Procedures and Rationale for Marking Sea Otters Captured and Treated During the T/V *Exxon Valdez* Oil Spill

by

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ABSTRACT.—Four methods were used for marking sea otters (*Enhydra lutris*) captured and treated during the response to the T/V *Exxon Valdez* oil spill. Colored and numbered flipper tags were placed on each sea otter that was brought to the otter treatment centers. These tags allowed individual recognition and permitted the tracking of individuals through the treatment and holding processes. Recovery of tagged carcasses may provide a crude measure of the fates of rehabilitated otters. Seven sea otters were instrumented with radio transmitters attached to flipper tags as part of a pilot release program. The results of that study were inconclusive. Forty-five sea otters were implanted with radio transmitters as part of a study to assess the fate of rehabilitated sea otters. Specific objectives of the study include estimating survival rates and monitoring the reproductive success of the sample of rehabilitated sea otters and comparing the results with similar variables in a control population. Transponder chips were injected in the perianal region of all but seven of the instrumented sea otters, and all were tagged with red flipper tags. The advantages and disadvantages of each type of tag are discussed.

More than 400 sea otters (*Enhydra lutris*) were captured during the response to the T/V *Exxon Valdez* oil spill; 358 of these otters were brought to otter rehabilitation centers in Valdez and Seward. The treatment and rehabilitation processes and the long-term postrelease monitoring efforts required different marking and tagging techniques. Four marking techniques, all in wide use on free-ranging sea otters in Alaska and California, were used in the otter rehabilitation centers: flipper tags, flipper-tag radio transmitters, implantable radio transmitters, and transponder chips. We describe the marking techniques used on sea otters during the oil spill response, describe the rationale behind using the various tags, and discuss the advantages and disadvantages of each tag.

Tag Description, Methodology, and Rationale

Flipper Tags

The large numbers of sea otters that were captured, treated, and released from the otter centers necessitated a tagging system that permitted the tracking of individuals through the rehabilitation process. The tags also needed to be readily available and easy to apply. Flipper tags have been used on sea otters since the mid-1970's. The tag in common use on sea otters is a cattle ear tag manufactured by the Temple Tag Company in Temple, Texas. The tags, usually referred to as Temple tags, are made of durable plastic and come in many colors. They can be imprinted with unique combinations of letters and numbers.

Flipper tags are applied to the interdigital webbing of the hind flippers. The tags are applied by punching a hole in the webbing with a leather punch and inserting the tag through the hole. Predrilling the tag and affixing it with a brass screw through the top of the tag and the post may increase tag retention. By using a variety of colors and varying the placement of the tags between various digits, a large number of combinations are available to permit individual recognition from a distance (Jameson 1989). Because of the large numbers of sea otters that were captured and treated, it was not possible to release each otter with a unique color and placement combination. However, each sea otter was released with a uniquely numbered tag that was color-coded by otter center; gold for the Jakolof Pre-Release Facility (JPRF) and gray for the Valdez Otter Rehabilitation Center (VORC). Unfortunately, sea otters from the Seward Otter Rehabilitation Center (SORC) were released with a variety of colors. Gray and gold tags, although not ideal for viewing from a distance, were selected to avoid confusion with ongoing studies of free-ranging sea otters.

Transponder Chips

The transponder chip or PIT (passive integrated transponder) tag is a small, biologically inert, battery-free tag that is now in use as a permanent identifier for free-ranging sea otters (Thomas et al. 1987; R. J. Jameson, U.S. Fish and Wildlife Service, San Simeon, California, personal communication). All but seven of the sea otters that were implanted with radio transmitters were marked with transponder chips.

PIT tags are about 10 × 2 mm and have a cylindrical glass casing. They consist of a transponder and an integrated circuit. The tag is powered by a 400-kHz radio signal emitted from a hand-held transmitter. When activated by being passed close to the transmitter, the PIT tag transmits a 10-digit code at 50 kHz. The transmission is detected by the transmitter, which sends it through a cable to the reader, which is a self-contained unit that displays the code number of the tag on an LCD display. The PIT tag does not require an internal power source and has an unlimited lifespan.

Application of the PIT tag is relatively simple. The tag is inserted subcutaneously in the perianal region of a restrained sea otter with a sterile 12-gauge needle.

Flipper Tag Transmitters

Radio transmitters have been used on sea otters since the mid-1970's. Early radiotelemetry studies used transmitters attached to collars (Loughlin 1979), but collars caused several deaths or were removed by the otters. Garshelis and Garshelis (1984) and Ribic (1982a,b) used radio transmitters attached to the hind flippers, but these sometimes lead to tears in the interdigital webbing or even broken toes (Garshelis and Siniff 1983). In 1987, experiments in Alaska were undertaken using a new generation of transmitters for attachment to the interdigital webbing of the hind flippers (DeGange, unpublished data; C. W. Monnett and L. M. Rotterman, Prince William Sound Science Center, Cordova, Alaska, unpublished data). Those transmitters were small enough to cement to standard flipper tags and light enough not to cause the degree of trauma associated with earlier transmitters.

The flipper tag transmitters (manufactured by Advanced Telemetry Systems of Isanti, Minnesota) measure about 2.5 × 1.3 × 0.6 cm. They are equipped with an internal, coiled antenna that is potted as a unit with the battery and circuitry. The transmitters are powered by a 3.5-V lithium battery that provides a maximum operating life of 60 days. The transmitter plus the flipper tag on which it is cemented weigh about 15 g; they are attached to the sea otter in the same way as flipper tags.

The flipper tag transmitters were used as the principal marking device in a pilot release program for sea otters treated during the oil spill response. The primary objective of the study was to determine if sea otters released near Cordova in water

unaffected by the oil spill remained there or returned to the affected habitats from which they were captured. The U.S. Fish and Wildlife Service was operating on the assumption that it was better to release sea otters in clean waters adjacent to the spill zone rather than translocate them extremely long distances. The operating plan was to track the sea otters for 30 days and use the information to guide the release of other rehabilitated sea otters.

One moderately oiled, three lightly oiled, and two unoiled sea otters, all captured after the oil spill and held at VORC, were instrumented and released near Cordova on 15–16 May. The release group was composed of three male and three female otters. A male sea otter from Port Valdez, who became a nuisance around the otter holding center, was also instrumented, moved to the Cordova area, and released as part of that effort. Only two of the sea otters were relocated throughout the 30-day monitoring period. Unfortunately, the results of the study were inconclusive, partly as a result of limitations in transmitter capabilities and performance (Monnett et al. 1990).

Implanted Radio Transmitters

One of the most controversial aspects of the response to the oil spill was the decision by Service personnel to implant radio transmitters in a sample of sea otters to monitor their fate after release into the wild. Implantation of radio transmitters is the preferred method of instrumentation for mustelids such as mink (Eagle et al. 1984), river otters (Melquist and Hornhocker 1983), and sea otters (Garshelis and Siniff 1983; Williams and Siniff 1983). Implanted transmitters do not restrict movements, are not manipulated by the animal, and in sea otters, do not limit the animals' ability to groom. Implantable transmitters were first used on sea otters in Alaska in 1982 (Garshelis and Siniff 1983; Williams and Siniff 1983). As long as the transmitters are implanted intraperitoneally, there seems to be no adverse effects (Ralls et al. 1989; Monnett and Rotterman, unpublished data).

Instrumentation of sea otters in this study was done as part of the natural resource damage assessment (Stieglitz 1990). The two principal objectives of the study were to monitor the movements of a sample of instrumented sea otters for 20 days after release and to use that information to guide later releases of sea otters and to determine the fate of sea otters that underwent oiling, treatment, holding, and release over a 2-year postrelease period. The specific hypotheses for the study were that survival of rehabilitated sea otters does not differ significantly from survival of free-ranging sea otters that were not affected by the oil spill, reproductive rates of rehabilitated sea otters do not differ significantly from reproductive rates of females that were not affected by the oil spill, and survival of rehabilitated sea otters that reenter oiled areas does not differ significantly from rehabilitated sea otters that remain in oil-free areas.

Forty-five sea otters were selected for instrumentation (Table). The sample size was the minimum allowable for statistical validity but still adequate to fill a balanced design of 15 animals from each center (Valdez, Seward, and Jakolof). The intention was to focus the study on females. As instrumentation proceeded, the design was modified in response to the changing availability of animals. Principal criteria for selection of sea otters included sex, capture or location, and degree of oiling; however, the otter's health became the ultimate criterion. The health of each candidate otter was evaluated by a team of 3 or 4 veterinarians, which included R. Haebler, the Federal on-scene veterinary pathologist; T. D. Williams, who developed the surgical protocol for transmitter implantation; C. R. McCormick, the chief veterinarian at SORC, and R. Wilson, the chief veterinarian at VORC. The appearance of the otters, their clinical histories, and their blood hematology and chemistry profiles were used to evaluate health. A number of candidate otters were rejected by the veterinary panel. Two other factors further eroded the original candidate list of sea otters: the unauthorized release of otters from VORC and JPRF, and the discovery of herpes-like oral lesions in sea otters, at SORC (see Harris et al. 1990). These factors contributed to the instrumentation of a group of rehabilitated sea otters that in terms of sex composition, otter treatment center from which they originated, and degree of oiling were different than originally intended.

Implantable transmitters were designed and constructed by Cedar Creek Bioelectronics Laboratory in Bethel, Minnesota. They measured about 7.6 × 5 × 2.5 cm and weighed about 120 g. The lithium batteries were MIREL T cells supplied by Promeon Division of MEDTRONIC Inc., in Haverhill, Massachusetts. These batteries are designed for long-life applications. The use of thionyl chloride as the cathode material provides the peak current capacity required of the transmitters. The transmitters were encapsulated in Scotchcast #5

Table. *Capture location, capture date, degree of oiling, and sex of rehabilitated sea otters* (Enhydra lutris) *instrumented and released in Prince William Sound (PWS).*

Otter number	Sex[a]	Capture Region	Capture location	Otter center[b]	Degree of oiling
V-029	M	PWS	Green Island	VORC	High
V-048	M	PWS	Fleming Island	VORC	Low
V-062	M	PWS	Hogan Bay	VORC	Low
V-068	F	PWS	Herring Bay	VORC	High
V-104	M	PWS	Iktua Bay	VORC	Low
V-123	M	Kenai Peninsula	Natoa Island	VORC	Low
V-130	M	Kenai Peninsula	Natoa Island	VORC	Medium
V-137	M	PWS	Crab Bay	VORC	Low
V-138	M	PWS	Crab Bay	VORC	Low
V-139	M	PWS	Crab Bay	VORC	Low
V-140	M	PWS	Crab Bay	VORC	Low
V-145	F	Kenai Peninsula	Tonsina Bay	VORC	Low
V-146	M	Kenai Peninsula	Nuka Bay	VORC	Low
V-148	M	Kenai Peninsula	Windy Bay	VORC	Low
V-150	F	Kenai Peninsula	Tonsina Bay	VORC	Low
V-152	M	Kenai Peninsula	Berger Bay	VORC	High
S-002	F	Kenai Peninsula	Tonsina Bay	VORC	None
S-003	F	Kenai Peninsula	Tonsina Bay	JPRF	None
S-006	F	Kenai Peninsula	Tonsina Bay	JPRF	Low
S-007	F	Kenai Peninsula	Tonsina Bay	JPRF	Low
S-015	F	Kenai Peninsula	Bootleg Bay	VORC	Low
S-017	F	Kenai Peninsula	Bootleg Bay	VORC	Medium
S-035	F	Kenai Peninsula	Windy Bay	VORC	Unknown
S-038	M	Kenai Peninsula	Windy Bay	JPRF	Medium
S-043	F	Kenai Peninsula	Taylor Bay	SORC	Low
S-044	M	Kenai Peninsula	Taylor Bay	JPRF	Low
S-045	F	Kenai Peninsula	Picnic Harbor	VORC	None
S-080	F	Kenai Peninsula	Rocky Bay	JPRF	Medium
S-053	F	Kenai Peninsula	Windy Bay	JPRF	Low
S-054	F	Kenai Peninsula	Windy Bay	JPRF	Medium
S-057	F	Kenai Peninsula	Natoa Island	JPRF	Medium
S-059	F	Kenai Peninsula	Windy Bay	VORC	Unknown
S-060	F	Kenai Peninsula	Windy Bay	SORC	Low
S-068	F	Kenai Peninsula	Rocky Bay	VORC	Low
S-069	F	Kenai Peninsula	Rocky Bay	JPRF	Medium
S-114	M	Kodiak	Kodiak Island	JPRF	Medium
S-122	M	Kodiak	Kupreanof Strait	JPRF	Low
S-124	F	Kenai Peninsula	Rocky Bay	SORC	Low
S-128	F	Kenai Peninsula	Rocky Bay	SORC	Low
S-146	F	Kenai Peninsula	Windy Bay	SORC	Low
S-152	M	Kenai Peninsula	Windy Bay	SORC	Low
S-155	F	Kenai Peninsula	Rocky Bay	SORC	Medium
S-157	F	Kenai Peninsula	Rocky Bay	SORC	Low
S-161	F	Kenai Peninsula	Tonsina Bay	SORC	Low
S-162	F	Kenai Peninsula	Tonsina Bay	SORC	Low

[a] M = male and F = female.
[b] VORC = Valdez Otter Rehabilitation Center, JPRF = Jakolof Pre-Release Facility, and SORC = Seward Otter Rehabilitation Center.

and coated with Medadhere, a medical-grade urethane. All the transmitters were gas-sterilized and stored in sealed plastic bags until implanted.

Before surgery, the otters were immobilized with a combination of fentanyl citrate, valium, and azaperone (Williams et al. 1981). Surgeries were performed in a protected area adjacent to the otter holding areas by either T. D. Williams or C. R. McCormick. The surgical procedures have been described in detail elsewhere (Williams and Siniff 1983), with the exception that all transmitters were left free-floating in the body cavity. The surgical procedure lasted about 30 min for each sea otter. After the procedure was completed, chemical immobilization was reversed using naloxone hydrochloride. Otters were held a minimum of 6 days in the otter centers before release.

Discussion

The four marking methods used on sea otters captured during the response to the oil spill are useful depending on the goals and objectives for tagging. PIT tags are useful as a permanent marking device for sea otters; however, live sea otters must be restrained while the tags are implanted or read. The detection distance for the PIT tags is usually only inches. PIT tags are especially useful for identifying sea otter carcasses that have lost their flipper tags.

Flipper tags are widely used in studies of free-ranging sea otters, but their usefulness is also limited. Generally, the observer must be close to distinguish the color and placement of tags on individuals. The imprinted numbers or letters are rarely readable except from extremely close distances, and tag loss does occur (Siniff and Ralls 1988). Color selection is important, as some colors are more prone to fading than others. Despite these limitations, several studies relying solely on this marking method have been successfully completed (Jameson 1989; K. Lyons, U.S. Fish and Wildlife Service, University of California, Santa Cruz, personal communication). Flipper tags proved to be of great usefulness in the otter rehabilitation centers by permitting the staffs to track individuals through the rehabilitation process. The ability to identify individual sea otters that die after release may help us understand the ultimate fate of some of the sea otters that survived the oil spill, and the results of our attempts to treat their injuries.

To date, flipper tag transmitters have been used with only limited success. The limitations of the transmitters themselves are part of the problem. They have a short operating life and a limited range. They are also susceptible to damage by the sea otter, and the radio signal is not audible when the otter has its flipper underwater. Loss of the signal is therefore difficult to interpret. Unfortunately, flipper tag transmitters have not been used in the types of studies for which they are probably best suited (i.e., studies of relatively sedentary animals over short periods). They are probably ideally suited for studies of dependent sea otter pups or those recently weaned from their mothers.

Implantable radio transmitters have proven very useful, despite their relatively high cost ($500 each) and limited range when compared with transmitters attached externally to other kinds of animals. For studies of movements and home range, and for estimating rates of survival, reproduction, and tag loss, implantable transmitters are essential. Implantable transmitters are also essential for studies linking sea otter behavior to the distribution and abundance of their food supply through activity pattern and time budget analyses (Garshelis et al. 1986; Estes et al. 1987; Ralls and Siniff 1988; Ralls et al. 1989). The transmitters are highly reliable and have a 2.5-year lifespan that allows long-term monitoring. Implantable transmitters were the best option available for the long-term monitoring of rehabilitated sea otters.

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