A SIMULATED TRANSLOCATION OF SEA OTTERS, ENHYDRA LUTRIS, WITH A REVIEW OF CAPTURE, TRANSPORT AND HOLDING TECHNIQUES

RESOURCES AGENCY
CALIFORNIA
DEPARTMENT
FISH & GAME

by

JACK A. AMES
ROBERT A. HARDY
and
FREDERICH E. WENDELL

MARINE RESOURCES
TECHNICAL REPORT NO. 52 1986

CALIFORNIA DEPARTMENT OF FISH AND GAME
MARINE RESOURCES TECHNICAL REPORTS

****

Marine Resources Technical Reports are research documents by Department personnel that are of sufficient importance to be preserved, but which for some reason are not appropriate for primary scientific publication. No restriction is placed on subject matter.

These Reports may be cited in publication. The material in these Reports may eventually appear in the primary scientific literature.

Inquiries concerning the Reports should be directed to The Editor, Marine Resources Division, Department of Fish and Game, 1301 West 12th St., Long Beach, California 90813.

A SIMULATED TRANSLOCATION OF SEA OTTERS, *ENHYDRA LUTRIS*, WITH A REVIEW OF CAPTURE, TRANSPORT AND HOLDING TECHNIQUES

by

Jack A. Ames
Robert A. Hardy
and
Frederich E. Wendell

MARINE RESOURCES TECHNICAL REPORT NO. 52
California Department of Fish and Game

1986

This report should be cited as follows:

Ames, J.A., R.A. Hardy, and F.E. Wendell. 1986. A simulated translocation of sea otters, *Enhydra lutris*, with a review of capture, transport and holding techniques. Calif. Dept. Fish and Game, Mar. Res. Tech. Rep. No. 52, 17 p.

ABSTRACT

A number of techniques and pieces of equipment judged necessary for the translocation of sea otters were field tested. Captures were accomplished with either a scuba diver operated capture device (Wilson trap), a surface set tangle net or a dip net. A portable floating pen proved very satisfactory for simultaneously holding at least ten otters for several days. Commercially available pet transport kennels, with the capability of holding water, were adequate for maintaining the otter's pelage in good condition during a transport of approximately five hours duration. Subsequent observations indicated no apparent stress related dispersal.

A SIMULATED TRANSLOCATION OF SEA OTTERS, <u>ENHYDRA LUTRIS</u>, WITH A REVIEW OF CAPTURE, TRANSPORT AND HOLDING TECHNIQUES

TABLE OF CONTENTS

ACKNOWLEDGMENTS

The following people participated in this project or otherwise helped produce this report: Sandy Ames, Alan Baker, Suzanne Benech, Bill Clark, Earl Ebert, Dennis Eimoto, Ellen Faurot, Lisa Ferm, Mark Flippo, Dan Gotshall, Brian Hatfield, Jim Hardwick, Kristine Henderson, Robert Hofman, Robert Lea, Bob McAllister, John Mello, Christine Ribic, Dave Rose, Leslie Smith, Jerome Spratt, Steve Webster and Tom Williams. Karl Schneider, ADFG, provided us with an unpublished manuscript from which we obtained many useful suggestions and most of the Alaskan data for 1965 through 1972. Monterey Bay Aquarium and Hopkins Marine Station allowed us beach access and camping privileges during the Monterey experiment. This project was partially supported by section six funds pursuant to the Endangered Species Act through interagency agreement with the USFWS.

To those listed above as well as those we may have inadvertently overlooked, we offer thanks.

INTRODUCTION

Background

The California population of sea otters, Enhydra lutris, has been fully protected by state and federal law since the early 1900's. Under this protection, the small remnant population of sea otters expanded its numbers and range. Passage of the federal Marine Mammal Protection Act (MMPA) in 1972 and the designation of this population as threatened under the Endangered Species Act (ESA) in January 1977 provided additional protection. Under the auspices of the MMPA and ESA, both state and federal regulatory and research activities on sea otters in California were directed toward the protection and recovery of the population.

Justification for the 1977 threatened determination was based on the detrimental impact a major oil spill could have on the sea otter population in California (Federal Register 1977). The potential impact was considered significant because of the relatively small size of the population and its reduced range. This possible threat to the existing sea otter population would be decreased by establishing a second viable population at some geographically removed location.

The development of the equipment and techniques necessary to capture and translocate sea otters has had a relatively short history. Russian scientists in the 1930's began experimenting with the husbandry of sea otters. In 1937, they successfully transported two otters (seven otters died early in the experiment) approximately 9000 km aboard ship and train (Barabash-Nikiforov et al. 1947).

U. S. scientists began similar efforts to develop capture and holding techniques early in the 1950's. In 1951, 35 otters were captured and held in shallow mud-bottom ponds at Amchitka Island, Alaska. All died within days apparently from fouling of their fur and resulting pathological conditions (Kenyon and Spencer 1960).

Observations on the physiology of captive otters were conducted at Amchitka in 1954 (Kirkpatrick et al. 1955; Stulken and Kirkpatrick 1955). It was concluded that captive otters were dying of gastrointestinal problems associated with acute stress precipitated by insufficient food and unsuitable environmental conditions.

Three otters were transported by boat on dry bedding from Amchitka to Seattle in 1954. Upon arrival, the soiled fur of the three otters required many days of near constant attention by keepers before it regained a healthy, waterproof state. However, the animals all died shortly after air shipment to Washington, D. C. (Kenyon and Spencer 1960).

Similarly, translocation attempts in 1955, 1956, 1957 and 1958 were almost totally unsuccessful. During that period 50 sea otters were captured for transplant. Twelve died during capture or in holding facilities, and 35 died of hyperthermia (overheating) during transport or of hypothermia (chilling) shortly following release. Three animals survived trips from Amchitka to Seattle; one survived for approximately a week, one for approximately a year and one for more than 10 years. None of the 38 animals transported were transported in water (Kenyon and Spencer 1960).

In 1959 ten otters were captured, seven of which were held captive for up to two weeks. To prevent some anticipated problems with overheating and high altitude transport, the seven were flown to the Pribilof Islands in a dry, cool (48 to 49° F) environment. The flight was 4.3 h with a maximum altitude of 600 m. Although this was felt to be the first "successful" transplant of sea otters, a population was not established. It was suggested that seven animals (four females and three males) were too few to form a breeding population (Kenyon 1969). Promozine hydrochloride was reported as a "useful tranquilizer to speed the adjustment to captivity of nervous sea otters" (Kenyon and Spencer 1960).

During transplant operations from 1965 through 1972 the Alaska Department of Fish and Game (ADFG) captured 1065 sea otters (16 others escaped or were released at capture) and transplanted 714 to no fewer than ten sites in British Columbia, Washington, Oregon, and within Alaska. Three hundred fifty-one died during these operations; 137 during capture operations, 151 in holding pens and 63 in transit. Prior to 1965, researchers in Alaska, using dip nets, had captured only hauled-out otters. ADFG then modified techniques of Russian fur hunters and scientists using floating tangle nets to capture otters. Methods to reduce the relatively high mortality rate (13% in nets and 33% overall) were not vigorously pursued by ADFG because the loss of animals did not seriously interfere with the objective of establishing additional populations. Also, the state of Alaska was harvesting sea otters at the same time and otters that died in transplant operations were simply used to meet harvest quotas. Other significant methodological innovations made during this period included wet cage transport (which greatly reduced transport mortality) and the routine use of an anti-stress drug, dexamethazone (Karl Schneider, ADFG, pers. commun.). Battelle Memorial Institute researchers also noticed improved survival of severely stressed captive otters after administering a similar steroid, prednisolone, in combination with a large dose of penicillin (Wright 1971). In addition, ADFG also occasionally used tranquilizers, including acepromazine and propiopromazine hydrochloride. Floating holding pens were also developed and used in Alaska during the sixties. These pens greatly reduced the cost of adequate holding facilities since pumping large volumes of water became unnecessary (Wright 1971; Schneider 1973 and Schneider pers. commun.). In recent years inexpensive floating pens have been rigged in empty boat slips in marinas (Schneider pers. commun.).

The California Department of Fish and Game (CDFG) captured 29 sea otters in floating gill nets in 1969 and 1970. Five animals were tagged and released on site and four drowned during capture. Seventeen were successfully transported 72 km from Cambria to Big Creek where they were released. Three were transported approximately 300 km to Stanford Research Institute's facility in Coyote Hills, California, where they survived from two weeks to nine months (Odemar and Wilson 1969).

The development of a scuba diver operated capture device (Wilson trap) by CDFG in the early 1970's provided a method which virtually eliminated capture mortality. Between 1971 and 1984 over 300 otters were captured using this device, with one mortality (Wild and Ames 1974; Loughlin 1980;

Dan Costa, University of California at Santa Cruz, pers. commun.; Ribic 1980 and 1982; Pastorok and Bigham 1983).

Since 1978, many juvenile sea otters have been captured using a dip net from a small boat. This method was utilized by the United States Fish and Wildlife Service (USFWS) in California and very recently in Alaska by researchers from the University of Minnesota (UOM) (Ron Jameson, USFWS, pers. commun.; Don Siniff, UOM, pers. commun.).

Between 1972 and 1984 Sea World and Scripps Institution of Oceanography (SIO), in cooperation with CDFG, transported a total of 21 sea otters from Monterey to San Diego with no mortality (Jim Antrim, Sea World, pers. commun.; Gerald Kooyman, SIO, pers. commun.). In recent years, many sea otters have been successfully transported on a bed of crushed ice, or on a screen over crushed ice with water sprayers on hand to rinse away feces and urine (John Nightingale, formerly with Seattle Aquarium, pers. commun.; Pastorok and Bigham 1983; Schneider pers. commun.).

This Study

With the above as background, CDFG in 1979 conducted the following experiments to test selected equipment and techniques that will facilitate a sea otter translocation in California if one is undertaken. Fifteen sea otters were captured and maintained in two floating holding pens (one near Monterey, California and one near Port San Luis, California) for three to five days. The five otters from Monterey were then transferred to individual transport containers and transported for approximately five h. They were then returned to the floating pen, held overnight and observed for possible ill effects of the "trip". All were released near the sites of capture.

MATERIALS AND METHODS

Methods Of Capture

Wilson Trap

The Wilson trap (developed by Ken Wilson, CDFG) is a scuba diver operated sea otter capture device. This device consists of an aluminum pipe frame 76 cm in diameter by 80 cm deep (2.5-cm diameter pipe). The frame supports a net bag (a modified salmon landing replacement net, 76 cm in average diameter by 1.2 m deep; size 9-PR, Lininger Co.) with a mouth that may be closed by pulling a pursing line (Figure 1). The device is positioned under a resting or grooming otter by two scuba divers, and as they push it up around the otter, the net is pursed. This technique is generally used only in water with visibility greater than 2 m, and with a surface canopy of kelp. A recent modification of the trap utilizes a diver propulsion vehicle (DPV MK-III, Farallon Industries), which enables a single diver to manipulate the trap through the water. (Any reference to trade names or manufacturers does not imply endorsement by the CDFG).

Tangle Net

Sea otters were also captured during these studies in two loosely hung floating tangle nets (gill nets) approximately 100 m in length, patterned

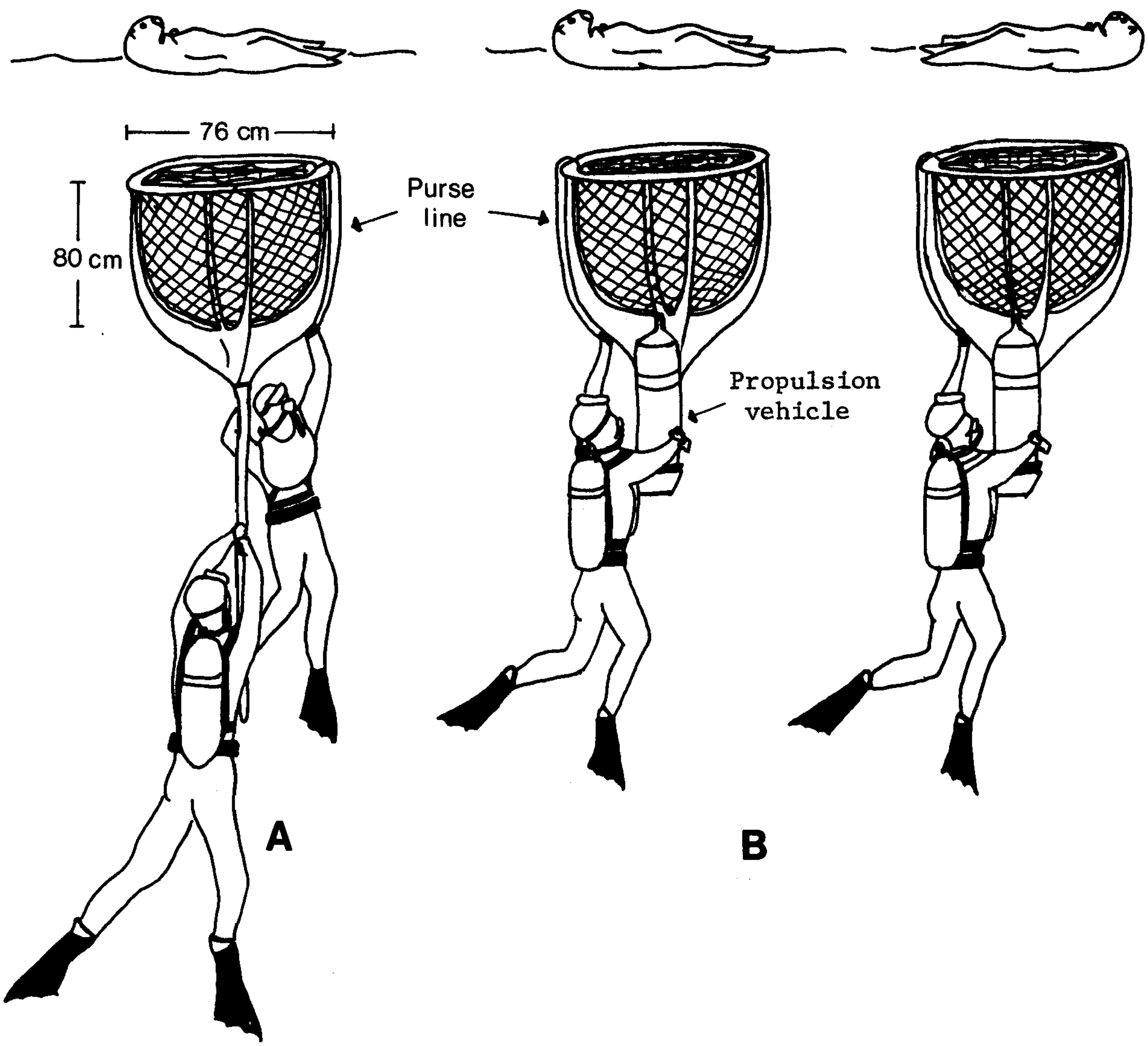

FIGURE 1. A) Wilson Trap in traditional two-diver capture configuration. As the divers push the trap up around a resting otter, the draw string is pulled, closing the opening of the net. B) In a recent modification, a diver propulsion vehicle is attached in a way which allows a single diver to manipulate the trap. This configuration will allow teams of divers to attempt simultaneous captures.

after those used by ADFG in Alaska and USFWS in Alaska and California. These nets had lead lines that were very lightly weighted, (most similar nets constructed for this purpose utilize only a sinking rope, with no weights, for a lead line) to minimize the effort necessary for a tangled animal to remain afloat. The cork line was constructed of self-floating polyfoam core line. Floatation was enhanced and net tangling minimized by using ten evenly spaced 20-cm diameter rigid plastic floats (Figure 2). These floats were too large to drop through the net meshes, eliminating some of the tangling experienced when smaller floats were used. The

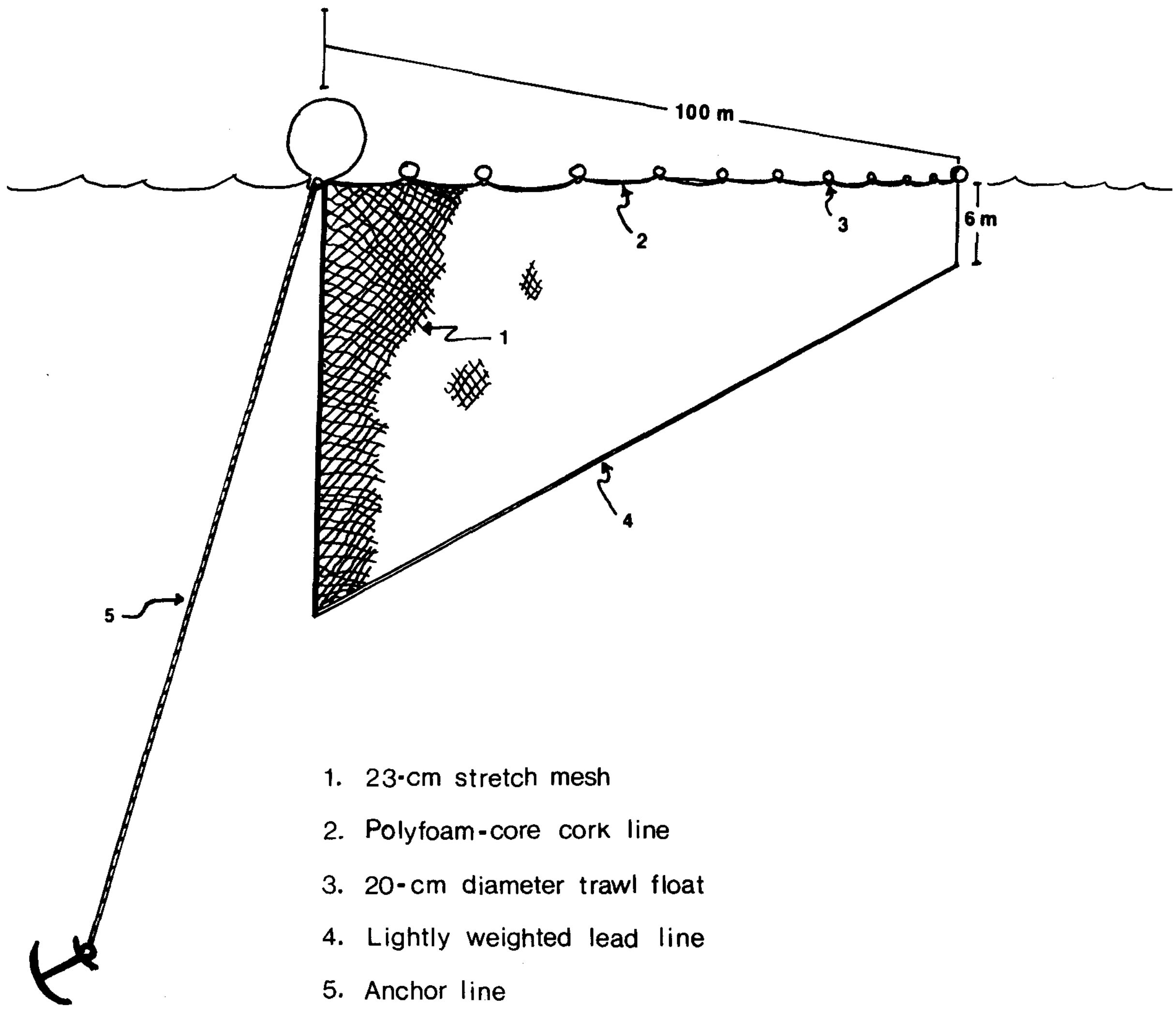

FIGURE 2. A tangle net. Otters become entangled when they attempt to swim through the loosely hung webbing.

multifiliment netting was dyed green, had a 23-cm mesh size (stretch measure) of number 12 size nylon twine and was 30 meshes deep (approximately 6 m). The nets were set at the surface and left overnight near an otter rafting site or along likely travel routes. Tangled animals were approached in a boat, restrained if necessary with a Katch All pole (Figure 3), and injected with an anesthetic (see Anesthetics). After allowing time for the anesthetic to take effect, immobilized otters were removed from the net, usually by cutting of one or two meshes of netting.

Dip Net

With a technique recently developed by the USFWS in California (Ron Jameson, USFWS, pers. commun.) we also captured one small (probably recently weaned) otter with a modified dip net. The dip net consisted of a handle approximately 1.5 m in length made of double shaft aluminum with a titanium reinforced tip to which a flexible 1.9-cm thick by approximately 1.8-m circumference pentagonally shaped hoop was attached

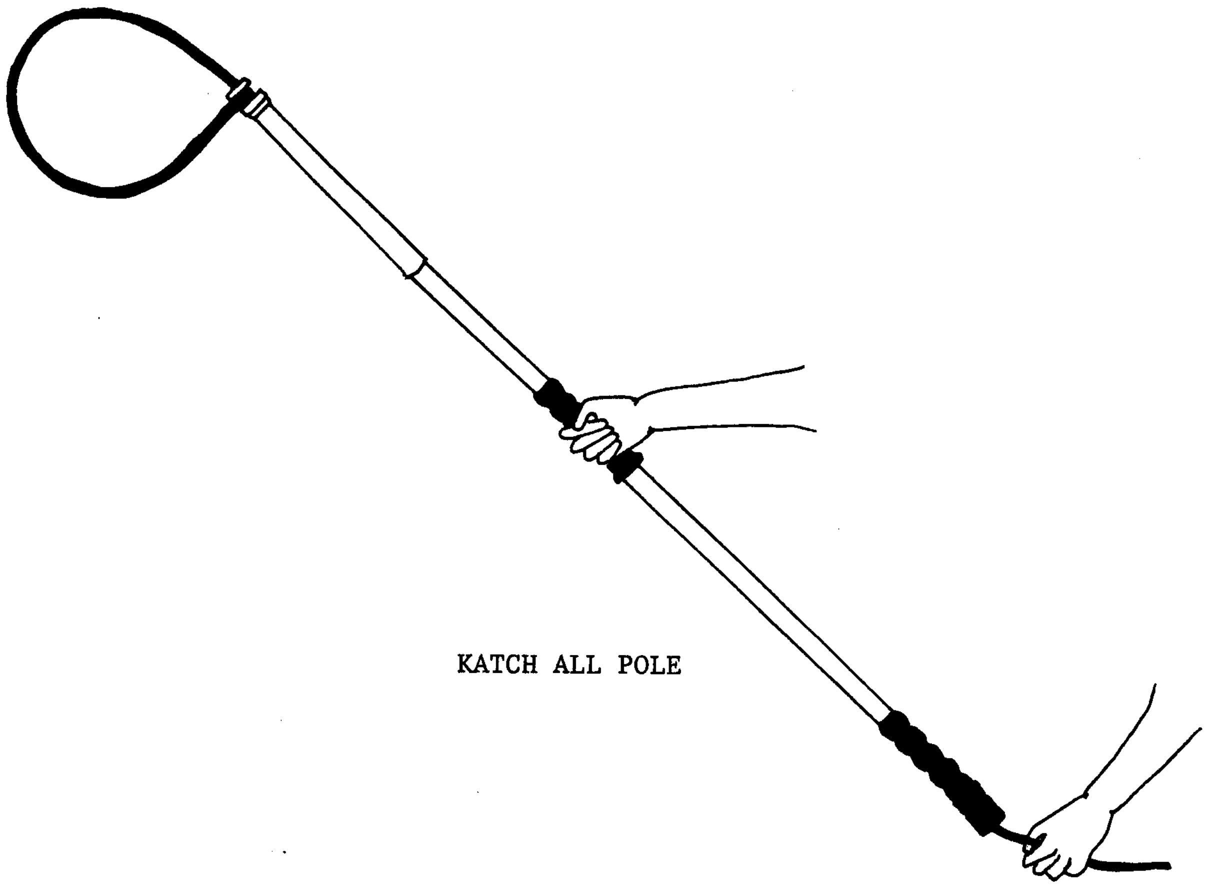

FIGURE 3. The noose at the end of the pole is placed around the head of a tangled otter and tightened, helping to restrain it for injection of anesthetic.

(Penta Net, Furman Diversified). The net attached to the hoop was a replacement salmon landing net 76 cm in average diameter by 1.2 m deep (size 9-PR, Lininger Co.). The net was equipped with a pursing line which extended along the handle. The net was attached to the hoop by tape which allowed us to separate the net from the hoop when it was pursed (Figure 4).

Anesthetics

Following capture each sea otter was weighed on a spring scale. A combination of fentanyl (.05 to .09 mg per kg of body weight) and azaperone (.2 to .4 mg per kg of body weight) was then used to anesthetize the otters (Williams et al. 1981). The fentanyl and azaperone were injected together using a single hand-held 1-ml syringe, and were usually diluted with .2 cc of sterile water to insure that significant portions of the active drugs did not remain in the syringe. In addition, 2 to 4 mg of

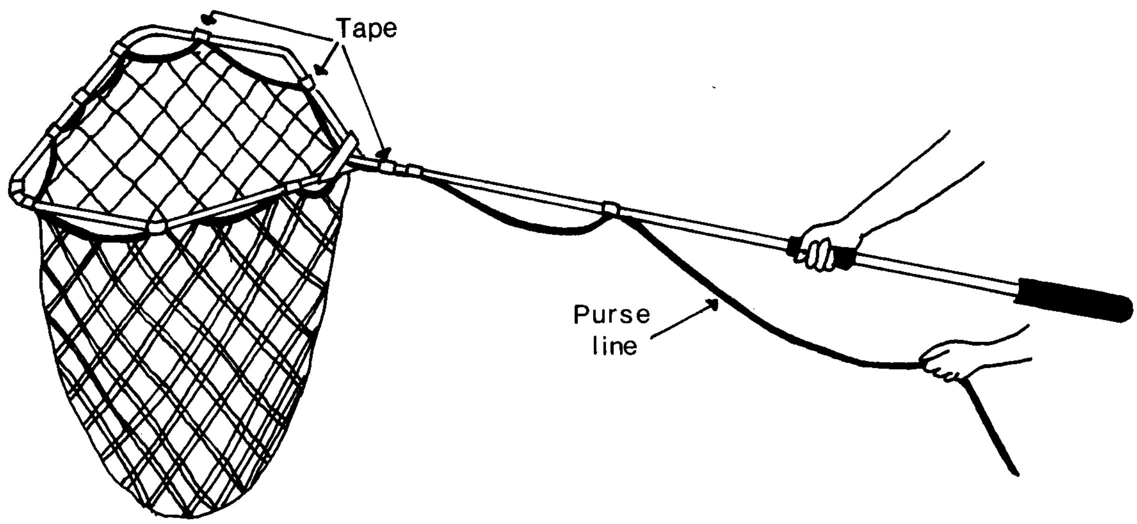

FIGURE 4. A breakaway dip net. As an otter is netted, the purse line is pulled, breaking the tape and closing the net as it is detached from the hoop.

diazepam (Valium, Roche Laboratories) was occasionally administered to alleviate convulsions in anesthetized animals. In previous experiments otters have been successfully anesthetized using etorphine mixed with diazepam (Williams and Kocher 1978).

While anesthetized, all animals were flipper tagged with solid colored plastic tags and ear tagged with small monel tags to insure individual identification (Ames et al. 1983). Additionally, five of the animals captured and held in the Port San Luis area had small radio transmitters bolted across the middle digit of one hind foot (Ribic 1980 and 1982). All animals retained in the Monterey area had approximately 20 ml of blood taken from a femoral vein as part of a blood parameter baseline study (Williams and Pulley 1983). The blood work also helped ensure the selection of healthy test animals.

Holding Pens

We constructed two portable floating holding pens following a basic design used in Alaska by Seattle Aquarium personnel (Nightingale et al. 1978). Our pens were 3.7 m square by 1.8 m deep, and were constructed of 3.2-cm (1 1/4-in.) diameter schedule 40 aluminum tubing (Figure 5). Eight of the perimeter pipes and two of the cross pipes were left in 3.7-m lengths for maximum strength. The remaining pipes were cut in 1.8-m lengths. The fittings were standard aluminum railing fittings (Hollaender Mfg. Co.) and consisted of eight side-outlet ell's, eight side-outlet tee's and two side-outlet crosses. The set screws standard with these fittings were discarded. All pipes were precision drilled and stainless steel bolts were used to anchor pipes to fittings. Floatation was provided by four 43-cm by 30-cm by 2.4-m pieces (logs) of polystyrene foam (Floatation Logs, Henderson Marine Supply). These logs were sandwiched between two pieces of 1.3-cm (1/2-in.) fiber-glass-resin coated, exterior grade

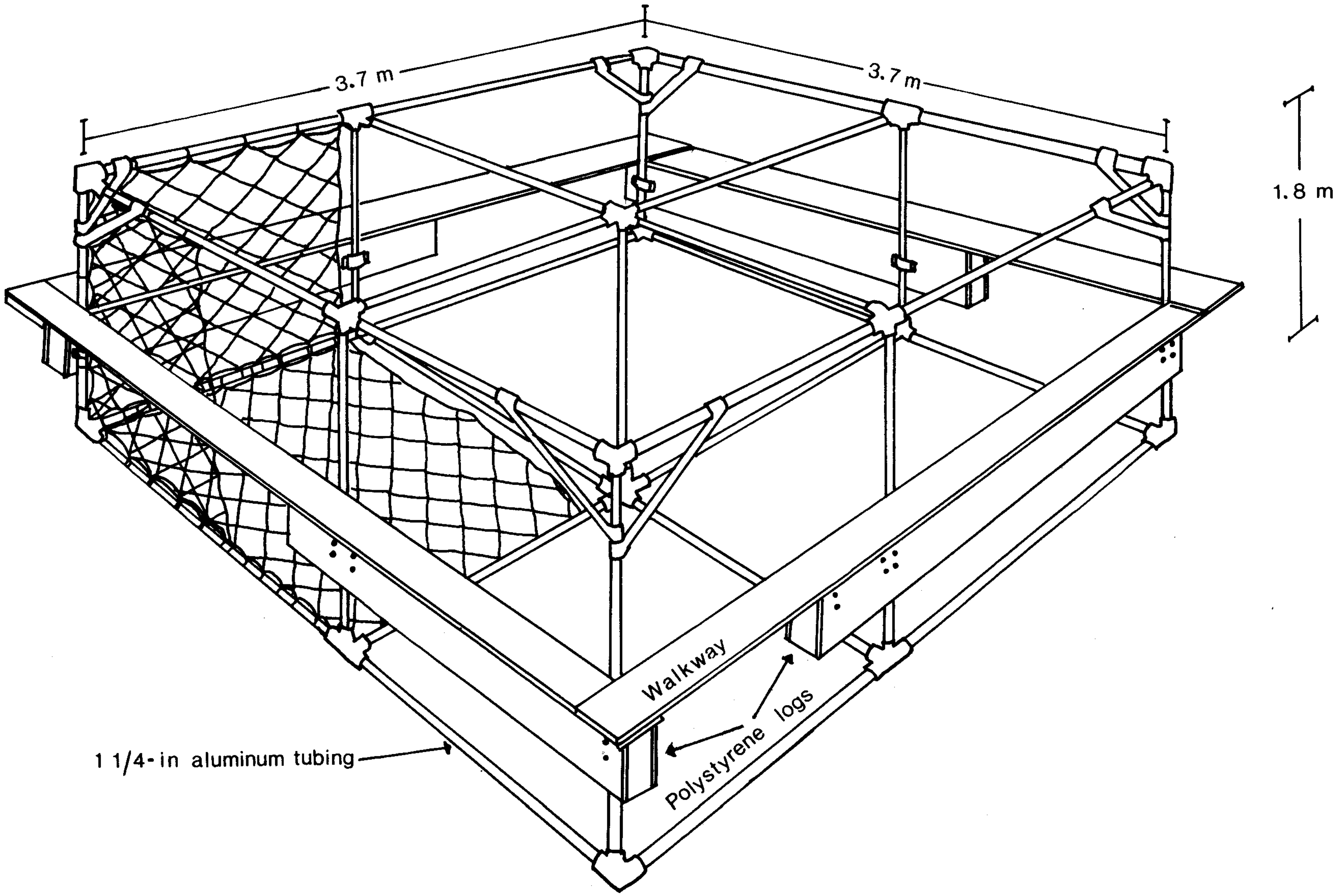

FIGURE 5. Floating holding pen. Heavy netting (9 cm stretch measure) is attached to the sides and bottom of the pen frame. (Netting is shown only in one corner).

plywood and attached to the sides of the pen with two square base wall flanges. The adjustable wall flanges were set so that approximately 1.2 m of the pen was above the water line and .6 m below. Additional floatation was provided by filling the submerged portions of pipe with foam (Froth Pak Kit, Insta-foam Products Inc.). Four additional 1.9-cm (3/4-in.) by 30-cm by 2.4-m pieces of fiber-glass-resin coated plywood were placed to join one floatation log to the next to form a walkway around the entire pen. Very heavy (approximately 168 size nylon twine) 9-cm mesh size (stretch measure) webbing was cut and sewn to form the walls and the floor of the pen. This was then laced to the inside of the pen frame to form a taut net liner. The pens were anchored from all four corners.

Food

Food provided to captive otters consisted of frozen squid, *Loligo opalescens*, frozen black abalone, *Haliotis cracherodii*; live rock crab, *Cancer antennarius*; fresh gaper clam, *Tresus nuttallii*; and fresh Washington clam, *Saxidomus nuttallii*. Food was placed in the pen at least three times per day, usually until it began to accumulate on the bottom of the pen.

Transport Cages

Commercially available plastic pet transport kennels were used to hold individual otters during transport (number three Vari-Kennels, Doskocil Mfg. Co.). The kennels were approximately 50 cm wide by 70 cm long by 60 cm deep and held approximately 5 cm of water. Some were modified with a plastic dam across the front which allowed about 10 cm of water to be held. Clean fresh water was carried in five-gallon plastic buckets and was used to replace fouled water. Crushed ice was added to cage water to help prevent overheating.

Follow-up Observations

Upon release animals were observed periodically with binoculars and spotting scopes to help assess whether the period of captivity and/or transport had been detrimental to them.

RESULTS

Monterey Experiment

Location and Number of Animals

A protected cove and adjacent beach within the Hopkins Marine Reserve, approximately 2 km north of Monterey harbor, was selected as the site to erect and anchor our floating pen for the Monterey experiment (Figure 6). Eight sea otters (five females and three males) were captured (seven using the Wilson trap and one using the dip net) from October 31 through November 2, 1979 between the Monterey breakwater and Point Pinos. All were apparently independent animals weighing between 11.3 and 28.1 kg. The first male caught, an older adult, and all five females caught were tagged and placed in the holding pen. Continuous monitoring of the otters was maintained during the period of captivity. The second and third males

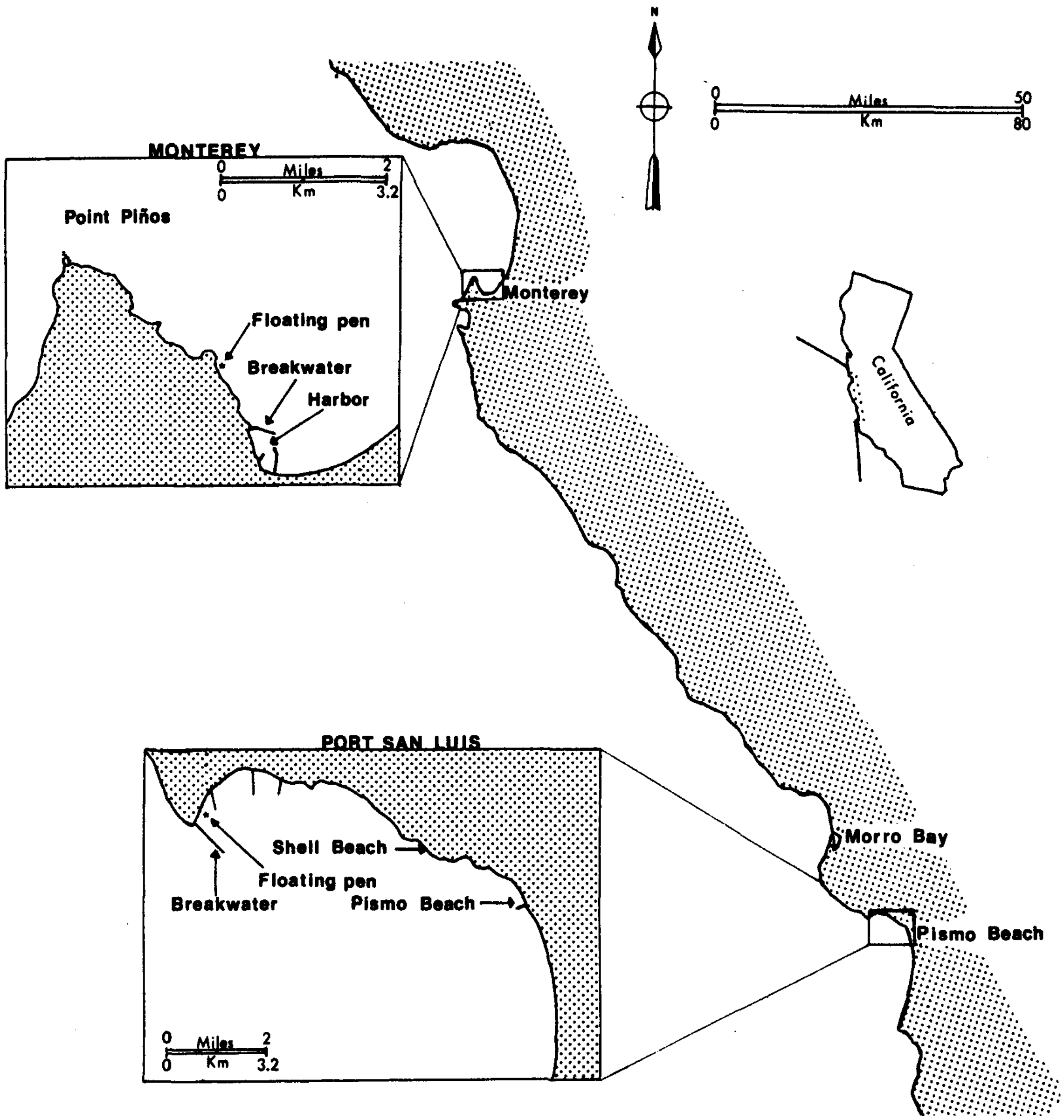

FIGURE 6. Locations of floating pens.

captured were tagged and released since we thought that more than one male in an enclosure with females would lead to fighting. Indeed, during the first three days otters were held captive, a non-captive ("free") male repeatedly fought with the captive male through the nylon mesh. By the third day the captive male had received noticeable bite marks on his snout and one eyelid, became lethargic and quit eating. He was transferred from the floating pen to a transport cage, treated by a veterinarian and released. (He survived and was observed occasionally for several years after this incident). The " free" male otter frequented the pen area throughout the remainder of the experiment, particularly during feeding times. No agressive behavior, however, was noted toward any of the captive females. Many attempts to capture this male with the dip net were unsuccessful.

Simulated Translocation

The simulated translocation was conducted after all five otters had been held at least three days. A dip net was used to transfer otters into individual transport cages. The caged individuals were transported two km by boat to the Monterey harbor area and transferred into an air-conditioned van. Before loading the cages into the transport vehicle, each cage was rinsed out and fresh water was added to a depth of about five cm. (Fresh water is preferable in transport vehicles due to the rust problems inherent with spilled salt water). After transporting the otters through the streets of Monterey, Seaside and Pacific Grove they were returned by boat to the holding pen. The total time the otters were out of the floating pen and maintained in the transport cages was approximately five h. During transport the air temperature in the van was maintained between 67 and 70° F (20° C.). Crushed ice was added to the water in the cages to help prevent the otters from overheating. No food was offered for five h before transfer to the individual cages, yet each animal defecated twice during the five h simulated transport. The first defecation occurred 6 h 50 min after the feeding period and the last defecation occurred 9 h 25 min after feeding.

After the sea otters were returned to the holding pen they were held overnight (approximately 15 h) to allow them time to adjust from the possible stress of the "trip". All animals were fed abalone and squid immediately upon return to the floating pen. Each was observed to eat, but the volume consumed by each otter was not assessed. During and after the feeding period each otter spent considerable time grooming. The grooming bout following the simulated trip appeared to be more vigorous and thorough than those previously observed in the pen. Due to a variety of constraints, a systematic assessment of individual behavior within the holding pen was not attempted. The captive sea otters were released one at a time the following morning to maximize daylight observation time. Each was observed for as long as possible to determine initial reaction to release. All seemed quite calm and no obviously unusual post-release activity was noted. For example, two of the otters were observed resting in a kelp bed within one-half km of the holding pen less than one h after release.

Follow-up Observations

Although continuous observations of each individual were not made, two of the otters were observed in the immediate capture area during the first three days following release. The other three were observed within three km of their capture area. One of the study animals was observed dead approximately six days after release. Although there was evidence of trauma associated with breeding, the decomposed state of the carcass at the time of the necropsy did not allow definitive identification of the cause of death (the carcass remained on the beach for more than two weeks before being reported to us). One of the remaining four females was found dead on Manresa State Beach, 40 km north of the release site, ten months after release. She had been observed frequently within four km of the release site for over nine months. All other sea otters (including the male who was released early) were observed on numerous occasions for more than two years within a nine-km area that included the release site.

Port San Luis Experiment

Location and Number of Animals

A protected area at the southern end of the sea otter range, just inside the Port San Luis breakwater (Figure 6), was selected for the second holding pen experiment. Twenty-four otters from the peripheral male group were captured in a kelp bed offshore from Shell Beach (approximately 4 km north of the Pismo Beach pier) from November 28 through December 2, 1979. All animals were captured using floating gill nets, and were apparently independent animals, weighing between 15.4 and 34.9 kg. Ten of the captured otters, all caught during an 18 h period, were transported 6.5 km from the capture site to the holding pen. Four of the sea otters were held a total of five days and the remaining six were held four days. These ten were released on the same day.

Follow-up Observations

No obvious aberrant behavior was noted upon release among any of the ten animals held in the floating pen. One animal, however, which was tagged and immediately released at the capture site, died very shortly afterwards. This death was attributed to bite wounds received from a larger otter entangled nearby, and was possibly aggravated by the stress of capture handling and anesthesia. The decomposing carcass of this sea otter was found on a nearby beach four days after release.

All ten of the experimental animals released at Port San Luis returned to the capture area and were periodically observed rafting there for at least six months. One of these animals was frequently resighted for 15 months in the Shell Beach area. He was then observed approximately 100 km to the north, but one month later had returned to Shell Beach.

In addition to the plastic flipper tags placed on all captured individuals, five of the otters had a radio transmitter placed on one flipper (Ribic 1980 and 1982). The radio transmitters not only enhanced our abilities to locate tagged otters, but allowed documentation of nighttime foraging along Pismo and Oceano beaches, 10 to 13 km south of the rafting site.

DISCUSSION

Equipment and Techniques

All three capture techniques employed during these experiments worked well. Mortality associated with fighting between tangled otters in gill nets could be reduced or eliminated by setting nets only in the daytime and/or continuously checking them. However, in many situations continuous nighttime checking would be very difficult. Although past gill net captures by ADFG in Alaska resulted in relatively high mortality (13% dead in nets), recent gill net captures in Alaska and California by USFWS, CDFG, UOM and SIO have resulted in very few mortalities (Schneider, ADFG, pers. commun.; Johnson and Jameson, USFWS, pers. commun.; Costa, formerly SIO, pers. commun.; Siniff, UOM, pers. commun.). Although we used number 12 nylon twine size in our floating gill nets with success, we would suggest using slightly stronger twine (number 15) to possibly cut down on the number of otters that break free. Capture mortality using the Wilson trap has been virtually zero and it is expected that the mortality rate associated with dip net captures would be similar.

Based on several years' experience, average catch rates have been about equal for tangle nets and the Wilson trap. We have only made two captures with dip nets, but based on other researchers' experiences, comparable or higher catch rates with dip nets are expected (Jameson, pers. commun. and Siniff, pers. commun.). There are situations where each of these techniques would be preferred over the others. The best catch rates with tangle nets would be expected in areas of high sea otter density. The Wilson trap works well in all areas with kelp canopies, but requires good underwater visibility. Use of the Wilson trap also allows some choice in selecting individuals for capture. Use of the dip net also allows some selectivity and works well for catching young animals (Jameson, pers. commun.; Siniff, pers. commun.).

The floating pens used in these experiments worked particularly well. Disassembled they were easily portable and could be erected and moored within two to three h. These floating pens were largely self-cleaning. Food debris that did collect on the bottom was easily removed using a dipnet from the walkway around the pen. No otter escaped nor was one observed close to escaping. No otters were observed injuring themselves on any part of the pen. We did not provide a haul-out area in the floating pens, but the design would permit easy construction of one surrounding the center post. Although we experienced only minor mooring problems, we would anticipate difficulties maintaining these pens in swells or wind waves more than .5 m in height. The mooring problems we experienced could be alleviated through the use of Danforth anchors approximately 10 kg in weight with 10 to 15 m of .64-cm (1/4-in.) chain and enough line to provide adequate scope for the anchors to hold.

Water in the bottom of the transport cages possibly facilitated thermoregulation and diluted feces and urine quickly, thereby reducing fur fouling. ADFG concluded that there appeared to be a beneficial psychological effect on otters transported in even a small amount of water (Schneider, pers. commun.). Sufficient water to allow normal grooming would be desirable; however, having a large quantity of water is not practical in portable transport cages, nor in the motor vehicle used for transport. The method employed to replace fouled water with clean water during the transport phase of this study appeared to work adequately. Other methods of evacuating fouled water (e.g. pumping) would perhaps cause the animals less stress than tipping the cage to pour out waste water. We would suggest replacing, where possible, the wire mesh in the transport cages with line or net which would reduce the potential for damage to the otter's teeth.

Food was not offered during the five h prior to transport in an attempt to minimize cage cleaning requirements. We thought five h was adequate time for food to be digested and eliminated, since gut transit time of approximately three h has been reported for sea otters (Kirkpatrick *et al.* 1955; Stulken and Kirkpatrick 1955). We noted gut transit times of 6.8 to 9.4 h (some food may have been eliminated in the first five h following feeding that we did not observe). Since we noted these gut transit times, it appears that it would not be advisable to subject captives to the additional stress of withholding food prior to transport in an attempt to reduce defecating in transport cages.

To facilitate handling captured animals and reduce the chance of injury, otters were routinely anesthetized. Williams et al. (1981) found the combination of fentanyl and azaperone to be satisfactory for producing a workable anesthetized condition with no serious side affects. We encountered a few mild cases of convulsions which were successfully treated with injections of diazepam.

We did not regularly administer antibiotics, anti-stress or tranquilizing drugs in these experiments (other than during anesthesia). However, the improved survival noted by others using such drugs in the past suggests that routine use or use in selected instances might be a prudent practice (Kenyon and Spencer 1960; Wright 1971; Schneider, pers. commun.). If a sedative and/or anti-stress drug was administered, particularly if it could be given without handling the animal (e.g. when mixed with food), it might lessen the overall stress of captivity.

Behaviors Relevant to Transplants

Fighting

No fighting was observed among the captives at either location in these experiments. However, reported fights, apparent fighting wounds on carcasses and reported territorial behavior led us to suspect that having more than one male in the pen with females would lead to fighting (Jud Vandevere, pers. commun.; Loughlin 1977; Morejohn et al. 1975). We released two males rather than place them in the pen with another male and the females. Fighting between the captive male and a male outside the floating pen in Monterey gave credence to our suspicions. Follow up observations of the captive male indicated that he was not an actively breeding animal. It may have been that the "free" male was the resident breeding or territorial male in the area where we moored the floating pen, thus leading to the observed fighting behavior.

Dispersal

Although we question the way numbers of otters released were compared to numbers of otters later counted as a measure of dispersal, it is reported that there has been rapid initial dispersal following several previous sea otter transplants (Jameson et al. 1982). Sea otters in this experiment were subjected to all the stresses associated with a transplant, but released into familiar habitat. Since they did not disperse, we suggest that the main reason for dispersal in transplants is release into unfamiliar surroundings. Schneider (pers. commun.) has suggested, moreover, that transplanted sea otters for unknown reasons sometimes do not stay in what appears to be ideal habitat, and eventually congregate in a spot of their choice often several miles distant from the release site. Whatever the dispersal mechanism, the potential of holding otters in floating pens at the release site to reduce initial dispersal tendencies (and insure healthy pelage) should be considered.

Other Behaviors of Interest

During both holding pen experiments a variety of vocalizations, some very loud, were made by most or all of the captive otters. In addition to cries like those of a mother or pup, we also recorded "chirping" and "cooing" sounds that we had not heard before. Other than mother and pup cries, vocalizations by otters in the wild have seldom been heard by observers.

Another unusual behavior noted in the holding pens was the pairing of otters in three instances. Physical contact was maintained almost continuously for up to five days in male-male and female-female pairs. This behavior was not noted during follow-up observations of these sea otters.

Summary

In summary, we believe that equipment and techniques similar to those tested in this study will have insignificant, if any, detrimental effect on the health of sea otters and therefore will work well for a translocation.

REFERENCES

Ames, J. A., R. A. Hardy and F. E. Wendell. 1983. Tagging materials and methods for sea otters, Enhydra lutris. Calif. Fish and Game 69(4):243-252.

Barabash-Nikiforov, I. I .,V. V. Reshetkin and N. K. Shidlovskaya. 1947. The sea otter (Kalan). Transl. from Russian by A. Birron and Z. S. Cole, 1962. Natl. Sci. Found. and U. S. Dept. Int., Washington, D.C. (Israel Program for Sc. Transl.). 277 p.

Federal Register, 1977. Determination that the southern sea otter is a threatened species. 42(10):2965-2968.

Jameson, R. J., K. W. Kenyon, A. M. Johnson and H. M. Wight. 1982. History and status of translocated sea otter populations in North America. Wildl. Soc. Bull. 10(2):100-107.

Kenyon, K. W. 1969. The sea otter in the Eastern Pacific Ocean. U. S. Bur. Sport Fish. and Wildl., North American Fauna, No.68, 352 p.

Kenyon, K. W. and D. L. Spencer. 1960. Sea otter population and transplant studies in Alaska, 1959. U. S. Dept. of Int. Fish and Wildl. Service. Special Sci. Rep.-Wildl. No. 48, 29 p.

Kirkpatrick, C. M., D. E. Stulken and R. D. Jones, Jr. 1955. Notes on captive sea otters. Arctic 8: 46-59.

Loughlin, T. R. 1977. Activity patterns, habitat partitioning, and grooming behavior of the sea otter, Enhydra lutris, in California. Ph.D. dissert., Univ. of Calif., Los Angeles. 110 p.

------. 1980. Home range and territoriality of sea otters near Monterey, California. J. Wildl. Manage. 44(3):576-582.

Morejohn, G. V., J. A. Ames and D. B. Lewis. 1975. Post mortem studies of sea otters, Enhydra lutris, in California. Resources Agency, Calif. Fish Game, Mar. Res. Tech. Rep. 30, 81 p.

Nightingale, J., J. Styers and K. G. Hewlett. 1978. The design and evaluation of a portable otter pen holding system. Seattle Aquar. Tech. Rept. No. 4: 1-3.

Odemar, M. W., and K. C. Wilson. 1969. Results of sea otter capture, tagging and transporting operations by the California Department of Fish and Game, p. 73-79. In: Sixth Ann. Conf. on Biol. Sonar and Diving Mammals, Stanford Res. Inst., Menlo Park, Calif., Proc.: 1-113.

Pastorok, R. A. and G. N. Bigham. 1983. Cleaning and rehabilitation of oiled sea otters. Draft final report TC-3746, prepared for Western Oil And Gas Assoc. 70 p.

Ribic, C. A. 1980. Fall movements and activity patterns of sea otters, Enhydra lutris, in California. M. S. Thesis, Univ. of Minnesota, Minneapolis, Minnesota. 124 p.

------. 1982. Autumn movement and home range of sea otters in California. J. Wildl. Manage. 46(3):795-801.

Schneider, K. B. 1973. Sea otter transplant. Alaska Fish and Game. 6(2): 2-3.

Stulken, D. E., and C. M. Kirkpatrick. 1955. Physiological investigations of captive mortality in the sea otter, Enhydra lutris. No. Amer. Wildl. Conf., Trans. (20): 476-494.

Wild, P. W., and J. A. Ames. 1974. A report on the sea otter, Enhydra lutris, in California. Resources Agency, Calif. Dept. Fish Game, Mar. Res. Tech. Rept. No. 20, 93 p.

Williams, T. D. and F. H. Kocher. 1978. Comparison of anesthetic agents in the sea otter. J. of Amer. Vet. Med. Assoc. 44(3): 1127-1130.

Williams, T. D. and L. T. Pulley. 1983. Hematology and blood chemistry in the sea otter, (Enhydra lutris). J. of Wildl. Disease 19(1): 44-47.

Williams, T. D., A. L. Williams, and D. B. Siniff. 1981. Fentanyl and azaperone produced neuroleptanalgesia in the sea otter (Enhydra lutris). J. of Wildl. Disease. 17(3): 337-342.

Wright, R. A. 1971. Sea otter studies during "Milrow". Amchitka Bioenvironmental Program, Final Progress Report. Batelle Memorial Institute. 16 p.