Field immobilization and use of radiocollars on long-tailed weasels

Thomas M. Gehring and Robert K. Swihart

Abstract Using radiocollars to conduct relatively long-term studies of weasels (Mustela spp.) is problematic because individuals shed collars frequently and because collars may induce behavioral changes. During 1998–1999, we immobilized 16 free-ranging long-tailed weasels (Mustela frenata) using 25-mg/kg ketamine hydrochloride and 2-mg/kg xylazine hydrochloride. Mean induction time was 2 minutes and time to first arousal averaged 26 minutes. We fitted 9 male and 6 female weasels with 6.5-g and 3.2-g tuned-loop radiocollars, respectively. Of these, we observed 5 males and 2 females in captivity under semi-natural conditions. Radiocollars did not appear to influence weasel use of burrows and coarse woody debris or compromise their ability to kill prey. In the field, 8 of 9 males and all females retained collars more than one week. Males were tracked for a mean of 62 days (range = 5-158 days), whereas females were tracked for a mean of 51 days (range = 8-108 days). Radiocollars did not appear to adversely affect foraging or reproduction of tagged weasels.

Key words anesthesia, handling, immobilization, ketamine hydrochloride, long-tailed weasel, Mustela frenata, radiotelemetry, xylazine hydrochloride

Relatively little is known of the ecology of weasels (Mustela spp.) as compared to other North American furbearers (Fagerstone 1987) and quantitative assessments of habitat selection and movements are lacking (DeVan 1982, King 1989). The dearth of ecological information on weasels is due partly to the difficulty in radiotagging these animals for extended periods of time. Weasels have been radiocollared by several researchers (Erlinge 1977, 1979; Pounds 1981; DeVan 1982; Erlinge and Sandell 1986; Sandell 1986; Slemman 1987; Murphy and Dowding 1994, 1995; Jedrzejewski et al. 1995; Samson and Raymond 1998). However, radiocollared weasels in these studies were tracked for short time periods (2 = 15 days, range = 1-91 days), mainly due to failed or shed collars.

Collar and harness transmitter attachments can be generally problematic with mustelids (Melquist and Hornocker 1979, Eagle et al. 1984, Murphy and Dowding 1995) due to their long necks and small heads (Murphy and Dowding 1994). These attachment methods can result in shed transmitters and neck abrasions or may influence the behavior of marked animals (Delattre et al. 1985). However, radiocollars have been used successfully with black-footed ferrets (Mustela nigripes, Biggins et al. 1985, Fagerstone et al. 1985). Melquist et al. (1981) and Eagle et al. (1984) implanted radiotransmitters in the peritoneum of mink (M. vison) to try to reduce transmitter loss and neck irritation. Eagle et al. (1984) suggested that implanted transmitters did not interfere with reproduction or result in excessive mortality in mink. However, transmitters implanted intraperitoneally often have a >50% reduction in transmitter range and require invasive, potentially stressful surgery (Anderka 1987). Animal Care and Use Committees also may restrict the implantation procedures (Anderka 1987), such as holding animals in captivity for 2-10 days following surgery.

Attaching collars or harnesses to weasels requires immobilization to ensure safety of the animal and the researcher. Weasels have been immobilized with ether (Lockie and Day 1963, King and Edgar 1977, Nams 1981, DeVan 1982, Jedrzejewski et al. 1995, Samson and Raymond 1998), phencyclidine hydrochloride (HCl) and promazine (Seal and
Erickson 1969, Seal et al. 1970), and ketamine HCl (Jessup 1982, Belant 1992). Ether is carcinogenic and flammable (American Society of Mammalogists 1998) and therefore an unacceptable immobilizing agent. Ketamine HCl has a wide safety margin (Jessup 1982), but can cause muscle rigidity, slight trembling, and seizures (Seal and Kreeger 1987). Using xylazine HCl combined with ketamine HCl provides muscle relaxation (Moreland and Glaser 1985). Seal and Kreeger (1987) recommended 10-15 mg/kg of ketamine HCl in combination with one mg/kg of promazine, 0.5 mg/kg of diazepam, or 0.5 mg/kg of xylazine HCl to immobilize long-tailed weasels (M. frenata). Moreland and Glaser (1985) cautioned against using ketamine HCl alone or ketamine-diazepam in ferrets (M. putorius) due to incomplete analgesia and muscle rigidity. A dose of 25 mg/kg of ketamine HCl and 2 mg/kg of xylazine HCl provided suitable muscle relaxation and smooth recovery (Moreland and Glaser 1985).

We know of only one radiotelemetry study conducted on long-tailed weasels and it collared and tracked only 5 male long-tailed weasels for a mean of 9 days (DeVan 1982). Here, we describe immobilization of long-tailed weasels using ketamine HCl and xylazine HCl and techniques we have developed for fitting radiocollars used in the field with male and female long-tailed weasels.

Methods

During 1998-1999, we conducted research in the Indian Pine Study Area (IPSA) located in Benton, Tippecanoe, and Warren counties, west-central Indiana. Approximately 82% of the IPSA was in agricultural production (corn and soybeans are the dominant crops). Forested lands comprised approximately 16% of the area, with 11% represented as riparian and 89% identified as forest patches (Shepherd 1994). Fencerows and drainage ditches bisected agricultural fields and provided varying levels of connectivity between forest patches.

We live-trapped long-tailed weasels within woodlots, grassland patches, fencerows, and drainage ditches using Edgar live traps (King and Edgar 1977, King 1989). We used fresh, dead domestic mice and commercial lures for bait. To reduce trap-related mortality, we checked traps daily and closed trap lines during extreme cold and wet periods (i.e., ≤0°C with rain showers). Furthermore, we covered traps with woody material or vegetation and provided poly-fiber-bedding material in traps during all seasons except summer. We did not use the nest box attachment for the Edgar trap as suggested by King and Edgar (1977). We restrained captured weasels in a canvas and mesh handling bag and immobilized them via an intramuscular (IM) injection (25-gauge × 16-mm needle) of ketamine HCl and xylazine HCl. We used the dosage recommended for ferrets of 25-mg/kg ketamine HCl and 2-mg/kg xylazine HCl (Moreland and Glaser 1985). We recorded age, sex, mass (g), and body measurements (mm) for immobilized weasels and attached uniquely numbered ear tags (size 1 Monel tag, National Band and Tag Co., Newport, Ky.).

We fitted males with 6.5-g and females with 3.2-g radiocollars (SOM-2190 M and SOM-2070 models, Wildlife Materials, Inc., Carbondale, Ill.). Radiocollars consisted of a 0.5-cm-wide brass collar, which served as a tuned-loop antenna. Collars were covered with heat-shrink tubing to reduce rubbing and neck irritation. Collars were secured with 2 hexagonal nuts. We used an index card folded 2 times (i.e., 4 layers or approximately 2 mm)

Radiocollars used on female (left) and male (right) long-tailed weasels.

Female long-tailed weasel with radiocollar attached.
collared weasels via telemetry twice daily for 7 days to index the well-being of animals and to quickly locate shed collars. After 7 days, we retrieved the nest box from the release site. We chose these procedures so that radiocollared weasels would have a secure environment in which to recover from anesthesia and time to acclimate to the radiocollar. Subsequently, we located radiotagged weasels daily via triangulation (Heezen and Tester 1967), using a vehicle-mounted 3-element Yagi antenna and handheld antenna. All handling methods were conducted in accordance with Purdue Animal Care and Use Committee (PACUC) guidelines (PACUC # 98-006).

**Results**

We captured 16 weasels (6 adult male, 3 juvenile male, and 7 adult female) during 1998-1999. Mean mass of adult and juvenile males was 195 g (SE=8 g) and 162 g (SE=9 g), respectively, and differed significantly ($t=2.56$, $P=0.04$). The average mass of adult females was 111 g (SE=5 g) and was significantly less than adult males ($t_{11}=9.44$, $P<0.001$) and juvenile males ($t_{8}=5.60$, $P=0.001$). We did not observe any evidence of canine or facial injuries with the Edgar live traps. We observed 7 weasels (5 male, 2 female) in captivity for 5 days during 1998 (Table 1). Weasels readily occupied the nest box as a surrogate den. Radiocollars did not appear to hinder weasel use of the nest box, burrows, or coarse woody debris. Additionally, radiocollared weasels were efficient in capturing and handling prey (Table 1). Once weasels detected mice, they typically required $<2$ seconds to subdue mice and they cached prey in the nest box before foraging again. Weasels were not visibly compromised by the radiocollar while foraging in burrows or coarse woody debris.

Prior to release, we allowed all immobilized weasels to recover in a wooden nest box ($30 \times 30 \times 15$ cm) provisioned with 2-3 dead domestic mice. Nest boxes contained ventilation holes and a sliding door. We released weasels from the nest box 2-3 hours after handling procedures by opening the sliding door. In the field, we monitored newly
Table 1. Foraging behaviors and related activities of radiocollared long-tailed weasels (Mustela frenata) observed in captive trials conducted in west-central Indiana during 1998. One-hour observation trials were conducted daily over a 5-day period. All response variables are presented as means (with standard errors in parentheses) of the one-hour trials.

<table>
<thead>
<tr>
<th>Weasel #</th>
<th>Sex</th>
<th>Frequency of burrow usea (number/hour)</th>
<th>Use of coarse woody debrisa (number/hour)</th>
<th>Number of prey killed/ released</th>
<th>Time to killb (minutes)</th>
<th>Percentage time activec</th>
<th>Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M</td>
<td>male</td>
<td>7 (1)</td>
<td>10 (3)</td>
<td>3/3 (0/0)</td>
<td>1.3 (0.4)</td>
<td>38 (19)</td>
<td>1.7 ± 0.2</td>
</tr>
<tr>
<td>2F</td>
<td>female</td>
<td>2 (1)</td>
<td>1 (1)</td>
<td>1/3 (1/1)</td>
<td>7.5 (6.5)</td>
<td>2 (1)</td>
<td>1.1 ± 0.1</td>
</tr>
<tr>
<td>3M</td>
<td>male</td>
<td>8 (3)</td>
<td>5 (3)</td>
<td>4/4 (0/0)</td>
<td>1.6 (0.7)</td>
<td>22 (15)</td>
<td>1.8 ± 0.1</td>
</tr>
<tr>
<td>4M</td>
<td>male</td>
<td>3 (1)</td>
<td>2 (1)</td>
<td>2/4 (1/1)</td>
<td>4.9 (2.4)</td>
<td>17 (12)</td>
<td>1.5 ± 0.2</td>
</tr>
<tr>
<td>6F</td>
<td>female</td>
<td>5 (1)</td>
<td>2 (1)</td>
<td>2/3 (0/1)</td>
<td>7.6 (3.1)</td>
<td>8 (3)</td>
<td>1.4 ± 0.05</td>
</tr>
<tr>
<td>7M</td>
<td>male</td>
<td>5 (4)</td>
<td>2 (1)</td>
<td>2/4 (1/1)</td>
<td>1.4 (0.4)</td>
<td>12 (6)</td>
<td>1.2 ± 0.1</td>
</tr>
<tr>
<td>8M</td>
<td>male</td>
<td>4 (3)</td>
<td>2 (1)</td>
<td>3/4 (2/1)</td>
<td>0.9 (0.4)</td>
<td>3 (2)</td>
<td>1.3 ± 0.1</td>
</tr>
</tbody>
</table>

a Recorded as number of times weasel entered burrow or coarse woody debris (CWD).

b The time to kill was recorded for each predation event.

c Activity was characterized by active foraging and exploratory movements. Weasels were considered inactive when they remained in the nest box or in CWD.

flaw was remedied for subsequent collars. Females were tracked for a mean of 51 days (range = 8-108 days, Table 2), whereas males were tracked for a mean of 62 days (range = 5-158 days, Table 3). Transmitter range was 400-800 m for females and 800-1,600 m for males using a vehicle-mounted antenna system.

Our trapping data suggested that radiocollars did not compromise the health of free-ranging weasels. No neck chafing or irritation was observed in 5 radiocollared weasels we recaptured 14-34 days after their initial capture. Of these recaptures, 4 weasels exhibited no change in body mass and one weasel gained 30 g. Our field observations on weasel movements and behavior also suggested that radiocollars did not adversely affect foraging or reproduction in tagged weasels. We documented den use (coarse woody debris and subterranean) by 11 radiocollared weasels (5 females and 6 males). Mean diameter of den entrances was 30 mm (SE = 1.3 mm) and 40 mm (SE = 2.5 mm) for females and males, respectively. Additionally, during the breeding season, a radiocollared female maintained a den and 2 males exhibited nomadic movements with localized activity in female home ranges (T. M. Gehring, unpublished data).

Table 2. History and fate of female long-tailed weasels (Mustela frenata) radio-tracked in west-central Indiana from 1998 to 1999.

<table>
<thead>
<tr>
<th>Weasel #</th>
<th>Agea</th>
<th>Weight (g)</th>
<th>Dates</th>
<th>Number of days tracked</th>
<th>Fate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F</td>
<td>Adult</td>
<td>115</td>
<td>19 August–24 September 1998</td>
<td>37</td>
<td>Collar expired</td>
</tr>
<tr>
<td>5F</td>
<td>Adult</td>
<td>115</td>
<td>18 October 1998</td>
<td>0</td>
<td>Capture mortalityb</td>
</tr>
<tr>
<td>6F</td>
<td>Adult</td>
<td>100</td>
<td>21–28 October 1998</td>
<td>8</td>
<td>Collar malfunction</td>
</tr>
<tr>
<td>11F</td>
<td>Adult</td>
<td>105</td>
<td>21 February–8 June 1999</td>
<td>108</td>
<td>Collar expired</td>
</tr>
<tr>
<td>12F</td>
<td>Adult</td>
<td>135</td>
<td>30 June–5 October 1999</td>
<td>98</td>
<td>Collar expired</td>
</tr>
<tr>
<td>13F</td>
<td>Adult</td>
<td>110</td>
<td>8–16 July 1999</td>
<td>9</td>
<td>Shed collar</td>
</tr>
<tr>
<td>14F</td>
<td>Adult</td>
<td>100</td>
<td>12 July–24 August 1999</td>
<td>44</td>
<td>Collar malfunction</td>
</tr>
</tbody>
</table>

a Determined by presence of nipples (Wright 1948, King 1989).

b Not included in calculation of mean number of radio days.

Discussion

Chemical immobilization of weasels with ketamine HCl and xylazine HCl was characterized by short induction times. Belant (1992) reported slight trembling in short-tailed weasels (M. erminea) immobilized with ketamine HCl. However, our combined dose of 25 mg/kg ketamine HCl and 2 mg/kg xylazine HCl produced no visible seizures.
or muscle rigidity and provided approximately 25 minutes for safe handling. Recovery from anesthesia likely was aided by use of a nest box, which provided a dark, secure environment.

We did not maintain a control group of uncollared weasels in captivity with which to compare our radio-collared sample. However, our observations on the foraging behavior of captive and free-ranging radio-collared weasels provided several indirect measures of the effects of radio-collars. Radio-collars might influence the foraging behavior of weasels if the collar and transmitter package interfere with a weasel’s ability to: 1) use tunnels, 2) capture and subdue prey, and 3) consume food.

Simms (1979) documented minimal passable tunnel diameters for female (n=9) and male (n=9) long-tailed weasels based on captive experiments with uncollared individuals. He reported a mean minimal tunnel diameter of 27.1 mm (range=26-30 mm) and 35.6 mm (range=32-40 mm) for females and males, respectively (Simms 1979). Radio-collared weasels in our study successfully accessed dens with entrance diameters similar to those reported by Simms (1979). Captive radio-collared weasels in our study were proficient in capturing and subduing live domestic mice and displayed stereotypic killing techniques, such as nape biting, throat biting, and pulling prey from cover prior to a nape bite (Glover 1943, Hcidt 1972, Byrne et al. 1978, King 1989). Although mean time from prey release to kill varied (see Table 1), weasels perceived a prey item they quickly attacked and killed it. Food consumption rates for our captive radio-collared weasels were similar to those reported by DeVan (1982). He found that uncollared male radiocollared common weasels (M. nivalis) compared to trapping data obtained prior to radiotagging. However, Delattre et al. (1985) collared only 2 male weasels and obtained telemetry data for a 10-day period. Radio-collared animals often spend several days becoming acclimated to collars (White and Garrot 1990). We found that long-tailed weasels often remained fairly sedentary for 1-4 days after radio-collaring and release. Thus, results of Delattre et al. (1985) may demonstrate temporary changes in movement behavior during this acclimation period.

DeVan (1982) radio-tracked 5 male long-tailed weasels for 1-34 days. The mean weight of transmitter packages was 12.6 g or 6.3% of body weight. He suggested that the transmitter package did not interfere with normal movements (DeVan 1982). DeVan (1982) did not radiotag female long-tailed weasels, but suggested that a 6-g transmitter would be suitable. We used a 6.5-g transmitter for males (3.4% of body weight) and a 3.2-g transmitter for females (2.9% of body weight), which conforms with recommendations that transmitter packages should be ≤5% of body weight (Cochran 1980, Anderka 1987, American Society of Mammalogists 1993). We believe that this smaller and lighter collar design resulted in a relatively short acclimation period and was less of a burden for foraging weasels.

Transmitter range was adequate given the road network in our study area and we often searched <30 minutes for the initial location of radio-collared individuals using a vehicle-mounted antenna system. A 50% reduction in range (e.g., as commonly reported for radio implants) would have increased

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**Table 3.** History and fate of male long-tailed weasels (Mustela frenata) radio-tracked in west-central Indiana from 1998 to 1999.

<table>
<thead>
<tr>
<th>Weasel #</th>
<th>Agea</th>
<th>Weight (g)</th>
<th>Dates</th>
<th>Number of days tracked</th>
<th>Fate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M</td>
<td>Adult</td>
<td>230</td>
<td>13-21 July 1998</td>
<td>9</td>
<td>Shed collar</td>
</tr>
<tr>
<td>3M</td>
<td>Adult</td>
<td>200</td>
<td>20 August–13 September 1998</td>
<td>25</td>
<td>Killed by musteld</td>
</tr>
<tr>
<td>4M</td>
<td>Adult</td>
<td>190</td>
<td>6 October 1998–12 March 1999</td>
<td>158</td>
<td>Killed by raptor</td>
</tr>
<tr>
<td>7M</td>
<td>Adult</td>
<td>195</td>
<td>22–26 October 1998</td>
<td>5</td>
<td>Shed collar</td>
</tr>
<tr>
<td>8M</td>
<td>Juvenile</td>
<td>175</td>
<td>28 October–2 December 1998</td>
<td>36</td>
<td>Collar malfunction</td>
</tr>
<tr>
<td>9M</td>
<td>Adult</td>
<td>175</td>
<td>26 January–10 June 1999</td>
<td>136</td>
<td>Collar expired</td>
</tr>
<tr>
<td>10M</td>
<td>Adult</td>
<td>180</td>
<td>19 February–6 May 1999</td>
<td>77</td>
<td>Unknown</td>
</tr>
<tr>
<td>15M</td>
<td>Juvenile</td>
<td>143</td>
<td>9 November 1999–14 February 2000</td>
<td>98</td>
<td>Collar still functioning</td>
</tr>
<tr>
<td>16M</td>
<td>Juvenile</td>
<td>165</td>
<td>30 January–14 February 2000</td>
<td>16</td>
<td>Collar still functioning</td>
</tr>
</tbody>
</table>

n=5 and female (n=4) long-tailed weasels consumed an average 25.5% (SE=1.4%) and 35.8% (SE =2.0%) of their body mass/day during the first 15 days in captivity when provided with live domestic mice (DeVan 1982). Thus, the foraging behavior of weasels did not appear to be substantially modified by radio-collars.

Delattre et al. (1985) reported changes in movement behaviors of
amount of search time and likely limited number of locations obtained. Eagle et al. (1984) reported that the surgical procedure for intraperitoneal implants in mink was simple and relatively quick. However, for long-tailed weasels, we suggest that radiocollaring would be a simpler, less invasive, and less time-consuming process, especially when replacing expired transmitters.

**Recommendations**

The immobilization and radiocollaring techniques that we used for long-tailed weasels provided efficient and safe handling of most weasels we captured. We believe that our modified protocol to handle potentially hypothermic animals and using Edgar live traps reduced risk of capture mortality and injuries substantially. Similarly, the "slow release" system we used with a nest box allowed immobilized weasels to recover adequately in a secure environment. The criteria we used to radio-collar weasels were necessary to determine collar fit and we suggest that researchers should use and improve them in future weasel studies. Researchers should strive to use the lightest and most streamlined radio-collar design available while maintaining adequate battery life and transmitter range.

King and Edgar (1977) suggested that a nest box attachment should be used with the Edgar live trap to ensure the health and safe immobilization of weasels. Although we did not use this attachment, we concur with them in the potential advantages of a nest box attachment relative to the well being and handling of captured weasels. A nest box attachment (with bedding) would provide a secure environment for potentially hypothermic individuals, thereby possibly reducing the need to hold these individuals for 6-8 hours. Furthermore, it might provide an effective immobilization chamber. Isoflurane or an equivalent inhalant anesthetic administered by a portable regulator could be used as the initial immobilizing agent to remove weasels from the nest box. Subsequently, an intramuscular injection of 25-mg/kg ketamine HCl and 2-mg/kg xylazine HCl would provide effective immobilization for radio collar weasels. We believe that this modification to the handling protocol would significantly reduce the handling stress to weasels. We believe that future researchers would benefit by using these techniques with all weasels (*Mustela* spp.).

**Acknowledgments.** We thank the American Society of Mammalogists, Furbearers Unlimited, and Purdue University for funding. D. E. Biggins, S. Erlinge, C. M. King, R. A. Powell, and L. Thomasma provided valuable advice during the initial stages of this study. We thank C. M. King, H. P. Weeks, Jr., and an anonymous reviewer for providing comments that improved the manuscript. We are grateful to S. Peachey, R. Becker, J. Osbourne, and T. Preuss for field assistance. We thank the numerous private landowners for allowing us to conduct this research on their lands.

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