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Status and Distribution of the Eastern Spotted Skunk in Maryland: A Historic Review and Recent Assessment

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Abstract - There have been no confirmed detections of *Spilogale putorius* (Eastern Spotted Skunk) since 1967 in Maryland. We summarized historical records, as well as recent studies from other available mammal projects completed in Maryland. We conducted camera-trap surveys between 2015 and 2018 at 33 sites in western Maryland. We sought information from outdoor recreationists, mail-surveys sent to licensed wildlife damage control operators (n = 56), and an online questionnaire of natural resources professionals (n = 149). We compiled 13 historic records, including 7 catalogued specimens. No Eastern Spotted Skunks were detected with our camera traps. Our call for public information did not result in any confirmed sightings, and there were no personal observations or secondary evidence reported by responding wildlife damage control operators (n = 10) or natural resource professionals (n = 49). It appears the Eastern Spotted Skunk may no longer be a permanent resident in Maryland. However, the state still retains potential habitat and is in close proximity to known populations in West Virginia, from which Eastern Spotted Skunks could potentially disperse to Maryland in the future.

Introduction

Spilogale putorius (L.) (Eastern Spotted Skunk) is a species of conservation concern throughout much of its range, which encompasses most of the central and southeastern regions of the United States (Eastern Spotted Skunk Cooperative Study Group 2020, Kinlaw 1995). Although once considered to be common throughout its range, analyses of trapping records indicate that populations of this species declined dramatically in the 1940s (Gompper and Hackett 2005, Sasse and Gompper 2006). The reason for this range-wide decline is uncertain, but possible reasons include overharvest, synthetic pesticide use, large-scale habitat alteration, changes in predator communities, disease, or a combination thereof (Gompper and Hackett 2005, Gompper and Jachowski 2016). The extensive population decline over much of their range has prompted a recent change in conservation status of the Eastern Spotted Skunks to vulnerable under the International Union for Conservation of Nature's (IUCN) Red List (Gompper and Jachowski 2016).

Pennsylvania represents the northeastern limit of the historical range of the Eastern Spotted Skunk where it was known to exist in low population densities in 3

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south-central counties (Bedford, Fulton, and Franklin) in dry, rocky, montane forests characterized by the presence of *Quercus* spp. (oak species), *Pinus rigida* Mill. (Pitch Pine) and *Pinus virginiana* Mill. (Virginia Pine) (Merritt 1987). In Maryland, there are scattered historical records and reports from the western part of the state, including the Allegany Plateau and Ridge and Valley physiographic provinces in Allegany, Garrett, and Washington counties (Bookhout 1964, Larson 1968). According to Larson (1968), most Eastern Spotted Skunks were incidentally caught in traps set for foxes (unknown spp.) in higher elevations of the Ridge and Valley providence, and frequented the same area as *Mephitis mephitis* (Schreber) (Striped Skunk).

Recently, surveying efforts have been initiated throughout the range of the Eastern Spotted Skunk to better understand the species' current distribution and conservation needs. In the southern Appalachians, Eastern Spotted Skunks are dependent on a dense, woody understory and midstory, and will use burrows, rocks, tree cavities, and uprooted trees as den-sites (Hassleer et al. 2021a [this issue], Sprayberry and Edelman 2018). Historical information as well as recent evidence from neighboring states (i.e., Pennsylvania, West Virginia, Virginia), suggest that both high-elevation mature forests and lower-elevation structurally complex forests (e.g., areas containing dense ericaceous shrub, extensive talus or rock outcroppings) may serve as important habitat for Eastern Spotted Skunks (Gifford and Whitebread 1951, Lesmeister et al. 2009, Thorne et al. 2017).

Recent events have spurred interest in targeted surveys for the Eastern Spotted Skunk in Maryland. In 2011, an Eastern Spotted Skunk was incidentally detected during an *Aquila chrysaetos* (L.) (Golden Eagle) camera-trap survey on a ridge at Nathaniel Mountain Wildlife Management Area, Hampshire County, WV, ~45 km from the Maryland border (Katzner and Rodrigue 2014). In October 2012, an Eastern Spotted Skunk was incidentally detected on a camera-trap set for *Neotoma magister* Baird (Allegheny Woodrat) in Fayette County, PA, north of the Monongalia–Preston county line in West Virginia, ~40 km from the Maryland border (G. Turner, Pennsylvania Game Commission, Harrisburg, PA, unpubl. data). Interestingly, this detection occurred west of what had been the historic range of the Eastern Spotted Skunk in Pennsylvania. Further, there was a reported sighting in Adams County, PA, about 40 km from the Maryland border, east of the presumed historic range of Eastern Spotted Skunks (G. Turner, pers. comm.). These recent camera-trap detections raise the possibility that Eastern Spotted Skunks are perhaps still extant in Maryland (i.e., the species has persisted undetected and/or reestablished itself via dispersal from adjacent states) prompting interest in better understanding the species' status, distribution, and habitat associations.

The primary objective of our study was to summarize available historical records and recent wildlife surveys that occurred in potential habitat for Eastern Spotted Skunks, use camera traps to determine if the species persists in Maryland, and seek information from outdoor recreationists, licensed wildlife damage control operators (WDCOs), and natural resource professionals in Maryland to determine if there is any direct or anecdotal evidence that indicates the species still occupies portions of the state.

Methods

Historical records of Eastern Spotted Skunks

We summarized available historical records of Eastern Spotted Skunks in Maryland from published papers (n = 2), natural history museums (n = 7), and biodiversity cataloging websites (n = 4). If records existed, we summarized detailed information on date and location of specimens.

Additional wildlife surveys

We summarized the location, dates, total trap-days, trap-types, and bait-types of other recent (within the last 30 years) wildlife surveys that were conducted in areas of potential Eastern Spotted Skunk habitat in western Maryland. This information included a carnivore survey conducted by Frostburg State University (Hanley 2010, Smith 2010), 2 studies of Allegheny Woodrats conducted by Maryland Department of Natural Resources (MD DNR) and Frostburg State University, a study of *Odocoileus virginianus* Zimmerman (White-tailed Deer) conducted by University of Delaware (Ness 2017), and a study monitoring Golden Eagles in western Maryland (D. Brinker, MD DNR, Wildlife Heritage Program, Catonsville, MD, pers. comm.).

Camera-trap surveys

Our camera-trap survey was conducted at 33 sites within Allegany, Garrett, and Washington counties (Fig. 1) comprising what is considered the historic range of

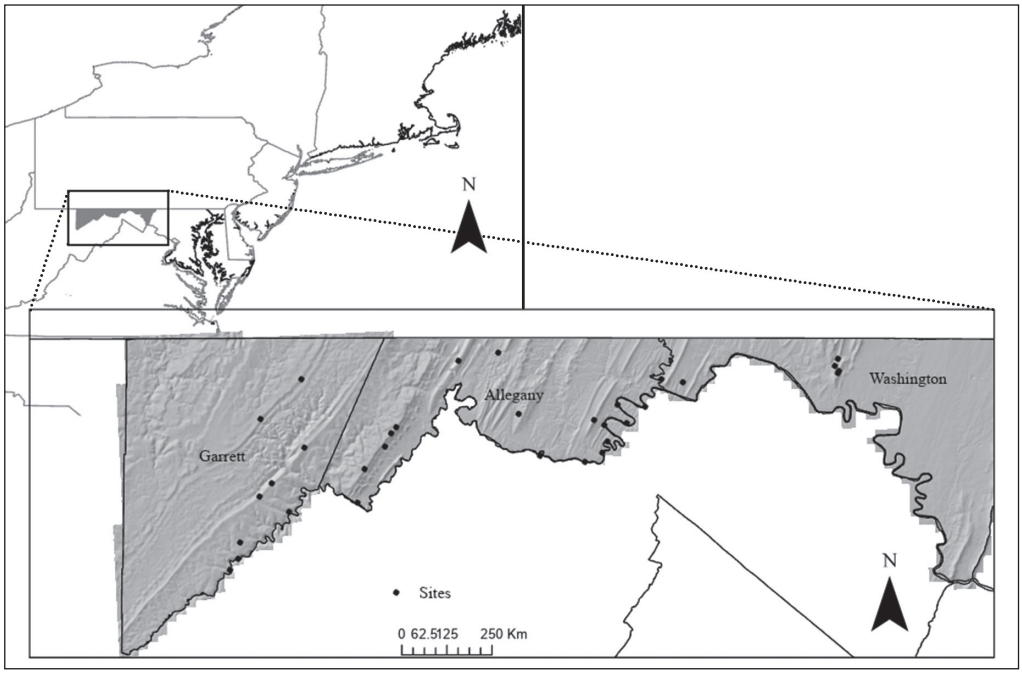

Figure 1. Baited camera-traps were set during 4 trapping periods (March–April 2015, November 2015–June 2016, February–May 2017, and March–June 2018) targeting *Spilogale putorius* (Eastern Spotted Skunk) at 33 sites in western Maryland. No Eastern Spotted Skunks were detected during the study.

Eastern Spotted Skunks in Maryland. All sites were on portions of public lands (managed either by the MD DNR, National Park Service [NPS], or United States Army Corp of Engineers). Most study sites (n = 23) possessed habitat features presumed to be preferable for Eastern Spotted Skunks (e.g., emergent rock along ridgetops surrounded by mixed hardwoods; Hassler et al. 2021a [this issue], Thorne et al. 2017), but we also surveyed 10 riparian corridor sites on the Potomac River considered to be important travel corridors from West Virginia. Eastern Spotted Skunks had been previously detected at 2 of our sites in Green Ridge State Forest (Table 1), but the other historical accounts were located on private land, and so we instead surveyed the nearest public-access area to those historical accounts.

We deployed 4–6 baited camera-traps placed >100 m apart at each survey site during 4 trapping periods (March–April 2015, November 2015–June 2016, February–May 2017, and March–June 2018). We conducted surveys primarily in winter and spring because recent evidence suggested that detection probability was highest during the winter breeding season when food is scarce (Hackett et al. 2007). We deployed each camera for at least 14 days because of reported low naïve occupancy (i.e., survey sites with Eastern Spotted Skunk detection / total number of survey sites; Thorne et al. 2017), and a long latency to initial detection (i.e., number of days until first detection) (i.e., 7.2 days [Hackett et al. 2007], 28.3 days [Eng and Jachowski 2019], 15–20 days [K. Oxenrider, West Virginia Division of Natural Resources, Romney, WV, pers. comm.]).

We placed Cuddeback Attack and Cuddeback C-Series (white flash, black flash, and infrared models) 20.0- megapixel cameras (Nontypical Inc., Green Bay WI) on trees ~2 m from bait. Bait varied depending on availability. Typically, we used lag bolts to attach sardines (in the can punched with holes to enable dissemination of the scent) to a tree 0.5 m above ground level. In some cases, road-killed animals, such as White-tailed Deer and *Castor canadensis* Kuhl (American Beaver), were staked to the ground using rebar, or caged to a tree. We set cameras to operate 24 hours a day and programmed each to take a 3-image burst over 7 seconds when triggered to increase our ability to detect fast-moving, small mammals (Lombardi et al. 2017). We also programmed a 30-second trigger delay between picture sets and set each camera to record time, date, and a unique camera ID on each image. We reviewed and cataloged all images. We defined a trap day (TD) as the sum of days [24-hr period] each camera was operational. We set an interval time of 60 minutes to separate independent detections of the same individual.

Information requests from outdoor recreationists, wildlife damage control operators, and natural resources professionals

We placed laminated "wanted" posters at MD DNR kiosks, parking areas, and visitor centers on public lands throughout western Maryland. The posters included an Eastern Spotted Skunk photo, a description of key diagnostic features, characteristics that distinguish it from the Striped Skunk, and contact information for reporting sightings.

We obtained the addresses of licensed WDCOs in Maryland (n = 56). In March 2018, we mailed each WDCO a packet that included a cover letter explaining

the scope of the project, a survey pertaining to the Eastern Spotted Skunk, and a postage-paid return envelope. We asked the following 3-questions. (1) Have you ever observed (sighting, roadkill, fur-trade event, etc.), trapped, or have other information about Eastern Spotted Skunks in Maryland? (2) How long ago did you view, trap, or hear about Eastern Spotted Skunks in Maryland? (3) In the past year, how frequently have you trapped Striped Skunks? We sent a second packet to all non-respondents in May 2018.

We used Survey Monkey® to develop and email a 3-question electronic survey to MD DNR and NPS employees, collectively referred to as natural resource professionals (n = 149) in May 2018. The survey contained the following questions. (1) Do you have direct (i.e., personal observation) or secondary (i.e., reports) evidence (e.g., sightings, roadkills, accidental captures during trapping seasons) of Eastern Spotted Skunks occurring in Maryland in the last 10 years? (2) Do you have direct or secondary evidence of Eastern Spotted Skunks occurring in Maryland from more than 10 years ago? (3) Do you know other people who might have information about the occurrence of Eastern Spotted Skunks in Maryland? We sent a reminder email 2 weeks later to those who had not responded.

Results

Historical records of Eastern Spotted Skunks

There were 13 published historical records (some involving multiple specimens) of Eastern Spotted Skunks in Maryland among 2 publications (Bookhout 1964, Larson 1968), all occurring in Allegany, Garrett, and Washington counties (Table 1). The dates of specimen collection or observation were in the span from 1952 to 1967 (Bookhout 1964, Larson 1968). Seven of those specimens reported in the 2 published papers were submitted to the Smithsonian National Museum of Natural History (USNM) for cataloguing (Tables 1, 2). None of the other 6 natural history museums reported any Eastern Spotted Skunk specimens. One of the 4 biodiversity websites (www.GBIF.org) reported a Pleistocene fossil record of an Eastern Spotted Skunk from a cave in Cumberland, Allegany County (Table 2).

Additional wildlife surveys in Maryland

Carnivore-monitoring study, Frostburg State University. Z. Hanley, J. Smith and T. Serfass conducted a carnivore-monitoring study in Savage River State Forest, Garrett County, between 31 July 2008 and 17 July 2009 (Hanley 2010, Smith 2010). Sites were baited with White-tailed Deer carrion, and American Beaver castor and skunk essence were used as lures. A total of 5505 TDs were completed with no detection of Eastern Spotted Skunks, although there were a large suite of other carnivores detected throughout the study period.

Allegheny Woodrat camera-trap study, Maryland Department of Natural Resources, Wildlife and Heritage Service and Frostburg State University. D. Feller, K. Pearce, T. Serfass, and A. Hotopp conducted a camera-trap study to evaluate interactions between Allegheny Woodrats and *Procyon lotor* (L.) (Northern Raccoon) in western Maryland. Between October and December 2016 and August to

Table 1. Summarized published historical records, including county, year, number of specimens, landowner source, and cataloging information of *Spilogale putoris* L. (Eastern Spotted Skunk) in Maryland. [Table continued on following page.]

County	Year	No. of specimens	Landowner	Source	Cataloged	Collector of cataloged specimen	Notes
Allegany[1]	1952, 1954	2	Green Ridge State Forest	Bookhout 1964	Yes	Maryland	One trapped during predator control work; noted that one specimen was mounted in pos session of the Maryland Game and Inland Fish Commission[2]
Allegany[1]	1957	1	Green Ridge State Forest	Bookhout 1964, Larson 1968	No	n/a	Observation by a Maryland State Game and Inland Fish Commission game warden
Allegany	1960–1964	4	Private	Bookhout 1964	No	n/a	Trapped
Allegany	1964	1	Private	Bookhout 1964	USNM[3]-382846 (skin, skull, baculum/baubellum)	J. Booth, T.A. Bookhout	Trapped; sub or young adult
Allegany	Unknown	Several observ.	Private	Larson 1968	No		Observations at bird carcasses following "Pigeon shoots"
Garrett	1963	1	Private	Bookhout 1964	USNM-382847 (skin, skull)	T.A. Bookhout	Killed in root cellar
Garrett	1967	4	Private	Larson 1968	USNM-392849 (skull), USNM-382850 (skull), USNM-392851 (skull), USNM-392852 (skull)	R. Harvey	Trapped at Eagle Rock in fox set
Garrett	1966	1	Private	Larson 1968	USNM-392848 (skull)	C. Harvey	Killed inside Burrel Bros. coal mine during blast

Table 1, continued.

County	Year	No. of specimens	Landowner	Source	Cataloged	Collector of cataloged specimen	Notes
Washington	1965–1967	1	Private	Larson 1968	No	n/a	Trapped in rock rubble area
Washington	1965–1967	1	Private	Larson 1968	No	n/a	Trapped in root cellar
Washington	1965–1967	2	Private	Larson 1968	No	n/a	Trapped on top and western side of Fairview mountain, respectively
Washington	1965–1967	5	Private	Larson 1968	No	n/a	Trapped near dumping area and Civil War iron-ore mining site
Washington	1965–1967	6 sightings	Private	Larson 1968	No	n/a	Observed near chicken coop

[1]This site was surveyed using camera-traps in 2015 and 2017.
[2]Now referred to as the Maryland Natural Resource Police. Unknown if this mounted specimen is still in possession of the Maryland Natural Resource Police
[3]Smithsonium Museum of Natural History

November 2017, they placed 77 remote cameras at 14 sites for a total of 1135 TDs. Camera sites were baited with sardines or a mixture of peanut butter and oats. In total, 1952 wildlife detections were recorded but none of Eastern Spotted Skunk.

Allegheny Woodrat live-trap study, Maryland Department of Natural Resources, Wildlife and Heritage Service. Between 1990 and 2018, D. Feller led live-trapping efforts of Allegheny Woodrats at 4 sites in Garrett and Allegany counties annually, and 2 sites in Washington and Frederick counties biennially (Ford et al. 2006). Fifteen additional Allegheny Woodrat sites were also live-trapped across these 4 counties 1 or more times during the same period. Extensive rocky outcropping and talus slopes characterize these sites. At each site, Tomahawk live traps (Model 202 [15.24 x 15.24 x 48.26 cm]; Tomahawk Live Trap, Tomahawk, WI) were baited with peanut butter and oats, and traps remained in field for 2 consecutive nights between July and September, for a total of 6533 TD. During the 28-year period, no Eastern Spotted Skunks were incidentally captured.

White-tailed Deer study, University of Delaware. E. Ness and J. Bowman conducted a camera-trap survey in Green Ridge State Forest, Allegany County, to compare White-tailed Deer recruitment rates to relative abundance of predators (Ness 2017). Three 60-day camera-trap periods occurred during June–August 2015, June–August 2016, and December 2016–February 2017 at 3 study sites (Ness 2017). Cavens gusto and anise oil were placed on a tree trunk 2 m from the camera trap (Ness 2017). A total of 10,140 TDs were conducted with no Eastern Spotted Skunk detections (Ness 2017).

Table 2. Summarized museum and online biodiversity records of *Spilogale putoris* (Eastern Spotted Skunks) in Maryland between 2015 – 2018.

Museum	Maryland record	Comments	Source
Cleveland Museum of Natural History	No		n/a
Carnegie Museum of Natural History	No	Pennsylvania specimens from 1939, 1946, and 1950	n/a
Delaware Museum of Natural History	No		n/a
Smithsonian National Museum of Natural History (USNM)	Yes	Seven specimens collected 1963–1967	See Table 1
NC Museum of Natural Sciences	No		n/a
American Museum of Natural History	No		n/a
Virginia Museum of Natural History	No		n/a
VertNet.org	No		n/a
IDigBio.org	No		n/a
Inaturalist.org	No		n/a
GBIF.org	Yes	Pleistocene fossil record from a Cumberland cave	Marine Science Institute, UCSB, Paleobiology database

Golden Eagle monitoring, Maryland Department of Natural Resources. As part of a larger Golden Eagle camera-trap study in the central Appalachian region (Jachowski et al. 2015), 24 ridge-top sites were surveyed in Maryland between 2011 and 2016 in January and February each year, although not every site was monitored annually. Sites were baited with road-killed White-tailed Deer. Approximately 3500 TDs occurred resulting in 194,832 images. No Eastern Spotted Skunk were detected during this study (D. Brinker, pers. comm.).

Camera-trap surveys

Cameras functioned properly throughout our survey periods at all sites, resulting in a total of 3682 TDs. The mean number of TDs per site was 26.5 days ± 17.74 SD. Over 5000 images were recorded during the survey periods, which, after excluding false triggers and non-independent detections of the same individual, represented 1668 independent detections. Of these, 32% (n = 528) were of carnivores, 48% (n = 800) were of non-carnivore mammals, 19% (n = 329) were of birds, and 0.01% (n = 11) were unidentifiable. A total of 10 non-carnivore mammal species, 10 carnivore species, and 10 bird species were detected. Eastern Spotted Skunks were not detected at any of the camera-trapping sites during our study.

Information requests from outdoor recreationists and natural resources professionals

We received 1 report of an Eastern Spotted Skunk sighting during our study. The report occurred on the Chesapeake and Ohio Canal by a cyclist at Fort Frederick State Park on 3 June 2016. We followed up on the report by placing baited camera-traps at the site, which did not result in any detections of Eastern Spotted Skunks. No additional reports were obtained during this contract period from the "wanted" posters, although we encountered numerous people who had reported seeing the posters while recreating.

We received 10 (18% response rate) returned questionnaires from the licensed WDCOs working in Maryland. Ten (100%) indicated that they had never observed, trapped, or have other information about Eastern Spotted Skunks occurring in Maryland.

A total of 51 (34% response rate) online questionnaires targeting MD DNR and NPS employees with potential knowledge of Eastern Spotted Skunks were completed. Of those, 51 (100%) indicated that they had no personal observation or secondary evidence of Eastern Spotted Skunks occurring in Maryland.

Discussion

Historical evidence demonstrates that Eastern Spotted Skunks were part of the native faunal community in Maryland up until at least 1967 (Table 1) and that populations likewise occurred in adjacent states (i.e., Pennsylvania [Gifford and Whitebread 1951, Merritt 1987] and West Virginia [Kinlaw 1995]). Recent evidence suggests that Eastern Spotted Skunks may continue to persist in portions of southern Pennsylvania (G. Turner, pers. comm.) and that West Virginia supports

populations large enough whereby individuals are readily detected in some areas of the state (i.e., Monongahela National Forest, North Fork Mountain; Hassler et al. 2021b [this issue]). Our investigation of Eastern Spotted Skunks focused on western Maryland in habitats similar to where researchers in West Virginia and Virginia have had success in consistently detecting Eastern Spotted Skunks (i.e., large, emergent rock along ridges with dense understory; Hassler 2020, Sprayberry and Edelman 2018, Thorne et al. 2017) in addition to riparian areas which are known to serve as travel corridors and as hunting areas for many carnivores (Kirkland and Serfass 1989).

In contrast to neighboring states, we were unable to demonstrate any direct evidence that Eastern Spotted Skunks are still extant in Maryland through a review of recent studies focused on carnivores (e.g., Hanley 2010, Smith 2010), Allegheny Woodrats (Ford et al. 2006), White-tailed Deer (Ness 2017) and Golden Eagles (Jachowski et al. 2015), even though incidental captures of Eastern Spotted Skunks occurred during similar studies in other states (e.g., Diggins et al. 2015, Katzner and Rodrigue 2014). Eastern Spotted Skunks are generalist predators and will readily scavenge, characteristics that should make them relatively easy to attract to bait and lure. This characteristic likely contributed to Eastern Spotted Skunks being potentially overharvested by trappers in some areas, and should likewise contribute to them being readily detected by camera-trap stations where baits and lures are used as attractants, as in our study. We were successful in attracting and frequently detecting carnivores at camera traps that are wary around human activity (e.g., *Canis latrans* Say [Coyote], *Martes pennanti* (Erxleben) [Fisher]), suggesting that our camera-trap setup would also serve to attract Eastern Spotted Skunks.

Additionally, we did not get any information regarding evidence of the presence Eastern Spotted Skunks from our posters or surveys. During our follow-up on the reported sighting in Fort Frederick State Park, we spoke with a Park Ranger who indicated numerous *Felis catus* L. (Domestic Cat) in the area that fit the description. Our low response rate (18%) for our WDCOs mail surveys could suggest that the WDCOs surveyed who did not respond felt they did not have any information to provide, but additional information is needed.

From our camera-trapping results and other evidence compiled during this study, we suspect that Eastern Spotted Skunks are either extirpated, exist at very low numbers in isolated populations, or only exist as dispersing individuals not associated with a population in Maryland. Detection of Eastern Spotted Skunks at camera traps placed for Golden Eagles in the central Appalachians (Katzner and Rodrigue 2014), occasional captures by fur trappers, camera trapping, and current radio-telemetry studies (i.e., Hassler 2020) provide compelling evidence that viable populations persist in West Virginia, and that Eastern Spotted Skunks can be detected in the region when present. Little is known about the ability or willingness of Eastern Spotted Skunks to cross bodies of water, and the Potomac River may serve as a barrier to dispersal, though a rcent report suggests spotted skunks at least occassionally do cross large rivers (Hassler et al. 2021b [this issue]). Ultimately, the confirmed presence of Eastern Spotted Skunks in nearby counties of neighboring states increases the possibility that this elusive mammal may become re-established

in Maryland through dispersal, and thus it is important that Maryland retains habitat for this species of conservation concern.

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