Long-tailed Weasel (*Mustela frenata)* Distribution Survey in Arkansas: Challenges in Detecting a Rare Species

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Running Title: Long-tailed Weasel Distribution

Abstract

Long-tailed weasels (*Mustela frenata*) have one of the widest distributions of mustelids in the western hemisphere and were distributed across a majority of the American continents ranging from Canada through the contiguous United States, Mexico, and into northern South America. However, on a local scale they are considered uncommon and rare. We assessed the distribution of long-tailed weasels across Arkansas to determine occupancy in each ecoregion of Arkansas, and determined the detectability on two local, adjacent sites. No long-tailed weasels were detected within the ecoregions, but the species was detected with intensive sampling on one local site. It should be emphasized that although the species was not detected within the ecoregions, this does not indicate it does not occur broadly across the state.

Introduction

Long-tailed weasels (*Mustela frenata*) have one of the widest geologic and ecologic ranges of mustelids in the western hemisphere (Fagerstone 1987) and historically were distributed across a majority of the American continents (Sheffield and Thomas 1997). Ranging from Canada through the contiguous United States, Mexico, and into northern South America, the species exhibits a broad distribution. However, on a local scale they are considered uncommon and rare due to low densities and their secretive nature (King and Powell 2007; Fagerstone 1987). Densities for most populations are unknown, though some states, such as Kansas, estimate local densities range from 1 to 32 per km^2 (Timm *et al*. 2019) depending upon prey availability and habitat. Knowledge of status and distribution at the regional scale of long-tailed weasels is lacking. Conservation and management of *M. frenata* would benefit from an increased understanding of the species and its distribution at the regional scale.

Status of long-tailed weasels in Arkansas is currently not known. Sealander and Heidt (1990) report the species as widespread, but rare in Arkansas; similar to its continental range. Availability of prey, such as pocket gophers (*Geomys spp.*), and suitable habitat, notably presence of permanent water sources (King and Powell 2007), likely dictates presence and density of long-tailed weasels. Listed as a species of least concern by the International Union for Conservation of Nature (IUCN 2014), it may be listed differently in individual states (Reid and Helgen 2008). In Arkansas, the long-tailed weasel is listed as a Species of Greatest Conservation Need (State Rank – S3 (Fowler 2015)); however, hunting and trapping seasons for the species are still open (Sasse 2012). Some neighboring states also list the species as protected or list it as a species of special concern. For example, Missouri lists *M. frenata* as Vulnerable and a Species of Conservation Concern (MDC 2014), and Louisiana considers the species rare (LDWF 2014).

Our goal was to assess the distribution of long-tailed weasels across Arkansas. Specifically, our objectives were to: (1) determine occupancy in each ecoregion of Arkansas, and (2) determine the detectability on two local, adjacent sites. These efforts were intended to better inform managers and biologists of where the species occurs and how to most effectively sample for the species.

Study Areas

Statewide

The study was conducted across the state of Arkansas in each of the ecoregions and included wildlife management areas, national wildlife refuges, and national forest properties. Four ecoregions (Figure 1), including the Ozark Mountains (Ozark Mountains, Boston Mountains, and Arkansas Valley), Ouachita

Mountains, Gulf Coastal Plain, and Mississippi Alluvial Valley (including Crowley's Ridge) occur in Arkansas. The Ozark Mountains region has narrow valleys walled by steep mountains, except the Arkansas River Valley which has broad valleys. Geology in this region is primarily sandstone and limestone with some dolostones in the oldest surface rock (Arkansas Geological Survey 2015). Cover types in the Ozark Mountains include savanna, prairie, and oak-hickory or oak-hickory-pine forests at higher elevations. At lower elevations, bottomland hardwood forests dominate (Omernik and Griffith 2014). Additionally, cedar glades are also present where soil is shallow (30 - 61 cm; Arend and Collins 1949).

The Ouachita Mountains are an east-west trending range with valleys that vary from narrow to broad and surface geology that is equally variable including shale, sandstone, and chert (Arkansas Geological Survey 2015). Oak-hickory-pine forests with open, grassy woodlands on south-facing slopes are the dominate cover type in the Ouachita Mountain region (Omernik and Griffith 2014).

The Gulf Coastal Plain is characterized by gently rolling hills made of sand, silt, clay, and gravel (Arkansas Geological Survey 2015). The Gulf Coastal Plain has oak-hickory-pine forests in the upland areas and hardwoods dominate the bottomlands (Omernik and Griffith 2014).

The Mississippi River shaped the eastern portion of the state, known as the Mississippi Alluvial Plain, depositing sediments such as sand, silt, clay, and gravel. Additionally, portions of this region have loess hills that provide the only topographic relief of the eastern section of Arkansas (Arkansas Geological Survey 2015, Omernik and Griffith 2014). Bottomland hardwoods and agricultural croplands dominate the Mississippi Alluvial Valley (Omernik and Griffith 2014).

Camp Robinson Special Use Area-Stone Prairie Wildlife Management Area

The Camp Robinson Special Use Area (CRSUA) and the Stone Prairie Wildlife Management Area (SPWMA) are located in Faulkner County, Arkansas. Camp Robinson Special Use Area is approximately 4,029 acre in size and the Stone Prairie WMA is approximately 898 acres in size (Figure 2). These two areas were chosen because of the perceived likelihood of the species occupying the sites. The CRSUA is managed intensely for bird dog training and field trials. As such, prescribed burns were conducted each winter. The SPWMA was recently purchased (March 2017) as a wildlife management area for the purpose of Northern Bobwhite (*Colinus virginianus*) restoration.

Both areas are within the Ouachita Mountains and have a sandstone, chert, shale, and novaculite parent material for soils (Arkansas Geological Survey 2015). Open fields and oak-savannahs dominate the CRSUA, while open grasslands and oak-pine woodlands are the dominate cover types on the SPWMA.

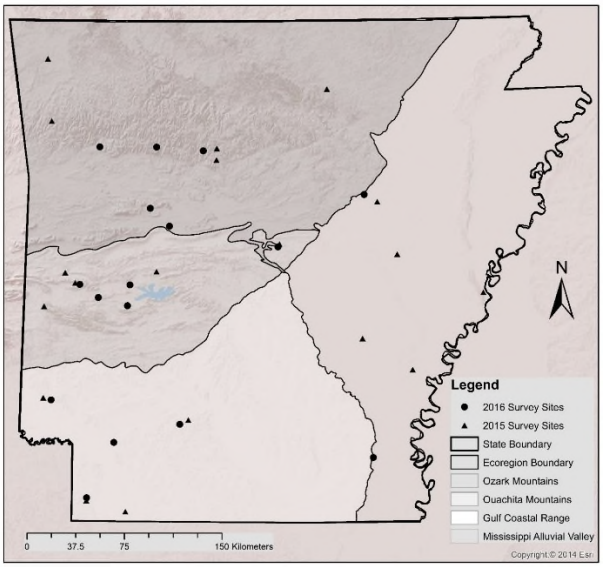

Figure 1. Sites sampled in Arkansas for long-tailed weasels (Mustela frenata) from 8 March to 15 June 2015 (circles) and from 24 February to 8 May 2016 (triangles) to determine occupancy and detectability.

Figure 2. Camp Robinson Special Use Area and adjacent Stone Prairie Wildlife Management Area (formally owned by the Nature Conservancy) sampled to assess methods to detect long-tailed weasels in winter 2017.

Methods

Data Collection

Long-tailed weasels are found in association with waterways adjacent to fields and forests (Schwartz and Schwartz 2001). As such, we created a sampling frame of potential sites based on those habitat features modeled in a GIS. Locations that were sampled (Figure 1) were randomly selected from the sampling frame. ArcMap® 10.2.1 was used to develop a sampling frame. Habitat covariates thought to be important to long-tailed weasels included open and forest cover types, proximity to permanent water, soil type (based on pocket gopher preferences identified by Kershen (2004)), and past presence of pocket gophers. These habitat layers were intersected in a GIS. A 200 m buffer was placed around the output of the data intersection; this distance represents the average distance traveled for foraging by weasels (Gehring and Swihart 2004). Finally 100 random points were generated as the sampling frame. We randomly selected 20 sampling points, five in each physiographic region, from the sampling frame as survey sites for each year of sampling (Figure 1). Publicly-owned land, such as state and federal lands (e.g., Arkansas Game and Fish Commission (AGFC), United States Forest Service (USFS) or National Wildlife Refuges (NWR)), was largely represented in the sampling scheme, but privately-owned property was also surveyed. We collected data from late February to mid-June because long-tailed weasel movement is increased during that time of year (Downey 2004).

The single species, single season approach (Mackenzie *et al.* 2006) was used with *a priori* assumptions for probability of detection, probability of occupancy, and variance set at $p = 0.1$, $\Psi = 0.1$, and $var(\Psi) = 0.2$, respectively. Values for probability of detection and occupancy were set low to account for the difficulty in detecting this species. Variance was liberal to account for the expected, sporadic detection of the species. The optimum number of surveys per site selected for this project was 14 (MacKenzie *et al.* 2006). Therefore, 14 stations per site were established. Stations were separated by $\geq$ 0.5 km and placed at least 50 m from roads and trails.

A station consisted of 2 track stations, 1 camera trap, and 2 hair traps to detect long-tailed weasels. Track stations are considered the most effective and inexpensive method of sampling weasels (Downey 2004). Track stations were housed in a small, wooden cubby, 60 cm in length that is open at both ends (Figure 3). On either side of the bait (approximately 20 g of raw chicken), a 20-cm aluminum plate covered with a fine layer of toner (King and Edgar 1977) was placed with contact paper on the innermost third of the plate for track collection. In addition to bait, we sprayed predator attractant (Wildlife Research® Paws and Claws, Ramsey, MN, USA) at the site. We replaced bait, contact paper, and toner as needed, but predator scent was refreshed at the station daily. All tracks were identified to species.

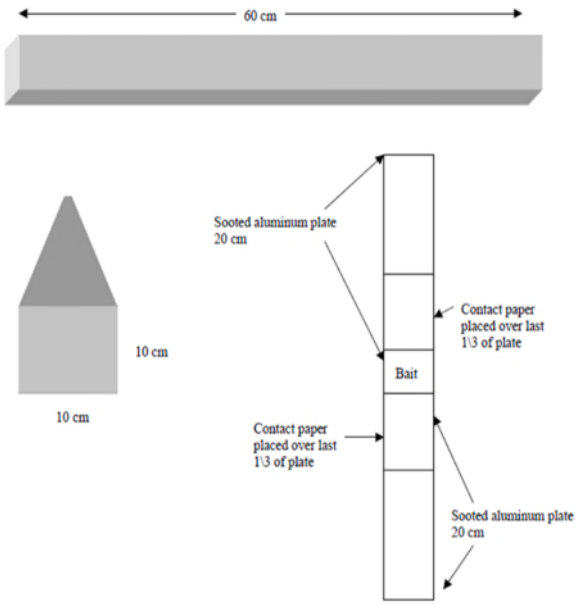

Figure 3. Cubby design used to house track plates to Arkansas 8 March - 11 June 2015 and 24 February - 8 May 2016.

The second detection technique used was a camera trap (Browning® Strike Force HD camera, Morgan, UT, USA). One camera was placed at each station to record images at a rate of 3 frames/sec for 2 sec when triggered by movement. At each station, cameras were mounted 0.5 - 1.0 m above ground on natural vegetation (i.e., trees) and 2.5 - 3.0 m from the cubby. We identified photos of animals to species as quality allowed (O'Connell and Bailey 2011). Hair traps, the third detection technique, were made of wooden dowels mounted on each side of the bait in the cubby, 3.75-cm from the floor of the cubby, rolled with packing tape (Henry *et al.* 2011). We collected tape with hair and stored it in envelopes with desiccate until returning to the lab (Kendall and McKelvey 2008). In the lab, hair was removed from the tape, placed on a glass slide and identified to species using a dichotomous hair key (Debelica and Thies 2009).

We checked stations daily for three nights at each site; bait, batteries, and memory cards were replaced as needed. During 2016, randomly selected sites were sampled additional nights to assess the effect of longer

sampling duration. The same methods were applied to the local, intensive sampling on the CRSUA and the SPWMA. We randomly selected locations across each area using a GIS. Research followed guidelines of the American Society of Mammalogists (Sikes *et al.* 2011) and was approved by the Tennessee Technological University Institutional Animal Care and Use Committee (#2014-001).

Results

Statewide

Data collection to estimate the distribution and status of long-tailed weasels in Arkansas occurred from 8 March to 11 June 2015, and from 24 February to 8 May 2016. Due to extensive flooding, one survey site in the Gulf Coastal Plain was not sampled in 2015; additionally, one survey site in the Ouachita Mountains and three sites in the Mississippi Alluvial Plain were not sampled in 2016.

During the 2015 season, 18 of 19 sites were on public land and all 16 sites in 2016 were on publicly-owned land. A total of 14 mammalian species was detected in 2015 (Table 1) and 18 species were detected in 2016 (Table 2). Species detected most often both years included northern raccoons (*Procyon lotor*), Virginia opossums (*Didelphis virginiana*), bobcat (*Lynx rufus*), and coyotes (*Canis latrans*). Most detections occurred with the infrared-triggered cameras, but some Virginia opossum detections were from tracks or hair traps. Northern raccoons and Virginia opossums were the most detected species in both years. Species detected the least were spotted skunk (1 site, both years) and striped skunk (1 site, 2016 only).

Of the 35 sites sampled, none resulted in long-tailed weasel detections. Previously, based on examination of hair with a microscope, we falsely detected long-tailed weasels in 2015. This was attributed to the similarity of morphology and hair size of long-tailed weasel and Virginia opossum hair. Genetic analyses confirmed that suspected long-tailed weasel detections were actually *D. virginiana*. Although this is not a promising result, it should be emphasized that although the species was not detected, this does not indicate it does not occur in the state.

Camp Robinson Special Use Area-Stone Prairie Wildlife Management Area

A total of 35 sites, 16 sites on CRSUA and 19 sites on SPWMA, was sampled. Sites were sampled from 7 February through 31 March on the CRSUA because of public events (e.g., field trials) being held, and sites were sampled from 7 January through 31 March on the SPWMA. Cameras were operable an average of 32.5 (± 17 (1 s.d.)) trap days on CRSUA and for 57.2 (± 22 (1 s.d.)) trap days on the SPWMA; a total of 1,606 trap days were surveyed for both sites. A total of 14,626 images of animals was taken on the CRSUA, and 35,319 images were taken on SPWMA; the total number of images taken on these two adjacent sites was 49,945. Cameras were set to capture three images per second for two seconds, and 8,324 events were captured.

Deer, northern raccoons, Virginia opossums, rabbits (Eastern cottontail and swamp) and squirrels (gray and fox) were the five most common species captured on the cameras (Table 3).

Only one (1) long-tailed weasel was captured by a camera (Figure 4). That image was captured 21 days after the site was established. The site where the image was captured had 44% canopy cover, 60% litter, 40% herbaceous cover, 10% visual obstruction at 1 m above the ground, was adjacent to a stream (~3.5 m) and 240 m from the nearest road. The overall success rate, based on the number of events, was 0.002%. No evidence of long-tailed weasels was observed with track plates or hair traps.

Discussion

Statewide

Although long-tailed weasels were not detected in Arkansas in the statewide portion of the study, the lack of detection does not indicate the species is absent from the state. We expected the species to be difficult to detect, thus the *a priori* assumption of a low detection rate. However, in occupancy studies such as the current study, false absences can occur with no solution to account for this issue (MacKenzie *et al*. 2006). There are several possible explanations for the absence of *M. frenata* detections in this study; some were the result of logistical constraints, some resulted from unpredictable and extreme abiotic events, and some were likely due to the absence of the species.

We followed the recommendations of Downey (2004) to determine the optimum time of year for this survey. In previous studies, surveys for *M. frenata* have occurred in the late winter and early spring months, approximately March through May (Downey 2004; Fowler and Golightly 1994). This time frame has been determined to be a period of increased activity for the species; thus, increasing the likelihood of detection. The studies by Downey (2004) and Fowler and Golightly (1994) both occurred at northern latitudes (Alberta and Placer County, California). Timing of high activity in

Table 1. Five most numerous species detected by site between 1 March and 15 June 2015 in Arkansas.

Site	Species				
	Northern Raccoon	Virginia Opossum	Bobcat	Coyote	American Mink
Camp Robinson WMA	X	X			
Miller Farms	X	X			
NACA	X	X		X	
Devil's Den SP	X	X	X		
Ouachita NF 45	X	X		X	
Ouachita NF 39	X	X		X	
Ouachita NF 30	X	X		X	
Pond Creek NWR	X	X			X
Poison Springs WMA		X			
Sulphur River WMA					
Lafayette WMA	X	X	X		X
Ozark NF 4	X		X	X	
Ozark NF 19	X		X	X	
Hurricane Lake WMA	X	X	X		
Dagmar WMA	X	X	X		
White River NWR	X	X		X	X
Ouachita NF 34	X	X			
Bayou Meto WMA	X	X	X		
St. Francis NF	X	X	X		
Total Sites Detected	17	16	8	7	3

the species may differ in the Southeast compared with the locations of these previous studies. Adjusting the survey time frame to encompass the winter months of December to March as Gehring and Swihart (2004) did in their northern Indiana trapping efforts may increase the likelihood of detecting long-tailed weasels in Arkansas. However, the current Arkansas trapping season for furbearers, including weasels and similarly-sized furbearers (e.g., American mink (*Neovison vison*)), is open during these months (Sasse 2014). In the last 25 years, very few captures, including incidental captures, of *M. frenata* have occurred during the Arkansas furbearer trapping season (Sasse 2012). Moving the survey time frame to late-spring and early- or mid-summer may be an option considered by managers and future researchers.

Most carnivore surveys implement sites for at least 10 to 14 days and often much longer periods of time to increase the likelihood of detection (Kendall and McKelvey 2008). During the current study, 14 stations at each site were left out for three nights on most occasions. Duration of stations ranged from 2 to 8 nights. During the 2015 season, some sites required up to 2.5 to 3 hours of driving time to reach the next closest site and time to set stations was limited by daylight. During the 2016 stations, the maximum driving time between sites was approximately 2 hours, so all sites were set in the first day of each 4-day trip. However, on one occasion, flash flooding prompted the early removal at two sites in southwestern Arkansas. Additionally, four sites remained out for 7 to 8 nights. Although the sites with longer duration did not produce *M. frenata* detections, increasing the duration of surveys across all sites may increase the probability of detection if long-tailed weasels are present. In a study by Foresman and Pearson (1998) of forest carnivores in southwestern Montana, American marten (*Martes americana*) latency to detection (LTD) ranged from 2.3 to 24.0 days. The mean LTD from this study across two methods (sooted-track plates and remote cameras) and three species was 13.5 $\pm$ 4.9 days; they indicated a range of 8.6 to 18.4 days was required to detect American marten, fisher

Table 2. Five most numerous species detected by site between 24 February and 8 May 2016 in Arkansas.

Site	Species				
	Northern Raccoon	Virginia Opossum	Coyote	American Black Bear	Bobcat
Cut-Off Creek WMA	X	X			
Bald Knob NWR	X				
Bois D'Arc Creek WMA	X	X			
Camp Robinson WMA	X				X
Ouachita NF 28	X				
Ouachita NF 33	X				
Ouachita NF 37	X	X			X
Ouachita NF 41	X	X			
Ozark NF 3	X	X	X	X	
Ozark NF 11		X		X	
Ozark NF 22		X			
Ozark NF 23	X	X	X	X	
Petit Jean River WMA	X	X	X		X
Poison Springs WMA		X			
Pond Creek NWR	X	X	X		
Sulphur River WMA	X				
Total Sites Detected	13	11	4	3	3

(*Pekania pennant*), and wolverine (*Gulo gulo*, Foresman and Pearson 1998). A similar time period may be required to detect long-tailed weasels because of their secretive nature, low populations densities, and small size (King and Powell 2007). We compensated for the temporal aspect by spatially sampling at 14 locations within a single site.

Long-tailed weasels occupy a wide variety of habitats and inhabit more ecoregions than any other member of the mustelids. The generalist nature of this species is the primary reason for their occupancy of low- to high-elevation ecoregions (Fagerstone 1987; Pasch and Pino 2013). Cover types the species occupies range from open areas such as prairies, marshes, meadows, alpine, and agricultural areas to fencerows, thickets, brushlands, open woodlands (e.g., oak savannas), swamps, and to some extent, forests (Fagerstone 1987; Sealander and Heidt 1990; Schwartz and Schwartz 2006; LDWF 2014). The lack of knowledge regarding specific habitat preferences of long-tailed weasels makes it difficult to select areas where opportunity for detection is increased. Ultimately, habitat preference is likely driven by prey availability and areas with diverse habitat patches tend to provide higher prey biomass and diversity (Gamble 1981).

Obtaining access to large tracts of privately-owned property proved difficult in 2015; therefore, this survey was restricted to surveying publicly-owned property for most of 2015 and all of 2016. Due to a randomized survey design, some sites were located in large tracts of forest owned by federal or state agencies, often in pine (*Pinus spp.*) plantations. Late seral stage forests and pine plantations exhibit lower biodiversity, including species that may be considered prey for long-tailed weasels; as such several survey sites had a reduced likelihood of habitation by *M. frenata* (Estades and Temple 1999, Gamble 1981). Additional access to privately-owned property would have increased the opportunity to survey portions of the state and habitat surrounding pasture, old fields, and hay fields, including favored prey species such as voles (*Microtus spp.*) and pocket gophers (*Geomys spp.*, Gamble 1981). Increased ecotones (i.e., edge habitats) should exhibit increased prey availability and future research may benefit from

Table 3. Number of sites that were visited by different mammalian species of the total sampled on the Camp Robinson Special Use Area (n = 16) and Stone Prairie Wildlife Management Area (n = 19) from 7 January to 31 March 2017.

Species	Camp Robinson SUA	Stone Prairie WMA
Northern Raccoon	13	15
Virginia Opossum	12	13
Squirrel (grey and fox)	12	11
Rabbit (Eastern cottontail and swamp)	12	12
White-tailed Deer	10	16
Armadillo	8	9
Coyote	7	8
Fox (Gray or Red)	6	3
Rat (*Rattus* spp.)	4	7
Bobcat	4	4
Feral Cat	3	0
Otter	2	0
Striped Skunk	2	8
Mouse (Species unknown)	1	1
Long-tailed Weasel	1	0
Unknown	1	2

diversifying land ownership, and thus habitat types, of survey sites for long-tailed weasels.

During both survey seasons, sites in the southern and eastern portions of Arkansas experienced extensive and, in some cases, long-term flooding. Flooding prevented surveys at 5 sites over the 2 years and reduced time spent at 2 sites. The effect of flooding on small mammals is generally in the form of displacement or death and little is known about recolonization rates (Triska *et al*. 2011). In a study of fisher in North Dakota riparian habitat, an extreme flood event occurred in the spring of 2009 with >95% of suitable habitat inundated for 7-8 weeks. Researchers expected detection rates to be greatly reduced from the 2008 surveys to the 2009 surveys. However, they found that fisher returned to the area 15 days after the river receded to below flood stage and 75 days after initial flooding (Triska *et al.* 2011). These findings suggest that medium-sized, highly-mobile mammals can recolonize an area relatively quickly after extreme flooding events. Conversely, Wijnhoven *et al.* (2006) found that it may take 9 months or more for small mammals to recolonize an area after flood water recedes. Although long-tailed weasels are a highly-mobile species, they are also considered a small mammal. Additionally, they depend on a high abundance of small mammals (namely rodents) due to their high metabolism. Long-tailed weasel populations displaced by extreme flooding events may take as long, or longer, than their prey base to return to habitat occupied prior to flooding. Because of the high probability of floods occurring in portions of Arkansas, detecting long-tailed weasels is further complicated due to sporadic fluxes in local distribution and potential prey abundance.

Land use changes over the last few decades, coincidental with the absence of long-tailed weasels in the trapping harvest, likely played a role in the lack of evidence of the species in the surveys. A very large percentage of the state has been in agriculture (41%) or saw-log production (57%), and the number of acres in agriculture and saw-log production increased by 100,000 acres and 300,000 acres, respectively, from 2010 to 2013 (University of Arkansas 2011, 2014). With a growing percentage of the state being managed for agriculture and timber, it is likely that our findings are, in fact, correct in that there were no long-tailed weasels where we randomly sampled. It should be noted that it is not possible to demonstrate the absence of a species with certainty.

Camp Robinson Special Use Area-Stone Prairie Wildlife Management Area

The local, intensive survey of two adjacent sites yielded the only observation of a long-tailed weasel during the study. The assumption of 14 trap days being required to observe an individual on a site was not met

Figure 4. Long-tailed weasel image captured 3 March 2017 on the Camp Robinson Special Use Area.

(MacKenzie *et al*. 2006). On our sites it appeared no less than 21 days were required to observe one individual; this is based on the fact that the site at which the image of the weasel was captured (#39) was operational for 21 days when the image was taken. However, there were 28 other sites operational during the same period as site #39. Based on the collective effort across the CRSUA and SPWMA and just the period site #39 was operational, the minimum number of "trap days" required to capture that image was 580; some sites were operational for more than a month prior to the site that captured the image was established. Moreover, many of the sites were operational for up to 3 weeks following capture of the image without any other instances of a long-tailed weasel being observed.

Given the images of the long-tailed weasel that were captured, there was no apparent interest in the cubby, lure, or bait that was at the station; the image appeared to be captured randomly. This observation is in comparison to the other furbearers, such as northern raccoons, Virginia opossums, coyotes, otters, and skunks, which were captured in images. Typical behavior includes some investigation of the cubby at least. While this may have occurred during the time delay following the six images that were taken, the individual did not remain in the area long enough for additional images to be captured. While use of cubbies are productive in the northern extent of the species distribution, their use in Arkansas was not. This is an area of interest that will require further investigation.

Acknowledgments

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