMPLANT	U	RELEASED PWS	/ /	F	07/27/89
SW047	107YL	F	05/10/89	45.00	KP, WINDY BAY	BKTM/NL/MLY-22	1ST TAG#26YL. RELEASE TAGS 39&40GY	U	RELEASED PWS	/ /	T	08/16/89
SW047P	NONE	M	05/28/89	0.00	BORN AT VORC		RELEASE TAGS 41&42GY	N	RELEASED PWS	/ /	F	08/16/89
SW048	107YL	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-23		L	EUTH	05/12/89	U	05/21/89
SW049	028YL	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-24		L	DECEASED	05/11/89	F	05/13/89
SW050	029YL	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-25		L	EUTH	05/11/89	U	05/17/89
SW051	033YL	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-28		L	RELEASED KHB	05/11/89	U	08/21/89
SW052	030YL	F	05/10/89	48.00	KP, WINDY BAY	MYSTIC LADY-26	RELEASE TAGS 61&62 GLD	L	RELEASED KNB	05/11/89	F	08/19/89
SW053	B026RD	F	05/10/08	40.00	KP, WINDY BAY	MYSTIC LADY-29	RADIO TRANSMITTER IMPLANTED 08/11/89	L	RELEASED PWS	05/11/89	T	08/22/89
SW053P	NONE	F	05/13/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	05/14/89
SW054	B041RD	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-30	R/TRANSM IMPLANTED 08/11 (STILLBORN PUP)	M	RELEASED PWS	05/11/89	T	08/22/89
SW055	032YL	F	05/11/89	70.00	KP, WINDY BAY	MYSTIC LADY-27	ESC PORT VALDEZ BAY	L	ESCAPED VH	05/11/89	F	05/19/89
SW056	114YL	F	05/10/89	0.00	KP, WINDY BAY	MYSTIC LADY-31	RETAG 522GR	M	RELEASED KHB	05/11/89	F	08/21/89
SW057	B033RD	F	05/11/89	0.00	KP, SOUTH BAY NATOA ISLAND	SHADOW	RADIO TRANSMITTER IMPLANTED 08/11/89	M	RELEASED PWS	05/11/89	F	08/22/89
SW058	111YL	F	05/11/89	0.00	KP, WINDY BAY	MYSTIC LADY-32	LATE TERM PG WHEN RELEASED	L	RELEASED J	05/12/89	T	06/17/89
SW059	112YL	F	05/11/89	59.00	KP, WINDY BAY	MYSTIC LADY-34	RADIO TRANS IMPLANTED. GAVE BIRTH 5/14	U	RELEASED PWS	/ /	T	07/27/89
SW059P	NONE	U	05/14/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	05/14/89
SW060	038RD	F	05/11/89	40.00	KP, WINDY BAY	NORTH LITE	RADIO TRANSMITTER IMPLANTED.	L	RELEASED PWS	05/12/89	F	08/22/89
SW061	054YL	F	05/11/89	47.00	KP, ROCKY BAY	BREAKTIME	ESC PORT VALDEZ BAY	M	ESCAPED VH	05/12/89	F	07/13/89
SW062	057YL	F	05/11/89	33.00	KP, ROCKY BAY	BREAKTIME/ROME	RELEASE TAG 105&106 GLD	L	RELEASED KHB	05/12/89	F	08/21/89
SW063	051YL	F	D5/11/89	46.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 69&70 GLD	U	RELEASED KJL	05/12/89	F	08/20/89
SW064	944GY	F	05/11/89	54.00	KP, WINDY BAY	NORTH LIGHT	REL TAG 121&122 GLD	U	RELEASED PWS	05/12/89	F	08/22/89
SW065	946GY	M	05/11/89	88.00	KP, WINDY BAY	NORTH LIGHT	REL TAG 107&108 GLD	H	RELEASED PWS	05/12/89	F	08/15/89
SW066	042YL	F	05/11/89	0.00	KP, WINDY BAY	MYSTIC LADY-33		U	RELEASED KHB	/ /	F	08/21/89
SW067	055GY	F	05/11/89	50.00	KP, ROCKY BAY	BREAKTIME/ROME		L	DECEASED	05/12/89	F	06/07/89
SW068	056YL	F	05/11/89	67.00	KP, ROCKY BAY	BREAKTIME/ROME	RADIO TRANSMITTER IMPLANTED	M	RELEASED PWS	05/11/89	F	07/27/89
SW069	B042RD	F	05/11/89	48.00	KP, ROCKY BAY	MYSTIC LADY-35	RADIO TRANSMITTER IMPLANTED 08/11/89	M	RELEASED PWS	05/13/89	F	08/22/89
SW070	055YL	M	05/11/89	70.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 31&32 GY	U	RELEASED PWS	/ /	F	08/15/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
SW071	040YL	F	05/11/89	58.00	KP, WINDY BAY	MYSTIC LADY-36	REL TAG 49&50 GLD	U	RELEASED KJL	/ /	F	08/19/89
SW072	118YL	F	05/11/89	45.00	KP, WINDY BAY	MYSTIC LADY-37		L	RELEASED J	05/14/89	F	08/11/89
SW073	116YL	F	05/11/89	40.00	KP, WINDY BAY	MYSTIC LADY-41	REL TAG 119&120 GLD	U	RELEASED PWS	05/13/89	F	08/22/89
SW074	061YL	F	05/11/89	25.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 77&78	H	RELEASED KJL	05/12/89	F	08/20/89
SW075	044YL	F	05/11/89	55.00	KP, WINDY BAY	MYSTIC LADY		L	DECEASED	/ /	F	05/13/89
SW076	063YL	F	05/11/89	50.00	KP, ROCKY BAY	MYSTIC LADY-38		M	DECEASED	05/13/89	F	05/24/89
SW077	054GY	F	05/11/89	48.00	KP, WINDY BAY	MYSTIC LADY-43		M	EUTH	05/13/89	F	07/24/89
SW078	948GY	M	05/11/89	70.00	KP, WINDY BAY	NORTH LITE		L	DECEASED	05/13/89	F	05/17/89
SW079	062YL	F	05/11/89	50.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 79&80 GLD	L	RELEASED PWS	05/13/89	T	08/22/89
SW080	B028RD	F	05/11/89	52.00	KP, ROCKY BAY	BREAKTIME/ROME	RADIO TRANSMITTER IMPLANTED 08/11/89	M	RELEASED PWS	05/13/89	T	08/22/89
SW080P	NONE	F	05/26/89	2.00	BORN AT SORC		PUP BORN TO SW-080, "HALF PINT"	N	EUTH	/ /	F	05/29/89
SW081	046YL	F	05/11/89	35.00	KP, WINDY BAY	*MYSTIC LADY40	REL TAG 17&18 GLD	L	RELEASED KHB	05/14/89	F	08/21/89
SW082	073GY	F	05/11/89	45.00	KP, WINDY BAY	*MYSTIC LADY42	PREGNANT - PUP DIED.	M	RELEASED KHB	05/14/89	T	08/22/89
SW082P	NONE	U	05/20/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	05/21/89
SW083	058GY	M	05/11/89	78.00	KP, ROCKY BAY	*BREAKTIME/ROM	REL TAG 63&64 GLD	N	RELEASED KNB	/ /	F	08/19/89
SW084	045YL	F	05/11/89	62.00	KP, WINDY BAY	MYSTIC LADY-39	REL TAG 21&22 GY	U	RELEASED PWS	/ /	F	08/15/89
SW085	119YL	F	05/17/89	0.00	KP, WINDY BAY	MYSTIC LADY-45	REL TAG 43&44 GLD	N	RELEASED KJL	05/18/89	F	08/19/89
SW086	120YL	F	05/17/89	48.00	KP, WINDY BAY	MYSTIC LADY-47	REL TAG 123&124 GLD	L	RELEASED PWS	05/18/89	F	08/22/89
SW087	123YL	F	05/17/89	51.00	KP, WINDY BAY	MYSTIC LADY-46	REL TAG 47&48 STILLBORN PUP 5/20/89	L	RELEASED KJL	05/18/89	T	08/19/89
SW088	127YL	F	05/17/89	54.00	KP, WINDY BAY	MYSTIC LADY-48	REL TAG 35&36 GLD	L	RELEASED KJL	05/18/89	F	08/19/89
SW089	053GY	F	05/17/89	40.00	KP, WINDY BAY	MYSTIC LADY-44	1ST TAG 5201	L	RELEASED KHB	05/18/89	F	08/22/89
SW090	121YL	F	05/17/89	44.00	WOODED ISLAND,2MI NW OUZINKI, KODIAK	TEN BEARS, K-4	REL TAG 13&14 GLD	L	RELEASED KHB	05/18/89	F	08/21/89
SW091	128YL	F	05/18/89	53.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 15&16 GLD. STILLBORN PUP 5/20/89	L	RELEASED KHB	05/19/89	T	08/21/89
SW092	133YL	F	05/18/89	36.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 133YL	L	RELEASED J	05/19/89	F	08/13/89
SW093	142YL	F	05/18/89	50.00	KP, ROCKY BAY	BREAKTIME/ROME	ACETONE TEST NEG. REL TAG 19&20 GLD	N	RELEASED KHB	/ /	F	08/21/89
SW094	132YL	M	05/18/89	86.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 1&2 GLD	U	RELEASED KJL	/ /	F	08/20/89
SW095	131YL	M	05/18/89	95.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 91&92 GLD	U	RELEASED KHB	/ /	F	08/21/89
SW096	144YL	M	05/18/89	82.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 3&4 GLD.	L	RELEASED KHB	05/27/89	F	08/21/89
SW097	130YL	F	05/18/89	69.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 81&82 GLD	U	RELEASED J	05/19/89	T	08/30/89
SW097P	NONE	M	05/30/89	0.00	BORN AT SORC			N	DECEASED	/ /	F	06/03/89
SW098	129YL	F	05/18/89	30.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 53&54 GLD	U	RELEASED KJL	05/19/89	F	08/19/89
SW099	145YL	M	05/18/89	79.00	KP, ROCKY BAY	BREAKTIME/ROME	REL TAG 05&100 GLD. METH CHL	L	RELEASED KHB	05/27/89	F	08/21/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
							TEST POS					
SW100	137YL	F	05/19/89	41.00	KP, ROCKY BAY	ROMAN E	REL TAG 71&72 GLD	U	RELEASED KJL	05/20/89	F	08/20/89
SW101	138YL	F	05/19/89	37.00	KP, ROCKY BAY	BREAKTIME	RE TAG 33&34 GLD	U	RELEASED KJL	05/20/89	F	08/19/89
SW102	NONE	F	05/10/89	13.00	KP, FLAT ISLAND, OFF ENG BY	BOOMTENDER	BABY OTTER "PRECIOUS"	N	SHEDD AQUAR	/ /	F	10/31/89
SW103	139YL	F	05/20/89	30.00	KP, GRANITE PASSAGE, ALIGO PT.	SEA DUCER	ACETONE TEST FOR OIL - NEG	L	DECEASED	05/21/89	F	06/19/89
SW104	140YL	M	05/20/89	51.00	KP, ROCKY BAY (5/19)	BREAKTIME/ROME	LIGHTLY WASHED	L	DECEASED	05/21/89	F	05/21/89
SW105	141YL	F	05/20/89	42.00	KP, W. MORNING COVE, MAC ARTHER PASS	MARY H		U	EUTH	/ /	F	05/31/89
SW106	NONE	M	05/21/89	6.00	KP, WINDY BAY (SEE BRITTONS LETTER)	BREAKTIME/ROME	PUP "BREAKTIME" - ABANDONED PUP	N	SHEDD AQUAR	/ /	F	10/31/89
SW107	NONE	M	05/21/89	90.00	KP, ROCKY BAY	BREAKTIME/ROME	ACETONE TEST FOR OIL - NEG.	U	EUTH	/ /	F	05/23/89
SW108	146YL	M	05/21/89	79.00	KP, WINDY BAY	BREAKTIME	REL TAG 11&12 GLD	U	RELEASED KJL	/ /	F	08/20/89
SW109	NONE	F	05/21/89	38.00	KP, E. ARM OF NUKA BAY	FOXY LADY		U	EUTH	/ /	U	05/23/89
SW110	523YL	F	05/22/89	25.00	CHIEF PT, SPIRODON BAY, KODIAK	WAYWARD, K-6	REL TAG 73&74 GLD	U	RELEASED KJL	05/23/89	F	08/20/89
SW112	148YL	F	05/23/89	53.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-8	ACETONE TEST FOR OIL POS. MOM OF SW113	L	RELEASED J	05/24/89	F	07/14/89
SW113	147YL	F	05/23/89	32.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-7	ACETONE TEST FOR OIL POS. PUP OF SW112	L	RELEASED J	05/24/89	F	07/14/89
SW114	B036RD	F	05/24/89	38.00	UYAK BAY, KODIAK	LARSEN B CW K9	RADIO IMPLANT. ACETONE TEST FOR OIL POS.	M	RELEASED PWS	05/25/89	F	08/22/89
SW115	149YL	F	05/24/89	50.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-10	POSITIVE ACETONE TEST FOR OIL	L	EUTH	05/25/89	F	06/19/89
SW116	150YL	F	05/24/89	62.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-11	POSITIVE ACETONE TEST FOR OIL	L	RELEASED KTB	05/25/89	F	08/17/89
SW117	004OR	F	05/25/89	56.00	SEAL IS., SEAL BAY, AFOGNAK	TEN BEARS,K-17	FLOWN DIRECT TO SEWARD	N	RELEASED J	/ /	F	07/15/89
SW118	NONE	M	05/25/89	10.00	SEAL IS., SEAL BAY, AFOGNAK	TEN BEARS,K-18	PUP OF SW117. RELEASED W/MOM W/OUT TAGS	N	RELEASED J	/ /	F	07/15/89
SW119	NONE	F	05/25/89	61.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-12	MOM OF SW120 REL TAGS 68&67 GLD	U	RELEASED KJL	/ /	F	08/20/89
SW120	NONE	F	05/25/89	30.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-13	PUP OF SW119	U	EUTH	/ /	U	06/04/89
SW121	153YL	F	05/25/89	58.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-14	POSITIVE ACETONE TEST FOR OIL	L	ESCAPED J	05/26/89	F	08/11/89
SW122	B012RD	M	05/25/89	86.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-15	RADIO IMPLANT. POS ACETONE TEST FOR OIL	L	RELEASED PWS	05/26/89	F	08/22/89
SW123	154YL	F	05/25/89	46.00	KUPREANOFF STRAITS, KODIAK	NORTH LT, K-16	POSITIVE ACETONE TEST FOR OIL	L	RELEASED KJL	05/26/89	F	08/19/89
SW124	018RD	F	05/31/89	46.00	KP, ROCKY BAY, ISLAND #1	BKTM/FXL/ROME	RADIO TRANSMITTER IMPLANTED 08/04/89.	L	RELEASED PWS	06/06/89	F	08/16/89
SW125	167YL	F	06/05/89	52.00	KP, ROCKY BAY, ISLAND #1	BKTM/FXL/ROME		L	DECEASED	06/06/89	F	06/06/89
SW126	166YL	M	06/05/89	83.00	KP, ROCKY BAY, ISLAND #1	BKTM/FXL/ROME		L	RELEASED KHB	/ /	F	08/21/89
SW127	052GY	F	06/05/89	59.00	KP, ROCKY BAY, ISLAND #3	BKTM/FXL/ROME		L	DECEASED	06/06/89	F	06/05/89
SW128	556RD	F	06/06/89	46.00	KP, ROCKY BAY, ISLAND #14	FOXY LADY	RAOIO TRANSMITTER IMPL 8/4/89.	L	RELEASED PWS	06/07/89	F	08/16/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
SW129	554RD	F	06/06/89	49.00	KP, ROCKY BAY, ISLAND #4	FOXY LADY		L	RELEASED KJL	/ /	F	08/19/89
SW130	555RD	M	06/06/89	66.00	KP, ROCKY BAY, ISLAND #4	BKTM/FXL/ROME		U	RELEASED KHB	/ /	F	08/21/89
SW131	NONE	F	06/10/89	3.80	LARSON BAY, KODIAK	SKIFF CW, K-19	PUP. "THELMA". DIED PT. DEFIANCE	N	D/PT DEFIANC	/ /	F	02/01/90
SW132	NONE	F	06/13/89	46.00	KP, WINDY BAY, KELP BED 0	BKTM/FXL/ROME	DROWNED AFTER BLOOD DRAW IN JAKOLOF	N	DECEASED	/ /	F	08/09/89
SW133	NONE	F	06/13/89	5.70	KP, WINDY BAY, KELP BED 0	BKTM/FXL/ROME	PUP OF SW132	N	SHEDD, AQUAR	/ /	F	10/31/89
SW134	173YL	F	06/13/89	42.00	KP, ROCKY BAY, ISLAND #1	BKTM/FXL/ROME		U	RELEASED KJL	/ /	F	08/19/89
SW135	553RD	M	06/13/89	77.00	KP, ROCKY BAY, ISLAND #1 (6/12)	BKTM/FXL/ROME		L	DECEASED	06/14/89	F	06/14/89
SW136	174YL	F	06/13/89	56.00	KP, WINDY BAY, KELP BED 0	BKTM/FXL/ROME		N	RELEASED KJL	/ /	T	08/19/89
SW136P	NONE	F	06/15/89	3.60	BORN AT SORC.		PUP OF SW136. "NAWASSA"	N	EUTH	/ /	F	06/16/89
SW137	094GY	F	06/14/89	57.00	FOUL BAY, AFOGNAK, KODIAK (6/12)	TEN BEARS,K-20	SPINAL INJURY; SPAYED. MOM OF SW138	L	RELEASED J	06/19/89	F	08/30/89
SW138	NONE	M	06/14/89	10.00	FOUL BAY, AFOGNAK, KODIAK (6/12)	TEN BEARS,K-21	"ICE PICK" PUP OF SW137	U	EUTH	/ /	F	06/18/89
SW139	057GY	F	06/17/89	50.00	KP, WINDY BAY	BKTM/FXYL/ROME	MOM OF SW140	N	RELEASED J	/ /	F	07/15/89
SW140	NONE	F	06/17/89	0.00	KP, WINDY BAY	BKTM/FXYL/ROME	PUP OF SW139	N	RELEASED J	/ /	F	07/15/89
SW141	185YL	F	06/17/89	50.00	KP, WINDY BAY	BKTM/FXYL/ROME	STUDY ANIMAL - LIGHTLY OILED ALL OVER	L	RELEASED KNB	06/18/89	F	08/19/89
SW142	B038YL	F	06/17/89	72.00	KP, WINDY BAY	BKTM/FXL/ROM76	STUDY ANIMAL NOT WASHED.	U	RELEASED KTB	/ /	T	08/17/89
SW142P	NONE	F	06/23/89	0.00	BORN AT SORC		PUP OF SW142 BORN AT SORC.	N	RELEASED KTB	/ /	F	08/17/89
SW143	B188YL	F	06/17/89	67.00	KP, WINDY BAY	BKTM/FXL/ROM80	STUDY ANIMAL - NOT WASHED. RELEASED	U	RELEASED KTB	/ /	T	08/17/89
SW143P	NONE	F	06/24/89	3.50	BORN AT SORC		LIVE PUP OF SW-143, "HOOT"	N	JAPAN	/ /	F	02/22/90
SW144	186YL	F	06/17/89	58.00	KP, WINDY BAY	BKTM/FXL/ROM78	STUDY ANIMAL. VISUAL-NO OIL.	N	RELEASED KHB	06/18/89	F	08/21/89
SW145	073YL	F	06/17/89	61.00	KP, WINDY BAY	BKTM/FXL/ROME	STUDY ANIMAL - NOT WASHED.	U	RELEASED KHB	/ /	F	08/22/89
SW146	079YL	F	06/17/89	45.00	KP, WINDY BAY	BKTM/FXL/ROM79	STUDY ANIMAL - RADIO TRANSM IM 7/15/89	L	RELEASED PWS	06/18/89	F	08/16/89
SW147	B056GY	F	06/17/89	0.00	KP, WINDY BAY	*BKTM/FXL/ROME	MOM OF PUP SW148	N	RELEASED KNB	/ /	F	08/19/89
SW148	NONE	F	06/17/89	0.00	KP, WINDY BAY	*BKTM/FXY/ROME	PUP OF SW147. RETURNED TO SORC FR HOMER	N	SEA WORLD	/ /	F	02/01/90
SW149	194YL	F	06/19/89	64.00	OUZINKIE, KODIAK	SKIFF CW, K-22	BILATERAL CATERACTS, PARALYSIS OF HND QU	N	EUTH	06/20/89	F	07/03/89
SW150	192YL	F	06/19/89	44.00	KP, ROCKY BAY ISLAND #1	BKTM/FXL/ROME	STUDY ANIMAL	L	RELEASED J	06/20/89	F	08/30/89
SW151	092YL	M	06/20/89	84.00	KP, ENT TO ROCKY RIVER	BKTM/FXL/ROME	STUDY ANIMAL, FOUND DEAD WINDY BAY ~9/7	U	RELEASED KHB	/ /	F	08/21/89
SW152	025RD	M	06/20/89	78.00	KP, ENTRANCE OF ROCKY RIVER	BKTM/FXL/ROME	STUDY ANIMAL. RADIO TRANSM	L	RELEASED PWS	06/21/89	F	08/22/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
							IMPLANT 7/15					
SW153	199YL	M	06/21/89	74.00	KP, PICNIC BAY	BKTM/FXL/ROME	STUDY ANIMAL. NOT WASHED	U	RELEASED KHB	/ /	F	08/21/89
SW154	198YL	M	06/21/89	54.00	KP, ROCKY BAY	*BKTM/FXL/ROME	STUDY ANIMAL. NOT WASHED	U	RELEASED KHB	/ /	F	08/21/89
SW155	022RD	F	06/21/89	59.00	KP, OFF ROCKY RIVER	BKTM/FXL/ROME	STUDY ANIMAL. RADIO TRANSM IMPLANT 7/15	M	RELEASED PWS	06/23/89	F	08/16/89
SW156	200YL	M	06/22/89	81.00	KP, OFF ROCKY RIVER	BKTM/FXL/ROME	STUDY ANIMAL. WASHED AFTER STUDY.	L	RELEASED KHB	07/07/89	F	08/21/89
SW157	021RD	F	06/23/89	30.00	KP, ROCKY RIVER	FXLY/ROME	STUDY ANIMAL. RADIO TRANSM IM 7/15/89	L	RELEASED PWS	06/24/89	F	08/16/89
SW158	204GD	F	06/23/89	49.00	KP, ROCKY BAY, ISLAND #1	BKTM/FXL/ROME	STUDY ANIMAL.	L	RELEASED KTB	06/24/89	F	08/17/89
SW159	068Y	F	06/23/89	63.00	*KP, ROCKY BAY	BKTM/ ROME	STUDY ANIMAL, WASHED/RIBS DN, STILLBORN	U	RELEASED KHB	07/07/89	T	08/22/89
SW160	072GY	M	06/25/89	24.00	KP, HARDOVER POINT	BREAKTIME		N	DECEASED	06/26/89	F	06/27/89
SW161	013RD	F	07/05/89	41.00	KP, TONSINA BAY, LONG ISLAND	BREAKTIME	RADIO TRANSMITTER IMPLANTED 08/04/89.	L	RELEASED PWS	07/06/89	F	08/16/89
SW162	016RD	F	07/05/89	45.00	KP, TONSINA BAY, LONG ISLAND	BREAKTIME	RADIO TRANSMITTER IMPLANTED 08/04/89.	L	RELEASED PWS	07/06/89	F	08/16/89
SW163	075GY	F	07/05/89	51.00	KP, TONSINA BAY, FROUNT POINT	BREAKTIME	DEGREE OF OIL -NONE VISUAL	N	EUTH	07/06/89	F	07/11/89
SW164	201GD	F	07/05/89	44.00	KP, TONSINA BAY, LONG ISLAND	BREAKTIME		L	RELEASED KTB	07/06/89	F	08/17/89
SW165	081GY	F	07/06/89	41.00	KP, E. ARM OF NUKA BAY	BREAKTIME	MOM OF SW166	U	RELEASED J	/ /	F	08/11/89
SW166	NONE	F	07/06/89	16.00	KP, E. ARM OF NUKA BAY	BREAKTIME	PUP OF SW165	N	RELEASED J	/ /	F	08/11/89
SW167	202GD	F	07/06/89	39.00	KP, NUKA BAY	BREAKTIME		L	RELEASED KTB	07/07/89	F	08/17/89
SW168	079	F	07/08/89	45.00	KP, TONSINA BAY (7/7)	FOXYL/BREAKTM		N	RELEASED KHB	/ /	F	08/21/89
SW169	078	M	07/08/89	38.00	KP, OUTER TONSINA BAY	FOXYL/BREAKTM		U	RELEASED KJL	/ /	F	08/19/89
SW170	083GY	M	07/17/89	89.00	KP, TONSINA BAY	FOXL/BREAKTM	ODOR OF DIESEL	N	EUTH	07/17/89	F	08/04/89
SW171	083YL	M	07/22/89	82.00	KP, WINDY BAY	ROMAN E	"SAM"	L	RELEASED KPH	/ /	F	08/17/89
SW172	NONE	M	07/23/89	13.00	CHIGNIK, ALASKA PENINSULA	FISHERMAN,K-28	FISHERMEN FOUND W/O MOM	N	SEA WORLD	/ /	F	02/01/90
SW173	NONE	M	07/25/89	12.00	OUZINKIE, KODIAK	OUZINKE C,K-24		N	SEA WORLD	/ /	F	02/01/90
SW174	NONE	M	07/26/89	25.00	KUPREANOFF STRAITS, KODIAK	PRT LYONS,K-25	SHIPPED VIA ANCHORAGE TO SEWARD (ERA)	N	EUTH	/ /	F	08/17/89
SW175	NONE	F	07/28/89	4.50	KP, PYE ISLAND	A BIRD BOAT	FISHERMEN OBS. >1HR. W/OUT MOM.	N	JAPAN	/ /	F	02/22/90
SW176	NONE	M	07/31/89	7.12	DISCOVER BAY, SHUYAK IS. (7/30)	SUMNER ST,K-26	FOUND IN AREA W/3 DEAD OTTERS	N	JAPAN	/ /	F	02/22/90
SW177	NONE	F	08/21/89	3.80	OUZINKIE, KODIAK	A CHRISTO,K-27	"EWOK". DIED AT PT. DEFIANCE	N	D/PT DEFIANC	/ /	F	01/19/90
VA001	556BL	M	03/30/89	29.80	PWS, SMITH ISLAND	UNK	DIED AT SEA WORLD 4/10/89	H	D/SEA WORLD	03/30/89	F	04/02/89
VA002	NONE	M	03/31/89	34.00	PWS, KNIGHT ISLAND, UPPER PASS	*DANCING BEAR1		H	DECEASED	03/31/89	F	04/03/89
VA003	NONE	U	03/31/89	0.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 1		H	DECEASED	/ /	F	03/31/89

OTTER_NO	TAG	SEX	ADM_DATE	AOM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
VA004	561BL	F	03/31/89	38.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 2		H	PT DEFIANCE	03/31/89	F	04/12/89
VA005	5998L	F	03/31/89	35.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 3		H	SEA WORLD	03/31/89	F	04/02/89
VA006	557BL	F	03/31/89	28.00	PWS, ELINORE ISLAND	*CITIZEN AIRCT	DIED AT SEA WORLD 4/10/89	H	D/SEA WORLD	03/31/89	F	04/02/89
VA007	NONE	F	03/31/89	35.00	PWS, APPLEGATE ROCKS	*RHODA MAE-4		H	DECEASED	03/31/89	T	04/06/89
VA008	560BL	M	03/31/89	36.00	PWS, GREEN ISLAND	*DANCING BEAR2		H	DECEASED	04/01/89	F	04/03/89
VA009	NONE	U	04/01/89	0.00	PWS, GREEN ISLAND	*RHODA MAE- 5		H	DECEASED	/ /	F	04/01/89
VA010	560BL	U	04/01/89	35.00	PWS, GREEN ISLAND	*DANCING BR-3		H	DECEASED	04/01/89	F	04/02/89
VA011	562BL	F	04/01/89	0.00	PWS, GREEN ISLAND	*DANCING BR-4	DIED AT SEA WORLD 4/05/89	L	D/SEA WORLD	04/01/89	F	04/02/89
VA012	NONE	U	04/01/89	28.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 6		H	DECEASED	04/01/89	F	04/01/89
VA013	555BL	M	04/01/89	28.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 7		H	DECEASED	04/01/89	F	04/10/89
VA014	NONE	U	04/01/89	0.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 8		H	DECEASED	/ /	U	04/02/89
VA015	558BL	M	04/01/89	47.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 9		H	DECEASED	04/01/89	F	04/02/89
VA016	559BL	M	04/01/89	30.00	PWS, APPLEGATE ROCKS	*RHODA MAE- 10	SENT TO SEA WORLD, BUT DIED IN ANCH	H	D/ANCHORAGE	04/01/89	F	04/01/89
VA017	NONE	U	04/01/89	46.00	PWS, GREEN ISLAND	*DANCING BR-5		H	DECEASED	04/01/89	U	04/01/89
VA018	NONE	F	04/01/89	52.00	PWS, GREEN ISLAND	*DANCING BR-6		H	DECEASED	04/01/89	T	04/02/89
VA019	NONE	F	04/01/89	44.00	PWS, GREEN ISLAND	*DANCING BR-7	VERY OLD ANIMAL	H	DECEASED	04/01/89	F	04/01/89
VA020	NONE	U	04/01/89	0.00	PWS, GREEN ISLAND	*DANCING BR-8		H	DECEASED	/ /	U	04/04/89
VA021	NONE	F	04/01/89	49.00	PWS, GREEN ISLAND	*DANCING BR-9		H	DECEASED	04/01/89	U	04/04/89
VA022	567BL	U	04/01/89	38.00	PWS, GREEN ISLAND	*DANCING BR-10		H	DECEASED	04/01/89	U	04/03/89
VA023	569BL	F	04/01/89	40.00	PWS, GREEN ISLAND	*DANCING BR-11	DIED AT SEA WORLD 4/10/89, "FLUFFY"	H	D/SEA WORLD	04/01/89	F	04/02/89
VA024	552BL	M	04/01/89	41.00	PWS, GREEN ISLAND	*DANCING BR-12		H	DECEASED	04/01/89	F	04/04/89
VA025	553BL	M	04/01/89	37.00	PWS, GREEN ISLAND	*DANCING BR-13		H	DECEASED	04/02/89	F	04/03/89
VA026	565BL	F	04/01/89	32.00	PWS, GREEN ISLAND	*DANCING BR-14	"KATIE"	H	SEA WORLD	04/01/89	F	08/04/89
VA027	5548L	F	04/02/89	25.00	PWS, GREEN ISLAND	*RHODA MAE-11		H	VANCOUVER	04/01/89	F	04/17/89
VA028	563BL	F	04/02/89	35.00	PWS, GREEN ISLAND	*RHODA MAE-12		H	DECEASED	04/01/89	F	04/02/89
VA029	564BL	M	04/02/89	43.00	PWS, GREEN ISLAND	*RHODA MAE-13	RADIO IMPLANT SURGERY	H	RELEASED PWS	04/02/89	F	07/28/89
VA030	566BL	M	04/02/89	31.00	PWS, GREEN ISLAND	*RHODA MAE-14	"GYPSIE"	H	RELEASED PWS	04/01/89	F	07/28/89
VA031	ORDGR	F	04/02/89	50.00	PWS, GREEN ISLAND	*RHODA MAE-15		M	DECEASED	04/02/89	F	04/03/89
VA032	5688L	F	04/02/89	44.00	PWS, GREEN ISLAND	*DANCING BR-15	WORE 564 BROWN TAG AUG 1 "KIM"	H	RELEASED PWS	04/02/89	F	08/16/89
VA033	NONE	U	04/02/89	0.00	PWS, GREEN ISLAND	*DANCING BR-16		U	DECEASED	/ /	F	04/04/89
VA034	572BL	M	04/02/89	40.00	PWS, GREEN ISLAND	*DANCING BR-17	DIED AT VANCOUVER	H	D/VANCOUVER	04/02/89	F	04/17/89
VA035	5708L	M	04/02/89	23.00	PWS, GREEN ISLAND	*OANCING BR-18		H	DECEASED	04/02/89	F	04/09/89
VA036	571BL	F	04/02/89	52.00	PWS, GREEN ISLAND	*DOTTY G	VIA DANCING BEAR	H	SEA WORLD	04/02/89	F	08/04/89
VA037	600RD	F	04/02/89	28.00	PWS, IKTUA BAY	*VIK/SEARAKR-1	DIED AT PT. DEFIANCE 5/17/89	H	D/PTDEFIANCE	04/02/89	F	04/12/89
VA038	NONE	F	04/02/89	0.00	PWS, GREEN ISLAND	*DANCING BR-19		H	DECEASED	/ /	F	04/03/89
VA039	574BL	M	04/03/89	47.00	PWS, NW TIP GREEN IS.	*RHODA MAE- 16		M	DECEASED	04/03/89	F	04/09/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
VA040	573BL	F	04/03/89	42.00	PWS, GIBBON/GREEN IS	*RHODA MAE- 17		H	DECEASED	04/03/89	F	04/03/89
VA041	575BL	F	04/03/89	58.00	PWS, GREEN ISLAND	*RHODA MAE- 18		H	DECEASED	04/03/89	T	04/04/89
VA042	860YL	F	04/03/89	40.00	PWS, GIBBON/ GREEN IS	*RHODA MAE- 19		H	DECEASED	04/03/89	F	04/07/89
VA043	576BL	F	04/03/89	20.00	PWS, GREEN ISLAND	*RHODA MAE- 20		M	DECEASED	04/03/89	F	04/06/89
VA044	NONE	F	04/03/89	5.50	PWS, IKTUA BAY (4/2)	VIK/SEARAKR-2	PUP "ANNIE"- HAULED OUT;MOM ABANDONED	L	MONT BY AQ	/ /	F	04/13/89
VA045	595RD	F	04/04/89	44.00	PWS, IKTUA BAY, EVANS IS	VIK/SEARAKR-3		M	DECEASED	04/04/89	T	04/09/89
VA046	519OR	M	04/04/89	37.00	PWS, IKTUA BAY, EVANS IS (4/3)	VIK/SEARAKR-4	"OLIVER"	U	RELEASED PWS	04/04/89	F	08/15/89
VA047	520OR	F	04/04/89	26.00	PWS, IKTUA BAY, EVANS IS	*VIK/SEARAKR-5		L	DECEASED	04/04/89	F	04/07/89
VA048	521OR	M	04/04/89	58.00	PWS, FLEMING ISLAND	VIK/SEARAKR- 6	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/04/89	F	07/28/89
VA049	577BL	F	04/04/89	54.00	PWS, IKTUA BAY, EVANS IS	VIK/SEARAKR- 7		M	DECEASED	04/04/89	F	04/05/89
VA050	579BL	F	04/04/89	56.00	PWS, IKTUA BAY, EVANS IS	VIK/SEARAKR- 8	LACTATING	U	DECEASED	04/04/89	F	04/29/89
VA051	578BL	F	04/04/89	30.00	PWS, MUMMY BAY	*RESOLUTION		U	PT DEFIANCE	04/04/89	F	04/12/89
VA052	580BL	M	04/04/89	41.00	PWS, MUMMY BAY	*RESOLUTION		M	RELEASED PWS	04/04/89	F	08/16/89
VA053	581BL	F	04/04/89	34.00	PWS, MUMMY BAY	*RESOLUTION		H	DECEASED	04/04/89	F	04/07/89
VA054	020YL	F	04/04/89	23.00	PWS, HOGAN BY/ KNIGHT IS	DANCING BR-20		H	DECEASED	04/04/89	F	04/05/89
VA055	518SL	M	04/04/89	39.00	PWS, HOGAN BY /KNIGHT IS	VIK/SEARAKR- 9		L	DECEASED	04/04/89	F	04/08/89
VA056	019YL	M	04/04/89	46.00	PWS, HOGAN BY/ KNIGHT IS	DANCING BR-21		L	DECEASED	04/04/89	F	04/06/89
VA057	584BL	F	04/05/89	38.00	*GIBBIN ANCH, GI (4/4)	*RHODA MAE- 21		N	DECEASED	04/05/89	T	04/08/89
VA058	598RD	F	04/04/89	48.00	PWS, IKTUA BAY (4/4)	VIK/SEARAKR-10	DIED ON WASH TABLE	N	DECEASED	/ /	F	04/05/89
VA059	582BL	F	04/05/89	49.00	UNK	UNK		H	DECEASED	04/05/89	F	04/10/89
VA060	583BL	F	04/05/89	39.00	UNK	UNK		M	EUTHANIZED	04/05/89	F	04/18/89
VA061	585BL	M	04/05/89	41.00	UNK	UNK		L	RELEASED PWS	04/05/89	F	07/28/89
VA062	022YL	M	04/05/89	40.00	PWS, HOGAN BY/ KNIGHT IS	RESOLUTION	VIA DANCING BR. ESC & RETURN. RADIO IMPL	L	RELEASED PWS	04/05/89	F	07/28/89
VA063	586BL	F	04/05/89	39.00	SW HERRING BAY/KNIGHT IS	NEEVA	VIA SEA RAKER	U	DECEASED	04/05/89	F	04/14/89
VA064	NONE	F	04/05/89	0.00	SW HERRING BAY/KNIGHT IS	NEEVA	VIA SEA RAKER	U	DECEASED	/ /	F	04/06/89
VA065	587BL	M	04/05/89	40.00	UNK	UNK	PARTIAL PROLAPSED PENIS	M	EUTHANIZED	04/05/89	F	05/05/89
VA066	590RD	F	04/05/89	39.00	PWS, HERRING BAY/KNIGHT IS	VIK/SEARAKR-11	DIED ON WASH TABLE	M	DECEASED	04/05/89	T	04/05/89
VA067	589BL	M	04/05/89	43.00	UNK	UNK		U	DECEASED	04/05/89	F	04/07/89
VA068	525OR	F	04/05/89	40.00	PWS, HERRING BY/ KNIGHT IS	VIK/SEARAKR-12	RADIO IMPLANT SURGERY	H	RELEASED PWS	04/05/89	F	07/27/89
VA069	588BL	F	04/05/89	42.00	PWS, HERRING BY/ KNIGHT IS	SYLVIA ANN		M	DECEASED	04/05/89	F	04/11/89
VA070	590BL	F	04/05/89	46.00	HERRING BAY/KNIGHT IS	SEARCHER	VIA SEA RAKER	H	DECEASED	04/05/89	F	04/08/89
VA071	591BL	F	04/05/89	34.00	HERRING BAY/KNIGHT IS	SEARCHER	VIA SEA RAKER	U	DECEASED	04/05/89	F	05/08/89
VA072	558BL	F	04/05/89	41.00	PWS, HERRING BY/KNIGHT IS	VIK/SEARAKR-13	DIED AT PT. DEFIANCE 5/25/89	M	D/P DEFIANCE	04/05/89	F	04/12/89
VA073	589RD	F	04/05/89	42.00	PWS, HERRING BY/KNIGHT IS	VIK/SEARAKR-14		U	DECEASED	04/05/89	F	04/08/89
VA074	594RD	M	04/06/89	51.00	UNK	UNK		L	DECEASED	04/06/89	F	04/29/89
VA075	026YL	F	04/06/89	23.00	PWS, BAY OF ISLES/KNIGHT IS	MYRA JEAN	VIA DANCING BEAR(IN HOLD W/25)	L	DECEASED	04/06/89	F	04/07/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
					(4/5)							
VA076	024YL	F	04/06/89	42.00	PWS, SOUTH ENO KNIGHT IS (4/5)	CAPRICE	VIA DANCING BEAR	U	EUTHANIZED	04/06/89	T	04/15/89
VA077	025YL	F	04/06/89	47.00	PWS, SNUG HAR/KNIGHT IS	MYRA JEAN	VIA DANCING BEAR (IN HLD W/25)	H	DECEASED	04/06/89	T	04/07/89
VA078	592BL	F	04/06/89	45.00	UNK	UNK		H	DECEASED	04/06/89	T	04/07/89
VA079	023YL	F	04/06/89	43.00	PWS, SNUG HAR/KNIGHT IS (4/5)	DANCING BR-22	"FIESTY"	L	DECEASED	04/06/89	F	04/30/89
VA080	593BL	F	04/06/89	48.00	UNK	UNK		M	DECEASED	04/06/89	F	04/08/89
VA081	594BL	M	04/06/89	43.00	PWS, N CHENAGA BAY	BONNIE JEAN		L	EUTHANIZED	04/06/89	F	04/12/89
VA082	559RD	F	04/07/89	25.00	PWS, SW KNIGHT ISLAND	VIK/SEARAKR-15		L	VANCOUVER	/ /	F	04/17/89
VA083	NONE	M	04/06/89	8.00	PWS, N PERRY ISLAND	MISS CARROL	CAPTURED AS PUP "SCARF"	U	MONT BY A	/ /	F	04/13/89
VA084	595BL	F	04/07/89	52.00	PWS, UKN	UNK	"FATSO". ESC PORT VALDEZ BAY.	U	ESCAPED VH	04/07/89	T	07/13/89
VA085	518OR	F	04/07/89	52.00	PWS, PRINCE/WALES	VIK/SEARAKR-16		M	DECEASED	04/07/89	F	04/08/89
VA086	596BL	F	04/07/89	32.00	PWS,POWOER POINT, NW LATOUCHE IS	DOTTY G		U	RELEASED PWS	04/07/89	F	08/16/89
VA087	514OR	M	04/07/89	22.00	PWS, PRINCE/WALES	VIK/SEARAKR-17	PUP OF VA88	L	DECEASED	04/07/89	F	04/09/89
VA088	593RO	F	04/07/89	46.00	PWS, PRINCE/WALES	VIK/SEARAKR-18	MOM OF VA087	L	OECEASED	04/07/89	F	04/11/89
VA089	597BL	F	04/07/89	29.00	UNK	UNK		M	RELEASED PWS	04/07/89	F	07/27/89
VA090	563BR	M	04/07/89	37.00	PWS, IS ON W SIDE/LATOUCHE IS	DEC,AURORA OPS	RADIO FLIPPER TAG # 860	L	RELEASED SB	/ /	F	05/15/89
VA091	598BL	F	04/07/89	29.00	PWS, BAY OF ISLES/KNIGHT IS	UNK		L	VANCOUVER	04/07/89	F	04/17/89
VA092	574BL	M	04/07/89	43.00	PWS, BTWN HORSESHOE & MONT BY/LATOUCHE I	DOTTY G		H	RELEASED PWS	04/07/89	F	08/15/89
VA093	NONE	M	04/07/89	0.00	UNK	UNK		U	DECEASED	/ /	F	04/07/89
VA094	524OR	F	04/07/89	38.00	PWS, KNIGHT ISLAND	VIK/SEARAKR-19		H	DECEASED	04/07/89	T	04/07/89
VA095	600BL	M	04/08/89	31.00	UNK	UNK		L	OECEASED	04/08/89	F	04/09/89
VA096	521SV	F	04/08/89	53.00	PWS, PRINCE/WALES. DEL BY F/V CP CLEARY	VIK/SEARAKR-20	STILL BORN PUP BORN 5/6/89	L	RELEASED PWS	04/08/89	T	08/16/89
VA097	551RD	F	04/08/89	35.00	PWS, IKTUA BAY	VIK/SEARAKR-21	ESC POR VALDEZ BAY & RETURNED	U	RELEASEO PWS	04/08/89	F	07/27/89
VA098	551BL	M	04/08/89	34.00	UNK	F/V CP CLEARY		U	DECEASED	04/08/89	F	04/09/89
VA099	565RD	M	04/08/89	48.00	PWS, SHELTER BY/KNIGHT IS	VIK/SEARAKR-22		L	DECEASED	04/08/89	F	05/01/89
VA100	599RD	F	04/08/89	36.00	PWS, SAWMILL BY/EVANS IS	VIK/SEARAKR-23		M	DECEASED	04/08/89	F	04/09/89
VA101	596RD	M	04/08/89	24.00	PWS, PRINCE/WALES	VIK/SEARAKR-24	ESC PORT VAL BAY, RETURN 7/14,ESC 7/25	L	ESCAPED VH	04/08/89	F	07/25/89
VA102	515OR	F	04/08/89	28.00	PWS, PRINCE/WALES	VIK/SEARAKR-25		L	DECEASED	04/08/89	F	04/28/89
VA103	597RO	M	04/08/89	55.00	PWS, PRINCE/WALES	VIK/SEARAKR-26		L	DECEASED	04/08/89	F	04/29/89
VA104	562RD	M	04/09/89	56.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-27	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/09/89	F	07/28/89
VA105	591RD	F	04/09/89	52.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-28	RADIO FLIPPER TAG # 840	N	RELEASED SB	/ /	F	05/15/89
VA106	560RD	F	04/09/89	45.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-29	NOSE CHEWED BY VA104 IN CAPTURE NET	L	DECEASED	04/09/89	F	04/11/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
VA107	NONE	F	04/09/89	47.20	PWS,OUTSIDE MAIN BAY (4/9)	F/V GOLODRINA		L	DECEASED	04/09/89	F	04/10/89
VA108	566BR	M	04/09/89	34.00	PWS, MONTGOMERY/LATOUCHE IS	RHODA MAE-22		M	RELEASED PWS	04/09/89	F	08/15/89
VA109	NONE	M	04/09/89	46.00	PWS, SNUG H/KNIGHT IS	F/V SUR B	"BRINDLE MUZZLE"	M	DECEASED	04/09/89	F	04/13/89
VA110	NONE	F	04/09/89	36.00	PWS, SNUG H/KNIGHT IS	JIMANI		H	DECEASED	/ /	F	04/09/89
VA111	NONE	F	04/09/89	43.00	PWS, CRAB BAY	MISS JEANNE	VIA RHODA MAE	H	DECEASED	04/09/89	T	04/10/89
VA112	NONE	F	04/09/89	0.00	PWS, HERRING BY/KNIGHT IS	GROWLER		H	DECEASED	/ /	U	04/09/89
VA113	NONE	F	04/09/89	48.00	UNK	UNK	CARRIED TAG 555 WHEN DIED	M	DECEASED	04/09/89	T	04/10/89
VA114	519SV	F	04/10/89	55.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-30	VALDEZ BY BOAT,ESC PORT VALDEZ BAY.	L	ESCAPED VH	04/10/89	F	04/24/89
VA115	517OR	F	04/10/89	38.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-31	TO VALDEZ BY BOAT	L	PT DEFIANCE	04/10/89	F	04/12/89
VA116	522SV	M	04/10/89	66.00	PWS, IKTUA B/EVANS IS	VIK/SEARAKR-32	TO VALDEZ BY BOAT	L	VANCOUVER	04/10/89	F	04/17/89
VA117	600BL	M	04/11/89	62.20	PWS, SW LATOUCHE IS	DANCING BR-23		L	PT DEFIANCE	04/11/89	F	04/12/89
VA118	536SV	F	04/13/89	53.00	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-33		L	D/VANCOUVER	/ /	T	04/19/89
VA119	546SV	M	04/13/89	53.90	PWS, IKTUA BY/EVANS IS	VIK/SEARAKR-34		L	RELEASED PWS	04/13/89	F	08/16/89
VA120	510YL	F	04/13/89	29.00	PWS, EWAN BAY/DELENIA IS (4/12)	VIK/SEARAKR-35	ESC PORT VALDEZ BAY & RETURNED	L	RELEASED PWS	04/13/89	F	08/16/89
VA121	NONE	M	04/13/89	27.50	PWS, INGOT IS *	*CITIZEN AIRCR	(PERSONAL COMM W/ PILOT)	N	DECEASED	/ /	F	04/14/89
VA122	596BR	M	04/13/89	74.10	PWS, BAY OF ISLES/KNIGHT IS (4/11)	DANCING BR-24	RADIO FLIPPER TAG# 750 "WHITEFACE"	N	RELEASED SB	/ /	F	05/15/89
VA123	597BR	M	04/15/89	40.70	KP, NATOA ISLAND.(VIA BOAT)	BREAKTIME-2	RADIO IMPLANT SURGERY "LAZARUS"	L	RELEASED PWS	04/15/89	F	07/28/89
VA124	556BR	M	04/15/89	41.70	KP, NATOA IS, VERDANT IS,BEACH(VIA HELI)	BREAKTIME-1	RADIO FLIPPER TAG # 930	L	RELEASED SB	04/16/89	F	05/15/89
VA125	960GY	F	04/16/89	35.60	PWS, HORSESHOE BY/LATOUCHE IS (4/15)	VIK/SEARAKR-36	RADIO FLIPPER TAG#870	L	RELEASED SB	04/16/89	F	05/15/89
VA126	964GY	F	04/16/89	46.00	PWS,2 MI N HORSESHOE BY/L. I. (4/15)	SEARAKR-37	HAULED OUT, EMACIATED "BROWNIE"	M	SEA WORLD	04/16/89	F	08/04/89
VA127	577RD	F	04/16/89	43.00	PWS, NW SQUIRE I	SEARAKR-38	GAVE BIRTH TO VA142P	H	RELEASED PWS	04/16/89	T	08/15/89
VA128	956GY	F	04/17/89	41.90	PWS, HERRING BY/KNIGHT IS	VIKING-39	VERY THIN, PREGNANT?	L	RELEASED PWS	04/17/89	F	08/15/89
VA129	957GY	F	04/17/89	44.10	PWS, SE HERRING BY	SEARAKR-40	RADIO FLIPPER #650, "LUCKY"	M	RELEASED SB	04/17/89	F	05/15/89
VA130	599BR	M	04/17/89	43.40	KP, NATOA ISLAND (4/17)	BREAKTIME-3	SEWARD VIA COYOTE II,VIA HELI, RADIO IMP	M	RELEASED PWS	04/17/89	F	07/28/89
VA131	567BR	F	04/17/89	37.70	PWS, GIBBON ANC/GREEN IS	DANCING BR-25	ESC PORT VALDEZ BAY	L	ESCAPED VH	04/17/89	F	07/13/89
VA132	574BR	F	04/17/89	42.60	PWS,OUTSIDE GIBBON ANC/GREEN IS	LADY GRACE	VIA DANCING BEAR	H	SEA WORLD	04/17/89	T	08/04/89
VA133	598BR	M	04/18/89	39.00	KP, NATOA ISLAND (4/17)	BREAKTIME-4	TO SEWARD VIA SHAWDOW	L	RELEASED PWS	04/18/89	F	07/28/89
VA134	570BR	M	04/18/89	45.90	KP, NATOA ISLAND	BREAKTIME-5	TO SEWARD VIA FWS/VORC VIA HUEE	M	DECEASED	04/18/89	F	04/29/89

OTTER_NO	TAG	SEX	ADM_DATE	ADM_WT	CAP_LOC	CAP_BOAT	COMMENT	OIL	STATUS	WASH_DATE	PREG	FINAL_DISP
VA135	555BR	F	04/19/89	48.70	PWS, MARSHA BAY/KNIGHT IS	DANCING BR-26		H	DECEASED	04/19/89	F	04/23/89
VA136	573RD	M	04/19/89	67.00	PWS, ORCA INLET/CORDOVA	LOCAL RESIDENT	NOT OIL SPILL RELATED. "SLUGGO"	N	DECEASED	/ /	F	04/27/89
VA137	572BR	M	04/20/89	48.90	PWS, CRAB BAY, EVANS ISLAND	RHODA MAE- 23	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/20/89	F	07/28/89
VA138	559BR	M	04/20/89	49.70	PWS, CRAB BAY, EVANS ISLAND	RHODA MAE- 24	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/20/89	F	07/28/89
VA139	560BR	M	04/20/89	50.90	PWS, CRAB BAY, EVANS ISLAND	RHODA MAE- 25	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/20/89	F	07/28/89
VA140	562BR	M	04/20/89	50.00	PWS, CRAB BAY, EVANS ISLAND	RHODA MAE- 26	RADIO IMPLANT SURGERY	L	RELEASED PWS	04/20/89	F	07/28/89
VA141	561	F	04/20/89	64.40	PWS, CRAB BAY, EVANS ISLAND	RHODA MAE- 27		L	DECEASED	04/20/89	T	04/20/89
VA142P	PUP	F	04/22/89	2.50	BORN AT VORC 4/22	UNK	PUP OF VA127; BORN 4/22/89	N	DECEASED	/ /	F	04/24/89
VA143	576BR	F	04/22/89	16.00	PWS, ELRINGTON PASSAGE	RHODA MAE- 28	OR FROM SILVER BULLET	M	RELEASED PWS	/ /	F	08/16/89
VA144	575BR	M	04/22/89	62.00	PWS, NEW CHENEGA HARBOR	RHODA MAE- 29		L	RELEASED PWS	/ /	F	08/15/89
VA145	541GY	F	04/27/89	31.00	KP, TONSINA BAY (NOT ASSIGNED H#)	BREAKTIME- 7	TO HOMER BY KATCHAMAK AIR. RADIO IMPLANT	L	RELEASED PWS	04/27/89	F	07/27/89
VA146	539SV	M	04/27/89	31.50	KP, HARDOVER PT/NUKA IS (NO H#)	BREAKTIME- B	TO HOMER BY KATCHAMAK AIR. RADIO IMPLANT	L	RELEASED PWS	04/27/89	F	07/28/89
VA147	PUP	F	04/27/89	3.00	KP, PORT GRAHAM (4/26)	UNK	(HOMER H-2)"ADDY".TRANSFERRED TO SORC	N	DECEASED	/ /	F	05/17/89
VA148	579BR	M	04/29/89	44.50	PWS, BANBRIDGE IS (4/28)	RHODA MAE- 30	RADIO IMPLANT SURGERY	L	RELEASED PWS	05/01/89	F	08/16/89
VA149	580BR	F	04/29/89	49.80	KP, TONSINA BAY (4/28)	MYSTIC LADY-1	TO SEWARD DIRECT. ESC PORT VALDEZ BAY	M	ESCAPED VH	04/29/89	T	07/13/89
VA150	581BR	F	04/29/89	38.80	KP, TONSINA BAY (4/28)	MYSTIC LADY-2	TO SEWARD DIRECT. RADIO IMPLANT SURGERY	L	RELEASED PWS	/ /	F	08/16/89
VA151	582BR	F	04/29/89	53.10	KP, TONSINA BAY (4/29)	MYSTIC LADY-3	(H-3)KATCH AIR. ESC/RETURN,MOM OF VA154P	L	RELEASED PWS	/ /	T	08/15/89
VA152	587RD	M	04/29/89	34.20	KP, BERGER BAY (4/28)	FOXY LADY	HOMER (H-5), KAT. AIR SER. RADIO IMPLANT	H	RELEASED PWS	04/29/89	F	07/28/89
VA153	583BR	F	04/29/89	62.20	KP, TONSINA BAY (4/29)	MYSTIC LADY-4	HOMER (H-4), KATCHAMAK AIR SERVICE	L	RELEASED PWS	04/29/89	T	08/15/89
VA154P	PUP	F	05/03/89	2.50	BORN AT VORC		PUP OF VA151; BORN 5/3/89	N	DECEASED	/ /	F	05/04/89
VA155V	595RD	M	05/06/89	72.00	VALDEZ HARBOR	"VOLUNTEERED"	ROGUE, RADIO FLIPPER TAG #580	N	RELEASED SB	/ /	F	05/15/89
VA156	NONE	F	05/29/89	44.00	LITTLE BAY/KNIGHT IS	PT. STEEL	VIA RHODA MAE	N	DECEASED	/ /	T	05/29/89

Appendix 7. Blood collection and laboratory protocol

Blood Collection and Analyses for Sea Otters

SUPPLIES: 5 ml and 12 ml syringes; 19 - 21 gauge x 1" needles; 2 ml lavender top (EDTA) blood collection tubes; 5 ml grey top (potassium oxalate) blood collection tubes; 10 ml red top (clot) blood collection tubes

PROTOCOL:

1. Labeling: Include animal's identification number, date and time of day on all tubes and specimen containers.

2. Collection: One lavender top and two red top tubes should be collected each time blood is taken from an animal. In addition, one grey top tube should be collected when an animal is admitted to the rehabilitation facility and prior to release. Draw blood samples on deceased animals when possible. Blood samples should be refrigerated or placed on ice until processing.

3. Processing:

Lavender Top Tube: Remove needles from syringes and rubber caps from the collection tubes. Slowly place 2 ml of whole blood into the tube. Recap and gently rotate tube for 30 seconds.

This sample is used for the following analyses:

Hematocrit	White blood cell count
Blood glucose	Sedimentation rate
Blood urea nitrogen	Serum color
Total protein	

Blood used to determine sedimentation rates can be reused for clinical blood chemistries. Return blood from the sedimentation rate tube to the lavender top tube (this tube should contain at least 0.5 ml). Refrigerate.

Red Top Tube (non-separator type): Collect two tubes if possible. Do not rotate. Allow at least 90 minutes or more for clotting. Centrifuge for 20 minutes, decant serum into a clean tube, label, and refrigerate.

Serum not used immediately should be subdivided into plastic vials and frozen for future analyses. (Note that the effects of freezing on these analyses should be taken into account.) Use a tuberculin syringe to measure 0.2 ml aliquots. The tuberculin syringe can be used as a sample container if small plastic vials are not available. Serum should be stored in the following proportions:

Serum Analysis	Volume of Serum
Serum Chemistry	1.25 ml
Serology	0.2 ml
Distemper Titers	0.2 ml
Electrophoresis (freeze)	0.2 ml

Blood clots: Clots can be frozen in the original red top tubes for toxicology. However, the rubber top must be wrapped in tin foil, and the tube frozen in an upright position.

Grey Top Tube: During collection place 3-4 ml of whole blood in a grey top tube. Transfer and store in acid washed jars with teflon lids (i.e. I-chem Jar). Freeze until analysis.

Appendix 8. Sea otter pup formula

Sea otter pup formula

From Julie Hymer (Monterey Bay Aquarium) as modified at the Seward rehabilitation center

4 oz. finely chopped clams (geoduck fillets)
4 oz. squid (skin and guts removed)
100 ml dextrose 5%
100 ml Lactated Ringer's solution
200 ml. whipping cream
2 ml Hi Vite™
1 tsp. dicalcium phosphate
2 ml cod liver oil
1 tsp. bran

Blend thoroughly, adding squid and fluids first, then cream and clams. Mix fresh daily and keep refrigerated at all times.

Appendix 9. Essential equipment and supplies for the sea otter pup nursery

Sea otter pup nursery: equipment and supplies

water supply - sea water plus hot and cold fresh water
1 waterbed mattress (no heater) with plywood frame
2 bathing tubs
1 refrigerator
1 blender
hot plate or microwave oven and pans
(for heating water bath for formula)
kitchen utensils (measuring cups and spoons)
plastic bowls (2 x 2 qt., 2 x 4 to 8 oz.)
paper towels
bath towels
scale - 0 to 15 lbs
(accurate for grams or fractions of ounces)
nasal bulb aspirator
combs and grooming tools
night light
clipboards, pens and log sheets

formula supplies	-lactated ringers	-20 cc syringes
	-5 % dextrose	-6 cc syringes
	-Pedialyte™	-feeding catheters
	-cod liver oil	-Hi Vite™
	-dical phos powder	-bran supplement
medical supplies	-TB syringes	-20 g needles
	-latex exam gloves	-emergency drug kit
	-rectal thermometer	- alcohol bottle