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DEVELOPMENT AND USE OF A TELEMETRY TECHNIQUE FOR STUDYING RIVER OTTER

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ABSTRACT

A feasible telemetry technique was developed in order to accurately study activity patterns, movements, habitat preferences, and social behavior of river otter (Lutra canadensis) in central Idaho. In 1976 and 1977, 17 otter were instrumented with several different collar designs in an effort to find a suitable method of utilizing external transmitters. This resulted in limited success and prompted an investigation into the feasibility of surgically implanted transmitters. Since December, 1977, transmitters have been implanted in the intraperitoneal cavity of 11 river otter. Advantages and disadvantages of different telemetry techniques, as applied to river otter, are discussed.

INTRODUCTION

Historically, the river otter (Lutra canadensis) has been an important furbearer in North America. Extensive exploitation of otter by trappers occurred in the 1800s, resulting in population reductions throughout much of its range. Various accounts of these population changes have been described by Beidleman (1958), Green (1932), Grinnell (1914), Schorger (1970), and Schultz (1954).

Previous work on river otter has been limited primarily to food habits studies, observations of captive animals, and data collection from carcasses (see Shump et al. 1976).

Distinctly lacking has been an objective appraisal of activity patterns, movements, habitat preferences, and social behavior of wild, free-ranging river otter. The meager information available, with regard to these types of data, is largely subjective. Until recently, no serious attempt had been made to conduct a telemetry study of the river otter, although Deems and Pursley (1978) report that 36 organizations in 27 states and provinces in North America were conducting some type of research on the species in 1976. Telemetry had not been used primarily because (1) otter are difficult to capture, and (2) their physical shape and behavior largely preclude the use of external transmitter packages. The recent development and availability of implantable transmitters have given researchers a tool by which to collect data on certain aquatic, semi-aquatic, and terrestrial species that was heretofore considered impossible.

We felt that the results of our tests on different collar designs proved them inadequate. Collars that were designed to prevent removal by the animal caused neck irrigation. The extreme conditions to which the transmitter packages were subjected probably contributed to premature failure. A different system had to be developed if we were to continue the use of telemetry in otter research.

Encouraged by what transpired at the First International Conference on Wildlife Biotelemetry in Laramie, Wyoming (Long 1977), we investigated potential transmitter implant systems. Subcutaneous implants tend to alter the natural contour of animals and could reduce survival (Smith and Whitney 1977) or alter behavior (Rawson and Hartline 1964). For otter, a package that would satisfy the required range and life expectancy would be too large to implant subcutaneously. Therefore, a transmitter that could be surgically implanted in the intraperitoneal cavity of otter seemed most feasible. Neely and Campbell (1973) used intraperitoneal implants on white-footed mice (Peromyscus leucopus) to facilitate the recovery of carcasses. Intraperitoneal implants were used by Bakko and Olson (1977) to gather physiological data on gray squirrels (Sciurus carolinensis) and blacktail prairie dogs (Cynomys ludovicianus). Smith and Whitney (1977) examined the feasibility of this type of implant to study small mammals and recognized its potential use in studying semi-aquatic species such as the otter. This paper describes the construction and testing of radio collars that eventually led to the use of implant transmitters to study various aspects of otter ecology and interspecific relationships with mink (Mustela vison) and other animals. Several aspects of this study, which commenced in June 1976, are still in progress.

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THE STUDY AREA

The study took place in approximately 608 km^2 of the upper portion of the North Fork Payette River drainage in west-central Idaho. Originating in a high mountain meadow, the North Fork Payette River flows through a long, narrow valley ranging from 1500-2100 m. Lake Fork Creek, the other major stream, enters this same valley to the south. Interrupted by three major lakes, both of these streams are fed by mountain lakes and streams before entering Cascade Reservoir near the southern part of the study area.

The study area is bordered on three sides by mountain ranges with peaks reaching above 2700 m. The region is typified by heavy snowfalls in the winter, with moderately dry summers. Cash crops are grown in the valley while cattle and sheep graze throughout most of the area. At lower elevations, big sagebrush (Artemisia tridentata) dominates undisturbed open areas. Riparian vegetation, composed of numerous shrub and forb species, is moderate to dense along most of the stream banks. Forest communities are a transition from lodgepole pine (Pinus contorta)/ponderosa pine (Pinus ponderosa) dominating the lower elevations, to Engelmann spruce (Picea engelmannii)/subalpine fir (Abies lasiocarpa) at the higher elevations.

METHODS AND MATERIALS

Otter were live-trapped using a variety of trapping techniques (Melquist and Hornocker 1979). Captured animals were drugged with an intramuscular injection of ketamine hydrochloride (22 mg/kg) and transferred to the holding pen.

Components and equipment for the telemetry system used in this study were supplied by several companies. The transmitting subsystem consisted of a transmitter (frequency of 164 MHz), power source (mercury or lithium battery), and transmitting antenna (loop configuration in collars; loop and truncated helix in implants). The transmitted signal was received by a receiving antenna (2-4 element beam or omnidirectional whip) and displayed by a multichannel receiver. Animals were generally located with a 4-element Yagi antenna mounted on a vehicle. During the winter, when snowmobiles were frequently used to locate instrumented otter, both an "H" directional antenna and a whip omnidirectional antenna were mounted on a backpack (Fig. 1). The whip antenna was used to pick up the signal, after which the "H" antenna allowed determination of the actual location. The backpack was quite useful when riding a motorcycle, skiing, or on foot. An airplane with 4-element Yagi antennas mounted to each strut was used when other methods failed to locate instrumented animals.

Several different collar designs were constructed for use on river otter (Fig. 2). In each instance, the soldered components were first coated with beeswax and then covered with dental acrylic. The initial design (Type I, Fig. 2-A) consisted of a plastic-coated cable approximately 6 mm in diameter which served both as the antenna and collar. A Type II collar was constructed by placing the waxed components in a polyvinyl chloride (PVC) mold and then adding dental acrylic. The transmitter package was attached to the animal by a flat, plastic-coated antenna wire approximately 15 mm wide. The Type III collar (Fig. 2-B) was identical to the Type II collar, with the exception of the loop construction. In the Type III design, a 16 mm wide strip of velcro material was used to secure the radio to the animal. The antenna wire was imbedded in "Shoe Goo" (Eclectic Products, Inc.,[1] 753 Basin St., San Pedro, CA 90731) on the outside of the velcro loop. A short strip of velcro was also secured across the top of the transmitter package. This collar was designed for use on adult otter. The Type IV collar was designed for use on juvenile and yearling otter. The transmitter package was similar to the Type II and III collars, but the loop consisted of nylon braided rubber tubing. The antenna wire was inserted through the tubing. The Type V collar was identical to the Type IV collar except small pieces of velcro material were either sewn around the tubing (Fig. 2-C), or glued flat to the inside (not shown). Since the rubber tubing had a certain amount of elasticity,

[1]Reference to trade names does not constitute an official endorsement by the Idaho Cooperative Wildlife Research Unit or its cooperating agencies and organizations.

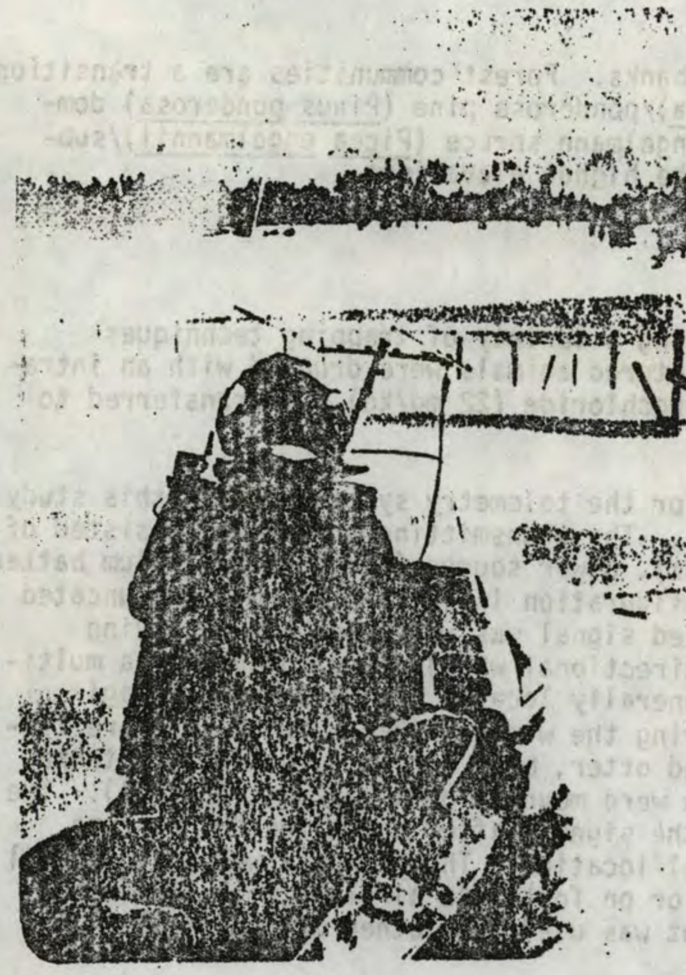


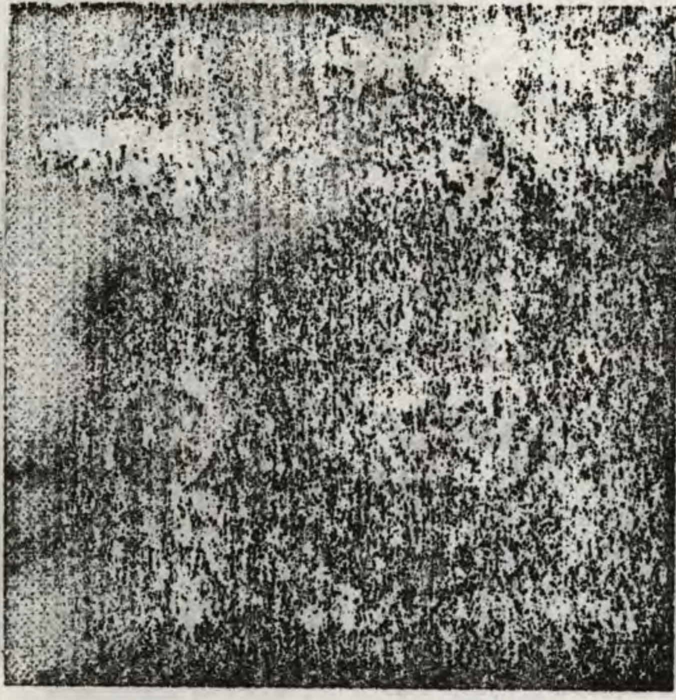
Fig. 1. Omnidirectional whip and "H" antenna attached to pack frame

it would stretch to compensate for the animal's growth. The collar was designed to fall off as the rubber weakened with age.

Animals outfitted with collars (Fig. 2-D) were retained for at least one night in a 3 m x 4 m x 2 m holding pen. This was important because if the collar was not properly attached, an otter would generally remove it during this period. Instrumented otter were released at or near the capture site.

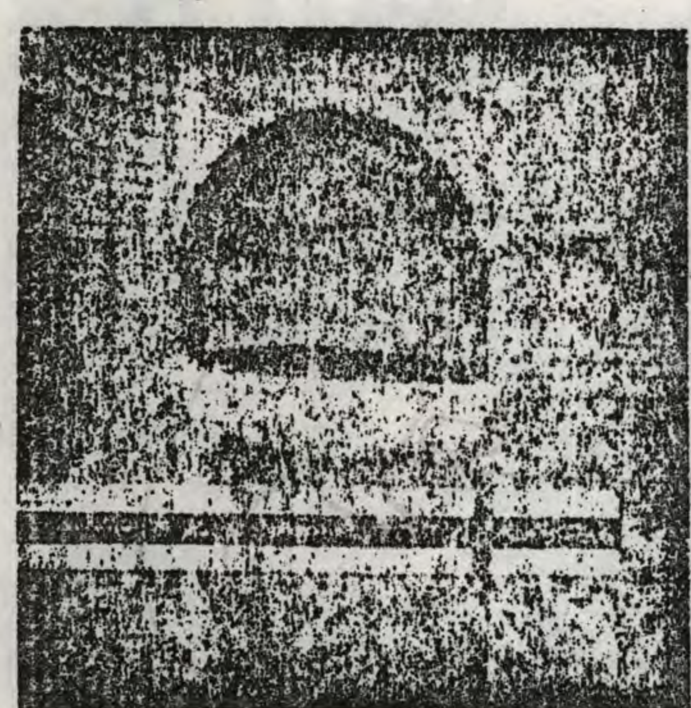
Surgically implantable transmitters, constructed by Telonics, Inc., 120 S. Mesa Drive, Mesa, AZ 85202, and Wildlife Materials, Inc., Rt. 2, Carbondale, IL 62901, were subsequently tested and used when collars proved to be unsatisfactory. The type of Telonics implant used was cylindrical in shape (Fig. 4), approximately 10 cm x 4 cm, and weighed 130 g. The Wildlife Materials implant was considerably smaller (6.5 cm x 3 cm) and weighed 65 g. Both implants were designed to transmit for 12-17 months.

The transmitter was surgically implanted in the intraperitoneal cavity of the otter (Fig. 5) through an incision made on either the right or left side of the animal (Fig. 6), favoring the dorsal surface, posterior to the ribs and anterior to the hind leg. Care must be taken not to injure the kidneys, diaphragm, and intestines. Initially, we made the incision on the ventral surface at the linea alba. Since otter frequently rub this area, we felt that this rubbing, combined with the implant lying against the incision,

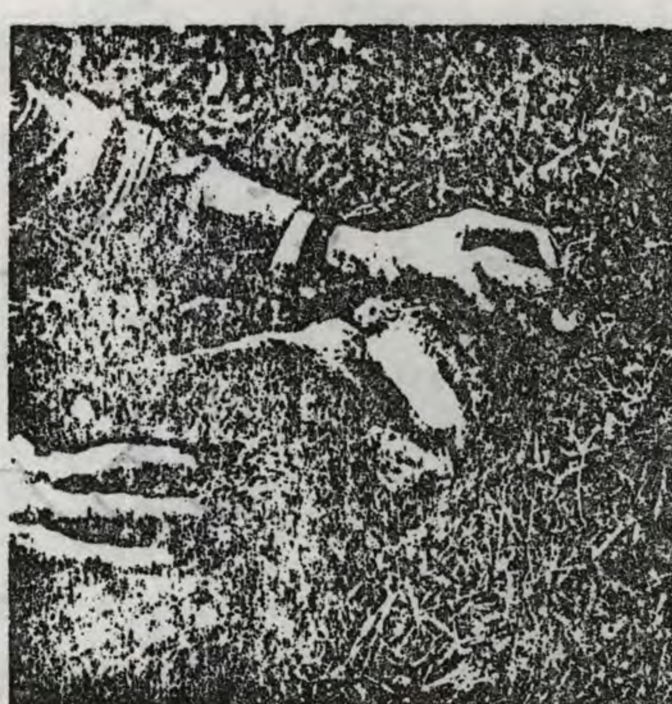


A. Solid collar with circular loop (Type I).

B. Solid collar in PVC mold with velcro loop (Type III).



C. Expandable velcro collar (Type IV).



D. Type II collar attached to river otter.

Figure 2. Various collar designs used on river otter.

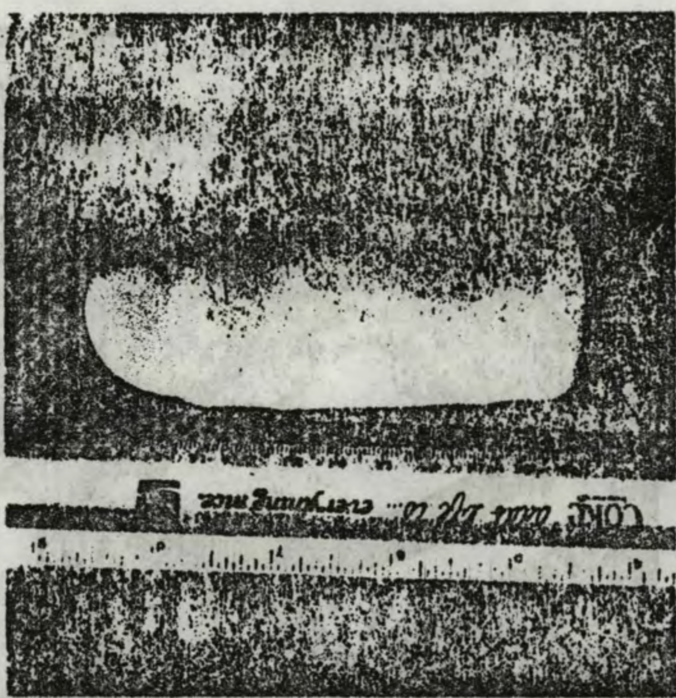


Figure 4. Telonics implant.

Figure 5. Inserting transmitter into intraperitoneal cavity.

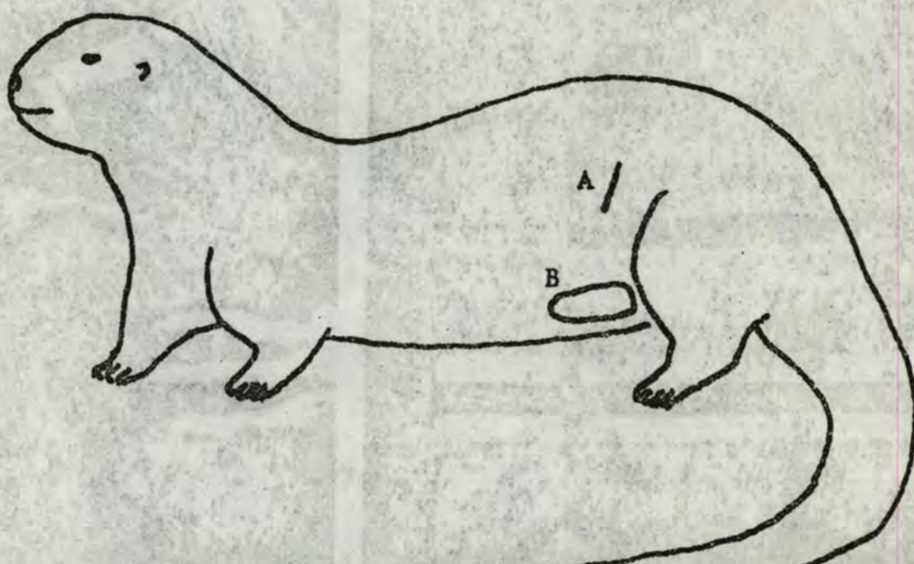


Figure 6. Location where incision is made (A) and position of transmitter (B) for intraperitoneal implant in river otter.

might cause breakage of the sutures. Procedures for preparing the transmitter for implant, preparing the animal for surgery, the actual surgery, and post-operative care of the animal have previously been reported (Melquist and Hornocker 1979).

RESULTS

Collars were placed on 17 otter during 1976 and 1977 (Table 1). Known retention periods ranged from 2-278 days. We obtained head and neck measurements from these animals and found that the head circumference of juveniles (<1 year old) was an average of 10.4 mm larger than the neck ($t = 4.81$, $n = 10$, $P < .001$). Conversely, in the two yearlings and five adults (>2 years old) measured, the necks were an average of 8.6 mm larger ($t = 5.69$, $n = 7$, $P < .002$). These measurements help emphasize the difficulty in using external transmitters on yearling and older river otter.

Juveniles were outfitted with Type I, IV, and V collars. Animal F1 retained a Type I collar for 131 days while M4 slipped his sometime after 7 days. Type IV and Type V collars were retained satisfactorily by the young otter but caused neck irritation. Otter managed to remove these collars if they were not secured tight enough. The two yearlings retained Type III and Type V collars, but they too caused neck irritation.

Five adults were outfitted with either Type II or Type III collars. Male M5 slipped a Type II collar within two days after being released. The Type III collar solved this problem, but again caused neck irritation. When F20 was found dead, 278 days after being released, there was evidence of only mild neck irritation.

All instrumented otter rubbed their collar on various objects. Initially, this rubbing was directed at the package in an effort to remove it. As the animal appeared to accept the collar, it was often difficult to determine whether the rubbing behavior was normal or a response to the radio. Autogrooming did not appear to be affected by the presence of the collar. Allogrooming, on the other hand, was occasionally altered when noninstrumented members of a social group would bite at and direct their attention to the collar.

Other activities of otter were not noticeably limited by the collars. The potential for becoming snagged in branches and other vegetation existed if the collars were not properly fitted. We freed one collared otter when it became entangled on a large branch from a partially submerged snag. Hamley and Falls (1975) experienced similar problems with collared *Microtus*.

Transmitters were surgically implanted in 11 otter (Table 2). The maximum monitor period was 225 days on a young male (total days to 1 May 1979). Three otter implanted with transmitters died. Our activities were directly responsible for the death of one of these animals. Male M16 died of exposure when the sutures in both the muscles and skin tore loose. Pulmonary and cardiac complications resulting in failure to eat were responsible for the deaths of M29 and M33. Although our activities likely contributed to their deaths, there were no abnormalities in the intraperitoneal cavity of M33 after carrying an implant for 150 days. F31 nearly died when several muscle and skin sutures tore loose and exposed a section of omentum. She was cleaned,

Table 1. River otter instrumented with collars

Animal number	Age	Circumference (mm) Head	Neck	Collar type	Retention/monitor period (days)	Explanation
F1	Juvenile	240	225	I	131	Slipped collar
M2	Juvenile	235	225	I	3	Died of injury
F3	Juvenile	237	230	I	2	Caught by trapper
M4	Juvenile	250	246	I	7+[a]	Malfunction/slipped
M6	Juvenile	227	200	IV	49	Malfunction/removed
F8	Juvenile	221	212	IV	4	Slipped collar
M12	Juvenile	215	211	V	6	Slipped collar
F14	Juvenile	222	216	V	52+	Malfunction/slipped
M16	Juvenile	238	225	V	112	Malfunction/removed
M18	Juvenile	237	228	V	50+	Malfunction
M4[b]	Yearling	245	260	V	21+	Malfunction
M26	Yearling	250	254	III	93	Found dead/unknown cause
M5	Adult	275	280	II	2	Slipped collar
F10	Adult	246	255	III	113+	Malfunction
F20	Adult	242	260	III	278	Found dead/unknown cause
M22	Adult	259	270	III	13+	Unknown
F24	Adult	253	261	III	21	Died of head injury

[a]Days accompanied by a "+" sign indicate monitor time; retention period unknown.

[b]Animal recaptured as a yearling.

Table 2. River otter instrumented with implants

Animal number	Age	Weight (kg) Animal	Implant	Implant-animal ratio (%)	Implant days	Explanation
M6	Juvenile	6.12	0.13	2.1	15	Malfunction
M16	Juvenile	6.92	0.13	1.9	11	Died of rupture
F31	Juvenile	4.08	0.13	3.2	68	Shot by hunters
M32	Juvenile	4.08	0.13	3.2	225[a]	Transmitting
M33	Juvenile	5.08	0.13	2.6	150	Found dead
M34	Juvenile	4.54	0.13	2.9	199[a]	Transmitting
F35	Juvenile	4.79	0.13	2.7	199[a]	Transmitting
F36	Juvenile	5.13	0.065	1.3	199[a]	Transmitting
F30	Yearling	7.03	0.13	1.8	72	Malfunction
M37	Yearling	7.39	0.13	1.8	--	Not released yet
M29	Adult	8.62	0.13	1.5	12	Found dead

[a]Total days to 1 May 1979.

resutured, and nursed back to health, only to be later shot by duck hunters. It was the problems that we experienced with M16 and F31 that convinced us to make lateral instead of ventral incisions.

Foraging activities and movement were not inhibited by the implants. Extensive upstream movements and cross-country treks between streams and over mountain ranges have been recorded. Social interactions were not altered or disrupted since the transmitter could not be visually detected. Because none of the implanted otter were of breeding age, the effects of an implant on the reproductive success of females is not known. Implant weights, which never exceeded 3.2% of the animal's body weight (Table 2), did not appear to have any effect on the otter.

Maximum ground-to-ground range using a 4-element Yagi antenna mounted on a truck in which a signal could be picked up was approximately 3.5 km for the implants. This was actually better than the range we obtained with collars. A range of 2.5-3.0 km was sufficient since most of the study area was accessible by road. The topography of the area, with ridges paralleling the Payette River valley, allowed us to use elevated areas to extend the range. An airplane was usually required to locate animals that moved out of the valley or into a mountain lake.

CONCLUSIONS

Implant transmitters of excellent quality and high performance are now available to researchers. According to Smith and Whitney (1977), collars are not biologically optimal for many species in which they have been used. When conducting studies that require telemetry, researchers need to decide which telemetry technique is most suitable for the animal under investigation. Consequently, the quality and accuracy of the data will increase. Too often the opposite is true, and results of data collected by inferior methods are accepted as "under normal or natural conditions," when in fact this may not be the case.

Both collars and implants have their advantages and disadvantages. Some of these advantages are listed in Table 3. In a situation where either of these transmitter designs could be used, implants appear to be biologically superior. Implants may be the only alternative if researchers wish to conduct telemetry studies on certain species such as the river otter. This does not mean that collars will become obsolete. Collars will continue to be used on small mammals until the time when miniature implants are developed that do not sacrifice range and transmitter (battery) life. Even then, the cost of such a unit will likely prohibit its use in most studies at the present level of funding. With the exception of certain limitations, the researcher must decide on which transmitter design to use. At least now there is a choice.

Table 3. A comparison of some of the advantages (+) of collars and implants

Category	Collar	Implant
Lower cost	+	
Superior range	+	
Brief recovery period of instrumented animal . . .	+	
Minimal exposure of transmitter to adverse conditions .		+
Increased reliability		+
Minimal irritation to animal after release		+
Less likely to inhibit movement		+
Minimal disruption of normal behavior		+
Less likely to draw hunter attention		+
Esthetically compatible		+

LITERATURE CITED

Bakko, E. B., and D. N. Olson. 1977. A portable auto-sequencing telemetry system for gathering field physiological data. Pages 15-21 in F. M. Long, ed. Proceedings First International Conference on Wildlife Biotelemetry, Laramie, Wyoming.

Beidleman, R. G. 1958. Early fur returns from the Pacific Northwest. J. Mammal. 39:145-147.

Deems, E. F., Jr., and D. Pursley, eds. 1978. North American furbearers: their management, research and harvest status in 1976. Internat. Assoc. of Fish and Wildl. Agencies, College Park, Maryland. 171 p.

Green, H. U. 1932. Observations of the occurrence of the otter in Manitoba in relation to beaver life. Can. Field Nat. 46:204-206.

Grinnell, J. 1914. Distribution of river otters in California. Univ. California Publ. Zool. 12(8):305-311.

Hamley, J. M., and J. B. Falls. 1975. Reduced activity in transmitter-carrying voles. Can. J. Zool. 53:1476-1478.

Long, F. M., ed. 1977. Proceedings First International Conference on Wildlife Biotelemetry, Laramie, Wyoming. 159pp.

Melquist, W. E., and M. G. Hornocker. 1979. Methods and techniques for studying and censusing river otter populations. Univ. Idaho For., Wildl. and Range Exp. Stn. Tech. Report 8. 17 p.

Neely, R. D., and R. W. Campbell. 1973. A system for gathering small mammal mortality data. U.S. Dept. Agric. For. Serv. Res. Paper NE-280. 6 p.

Rawson, K. S., and P. H. Hartling. 1964. Telemetry of homing behavior by the deer mouse, Peromyscus. Science 46(3651):1596-1597.

Schorger, A. W. 1970. The otter in early Wisconsin. Wis. Acad. Sci., Arts and Letters 58:129-146.

Schultz, V. 1954. Status of the beaver and otter in Tennessee. J. Tenn. Acad. Sci. 29:73-81.

Shump, K. A., Jr., A. U. Shump, R. A. Aulerich, and G. A. Heidt. 1976. Bibliography of Mustelids. Part V: Otters. Mich. Agric. Exp. Stn. No. 7759. Mich. State University, East Lansing. 32 p.

Smith, H. R., and G. D. Whitney. 1977. Intraperitoneal transmitter implants --their biological feasibility for studying small mammals. Pages 109-117 in F. M. Long, ed. Proceedings First International Conference on Wildlife Biotelemetry, Laramie, Wyoming.