MARKING AND RADIOTAGGING OF BLACK-FOOTED FERRETS (*MUSTELA NIGRIPES*)

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ABSTRACT

Marking and radiotagging are necessary tools in our research efforts to provide data on the population dynamics of the black-footed ferret (*Mustela nigripes*). This paper reviews marking and tagging techniques used by previous researchers and describes the history and development of marking and radiotagging techniques used by the Denver Wildlife Research Center (DWRC). We are currently using two marking techniques, an ear tattoo and a small metal fingerling eartag. For radiotagging, we are using a 2-stage, 3-volt transmitter with a whip antenna. This transmitter unit is sewn to a vinyl collar. The transmitter has a battery life of approximately two months.

WHY MARK AND TAG?

The process of capturing, handling, marking, and tagging poses certain risk to study animals, no matter how carefully it is done. When working with an endangered species such as the black-footed ferret, the ratio of benefit to risk must be carefully considered; harming one individual has potentially greater impact on a very small population than on the large population of a nonendangered species. With that in mind, why do we persist in marking and tagging endangered species? Clearly, the benefits in knowledge gained must outweigh the risks. With the black-footed ferret we feel strongly that this is true--and past experience in South Dakota supports our view. Erickson (1973) recognized that ferret populations in South Dakota were not increasing, despite consistent yearly litter production on areas free from predator or rodent control. He speculated that dispersal or disease could account for the lack of population growth, but stated that "until suitable instrumentation can be developed with captive ferrets, it is unlikely that an answer to these questions will be found." The South Dakota population disappeared before suitable instrumentation was developed and the reasons for its disappearance are still unknown.

Population growth is a function of three attributes: natality, mortality, and dispersal (Emmel 1976). Data on these three attributes are necessary to maintain the present ferret population and to provide information for future captive breeding and translocation efforts. Our long-term marking program is designed to provide information on present population numbers and trends, turnover rates (natality and mortality), breeding age, reproductive success, and ratios and survival by sex and age. Our radiotelemetry studies are designed to provide data on individual ferrets. Radiotagging can accurately document individual movements, causes or mortality, dispersal, spatial and temporal activity, and home range requirements.

DEVELOPMENT OF MARKING TECHNIQUES FOR BLACK-FOOTED FERRETS

In August, 1983, the DWRC began a cooperative effort with BIOTA Research and Consulting, Inc. to capture and mark 20 to 25% of the Meeteetse, Wyoming ferret population every year. Prior to this time, no black-footed ferrets had been permanently marked in the field. Our first goal was to find a permanent marker for black-footed ferrets so long-term information could be gathered on population attributes. Our second goal was to develop a marking technique that would be readily visible at night so: (1) each animal would be trapped only once; (2) population estimates could be made using spotlighting as a "recapture" technique; and (3) we could gather data on movement and fate of animals without radio-collars.

Investigations by Other Researchers

A variety of marking techniques has been used or proposed for use on mustelids. Ear punching has been used on stoats (*Mustela erminea*) by Erlinge (1983). Punches were done on the edge of the ears, at four positions and combinations on each ear. The marks were easily read and persisted throughout life. Ear notching was also tried by Sheets (1970) on three black-footed ferrets.

Hillman (1968) considered using colored plastic grouse leg bands on ferrets but tests on 31 black-tailed prairie dogs (*Cynomys ludovicianus*) showed a low retention rate, with all but one lost within 22 days. When placed on the front legs of prairie dogs, the bands were easily seen through a spotting scope. Hillman (1968) also tested cryogenic branding on black-tailed prairie dogs without success; three young prairie dogs branded on 5 July showed no evidence of white hair by 29 August.

Dyes have provided a good marking technique for some species but would be hard to see on a nocturnal species such as the ferret and are not permanent. Nyanzol D (a nontoxic cattle hair dye) lasts approximately six weeks on ground squirrels (*Spermophilus elegans*) (Fagerstone 1982). Hassien (1970) tested clothing dye, human hair dye, Rhodamine B, and picric acid on black-tailed prairie dogs (*Cynomys ludovicianus*); black human hair dye and Rhodamine B were the most permanent and visible, but faded after 20 to 30 days.

Colored collars were used by Fagerstone (1982) to identify Wyoming ground squirrels (*Spermophilus elegans*) by sex and age. Erickson (1973) stated that the use of conspicuously colored collars would not work on ferrets because they are seen above ground only a small part of each day and the collars would not be visible at night. To improve visibility, Clark et al. (1983) proposed reflective collars for use on black-footed ferrets. However, collars were not used because of potential problems with skin abrasion.

Eartags have been routinely used in marking numerous species of animals including mustelids (Clark et al. 1983). Eartags used were of two types (metal fingerling strap fish tags and metal strap monel wing tags) placed along the outer edge of the ear. Researchers attempted using eartags as a permanent mark with varying degrees of success. River otters (Lutra canadensis) were eartagged with monel metal fingerling tags (Melquist and Hornocker 1979). Ames et al. (1983) placed 196 small monel tags in sea otter (Enhydra lutris) ears with only two lost during the two year study. Carpenter and Hillman (1978) individually identified captive black-footed ferrets with small metal eartags. In contrast, several researchers found tags rarely persisted past two years in mustelids and were frequently lost within months (Newby and Hawley 1954; Francis and Stephenson 1972; King 1973; Kelly 1977; Campbell 1979; and Clark 1980). Sheets (1970) used monel strip tags in the right ear of two black-footed ferrets and a monel strip tag plus a plastic disc in the left ear; the disc tags were lost almost immediately but the strip tags remained.

Tattoos have been successfully used as a permanent marker of mustelids in recent years (Clark et al. 1983). Francis and Stephenson (1972) replaced lost marten (Martes americana) eartags with ear tattoos to positively identify individuals. Kelley (1977) suggested lip tattoing fishers (Martes pennanti) as an alternative to eartagging. Tattooing a number on the inside of the lip of river otters was tried with poor results by Melquist and Hornocker (1983) but tattooing a number on the interdigital membrane of two hind toes appeared to provide a permanent mark. Carpenter and Hillman (1978) successfully identified five captive black-footed ferrets at the Patuxent Wildlife Research Center with tattoos in the inner ear. A consulting veterinarian (J. Konitz, pers. commun.) suggested that cartilaginous tattoos (ear tattoos) persist longer and are easier to read than non-cartilaginous (lip or inner thigh) tattoos.

Investigations by the Denver Wildlife Research Center and BIOTA Research and Consulting, Inc.

Laboratory Tests

Prior to the 1983 field season, we tested commerical rabbit eartags, commercial self-piercing fingerling eartags, eartags made with a buttoneer device, and ear tattoos on prairie dogs, European ferrets (Mustela eversmanni) and Siberian polecats (M. putorius) to determine retention rates and the behavioral response of the animals. Both "Code-It" (3M Co.[1]) reflective paint and reflective tape (3M Co.[1]) were tested on the eartags to determine nocturnal visibility from variable distances.

Rabbit eartags: Rabbit eartags proved too heavy for use in the thin ear of the black-footed ferret.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

Self-piercing monel metal fingerling eartags: These eartags were placed in ears of 19 European ferrets and were all retained for six months minimum with no ill effects; one has been retained for 18 months.

Buttoneer eartag: The buttoneer eartag consisted of a small length of plastic with a plastic ball on one end and a flexible "T" on the other end (similar to the device used for attaching price tags to garments). The "T" was inserted with a special needle tool through the ear and through two 1 cm diameter discs of bright orange vinyl flagging material; the ear was sandwiched between the vinyl discs. One European ferret was marked on 8 July and three Siberian polecats were marked on 19 July. All of the ferrets eventually lost their eartags, the European ferret in 32 days, one of the Siberian polecats in eight days and two Siberian polecats in 12 days. It appeared that there was sufficient room between the vinyl and the ear for the vinyl to catch on the cage or for the ferrets to get hold of the vinyl and pull the eartags out. This eartag removal left a slit in the ear from the point of insertion to the margin of the ear. Based on these cage tests, we expected poor retention of the buttoneer eartags by free-ranging ferrets as they groomed or brushed against burrow walls or vegetation; therefore these tags were not used.

Reflective Tags: "Code-It" paint and reflective tape were tested on the orange vinyl discs used with the buttoneer eartags, and on aluminum washers (rabbit eartag washers -- Style 4-41, National Band and Tag Co., Newport, KY[1]) used with metal fingerling tags. "Code-It" paint did not adhere well to the vinyl material used with the buttoneer eartag and the 25-50 micron reflective beads in the paint did not apply evenly enough to the small metal discs to show good reflection. Reflective tape was more successful, particularly when applied to the aluminum disc. The aluminum disc was 1 cm in diameter, with a 3 mm hole through the center where the fingerling eartag was inserted. After the disc was cleaned with acetone, a piece of 1 cm diameter reflective tape was glued to the disc. In tests at night with a spotlight, discs could be seen at 200 m and the six colors tested (white, yellow, red, orange, blue and green) could be distinguished at 100 m. The fingerling tag and disc together weighed 0.15 g.

Tattoos: One European ferret and three Siberian polecats were ear-tattooed on 19 July 1983. Tattoos were readable when the ear was back-lit with a small penlight flashlight.

Field Tests

Between 7 and 26 August, 1983, 19 ferrets were captured. All were marked with a tattoo in the left ear. Five (two males and three females) were marked with a fingerling eartag in the right ear. Four ferrets (one male and three females) were marked with the combination fingerling eartag and reflective disc in the right ear. Two female ferrets were radiocollared and marked with a fingerling eartag in the right ear. The remaining eight ferrets were radiocollared and marked with the combination fingerling eartag and reflective metal disc in the right ear.

Nine of these marked ferrets have been recaptured and the tattoo was visible in every case, even after one year. The fingerling eartags by themselves also showed good promise for being a permanent marker. Three of the five animals marked with fingerling eartags have been retrapped and all retained the eartag for up to one year. The combination of fingerling eartag and reflective disc did not remain in any ferret's ear for longer than one month.

Current Marking Techniques

We are currently marking each ferret with an ear tattoo in the left ear (Ketchum Mfg. Sales Limited, Ottawa, Ontario[1]) and with a size 1 monel metal fingerling fish tag (Style 4-1005 Size, National Band and Tag Co., Newport, KY 41071[1]) in each ear. Each eartag is stamped with a unique number. We have not yet developed a retainable reflective marker that is readily visible at night from a distance.

DEVELOPMENT OF RADIO TRANSMITTERS FOR USE ON BLACK-FOOTED FERRETS

Investigations by Other Researchers

Prior to our studies, radio transmitters had not been used on black-footed ferrets. Sheets (1970) constructed collars consisting of aluminum bands carrying small hose clamps to simulate radio transmitter mountings; he tested these on captive prairie dogs but they were never used on ferrets. Erickson (1973) stated that "there is no known way to safely develop and test methods of installing radio transmitter harness on live ferrets in the wild." Collars on some other mustelid species like sea otters have met with only limited success because the thick tapering neck prevents retention (Loughlin 1978, Costa and Kooyman 1981). Melquist and Hornocker (1983) attempted to develop both solid and expandable transmitter collars for use on river otters but experienced continuous problems, including collar loss, neck irritation, and poor reliability; they finally used implant transmitters.

Investigations by the Denver Wildlife Research Center (DWRC)

A considerable amount of time and effort has gone into the development of radio transmitters for use on black-footed ferrets. In 1979, hoping that one of the numerous reported ferret citings received by the USFWS would result in the discovery of a live animal, Steve Martin of DWRC and Conrad Hillman of USFWS in South Dakota tested a commercially available radio transmitter on a Siberian polecat and on a European ferret. The AVM Instrument Co.[1] unit consisted of a BT collar with an SM1 transmitter. The SM1 is a single-stage, 1½-volt transmitter coated with dental acrylic and weighing approximately 15 g. The BT collar (a rigid 7 mm-wide brass loop covered by heat shrink tubing) served as the antenna for the transmitter. This collar was divided into two halves, one with five pre-drilled holes spaced 8.5 mm apart and the other with a fixed threaded bolt 5 mm long and 2 mm in diameter soldered permanently into place near the end. The collar was attached by placing the halves around the ferret's neck and fitting the bolt through one of the receiving holes, adjusting collar tightness by selecting different holes. Once fitted, a small brass nut was screwed onto the bolt and the bolt tip was damaged to prevent the nut from working loose. Three problems were observed with this transmitter package:

precise fitting was impossible; the use of any hole other than the center one changed the antenna length, detuning the collar and causing loss of signal range; and the transmitter caused some hair loss and a slight neck abrasion, possibly because the bolt head protruded slightly on the inside of the collar.

On 26 September, 1981, a male black-footed ferret was killed by a dog 18 km west of Meeteetse, Park Co., Wyoming. On 29 October, Steve Martin and Dennie Hammer of the DWRC trapped a live male black-footed ferret and equipped it with an AVM SM1 radio transmitter. To prevent neck abrasion, a 40 mm length of 8 mm diameter heat shrink tubing was fitted over the half of the collar having the soldered bolt before the collar was placed on the ferret. Once the collar was attached, the tubing was slipped over the exposed nut and heated with a battery-operated soldering iron to shrink it. When recaptured on 15 November, the ferret showed no signs of neck abrasion or hair loss. However, the reception range for this transmitter was poor.

In an effort to develop a transmitter with a longer range, a visit was made to Telonics in the spring of 1982. Telonics developed a prototype transmitter that proved too bulky for use on black-footed ferrets. Thus, the AVM SM1 transmitter was again used in the fall of 1982 by Max Schroeder of the DWRC to instrument six juvenile black-footed ferrets. Due partly to the collar design, and partly to excess caution in attaching the collar, three of the six animals removed their collars within the first few days after capture. These were recovered underground at depths of 84, 100, and 238 cm. Poor reception range was a major problem; ground-to-ground signal reception was generally less than 1000 meters even when animals were above ground and frequent moves of tracking stations were necessary to maintain contact with the ferrets. Aerial tracking was required on several occasions to relocate missing animals. Radio signals could not be heard from directly above them if ferrets were below 2 meters under ground.

Although the Telonics transmitter tested during the spring of 1982 proved too bulky, it was better than the AVM SM1 in other aspects. The weight of the transmitter was the same (15 g) but the reception range of this 2-stage, 3-volt unit was about 75% better than the SM1 in aerial tests, in ground-to-ground simulations, and in below ground trials when placed on a white-tailed prairie dog (Cynomus leucurus). Therefore, we knew it was possible to build a transmitter with a longer range. In early 1983, we requested that major suppliers of radio transmitters develop a better transmitter for use on black-footed ferrets; we specified maximum weight and dimensions, and minimum longevity. Prototype transmitters were received from five companies and were tested for output at the DWRC Electronics Lab and for actual range in the field. Outputs of the five transmitters ranged from -14 to -50 dbm. Transmitters from three companies exceeded weight or size requirements. Prototypes built by Wildlife Materials Inc. (WMI) and Custom Telemetry and Consulting (CTC) came closest to meeting requested specifications and a second modified prototype was requested from these companies. These modified units were tested in July, 1983, on Siberian polecats. The CTC unit proved too large for the animal and came off in the cage; the animal then chewed on the rubbery potting material, ingesting a quantity sufficient to cause impaction and death. The WMI unit caused no apparent problems. This 2-stage, 3-volt transmitter (two 1.5-volt lithium batteries) had a 6-inch whip antenna that greatly increased the reception range to above that of the previously tested Telonics transmitter. This transmitter was selected for use on black-footed ferrets.

In August, 1983, 10 black-footed ferrets were instrumented with the newly designed WMI transmitter. Two transmitters quit functioning within two weeks but the remaining eight functioned much better than the AVM transmitters used in 1982. Collar loss was not a problem because the collar, which no longer functioned as an antenna, was constructed of a flexible, lightweight vinyl material that could be fitted to the animal with greater precision. Also, the transmitter package was contoured to the animal's neck. Line-of-sight signal reception range was generally 2.5 to 3.5 km, enabling us to erect permanent tracking stations for monitoring animals. This new design proved to have three disadvantages. First, the increase in range caused a concomitant decrease in transmitter longevity, forcing us to recapture animals every four to six weeks to replace transmitters. Second, four of the 17 recovered transmitters had broken antennas, which reduced the transmitter output from -16 dbm to -30 dbm in laboratory simulations. This reduction in output causes a reduction of about 75% in actual range. A third problem with this transmitter design was mud accumulation around the main body of the transmitter. We noticed mud accumulation for the first time in late September; the problem became severe later in the fall, possibly associated with an increase in digging behavior by the ferrets. We removed the radio transmitters in late November and early December because ferrets became relatively inactive and we were not able to reobserve them at three to four day intervals to monitor their condition.

The WMI transmitter packages used in 1983 were coated with the same dental acrylic used on AVM transmitters in 1982 when no mud problems occurred. Therefore, we felt it possible that the mud accumulation resulted from the new collar design where collars were stitched onto the transmitter package and stitches coated with a sticky, rubber-cement material that extended over the upper surface of the acrylic-coated transmitter. Heaviest mud accumulations were located on the parts of the transmitter coated with the rubber-cement material. Mud could be dislodged fairly easily from the acrylic but had to be washed from the rubber. The vinyl collar did not accumulate mud and a prototype CTC transmitter potted with rubber accumulated little mud while on a ferret for one month.

Beginning in February, 1984, we began tests to develop a transmitter that would not be subject to mud accumulation. Four coatings were tested on transmitters placed on black-tailed prairie dogs near Denver, Colorado, and monitored for 7 weeks: (1) WMI dental acrylic on the top of the transmitter with the rubber cement material on the neck edge; (2) WMI dental acrylic on the top and neck edge of the transmitter; (3) CTC black rubbery potting; and (4) Teflon heat shrink tubing (Voltrex Brand Type SSI-064 1" Super Shrink Teflon Tubing, Newark Electronics, Denver, CO[1]) placed over the transmitter. During the test period, precipitation was heavy and the clay soil on the test area was almost constantly wet, giving ideal conditions for a mud accumulation test. The Teflon heat shrink tubing performed best in this test, showing no mud accumulation. The dental acrylic accumulated small spots of mud 2 mm thick, on both the top and neck edge, but caused no neck abrasion. Mud appeared to accumulate easier on the rubber cement material than on the acrylic, causing abrasion on the neck of one animal. The CTC black rubbery potting had the worst performance for several reasons: (1) the rubbery potting on one transmitter accumulated a very thin layer of mud; (2) the rubbery potting of both transmitters was chewed on, with one transmitter completely chewed up by other prairie dogs, leaving only the vinyl collar and a few remnants of transmitter components around the neck; (3) the antennas on the CTC collars had both been chewed off about 5 cm from the transmitter.

Based on these tests, we made the following recommendations:

1. Reduce the amount of rubber cement on the inside surface of the collar to a dot over each stitch;

2. Use dental acrylic potting rather than the black rubbery potting and coat over the rubber cement material on the neck edge.

3. Use a heavier antenna or support the base of the antenna.

4. Use Teflon heat shrink tubing over the entire transmitter unit.

5. Continue use of the vinyl collar.

The transmitter in use in 1984 is the result of our three years of experience. We are now using a WMI 2-stage unit with two 1.5-volt silver oxide batteries in series to give about two months of life. The unit is mounted on a plastic plate and sewn to a vinyl collar 1 cm wide (constructed of 18 oz. material). The stitching that binds the collar to the transmitter is covered with dental acrylic, as is the rest of the transmitter package. Teflon heat shrink tubing covers the acrylic. The 15 cm whip antenna is constructed of 1 mm diameter stainless steel with a 2.5 cm length spring at the base to help prevent breakage. The weight of the transmitter is about 12 g. A 3.5 mm pop rivet with two washers joins the two ends of the vinyl collar to place the transmitter on the ferret. Wildlife Materials has recently added these transmitters to their catalog (LPM-2165-LD[1]).

The latest transmitter design was placed on an adult male ferret on 10 May, 1984. His condition was checked frequently until 18 June, when he was retrapped and the transmitter was replaced. The ferret was in good condition with no neck abrasion, and the transmitter showed no mud accumulation. This male lost the second transmitter on about 5 July; when recovered, it showed no mud accumulation. We are using this latest transmitter design for our study in the fall of 1984.

Radio-collared black-footed ferrets in all of our studies behaved in what appeared to be a normal manner. Young animals have been observed and filmed at play with siblings and were accepted and fed by the adult female. Ferrets during 1983 carried transmitters for up to four months. Summaries of animal movements and mortality are being prepared and will appear in later publications.

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