

## Issues and Perspectives

# A Review of Camera-Trapping Methodology for Eastern Spotted Skunks

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## Abstract

Eastern spotted skunks *Spilogale putorius* are an understudied species that has experienced range-wide declines. Over the past 16 y, camera traps have become an increasingly common tool to monitor and understand their current distribution. To inform best surveying practices, we reviewed 16 camera-trap studies specifically targeting this species. We focused on reported latency to initial detection and three main aspects of study design: seasonality of detections, baits and lures, and camera-trap brands. Latency to initial detection ranged from 1 to 82 d with a mean of 17.1 d (SD = 9.1). Attractants varied among projects, but most (75%) used sardines as bait. The percentage of skunk detections tended to vary across the year, with the highest percentage of skunk detections occurring in March (92%). We conclude by suggesting best practices and directions for future research techniques that will aid in developing more efficient methods to address key knowledge gaps for this elusive species. Given the long timeframes for latency to initial detection, monitoring individual sites for at least 4 wk, with the use of bait, is likely the best strategy to detect eastern spotted skunks. We encourage further experimental approaches on the effectiveness of different baits and lures, and methods to increase latency to initial detection. Collectively, we hope this leads to the development of a standardized monitoring approach that researchers can implement across studies and states within the eastern spotted skunk's range.

Keywords: camera trap; eastern spotted skunk; *Spilogale putorius*; monitoring; lure

Received: August 2021; Accepted: March 2022; Published Online Early: March 2022; Published: June 2022

Citation: Dukes CG, Jachowski DS, Harris SN, Dodd LE, Edelman AJ, LaRose SH, Lonsinger RC, Sasse DB, Allen ML. 2022. A review of camera trapping methodology for eastern spotted skunks. *Journal of Fish and Wildlife Management* X(X):xx-xx; e1944-687X. <https://doi.org/10.3996/JFWM-21-073>



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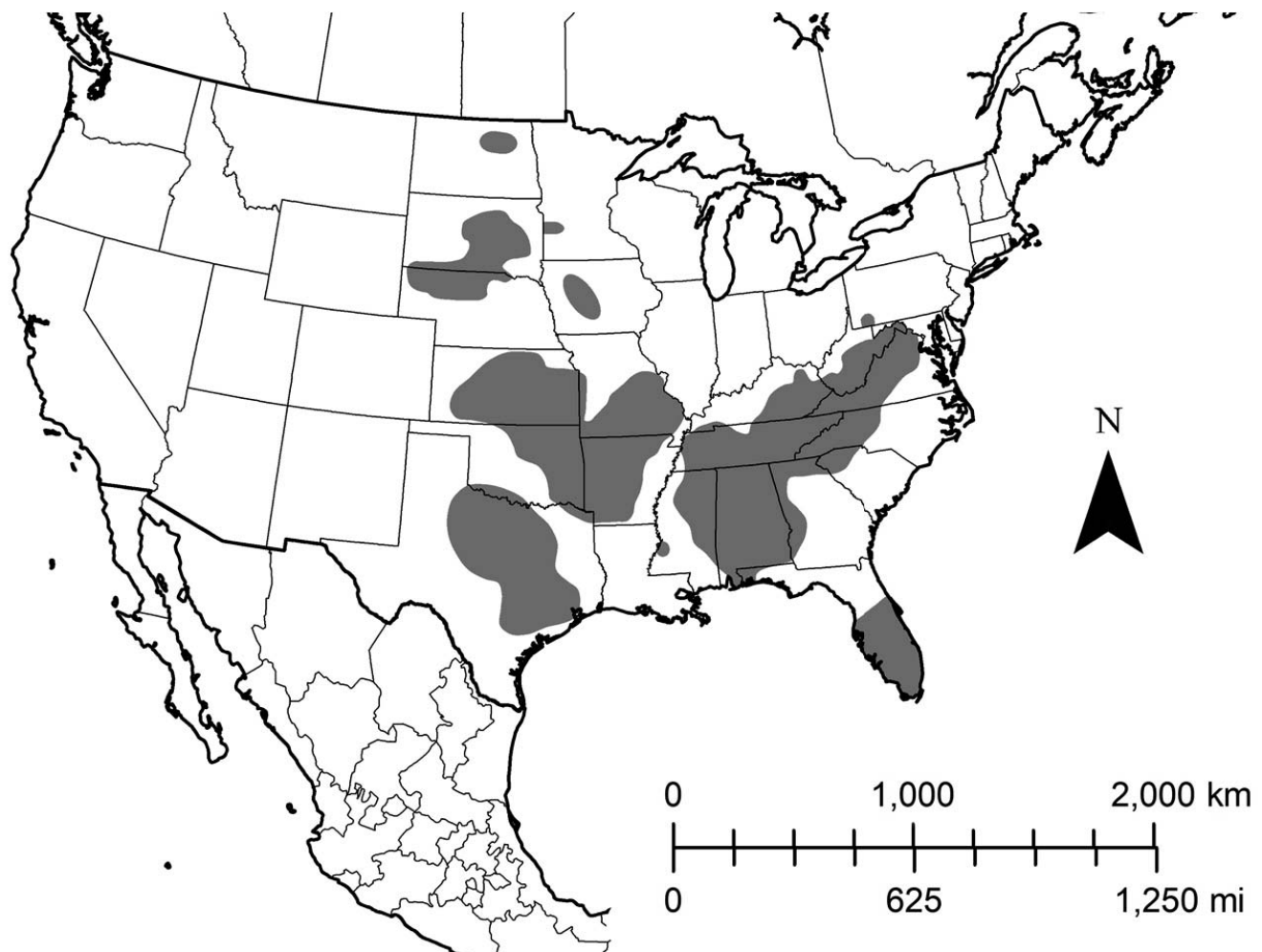
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## Introduction

Eastern spotted skunks *Spilogale putorius* were once widely distributed throughout much of the central and southeastern United States but have experienced range-wide declines since the mid-1900s (Gompper and Hackett 2005; Jachowski and Edelman 2021; Figure 1). Subsequently, the eastern spotted skunk has become a species of concern for many wildlife agencies and organizations in the United States (Jachowski and Edelman 2021). The eastern spotted skunk is listed as vulnerable in the International Union for Conservation of Nature Red List (Gompper and Jachowski 2016), and the

subspecies plains spotted skunk *S. p. interrupta* is under review for protection under the Endangered Species Act by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2012, Gompper and Jachowski 2016). The Eastern Spotted Skunk Cooperative Study Group (ESSCSG) is a group of biologists focused on enhancing communication about, identifying research priorities for, and facilitating cooperative research about eastern spotted skunks (Jachowski and Edelman 2021).

Until recently, the eastern spotted skunk had received little attention. Historically, most eastern spotted skunk presence data came from harvest, museum, and pelt purchase records (Gompper and Hackett 2005; Campbell



**Figure 1.** A map showing the contracted current range of eastern spotted skunks *Spilogale putorius* (gray shading).

et al. 2010; Sasse 2019). Over the past two decades, observations of eastern spotted skunks have been more frequently reported from track plate and camera-trap studies (Gompper and Hackett 2005; Hardy 2013), incidental live trapping (Diggins et al. 2015), and roadkill reports (Jachowski and Edelman 2021). However, the elusive nature of eastern spotted skunks and a lack of clarity surrounding best surveying practices have limited the success of recent surveying efforts. In the first documented study to assess surveying techniques for eastern spotted skunks, Hackett et al. (2007) compared the efficiency of noninvasive enclosed track plates and baited camera traps to detect plains spotted skunks in Arkansas and Missouri. Results indicated that track plates had a higher probability of detection and were also quicker to first detect skunks (latency to initial detection) than camera traps. However, proper identification of tracks typically depends on recognizing subtle differences in track features, (e.g., Evans et al. 2009); the amount of animal traffic on the plate may further confound identification. In contrast, camera trap-based surveying allows for positive identification of animals by visual observations. Compared to track plates, camera traps also can provide temporal data (e.g., date and time of day of a detection) and information on the number of individuals that visit a camera trap site (if more than one individual is recorded in a single photo or if individuals have unique pelage that make them distinguishable). These additional data allow for a better understanding of the ecology and dynamics of low-density or imperiled populations.

Logistical benefits and advances in technology have made camera traps the predominant noninvasive tool for surveying eastern spotted skunks (Gompper et al. 2006; Hackett et al. 2007; Jachowski and Edelman 2021). In 2019, 19 of the 28 member states of the ESSCSG reported using camera traps for research or surveying for the species. In many cases, camera traps were the only survey method being used (Jachowski and Edelman 2021). Although the initial costs of purchasing cameras may be high, camera traps can be cost-effective for long-term studies because they rely on passive sampling and thus lower labor costs (Burton et al. 2015). Further, when implemented in a systematic and replicated way, camera trapping can provide a long-term and large-scale surveying approach with minimal staffing (Steenweg et al. 2017). To date, most state agencies and researchers have used camera trapping methods for eastern spotted skunks that differed in bait or lure type, camera-trap brand and model, or length of time camera traps were deployed—all of which could influence detection probability of carnivores (along with surveyors' knowledge of the sites and the abundance of skunks in the area) and limit comparisons of results among studies (Meek et al. 2015; Rocha et al. 2016; Mills et al. 2019).

The ESSCSG has outlined six priority research areas and knowledge gaps in the Eastern Spotted Skunk Conservation Plan (Jachowski and Edelman 2021). The group identified guidance on effective monitoring methods for eastern spotted skunks as a key element of research necessary for updating the distribution and

status of the species. Specifically, the ESSCSG sought to evaluate techniques to improve camera-trap detections and compare results across studies, states, and subspecies. With the recent increase in research using camera traps for this species, our objectives were to 1) summarize and compare common methods for detecting eastern spotted skunks using camera traps and 2) make suggestions to improve monitoring for eastern spotted skunks using camera traps based on the findings of previous studies.

## Literature Review

We used three approaches to compile a comprehensive list of studies using camera traps that targeted eastern spotted skunks. First, we performed a literature search (from 1 July 2020 through 3 August 2020) using Google Scholar and the University of Georgia library's online multisearch (<https://www.libs.uga.edu/>) to identify peer-reviewed and gray literature that used camera traps to study eastern spotted skunks. We used "*Spilogale putorius*" and "eastern spotted skunk" as keywords for the search. Second, we contacted all members ( $n = 143$ ) of the ESSCSG ([www.easternspottedskunk.weebly.com](http://www.easternspottedskunk.weebly.com)) for published camera-trap studies on the species. Third, we contacted individual experts and state biologists in each state where eastern spotted skunks could be found to obtain information from past survey efforts that had not been reported in the published literature. For each study or survey effort identified, we attempted to collect information on the proportion of camera-trap sites where a detection occurred, latency to initial detection, and available information regarding three aspects of study design that we predicted would affect detection of eastern spotted skunks: season of detections, bait and lure combinations, and brand of camera trap.

We reviewed the 16 studies we found that used camera traps that targeted eastern spotted skunks from 2014 through August 2020 (details in Table 1). These studies occurred across the range of the plains and Appalachian subspecies (*S. p. putorius*; Table 1). Two studies in Wyoming targeted both western spotted skunks *Spilogale gracilis* and eastern spotted skunks (Boulerice and Zinke 2017; Riotto 2020). We excluded these Wyoming papers from analysis since recent data suggest that there are likely no eastern spotted skunks in the surveyed areas (Bell 2020). Not all studies reported all metrics we used in our descriptions and analyses, resulting in an uneven number of studies for some methods or variables.

We defined multiple terms to describe and analyze the impacts of study design, referring to the overall study site as a "study area" and individual camera trap locations as "sites." Studies reported the number of sites in which detections occurred per total number of sites in a study area, which we quantified as the "percentage of sites where detections occurred." We defined "season" as the period of months that surveyors conducted a study (e.g., January–March) from the time surveyors set the first camera trap until they removed

**Table 1.** A summary of data collected for camera-trap studies targeting eastern spotted skunks *Spilogale putorius* from 2014–2020, with studies arranged geographically from west to east and south to north.

Study	Purpose	Survey year	Study location	Study area size (km <sup>2</sup> )	Camera brand	Bait	Lure	Survey duration	Site detections/ total sites	Average latency to initial detection (d)
J.C. Perkins <sup>a</sup>	Detection	2016–2017	Texas	26.93	Bushnell, Reconyx	Sardines or no bait	Fish oil	21 d	2/9	12.3
Pekins and Allen <sup>a</sup>	Attractant effectiveness	2018–2019	Texas	886	Reconyx	Sardines or no bait	Fatty acid tablets	Mean 45 d	8/120	20.0
K.D. Branham <sup>a</sup>	Occupancy	2018–2020	Oklahoma	14,444	Reconyx	None	WCS Rosebud Skunk Paste, On-Target™ Liquid Grub	~28 d	5/79	4.8
S. Fino <sup>a</sup>	Nest predator occurrence	2018–2020	South Dakota	373	Moultrie	Wet cat food	Caven’s Yodel Dog	7 d	0/216	NA
R.C. Lonsinger <sup>a</sup>	Detection, occurrence	2019–2020	South Dakota	4,200	Browning, Bushnell, Moultrie	None	Canned sardines, <sup>b</sup> No lure	Mean 30.1 d	3/179	9.6
Higdon and Gompper 2020	Detection, habitat association	2017–2018	Arkansas	246	Bushnell, Reconyx	Canned tuna	Hawbaker’s Skunk/Opossum Lure	19 d	4/73	8.6
Edelman 2018	Distribution, occurrence	2017	Alabama	4,695	Moultrie	Sardines	Fatty acid tablets	Mean 15.4 d	2/201	7.0
Edelman, et al. 2020	Occurrence	2018–2019	Alabama	405	Moultrie	Sardines	None	Mean 33.9 d	2/186	21.0
J. Campbell <sup>a</sup>	Detection, distribution, occupancy, habitat association	2014–2020	Tennessee	580	Moultrie	Sardines and catfish stink bait	None	~4 mo	10/72	29.8
Wilson et al. 2016	Occurrence, field methods	2015	South Carolina	250 <sup>c</sup>	Bushnell	Sardines	None	Mean 23 d	5/56	19.6
Eng and Jachowski 2019	Detection, occurrence, habitat association, attractant effectiveness	2016–2017	North Carolina and South Carolina	1,500	Bushnell	Sardines	Caven’s Gusto, cherry oil	3 mo	25/45	28.3
S.N. Harris and D.S. Jachowski <sup>a,c</sup>	Distribution, occupancy	2017–2019	North Carolina	16,192	Bushnell	Sardines	None	~12 wk	24/147	33.8
S.N. Harris and D.S. Jachowski <sup>a,d</sup>	Occupancy, detection, attractant effectiveness	2020	North Carolina	42	Bushnell	Sardines or no bait	None	~12 wk	3/20	24.0
Lombardi et al. 2017	Occurrence, cospecies occurrence, habitat association	2015	Virginia	806	Moultrie	Sardines and meat	Caven’s Gusto	6 wk	7/48	Not reported
Thorne et al. 2017	Habitat association, detection probability, occupancy	2017	Virginia	5,522 <sup>e</sup>	Reconyx	Deer carcass	None	Mean 38.7 d	19/91	7.2
Hayes 2018	Field methods, detection	2017	Kentucky	38	Browning	Sardines	Fatty acid tablets	2–4 wk	3/64	14.7

<sup>a</sup> Unpublished data: Charles Pekins and Maximilian Allen, Fort Hood Resource Management, Fort Hood, Texas, and University of Illinois, Champaign, Illinois; Stephen N. Harris and David Jachowski, Clemson University, Clemson, South Carolina; Samantha Fino, South Dakota State University, Brookings; KaLynn D. Branham, University of Central Oklahoma, Edmond; Robert Lonsinger, South Dakota State University, Brookings; J. Clint Perkins, Texas Tech University, Lubbock; Josh Campbell, Tennessee Wildlife Resources Agency, Nashville.

<sup>b</sup> Canned sardines were encapsulated and inaccessible for consumption. Therefore, the smell of the sardines was used as a lure.

<sup>c</sup> Study occurred over multiple years at a landscape scale across the Blue Ridge ecoregion of western North Carolina, with all camera sites baited with sardines for the duration of the study and 1-2 cameras deployed per site.

<sup>d</sup> Study occurred over 1 y at a single study area (DuPont State Recreational Forest), with camera sites alternating between being baited and unbaited.

<sup>e</sup> Study area size was not directly reported and was estimated using available information.

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**Table 2.** A seasonal summary of camera-trap studies targeting Eastern spotted skunks *Spilogale putorius* from 2014 to 2020 ( $n = 16$ ). Values of “X” denote detection of eastern spotted skunks, whereas values of “O” denote survey effort with no detections. Cells without a value indicate that no monitoring occurred during that month.

Studies	Survey state	January	February	March	April	May	June	July	August	September	October	November	December
J.C. Perkins <sup>a</sup>	Texas	—	O	X	O	—	—	—	—	O	O	X	—
M.L. Allen <sup>a</sup>	Texas	X	O	X	X	—	—	—	—	—	—	X	X
K.D. Branham <sup>a</sup>	Oklahoma	X	X	X	O	—	—	—	—	—	X	O	O
S. Fino <sup>a</sup>	South Dakota	—	—	—	—	O	O	O	—	—	—	—	—
R.C. Lonsinger <sup>a</sup>	South Dakota	—	—	—	—	O	X	X	X	—	—	—	—
Higdon and Gompper 2020	Arkansas	O	O	X	O	O	O	O	O	X	O	O	O
Edelman 2018	Alabama	O	X	O	O	O	X	—	—	—	—	—	—
Edelman, et al. 2020	Alabama	O	O	X	X	X	O	O	O	O	O	O	O
J. Campbell <sup>a</sup>	Tennessee	X	X	X	O	O	—	—	—	—	O	O	O
Wilson et al. 2016	South Carolina	O	X	X	—	—	—	—	—	—	—	—	—
Eng and Jachowski 2019 <sup>d</sup>	North Carolina, South Carolina	X	X	X	O	—	—	—	—	—	—	—	—
S.N. Harris and D.S. Jachowski <sup>a,b,d c</sup>	North Carolina	X	X	X	X	—	—	—	—	—	—	—	—
S.N. Harris and D.S. Jachowski <sup>a,c,d</sup>	North Carolina	O	O	X	X	—	—	—	—	—	—	—	—
Lombardi et al. 2017	Virginia	—	—	—	—	O	O	X	X	X	O	—	—
Thorne et al. 2017	Virginia	X	X	X	X	X	—	—	—	—	—	—	X
Hayes 2018	Kentucky	O	X	X	O	O	O	O	O	O	O	O	O

<sup>a</sup> Unpublished data: Charles Pekins and Maximilian Allen, Fort Hood Resource Management, Fort Hood, Texas and University of Illinois, Champaign, Illinois; Stephen N. Harris and David Jachowski, Clemson University, Clemson, South Carolina; Samantha Fino, South Dakota State University, Brookings; KaLynn D. Branham, University of Central Oklahoma, Edmond; Robert Lonsinger, South Dakota State University, Brookings; J. Clint Perkins, Texas Tech University, Lubbock; Josh Campbell, Tennessee Wildlife Resources Agency, Nashville.

<sup>b</sup> Study occurred over multiple years at a landscape scale across the Blue Ridge ecoregion of western North Carolina, with all camera sites baited with sardines for the duration of the study and one or two cameras deployed per site.

<sup>c</sup> Study occurred over 1 y at a single study area (DuPont State Recreational Forest), with camera sites alternating between being baited and unbaited.

<sup>d</sup> Study consistently used the same camera sites across all months of study.

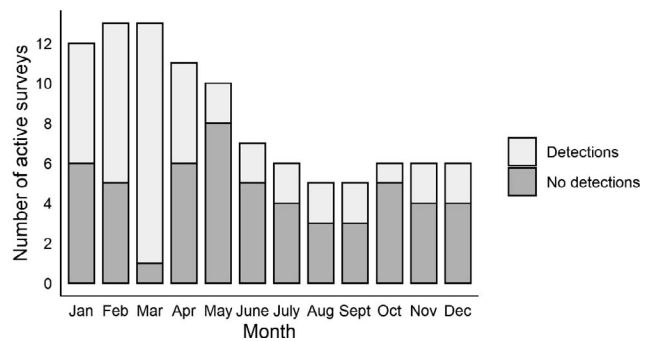
the last camera trap or it stopped working. We defined camera trap “deployments” (i.e., the duration of a given survey) as the number of days surveyors deployed a camera trap at a site within the given survey. We defined “latency to initial detection” as the number of days until the first detection of an eastern spotted skunk at a site (Gompper et al. 2006). We considered “bait” to be a potential food item that eastern spotted skunks could access and eat. “Lures” were substances, often commercial, that emitted a strong odor and were either nonconsumable or nonaccessible for consumption. We conducted data visualizations in R (version 3.6.0; R Core Team 2019) with the ggplot2 package (Wickham 2016).

The 16 camera-trap studies we reviewed occurred in 10 of 28 states within the known historical distribution of eastern spotted skunks (Table 1). Researchers conducted studies for a variety of reasons including to determine occurrence, to determine occupancy (including estimating probability of detection), and to evaluate field sampling methods (Table 1). Only one study (Fino, unpublished) did not detect any eastern spotted skunks during its survey period.

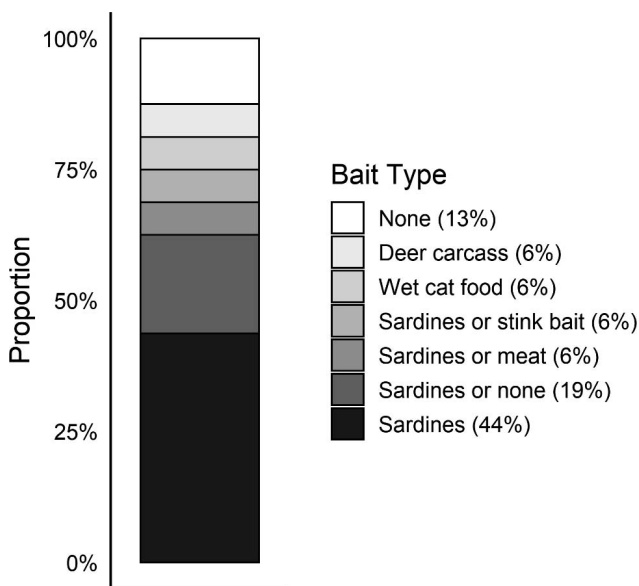
**Seasonality of detections**

All 16 studies reported the months when surveyors deployed camera traps and whether detections occurred during those months (Table 2). Most studies ( $n = 13$ ) moved cameras among multiple camera-trap sites during their survey (averaging 7–45 d per site), although

three studies deployed camera traps for the entirety of their survey at each site. Studies differed on the duration and timing of data collection, but most studies ( $n = 12$ ) operated camera traps during the months of January, February, and March as recommended by Eng (2018) and Wilson et al. (2016). The highest percentage (92%) of detections occurred in March, followed by February (62%) and January (50%; Figure 2). Edelman et al. (2020), Hayes (2018), and Higdon and Gompper (2020) were the only studies to deploy camera traps year-round (Table 2), but overall rates of detections were lower in other months of the year than from January through March.



**Figure 2.** A review of the proportion of studies (active surveys) in which camera traps detected an eastern spotted skunk *Spilogale putorius* by month from 2014 to 2020.



**Figure 3.** A summary of different types of baits used in 16 camera trap surveys for detecting eastern spotted skunks *Spilogale putorius* from 2014 to 2020, shown as the proportion of studies using that bait. Bait was primarily sardines with or without a lure.

### Latency to initial detection

Fourteen studies reported latency to initial detection, ranging from 1 to 82 d with a mean of 17.1 d (SD = 9.1) across studies. Eleven of the 14 studies that reported latency to initial detection used multiple camera-trap deployments during the study, and among those studies, mean latency to initial detection was 14 d ( $n = 11$ , SD = 7.4, range = 1–31). Three studies that did not move camera traps during their survey had a mean latency to initial detection of 28.7 d (SD = 4.0, range = 1–82).

### Baits and lures

Of the 16 studies we surveyed, seven used a combination of bait and lure (percentage of sites where detections occurred = 12.6%, SD = 18.1), seven used only bait (percentage of sites where detections occurred = 14.0%, SD = 6.7) and two used only lures (percentage of sites where detections occurred = 4.0%, SD = 2.3; Table 1; Figure 3). No studies directly evaluated the effectiveness of multiple bait types, limiting our ability to control for site- or population-specific factors (i.e., density) or adequately make direct comparisons among bait types. Of studies that used bait, 75% ( $n = 12$ ) used canned sardines at every site or varied between canned sardines, meat, or no bait during each deployment. Other types of baits included carcasses of white-tailed deer *Odocoileus virginianus*, assorted meats, catfish stink bait, and wet cat food (Figure 3). Studies using canned sardines with a combination of unbaited sites had an average site detection rate of 14.7% (SD = 6.4,  $n = 3$ ) followed by a single study using a combination of sardines and meat (14.6%), a single study using canned sardines and catfish stink bait (13.9%), studies using only canned sardines (13.3%, SD = 17.9,  $n = 7$ ), and two

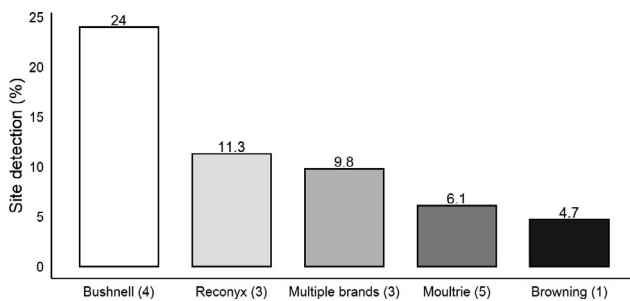
studies that did not use bait at all (4.0%). One study using white-tailed deer carcasses and no lure had one of the highest average percentage of sites where detections occurred (20.9%).

The most utilized lure was fatty acid scent tablets ( $n = 3$ ). Other lures included Caven'sGusto, Caven's Yodel Dog, Caven's Otter Lure Extreme (Minnesota Trapline Products, Pennock, MN), Hawbaker's skunk and opossum lure, Hawbaker's Long Distance 600 (Hawbaker and Sons, Fort Loudon, PA), WCS™ Rosebud Skunk Paste (Wildlife Control Supplies, East Granby, CT), On Target™ Liquid Grub Lure for Skunk (On Target, Cortland, IL), fish oil, cherry oil, and canned sardines protected from consumption. One study using lures alone reported a site detection rate of 6.3% (Table 1). Another study randomized three treatments among sites (i.e., a lure, no attractant, or no attractant for 14 d and then a lure for the remainder of the deployment) and had a detection rate of 1.7% (Branham, unpublished; Table 1), though too few Eastern spotted skunk detections occurred to test the effect of the treatments.

Surveyors used a variety of methods and specifications to place bait and lure. Of the 14 studies that used bait, securing the bait directly to a tree was the most common method ( $n = 9$ ), followed by staking the bait to the ground ( $n = 2$ ). Other methods included using pine bait-boards, mesh bags secured to a branch with zip-ties, and baiting a pipe secured to the ground. All studies that secured bait to a tree placed bait at a height between 0.5–1.5 m. The distance from camera traps to the bait or lure ranged from 1 to 10 m ( $n = 16$ ). Of the nine studies that used lures, two studies applied lure directly to a tree, one used fabric or rope attached to the tree to soak up lure scent, and two wedged tablets into tree crevices. Other techniques included securing lure in a polyvinyl chloride pipe and applying lure to the bottom of the bait can. Bait and lure were most commonly ( $n = 7$ ) replaced every 2 wk, but some studies checked attractants as frequently as two to three times per week, whereas other studies left attractants for up to 4 wk.

### Camera-trap brands

Most ( $n = 15$ ) studies used one camera trap per baited site, with a single in-progress study evaluating detectability with multiple camera traps at each trap site (Table 1). Studies using Moultrie brand cameras only ( $n = 5$ ) or Bushnell brand cameras only ( $n = 4$ ) were the most utilized camera trap setups, followed by those that used Reconyx brand cameras ( $n = 3$ ), a combination of camera-trap brands ( $n = 3$ ), or Browning brand cameras only ( $n = 1$ ; Figure 4). Multiple camera trap models were included for some brands but not all studies reported these models. Of the 16 studies that reported both camera-trap brand and percentage of sites where detections occurred, studies using Bushnell tended to report higher average percentage of sites where detections occurred (24%, SD = 18.5; Figure 4).



**Figure 4.** Average percentage of camera trap sites where detections occurred of eastern spotted skunks *Spilogale putorius* for studies using one or more camera-trap brands from 2014 to 2020, with sample size (number of studies) in parentheses.

## Discussion

Our review shows that researchers have successfully used a wide array of camera-trap study designs to detect eastern spotted skunks, but that additional research is needed to understand the most effective monitoring techniques. The past studies highlight differences in detection probability that may result from differences in the season of surveys, length of time surveys deployed the camera trap, placement of camera trap, bait or lure type used, and brand of camera trap. Inherent differences in population densities between study areas based on geographic range, habitat, and other factors presumably confound these differences in monitoring techniques. We suggest protocols that can be useful to those interested in monitoring eastern spotted skunks, and these findings provide a starting point for future comparative studies to understand how to further optimize detections.

Many projects have used the initial guidance set forth by Hackett et al. (2007) to determine time of year to survey for eastern spotted skunks (Wilson et al. 2016; Eng 2018). This guidance led to most studies focusing monitoring efforts on winter months, and most studies do show greater detections from January through March. Seasonality of winter trap success may partly reflect the choice of monitoring periods, or it may be due to increased movement during spring breeding season (March–April) or greater willingness to feed on baits or investigate lures due to decreased food availability in winter months (Mead 1968; Hackett et al. 2007; Lesmeister et al. 2009). However, some studies have had success, albeit at lower rates, detecting eastern spotted skunks from June to August (Lombardi et al. 2017; Edelman 2018 [reference S2]; Lonsinger, unpublished), and future researchers could consider year-round monitoring efforts. One reason for not including baited surveys during seasons outside of winter in many parts of their range is the degradation of bait from heat or losses to other species that are seasonally abundant (e.g., American black bear *Ursus americanus* or fire ants *Solenopsis* sp.). However, other bait configurations could prove effective in increasing percentage of sites where detections occurred while also decreasing nontarget-

species tampering and collecting ancillary data. Specifically, large polyvinyl chloride and corrugated pipe tubes designed to hold bait and prevent larger mesocarnivore and bear disturbance have successfully detected eastern spotted skunks (Lombardi et al. 2017). The use of tubes or other devices may allow more time between baiting frequency and reduce survey effort and costs. Tube setups may also help accomplish multiple study goals when their design orients eastern spotted skunks for individual identification with camera trap images or includes a hair snare for DNA sampling (e.g., Dowler et al. 2017).

Latency to detection is a key metric in camera-trapping studies for detecting eastern spotted skunks. On average, surveys needed to deploy baited camera traps for 17 d to detect eastern spotted skunks, but the latency to initial detection can range up to 82 d. Sites without bait may also detect the species, but by the time of our review no studies have made comparisons between unbaited and baited camera-trap detection (but see Avrin et al. 2021). We did not evaluate differences in latency to detection in terms of frequency of bait replacement, which varied between studies. Latency to initial detection is a key metric in eastern spotted skunk studies, and we stress the importance of reporting this metric, as well as future experimental studies to determine ways to increase it. Given the long timeframes for latency to initial detection, monitoring individual sites for at least 4 wk, with the use of bait, is likely the best strategy to detect eastern spotted skunks.

In general, the variety of baits successfully used to attract eastern spotted skunks to sites supports previous trapper reports that this species is susceptible to a wide variety of baits (Sasse 2018). By contrast, lures, or scent-based attractants, do not appear to improve detection probability for eastern spotted skunks at camera traps. We found that studies using only baits ( $n = 7$ ) had a slightly higher average percentage of sites where detections occurred than studies using both baits and lures ( $n = 7$ ). Similar to previous surveys for mesocarnivores (e.g., Hayes 2018; Heinlein et al. 2020), many eastern spotted skunk studies used canned sardines as bait following methods in Hackett et al. (2007). We also note that a single study with one of the greatest percentage of sites where detections occurred in our review used white-tailed deer carcasses as bait (Thorne et al. 2017). Eng (2018) tested the impact of lures (Caven's Gusto, cherry oil, and a control of no lure) and found that the addition of lures to the canned sardines did not significantly impact detection probability, and that Gusto may act as a deterrent while cherry oil may act as an attractant. Similarly, Hayes (2018) tested the use of fatty acid scent tablets in a mesocarnivore camera-trap survey but determined fatty acid scent tablets made little difference in the number of mesocarnivore species detected at camera-trap stations. Collectively, we encourage further experimental approaches on the effectiveness of different baits and lures to determine if the effectiveness varies by habitat, weather conditions, or region.

The location and placement of camera traps influence detections of eastern spotted skunks (e.g., Sasse 2021).

Habitat conditions at sites varied to such a degree within and across studies that it is difficult to draw conclusions. Future studies should focus on determining the effects habitat has on detection of eastern spotted skunks. However, in general, researchers placed camera traps in areas with closed canopies and had at least a line-of-site view of open understory to limit vegetation between the camera trap and the attractant. A majority of studies reported the placement of camera traps at  $< 1$  m in height on a tree or post, oriented toward the base of a target tree or post where surveyors deployed the attractant. Researchers rarely explicitly evaluated the influence of distance between the camera trap and the attractants within individual studies, with the exception of Eng and Jachowski (2019) who determined that increasing the distance between the bait station and the camera trap may increase detections of eastern spotted skunks, although all their detection distances were  $< 4$  m.

Camera-trap brands and settings are important to consider when trying to detect small-bodied mammals. Because eastern spotted skunks are primarily nocturnal (Wilson et al. 2016; Benson et al. 2019; Arts 2020; Higdon and Gompper 2020), a camera trap should have nocturnal low or no infrared glow flash for detecting this species. In addition, eastern spotted skunks often spend less than 9 s in front of camera traps (Eng 2018), suggesting that short delays between trigger events or video recording should be used to capture multiple images during a single visit. Placing two camera traps side-by-side may increase detections (Glen et al. 2013), as can placing camera traps to have a wide field of view (Eng 2018). Preliminary results from a study that deployed two camera traps at a subset of sites over 3 y suggest that two camera traps at a location may slightly shorten latency to detection and increase the total number of photos of eastern spotted skunks recorded, but occupancy differed little between sites with one or two camera traps (Harris and Jachowski, unpublished).

Although anecdotal, some camera-trap brands seem to have been more effective than others. Specifically, researchers documenting eastern spotted skunks across parts of three states (Georgia, North Carolina, and South Carolina) reported greater detections for Bushnell TrophyCams than Reconyx Hyperfire camera traps, to the point of abandoning the use of Reconyx camera traps on these repeated annual surveys (C. Olfenbittel, North Carolina Wildlife Resources Commission, personal communication). This corroborates findings from Urbanek et al. (2019) who experimentally concluded that *Sciurus* spp. and *Sylvilagus* spp. (species of similar size to spotted skunks) often did not trigger Reconyx camera traps because of the inherent design of their infrared motion-detection zones. In addition, advances in technology can impact ability to detect animals between models of the same brand, further complicating comparisons of camera-trap effectiveness. We suggest that camera-trap brands and settings should be accounted for in future survey efforts and analyses for eastern spotted skunks. Future experiments should investigate

camera brands and the specific attributes of those camera traps that increase detection.

### Suggested monitoring practices and next steps

The limited number of studies and the variety of approaches (timing, bait type, camera setup, effort, metrics collected, etc.) used by studies summarized in our review reduced our ability to make direct statistical comparisons. There are likely multiple factors influencing detection probability across studies, and our study highlights the need for standardizing survey practices for eastern spotted skunks. We did observe some patterns that could serve as useful starting points for those considering initiating monitoring of eastern spotted skunks. To increase detection probability, we generally encourage practitioners to take the following steps:

- Place the camera trap(s) at a low height ( $< 1$  m) and angled toward the base of a bait tree or post from at least 3 m away.
- Have camera traps run for a minimum of 4 wk at sites, to increase probability of detecting at least one skunk if they occupy the site.
- Prioritize the timing of surveys to, at a minimum, include January–March.
- Use bait at camera traps. Sardine cans punctured with a nail and secured to a location have been widely used and found effective, and logistically offer some benefits in terms of being readily available, easy to transport, highly odorous, and relatively secure when attached to a tree or similar object.
- Test camera-trap models and brands before widespread use to ensure they will capture similarly sized mammalian species, and use settings that will be optimal for your study design.

Using the above recommendations will allow better probability of detecting eastern spotted skunks, as well as provide more standardized methods for future comparative studies. However, it is also important to consider that the objectives of a given study will affect the ideal study design and monitoring practices. Additional research is clearly needed, and we emphasize the need for studies with appropriate controls and replicates for comparing factors that affect detection probability, including bait type, season, camera-trap model, and duration of monitoring. We encourage the development of a standardized monitoring approach that researchers could implement across studies and states within the eastern spotted skunk's range.

### Supplemental Material

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.



**Reference S1.** Edelman AJ. 2018. Final report: assessing distribution and habitat associations of eastern spotted skunks in Alabama. Montgomery: Alabama Department of Conservation and Natural Resources.

Available: <https://doi.org/10.3996/JFWM-21-073.S1> (1.631 MB PDF)

**Reference S2.** Edelman AJ, Sharp N, Arts KJ. 2020. Final grant report: eastern spotted skunk activity and movement patterns and pilot furbearer survey. Montgomery: Alabama Department of Conservation and Natural Resources.

Available: <https://doi.org/10.3996/JFWM-21-073.S2> (1.307 MB PDF)

## Acknowledgments

We thank the members of the Eastern Spotted Skunk Cooperative Study Group for their assistance in compiling data. Specifically, we thank KaLynn D. Branham, Josh Campbell, Marlin Dart, Samantha Fino, Charles Pekins, and Clint Perkins for their contributions of unpublished data and research. Portions of this project were funded by the Pittman-Robertson Federal Aid to Wildlife Restoration Grant. We also thank Colleen Olfenbittel and the North Carolina Wildlife Resources Commission for the logistical and financial support of this research.

Any use of trade, product, website, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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